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DESIGNING SUSTAINABILITY FOR ALL

Edited by Marcelo Ambrosio and Carlo Vezzoli

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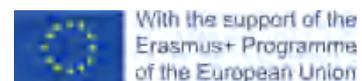
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Designing sustainability for all

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FOREWORD

Designing sustainability for All was a call for contributions and actions to the whole world design community, which is not limited to design researchers, design educators, and design practitioners but also unites other disciplines such as architecture, engineering, economy, policy-making, and sociology.

The Conference has been a unique event hosted simultaneously in Mexico City (Mexico), Curitiba (Brazil), Cape Town (South Africa), Bangalore (India), Beijing (China) and Milan (Italy), on 3rd-5th April 2019. In fact, in each of the 6 venues, it has been possible to listen to any of the presentations happening in the other ones.

LENSIN PROJECT

LeNSin, the International Learning Network of networks on Sustainability (2015-2018), is an EU-supported (ERASMUS+) project involving 36 universities from Europe, Asia, Africa, South America and Central America, aiming at the promotion of a new generation of designers (and design educators) capable to effectively contribute to the transition towards a sustainable society for all.

LeNSin ambitions to improve the internationalisation, intercultural cross-fertilisation and accessibility of higher education on Design for Sustainability (DfS). The project focuses on Sustainable Product-Service Systems (S.PSS) and Distributed Economies (DE) – considering both as promising models to couple environmental protection with social equity, cohesion and economic prosperity – applied in different contexts around the world. LeNSin connects a multi-polar network of Higher Education Institutions adopting and promoting a learning-by-sharing knowledge generation and dissemination, with an open and copyleft ethos.

During the three years of operation, LeNSin project activities involve five seminars, ten pilot courses, the setting up of ten regional LeNS Labs, and of a (decentralised) open web platform, any students/designers and any teachers can access to download, modify/remix and reuse an articulated set of open and copyleft learning resources, i.e. courses/lectures, tools, cases, criteria, projects.

LeNSin will also promote a series of diffusion activities targeting the design community worldwide. The final event will be a decentralised conference in 2018, based simultaneously in six partner universities, organised together by the 36 project partners from four continents.

THE LENS CONFERENCE

The Conference is the 3rd edition of one of the largest design international conferences for lecturers, researchers, professionals, and relevant institutions and organizations. It has become a reference event where experts from all over the world get together to present and share their knowledge, projects, tools, and visions to diffuse sustainability for all.

The Conference is organized as a part of the LeNSin, the International Learning Network of networks on Sustainability project (2015-2019, EU funded Erasmus+ program) that aims to be both visionary and pragmatic, and to stimulate new ways of thinking.

The scope is to share the latest knowledge and experiences around the concept of sustainability for all.

This will be achieved through cross-fertilizing a wide range of disciplines: predominantly design, but also engineering, economy, policy-making, and sociology.

LENS MANIFESTO

A new ethos for a design community: towards an open source and copy left learning-by-sharing attitude/action.

We, the undersigned, aware of both the urgent changes required by sustainable development, the potential role of design (and design thinking) in promoting system innovation in the way we produce, consume and interact, as well as the opportunities offered by the ever more interconnected society, propose the adoption and diffusion of a new ethos within a worldwide design community:

To view design as a unique multi-polar learning community promoting, enabling and activating any possible learning-by-sharing process aiming at effective knowledge osmosis and cross-fertilisation in design for sustainability in an open and copy left ethos.

We, the undersigned, commit our selves in such an ethos, trying our best to apply this in our daily life as individuals or representatives of institutions in the design community.

In relation to our competencies and possibilities we will make our acquired knowledge to be, as far as possible, freely and easily accessible in a copy left and open source modality (while safeguarding our authorship and scientific recognised publication activity), that enable others in the design community to acquire them free of charge, with the possibility to replicate, modify, remix and reuse, through e.g. adopting creative commons licences.

As researchers, this knowledge includes our acquired research knowledge base (e.g. papers, books, etc.) and knowhow (e.g. methods and tools).

As educators, this knowledge includes our educational resources (slideshows, texts, video of lecture, educational support tools, etc.)

As designers and design thinkers, this knowledge includes the design for sustainability concept proposal of products, services, systems and scenarios, as well as a knowhow they used to design them.

We commit our selves to seek the commitment of other individuals or institutions in such an ethos within the design community. In relation to our competencies and possibilities we will:

do our best to commit individuals such as researchers, educators, professional designers and design thinkers as well as institutions such as research institutions, design schools, and designer's associations to adopt the same ethos

do our best to generate and/or enable open learning networking of sustainability of design researchers, design educators, professional designers and design thinkers.

1.KEY NOTE PAPERS



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TOWARDS SUSTAINABLE DESIGN VALUES: EVOLUTIONARY CONCEPTS AND PRACTICES

Xiaobo Lu

Dean of Academy Arts & Design, Tsinghua University, dean of Tsinghua Arts & Design Institute in Milan, chairman of the Steering Committee for Education and Instruction for Design Majors, Ministry of Education of the People's Republic of China

Distinguished host, ladies and gentlemen, I am Lu Xiaobo from the Academy of Arts & Design, Tsinghua University. I am very glad to receive the kind invitation from the conference, letting me have the opportunity to participate in such a meaningful and sustainable design conference and express some of my ideas.

First of all, I'm going to 'thumb up' to Prof. Carlo at Politecnico di Milano. He curated a very meaningful form of meeting, a truly distributed meeting that minimized long trips as much as possible. You can imagine, six countries, 36 universities, nearly 800 people, if you want to travel, how much carbon emissions will bring.

The main theme of the conference is 'designing sustainability for all', so this brings us the thinking about what is sustainability.

We often say "human-centered design" or "human-oriented design", but under such a slogan, we often make some mistakes and bring many disastrous designs.

It also prompts us to think, who is 'human'?

From the intergenerational perspective, we need to consider not only the interests of our generation, but also the well-being of future generations. From the perspective of today's world, we also need to take into account the interests and fairness of different countries, regions and ethnic groups.

So what is 'Human' in this sense? It is an individual, a community, a society, and a whole human being. This is what we call a community of Shared Future for Mankind.

As we all know, sustainable development has three dimensions, and some scholars call it 'the Triple Bottom Line of Sustainable Development'.

So the first is the Environment, emphasizing the protection of the environment. Second, Social. The sustainability is about social harmony.

Third, the economy, which needs to be promoted. Only in the three dimensions of coordinated development, sustainability can be truly realized.

So what are the goals for the design community? In September, 2015, THE UN 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT meeting put forward the '17 sustainable development goals'. I think these 17 goals are our directions of efforts.

Under this background, what is the value and role of design?

The task of design is to 'solve the problem'. Design is a means of balance and a process of relationship coordination. This is the value of design.

So what is the issue? What is the problem?

In fact, with different times and different social backgrounds, different problems were produced, and the core task of design is always changing and evolving.

We can see that in the stage of natural civilization, namely the primitive society, primitive people and nature are in harmony. They invented simple tools, slash-and-burn, worshiped the nature and pursued simple aesthetics.

Then we enter the stage of humanistic culture, which is slave society and feudal society. The emergence of class led to the important orientation of handicraft based design, that is, to serve the elite class.

Then enter the scientific stage of culture, that is, the industrial society. Because the industrial production has brought the possibility of mass production, and also greatly promoted the consumption of people, new design concept of serving mass production appeared. Of course, each stage of social civilization has its own problems. For example, industrial civilization has brought huge environmental pollution and unbalanced social development.

Now we are entering a new stage. We are all thinking about what kind of civilization the future should be. Some scholars suggest that we are transforming into an information society. The concept of sustainable development, as a mainstream, advocates information and ecological civilization to lead our future developments.

Looking back into the history, we can cite many representative cases. Bauhaus, for example, is the enlightenment of modern design and the modern design education. It established industrial design standards and aesthetic standards.

In the United States after world war II, in order to cope with the economic crisis, the design circle put forward the slogan of 'the combination of design and business, and design should be market-oriented' and formed the American business design model, among which the most typical representative figure is Raymond Loewy, who is one of the most successful commercial designers.

There were also discussions of design in terms of values and ethics. In 1962, the writer Rachel Carson and her book *The Silent Spring* came up, illustrated the possible damage that chemical drugs could bring to nature, ecosystem, and human's health. The critical discussion on environmental protection and the application of science and technology thus developed.

In 1972, Victor Papanek and his book *Design for the Real World* put forward the idea of design for everyone. It is the start of social design and the development of design ethics.

There are many excellent design representatives who have systematic thinking and practice on this issue.

design master, the representative of minimalism design style, the founder and spokesman of new functionalism, Dieter Rams established the 10 standards of industrial design, including innovative, useful, aesthetic, understandable, unobtrusive, honest, long-lasting, thorough down to details, environmentally friendly, and as little design as possible.

In fact, he embodied a very forward-looking and sustainable concept of design, which is still influencing our

design concept until today.

In the face of the development of modern society, the concept of sustainable design, as we speak today, has gone through several stages of development.

The earliest was the green design, with low environmental impact of materials and energy to achieve environmental and ecological protection. Later, the concept of ecological design was put forward, which was to consider the design concept of a product life cycle. Then there was the product service system design, and then there was the design for social justice and harmony. In fact, they are not an iterative relationship, but coexist, and they are also aspects that our current design need to consider about.

Today's society is faced with more and more complex problems, such as environmental pollution, resource depletion, population explosion, information impact, the changes of the consumption patterns and lifestyle, and so on. The sustainable design has become a key topic in design.

As we see, DYSON's design was a huge success. In addition to its excellent ease of use and problem-solving functionality, it no longer requires disposable plastic dust bags, thus reducing the use of a large number of disposable garbage bags, and it is also electricity-saving.

Let's look at the case of Adidas. Adidas has teamed up with the environmental protection agency to launch a line of sneakers made from 100 percent recycled Marine waste, which demonstrates the famous brand's awareness of environmental protection, social responsibility, and it also received economic benefits.

This is a case from Prof.Liu Xin, Collaborative Innovation Center of Eco-Design, Academy of Arts & Design, Tsinghua University. We know China is a rapidly developing country with construction sites everywhere. But construction urinals are scarce. This design is an example of a systematic, modular solution to the urination problem for site workers. It gives workers the basic health care and dignity.

This is a case from the perspective of social equity. It is a large-format tactile graphic display terminal product which was jointly developed by the research team from both Academy of Arts & Design, and Future Lab of Tsinghua University. It is a convenient auxiliary tool for these visually impaired children to obtain knowledge and information. It received a highly rating from the academic community.

This is also Prof.Liu Xin and his team's project. It is called the 'Lettuce House': a sustainable lifestyle Lab. This is actually a sustainable lifestyle design. It has attracted great attention from the society and has been rated as the Third most concerned web celebrity building in recent years. The first two are Zaha Hadid's designs. The system is designed to recycle household kitchen waste, toilet waste, as well as vegetable wash, bath water and cleaning water.

Dieter Rams advocates minimalist design. I think it's a kind of human rationality.

China also has a fine tradition of design and creation. For example, the Song dynasty porcelain, and the Ming dynasty furniture, are very simple, but very delicate, with high taste and quality.

SWISS has the same philosophy, and they also advocate a minimalist design. ALPA cameras, another example, use the simplest but most essential technology to achieve the best photographic experience and functional requirements. LAMY's sketch pen also uses the least material to achieve the writing function with good user experience. These are simple design styles and concepts that we should advocate.

We know Tadao Ando, a master of architecture. His architectural design is as simple as possible, with very little raw material consumption to obtain extremely shocking artistic atmosphere and effect.

Designers are also experimenting with a variety of eco-friendly materials. For example, the use of bamboo is a great protection for the environment.

As we know, bamboo grows very fast and is a degradable material. Through the development and research of material characteristics, these designs not only retain the unique affinity of bamboo materials, but also produce a rich product category. More importantly, they are biodegradable environmental products.

This is also a design case that we did. The Hunan Pavilion at the 2010 World Expo in Shanghai is made entirely of bamboo. We wanted to put forward the idea of environmental protection.

In addition, the combination of high technology, advanced ideas, science and art can also create value.

Tesla, for example, uses new clean energy and advanced design concepts to integrate beauty into its electric vehicle products. I think this brings great convenience to human's travel, and also promotes our energy conservation.

At the same time, Musk himself announced that he would open all of Tesla's patents for electric cars, allowing the world to share the intellectual property in advanced energy technologies. I think it also reflects an entrepreneur's sense of social responsibility.

With the advanced ideas, he integrates the art and science together to achieve a successful and outstanding example.

And what we can do is exploit the digital economy and the design of virtual experiences. In doing so, we can reduce the consumption of a lot of material resources. For example, our project 973: the digital protection of cultural heritage. It is to protect the sustainability of cultural heritage, and at the same time to better spread cultural heritage. There is also the creative design of virtual manufacturing and virtual reality, which can enrich people's lives without consuming too many resources and causing too many environmental problems.

In fact, design sometimes has both positive and negative effects.

Capsule coffee, for example, is a very successful commercial design that has been well received by a wide range of consumers. But at the same time, it creates new problems because it creates hard-to-recycle waste. Even its inven-

tors have expressed regret that he did not anticipate such pollution problems.

Subsequently, a Swiss coffee company adopted bio-plastics on the new capsule coffee packaging, making the packaging materials of capsule coffee and instant coffee all organic and biodegradable. This is a good design for sustainability that we advocate.

Of course, we can also promote the sustainable development of human beings from the perspective of sharing economy.

If we imagine that you don't have to have a car and a bicycle for everybody, and you put the unused resources to good and shared use, I think that's a good idea for sustainability.

Although encountered many new challenges in the process of exploration, I think this understanding and exploration for shared economy is forward-looking and innovating.

Like many consumers, I am against the pursuit of a luxurious lifestyle. But we can find in life, a very classical design may be a bit more expensive, but because of its perfect function and its high quality in aesthetics, we often love them and fond of them. We will have the desire to keep it for a long time, to pass it on to our children and grandchildren, and they are more likely to gain more values over time.

So it also prompts us to think: compared with those disposable, rough, cheap, mass quantities of consumer goods, these classic products, or luxury goods, with a new character of ethics, can't they bring some kind of protection to our environment?

Sometimes we can also change the concept, the concept of the familiar judgment, and do some re-thinking. The concept of sustainability and the concept of 'everything use to the best' can be used as a way of re-examine our judgment criteria.

In addition, I think it is worth considering that Beauty is an inexhaustible resource, which is not like consuming other materials. Therefore, human beings can pursue beauty and endow products with a kind of charm and connotation to obtain huge added value of products.

The challenges we will be facing in the future including technology, environment, climate, population, energy, and so on. Especially artificial intelligence.

In the future, design will become: more interconnected, more thoroughly perceived, and more deep intelligence.

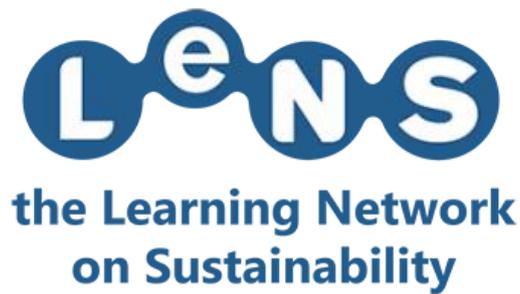
The changes brought by artificial intelligence and big data should not only be about efficiency, but more about innovative ideas, products and services. The design needs to integrate the data generated by human to human, thing to thing, and human to thing all together in accordance with the natural logic and social logic, so as to create economic and social value.

Perhaps what we see more is that big data can improve efficiency, that is, to solve problems according to the logic of natural science. However, I think it requires not only natural logic, but also humanistic and artistic perspectives to think and propose solutions, so as to achieve a higher social value.

Sustainable design is a future-oriented design, and a future-oriented design concept and practice.

Designers should be more forward-looking, anticipating risks and anticipating the future. Driven by the concept of sustainability, design is not only a service industry, but also an important driving force and leader of value innovation.

For such a task, we need both forward-looking research and take actions. Thank you!



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CIRCULAR ECONOMY, SYSTEMIC DESIGN AND SOCIAL DEVELOPMENT GUIDELINES FOR EMERGING ECONOMIES

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ABSTRACT

This paper synthesises the main ideas presented as a keynote speech for the First World Distributed Conference 2019: Designing Sustainability for All. The objective is to contextualize Product-Service Systems and Distributed Economies in the Brazilian and Latin American context from the perspective of sustainability. First, some initial reflections and ideas about the perception we have regarding sustainability in today's context are presented. We discuss why our present production and consumption system remains unsustainable and why the paradigm of circular economy still is challenging today. Then, the LeNSin Brazil Project is presented. To illustrate the project, case studies were systematically collected and classified. As a conclusion, we point out that the development of s.PSS for the context of DE is relatively recent field for design in Latin America and "classic" or "traditional" design methods do not fit all the new variables involved in this type of projects. Also, the lack of appropriate methods and tools opens a new field of research for the creation of methodological models to support the design of S. PSS in specific contexts. Finally, there is a (re)definition of the design process and designers need to improve their skills in order to better understand how users' needs can be met through intensive use of services and experiences.

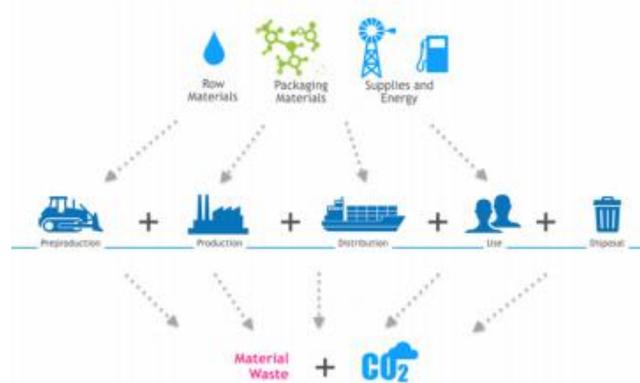
Key Words: Sustainable PSS, Distributed Economies, Latin American PSS.

1. WHAT IS WRONG WITH THE ECONOMIES OF SCALE?

Perhaps one of the reasons that bring people together to an event such as the First World Distributed Conference is that, in a way or another, their activities are closely related to sustainability.

In this regard, I'd like to begin this presentation with a particular definition of sustainability from professor Ezio Manzini in which "Sustainability is a way of being and doing thank to which people can live better, consume less and help to regenerate their contexts of life"

When we evaluate where our society is today in terms of sustainability, probably we might have mixed fillings about it. Optimistic and pessimistic scenarios might come to our minds. For instance, when looking at how products are made today, we realised that globalisation continues to give support to linear production systems, where huge amounts of raw materials are shipped away, traveling long distances in order to be transformed into products thanks to the use of enormous amounts of energy (Figure 1). Those products are then shipped back and commercialised worldwide to be used and consumed and, probably, at the end of their not so long lasting life cycle, what remains from those products will end up in a land fill or by the sea. This is why the idea of a circular economy remains challenging, even today.



[Figure 1] Representation of the current production system. (Source: the Author)

We could say that the economic laws that have so successfully governed industrial systems in the last 70 years do not provide the right signs for sustainable development for all.

It seems that something is wrong with the economies of scale and society is taking action in order to bring to the table the discussion of our future. For instance, at the time I'm writing (April 2019), thousands of young students across the globe are taking the streets of main cities across the globe calling for action against climate change. They refuse to attend school to protest adults' lack of concern for their future (Figure 2).

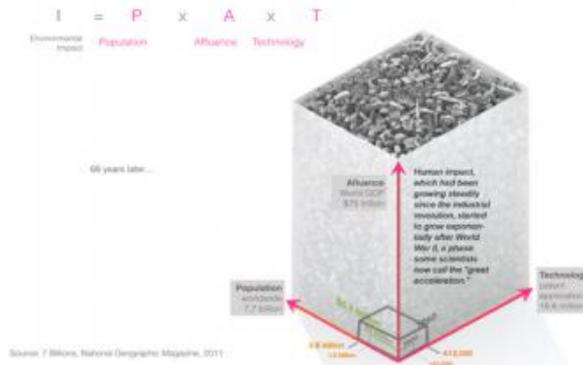
On the other hand, In France, the yellow vests have paralysed the country in recent days. They went to the streets demanding better conditions of work, of life, of health, of security, and sustainability as well. Among their claims, they demand that instead of financing the electric car industry, the French government should make more investments in alternative, clean fuels, such as hydrogen (Figure 2).



[Figure 2] Student (left) and Yellow Vest (right) calling for society action, February 2019.

We cannot say that our lack of action towards sustainability is due to our lack of information about it. I remember when I was a young researcher, 20 years ago, there were just a couple of films about sustainability. Inspiring films such as *Koyaanisqatsi*, *Baraka*, *Home* were precious jewels hidden in the last shelf of video rental shops. By contrast, today people have access to hundreds of films that, in one way or another, openly discuss diverse topics directly related to sustainability. A simple search on the internet for audiovisual material related to the economic, social and environmental pillars of sustainability brings a list with hundreds of recommendations of films and documentaries to watch. The reason I mention documentaries and films and not books or papers is because those documentaries have the power of reaching wider audiences across the globe, informing people about what's going on with the environment and society today, and inspiring and encouraging them to take immediate action.

Looking from another angle, environmental impact could be defined as the multiplicative contribution of three main factors: population, affluence and technology. It is called IPAT, and it measures the world's population, the affluence of society in terms of Gross Domestic Product (GDP) and technology, which measures how technology impacts, among other things, the processes that are used to obtain resources and transform them into useful goods.

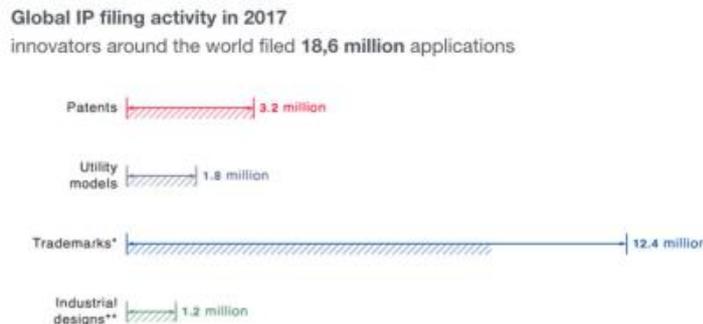


[Figure 3] Representation of Environmental Impact: (Source: 7 Billions, National Geographic Magazine, 2011)

In terms of Population, today we are 7.7 billion people. That number has steadily increased 1.2% a year since the 1950s and it will continue to do so for the next 20 years. Only by 2040, when we reach 9.3 billion people, according to predictions, it is when our population will begin to decrease and stabilise. Also, another important fact to mention is that back in the 1950s the population living in urban areas was approximately 30%. Today that number almost doubled. 57% of the population lives in urban centres.

The next component in the IPAT equation is Affluence, which can be measured according to GDP figures, in 2018 it was 87,5 trillion US dollars (almost 10% increase from the previous year) The truth is that since 1970s humanity has been in ecological overshoot, with annual demand on resources and energy that exceed what Earth can regenerate each year. Our ecological foot print is 1,7 planets. This means that it takes the Earth one year and six months to regenerate what we use in a year. Imagine our future scenario putting together the demands of an increasing population + increasing Affluence.

Finally the last component of the IPAT equation is technology. In the equation, patent registration is a way to measure how technology impacts, among other things, the processes that are used to obtain resources and transform them into useful goods. in 2017, innovators around the world filed 18,6 million applications (Figure 4).

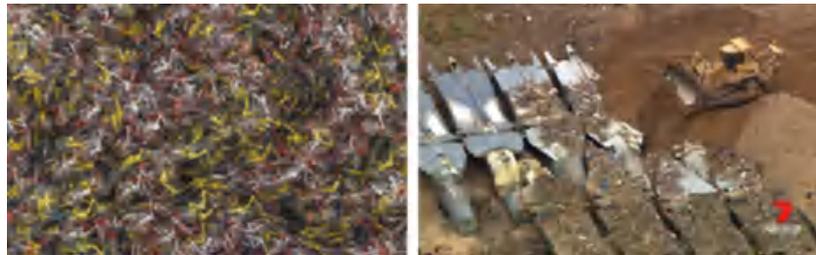


[Figure 4] Global IP filing activity in 2017. (Source: WIPO Statistics Database, March 2019)

At this point, some sectors of society could advocate in favor of technology as our hope towards the future. It could be true, but not for sustainability. At the present moment, two revolutions are quietly taking place. One the one hand the Information and Communication Technology (ITC) revolution and on the other the Biotechnology revolution. They are transforming humanity and the planet in ways we cannot yet comprehend. However So far, none of the advancements in these two directions have made solid sustainable claims. What are the benefits, in terms of sustainability, of the increasing use of autonomous systems, such as cars, robots, or digital assistants into our daily life? Or what are the possible sustainable gains of hacking our DNA? If, in the not so distant future, humans can extend their lives more than 100 years, what the implications would be for sustainability?

When we imagine a sustainable system innovation, we know that we need to radically reduce the consumption of environmental resources. What signs of less resource consumption do we have from ITC or Biotech experiments if they are produced with the same mindset of the industrial systems?

In summary, when comparing our environmental impact today with our IPAT in the 1950s we can see an exponential increase of everything. Almost everything we produce at some point is transformed into energy or ends up in landfills or the ocean. From bicycles that not so long ago were part of a bike sharing PSS, to fight airplanes being buried after some years of use. It seems that we were unable to reuse or recycle them. Also, thousands of polymers forming huge patches of plastic garbage in the middle of the oceans are clear signs that something is wrong with our system. Just imagine how many schools or hospitals could have been built with those resources and money that now rest on river basins, oceans and landfills.

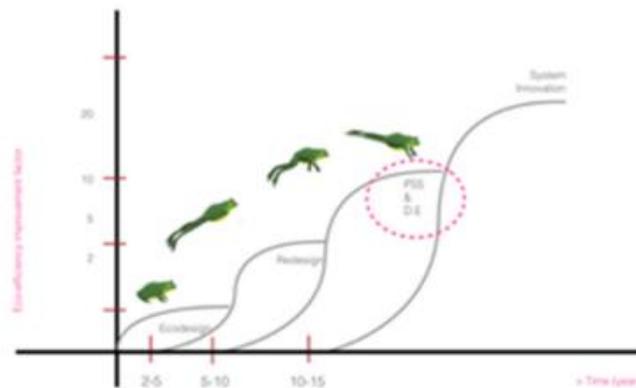


[Figure 5] Example of waste disposal in land fills: (Source: The Atlantic 2018 <http://bit.ly/2JLZ4Ph>)

Summarising, we could say that one of the objectives of the industrial system is to remain attractive and profitable for investors over the long run, and the key to remain as such is the prevalence of mass production and centralised industrial cores.

2. THE QUEST FOR ALTERNATIVE SUSTAINABLE SOLUTIONS

Over the past 30 years we have increasingly been looking for alternatives. For instance, in the design community, researchers envisioned future scenarios that might favor the transition towards a sustainable society. Back in the 1990s, one of the early stages in that transition was eco-design, where designers were committed to improve the environmental impact of artifacts.



[Figure 5] Degrees of environmental benefit and of innovation required. (Source: Source: A Promising Approach to Sustainable Production and Consumption, Brezet, 1997)

Soon, we realised that eco-design was not enough in terms of sustainability. So a more radical approach was envisioned. An approach that introduced sustainability criteria since the beginning of design process. We commonly called this approach Design For Sustainability.

Soon after, we focused on the idea of dematerialisation of the economy. It meant satisfying users's needs with services and PSS. At the same time attention to a new types of organisations such as DE, emerged. Perhaps, our next step will be to envision possibilities for system innovation. A system where hopefully we will be able to consume 90% less resources.

SUSTAINABLE PSS & DISTRIBUTED ECONOMIES: THE LENSIN PROJECT

Over the past 3 years, designers and researchers from all over the world joined the Learning Network of Networks on Sustainability International (LENSIN) to research two promising models of development within the sustainability perspective. The models are Sustainable Product Service Systems (S.PSS) and Distributed Economies (D.E). The project has been the result of a social interactive learning process involving 14 universities from around the world, more than 100 professors and researchers and 500 or more students, to discuss, develop and share knowledge regarding S.PSS and D.E at the local and global context (Figure 6).



[Figure 6] Typologies of Distributed Economies within the LENSIN Project. (Source: The LENSIN Project 2016)

Along the Lensin Project, it was possible to identify new forms of organisations, movements and initiatives that have a completely different approach to production and consumption of goods for the satisfaction of needs. From grass root movements to social innovation, crowd design e local production systems, cooperatives etc.

We identify those models as examples of Distributed Economies, since they promote the development of small-scale, decentralised, flexible production units, synergistically connected with each other and that make use of local resources, offering the advantage of being much more flexible and resilient to respond to change.

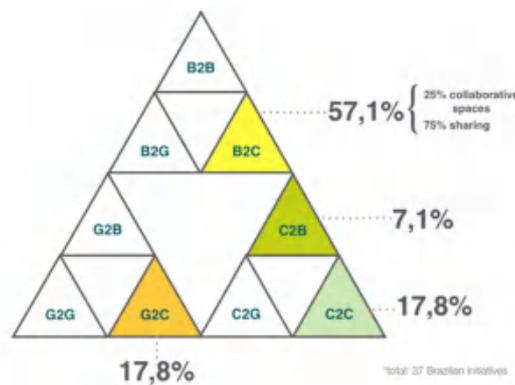
Distributed Economies have 3 main pillars: Structure, Scale and Sustainability Potencial. They represent a paradigm shift from centralised to distributed systems, from large scale to small scale of production and distribution. In terms of sustainability potential, D.E make use of renewable resources, they promote wealth creation, diversity and flexibility, as well as collaboration and empowerment among community members

In the Lensin Project, we classified DE into 5 categories renewable energy, hardware (artefacts), software, information and design. Everything in a distributed configuration.

What distinguishes DE from other kind arrangements is that in their essence they are decentralised organisations where information open to everybody. Every member is willing to contribute, sharing common values and ideologies. DE are benefitted with the so-called network effect, where every additional stakeholder makes the organisation stronger.

We began to search for initiatives with the characteristics of DE, in Brazil. From an initial list of 340 initiatives, we narrowed down to 37 that met the following criteria: Offering services to extend the product life cycle; Offering of enabling platforms; Complete services in DE system configuration; Stakeholder network optimisation; Proposals with alternative forms of payment.

Along the study, we classified the diverse initiatives according to who was the main proponent (Business, Government or Consumers) and whom was the PSS offered. According to this rationale we obtained 9 possible clusters of S.PSS offerings: Business offerings (B2B, B2C, B2G) such as collaborative spaces and sharing services, Consumer initiatives (C2B, C2C and C2G) like car pool and goods exchange among communities, and Government offerings (G2B G2C G2G) where we found proposals aimed at minimize urban environmental issues such as mobility and recycling solutions.

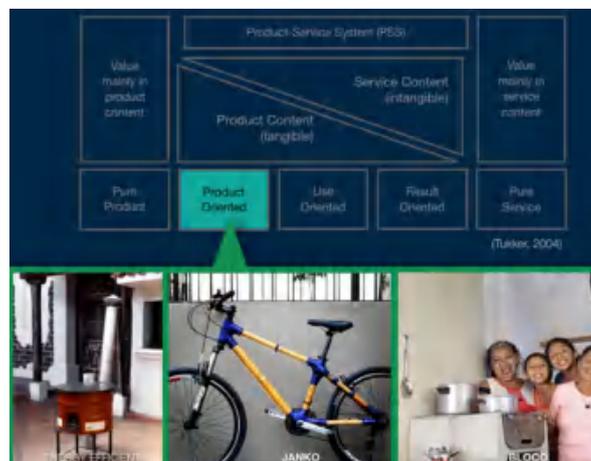


[Figure 7] Types of s.PSS within DE systems, Brazil. (Source: The Lensin Project 2016)

This initial study shows diffuse signs of the emerging of S.PSS offerings within a D.E. configuration. The study also shows opportunities for innovation with offerings in clusters such as B2G or G2G, where people could develop S.PSS offerings where the government is the main “user” or Governments offering S.PSS to other government agencies.

After our pilot experiment in Brazil, we decided to look for sPSS initiatives in the Latin American context, with the collaboration of our Lens partners from Argentina, Peru, Colombia and Mexico.

Taking as a reference the PSS typologies model from Tucker we found diverse Product Oriented PSS offerings. These case studies are a good sign of a shift towards sustainability thinking in our designers and entrepreneurs’ mindset.



[Figure 8] Examples of Product Oriented S.PSS offerings. (Source: The Lensin Project, 2016)

Things got more exiting when we were looking for Tucker's Use Oriented PSS. We found lots of PSS initiatives in this category promoting SHARING as a main value proposition. From wardrobes, electric rental bikes, washing machines, toys and food delivery. Those initiatives are based on the network effect, and largely supported by social media interactions. Some representative case studies include the following:

A Roupateca (<http://aroupateca.com>) a shared wardrobe in São Paulo where the user can dress on a daily or weekly basis, if she wants, for a monthly fee. The only condition: to return the clothes cleaned.



[Figure 9] Roupateca, Shared Wardrobe. (Source: (<http://aroupateca.com>))

Econduce (<https://econduce.mx>) electric bike rental in Mexico City. The user pays for a minute of ride. \$1 Mexican pesos US\$0,05 us cents.

Washing Machine Rental (https://www.youtube.com/watch?v=yc7_8Zuy7BU) a PSS service for the suburbs of big cities in Colombia. Without access to public transport. Many of them use rain water and pay for hours of use. Tok Tok (<https://www.toktok.com.mx>) from Mexico, and Joanninha (www.joanninha.com.br) from Brazil are good example of s.PSS toys rental where parents exchange toys for their kids once a month for a small fee.

Solar roasted organic coffee deliver (Source: <http://compadre.pe>) is a S.PSS where organic coffee is locally produced by cooperatives using solar energy.

Finally, in the Result Oriented PSS category, we found entire communities using and promoting alternatives ways of consumption and satisfaction of needs. In this kind of PSS, the core values are focused on the NETWORK effect and the EMPOWERMENT of stakeholders.

In lima, Peru where there is no rain fall the X-Runner Dry Toilet service (<http://compadre.pe>) attends low income communities with the rental of a dry toilet. The organic material is composted and commercialised for agro industry use.



[Figure 10] Dry Toilet Service. (Source: (<http://compadre.pe>))

Yolcan (<https://yolcan.com>) is an organic food deliver. More than a service is a platform connecting local farmers, consumers, academics and chefs. They promote the Chinampas, a type of agriculture that uses small areas of fertile, arable land to grow crops on the shallow lake beds in valley of Mexico.

LOuco Fab lab haker maker space dedicated to investigate possible solutions for the city, for instance by using sensors to monitor pollution levels, transit conditions in recife, Brazil and Hacedores (<https://hacedores.com>) fablab from México city are jus two examples of the fablab network in Latinoamérica. They are training young people under the idea of collaborative digital fabrication using shared tools and spaces.

Mercado Territorial (mercadoterritorial.observatorioess.org.ar) is a family agriculture network connecting farmers, the academy and consumers for a democratic distribution of agricultural products in Argentina. On the other hand, Mercado del Trueque (<http://data.sedema.cdmx.gob.mx/mercadodetrueque/index.html>) in Mexico, is an exchange market where people can exchange their recyclable waste for locally produced vegetables and food. No money is involved.

[Figure 11] Mercado Territorial, a familiar agricultural network (Source: <http://mercadoterritorial.observatorioess.org.ar>)



3. CONCLUSION

The development of s.PSS for the context of DE is relatively recent field for design in Latin America and “classic” or “traditional” design methods do not fit all the new the variables involved in this type of projects. The lack of appropriate methods and tools for conducting the design process opens a new field of research for the creation of methodological models to support the design of S. PSS development in specific contexts.

There is a (re)definition of the design process and designers need to improve their skills in order to better understand how users’ needs can be met through intensive use of services and experiences.

We also perceive a systemic change in the way artefacts are conceived in the contemporary world. An emerging scenario of customised and small scale local production, where users become part of the development process, assuming the designer’s role in a highly collaborative process, connected and networked.

We believe s.PSS and DE Models have advantages that can be levered as a new strategies to make industrial development less impactful to the environment, of decentralised, local scale, and consequently more sustainable.



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DESIGNING TO CREATE A SHARED UNDERSTANDING OF OUR COLLECTIVE CONCERNS

Poonam Bir Kasturi

Founder, Daily Dump – Compost at Home

Thank you to all the organizers and Srishti School of Art Design and Technology for inviting me to be part of this wonderful initiative.

The title of the Conference raised two questions in my mind. Designing Sustainability for All

How does design achieve sustainability for all?

What should designers focus on to make sure there is sustainability for all?

My experience has led me to think that sustainability for all cannot be designed without designing the conditions that allow everyone to build a shared understanding of the idea of sustainability!

While there is a growing trend across the world that shows more people are aware of the damage we have caused to the environment, there is not enough of capacity within our institutions and governments that allow this awareness to translate in action.

Most action is directed at the symptoms of the problem and much money is spent in this area. Often good intentions, sincere ground work and funds get channeled to “Projects” and “Schemes”. And then we are surprised to see so little change over time.

To quote Peter Senge “Without the capacity to see systems and their place in them, people and organizations will naturally focus on optimizing their piece of the puzzle, rather than building a shared understanding and a larger vision.”

And learning to see systems is like learning a new language. Systems thinking is like a language, a way of seeing our relationship with the world we live in, the work we do and the desired future we wish for. It requires us to think in new ways, using new vocabulary and unlearning our habits of seeing things in parts - and wanting quick fixes.

We have only to look around and we can see the silos of action. For example our current “start up” culture is reiterating our “seeing the parts” mindset. There are “Agri startups” or “clean energy startups” or “sanitation startups”. When will funds flow for a “mindset changing startup” or a “Building a shared understanding startup” or a “Provocation Startup”?

The Good news is that there is a growing unease. Young people all over the world are tired of seeing the same mistakes being made - there is an unease. They have a question - what will make real change happen? It is a scary place to be, because after all each of us just have too much to do and taking on responsibility for the big blue ball we live on is not something we signed up for. Also this is an emotional issue. The question - Do you care about the planet?

Often leads to one-upmanship, disengagement or polarisation.

In my mind the only way to really leverage this unease is to make sure that the language of seeing wholes and their relationships becomes the norm. This is the only enduring antidote for this unease.

So Designers need to make sure they work on spreading this way of seeing the world in addition to Designing for this new vision. Otherwise, a Designer will have to face deep-rooted resistance from the communities she serves because of legacy ways of thinking of the issues.

As a designer I learnt about systems thinking only later on in life. By then my mental models were quiet cemented and I had a lot of unlearning to do. But that helped me understand the barriers that stand in the way of seeing big pictures, patterns, and interrelationships. It made me aware of two things:

- 1). Design schools in our part of the world are not equipped to teach Systems
- 2). It is hard work to create the conditions for more participation in this new way of thinking of life on earth.

Point 1 - Capacity in Design Schools

We have the knowledge around Systems Thinking. Knowledge is not what we lack, there are philosophies, methodologies, science, art, culture that show us that systems thinking is very critical today if we are to make a shift in the way we take decisions.

But we do not have capacity.

It is like we do not have a capacity to fill the teacher positions in Indian engineering colleges. While we know we need the teachers.

We have not enough capacity today to actually embed systems in the way Design is taught.

Point 2: Creating conditions for more participation in this way of thinking.

If you are not exposed to system thinking in the early years, changing things around is very difficult. Because the world seems to work without the need to change the way you see it. This is the biggest barrier to get people interested in this new language. Unless things break down, there is no incentive. So in a way our current crisis is the right time for us to work to create the conditions for more participation.

Even in the area of sustainability many of the efforts are coming from a vision of seeing climate change, circular economies, high oil prices, social unrest, unsafe food, rising health issues, growing waste, increasing crime, as separate problems. While actually they are all interconnected and part of the same system.

So learning a new way of thinking is hard work since you have so much to unlearn.

So while different groups and designers all over the world are working to build this new way of thinking and working to make the new vocabulary accessible to all, I think that designers in our region need to play a bigger role in this. They need to push the idea of “Bringing systems in first” in all the work they do. They need to couple the powerful design process with the systems view.

As John Pourdehnad, Erica and Dennis say “..the most valuable principle that systems thinking can add to design thinking is the need to bring the whole system to the discussion from the beginning. The stakeholders within the system must plan for themselves. If problem formulation is the first step in the design process, then adopting a systems mindset can help with framing and especially reframing the problems.”

To illustrate how important it is to bring the system into the discussion at the start of a new venture, or change or improvement I have two stories.

I was at a meeting of different impact entrepreneurs and we were listening to a very successful e-commerce CEO who was sharing his growth story and the challenges he had faced. His excitement about ensuring that customers got a high fulfillment rate, faster deliveries, fresher produce showed that he cared about a quality product service system. Here was a highly educated, successful person who also cared about the environment - his company works hard to remove all plastic in their fresh produce packaging. He is using all the current technologies and strategies to achieve efficiencies and profitability in his sector. In this current context, the CEO excitedly shared how his goal was to reduce delivery times of all customers at all times to around 2 hours.

In such an environment who will be able to ask him these kinds of questions

- 1). “Why is a 2 hour delivery such a wonderful goal post to reach?”
- 2). “What will the environmental, social and economic unintended consequences of such a move be?”

Will it add to the traffic? Will it get customers addicted to a unreal appetite for immediacy? Will it add to air pollution?

If when his team was thinking of who they were and what they were setting out to achieve, had they started with an understanding of the system they were part of, they might not have defined a 2 hour delivery as a desirable goal despite what the competition was bragging about. Could it have been possible to build a position of a company that cared with giving customers and option of a later delivery with an incentive of a tree being planted for their patience?

The other story is from the work I do everyday.

Over the last 13 years we have worked to create a habit of insitu composting in India. For the bigger waste generators like apartments, schools, hotels, we have a buy back scheme for the compost they produce in our products. So we pick this up and there is no robust pipeline to make sure this nutrient rich material goes back to farms to regenerate soil and create more food.

Currently we are sitting on a stock of hundreds of tonnes of this material because there were no takers. There are no takers for many systemic reasons.

But what is interesting is the response we get from many seasoned business mentors when we seek advice on what to do about this. It usually is “your business is to sell more composters, forget about the compost. Dump it if you must, but don’t loose the core focus of your mission.”

But since we started this work first thinking of the system, we are not ashamed or hesitant to pursue this line of enquiry. We know it will need a cross boundary collaboration that can be fatiguing, long drawn out and maybe will come to nothing. But as a company we cannot just let that go. It is part of the system we work in and unless that part has also been fixed the whole will not work well in the long run and we will be back to square one.

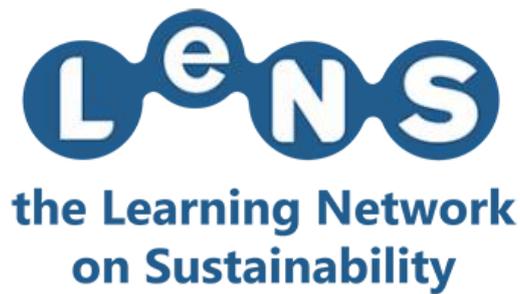
One would think that a large scale well funded venture might have the time and resources to begin their journeys from the larger systems perspective, but in my experience it is not size or funding that dictates this, it is the lack of capacity of big picture thinking that is the block.

As I am not a researcher, or a scholar of systems and design, I can only urge designers to look around all their work and push for big picture capacity building among their teams, their clients, their families and their colleagues.

So maybe what I am saying is that we need to add another facet to the Design Practice. Here the Designer builds a ground for shared conversations and then also helps build some of the forms analog or not to build out shared futures. This requires lots of cross boundary partnerships, connecting seemingly un-related ideas, getting people to take ownership of an idea and patience and doggedness. The best scenario would be that after sometime the form itself has lost all validity but the thinking sticks.

Many of you are already doing this, but our country needs many many more, if we are to leap frog and avoid the mistakes of the North. If we dot the landscape with many initiatives that begin with systems thinking, then it will build the eco-system where the idea of sustainability will become the norm.

To all the young and old who have participated in this important Lens Initiative, I wish you well and may all your efforts to bring laughter back in our soil, water, air, and life.



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DESIGNERS FACING GLOBAL CHALLENGES

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ABSTRACT

The goal of this paper is to review the Sustainable Development Goals suggested by United Nations and how design can focus on three of them: economic development; social inclusion; and environmental protection. Special focus is given to the situation of Mexico regarding the role of design inside these goals and in the creative industries, as well as the relationship design and economic growth.

Key Words: Design, Economic Growth, Environmental Protection.

1. INTRODUCTION

Some authors like John Heskett (2006) and Oscar Salinas (2003), suggest that design surged about 2.4 million of years when first tools were created by what has been called the Homo habilis. These tools were used to create other tools, something that involves human memory, planning and solve abstract problems activities which are essential in all design methodologies used now at days.

After thousands of years, first objects such as furniture were designed in Egypt and Mesopotamia; Penderbelli (2011) suggests that there is evidence that serial production began 400 years B.C., in Greece, where one hundred twenty craftsmen produced ceramics vases which were and looked quite similar to the first design. Centuries later, in the first century, during the imperial Rome, the Aretina Ceramics, produced in Arezzo, were produced using a mold to produce tableware; this practice allowed craftsman to produce enough pieces to cover the demand from Rome, as well as, the demand from other cities.

Despite design has been important in human kind development it is in the industrial revolution era when mass production began to generate a negative impact to the environment. One of the first call to action regarding this negative impact was that from professor Victor Papanek (2014) which in his work *Design for the real world* suggested: “There are professions that are more harmful than industrial design, but very few. And there may only one profession that is more insincere: Design Advertising”.

This call to action launched in the 70s did not have the answer expected from Papanek and other academics, in fact this call and other similar were considered fake news. However, the evidence shows that Papanek and other colleges were right, and that our planet will collapse due to many and complex reasons which are linked to industrialization and consumerism.



Fig 1. United Nation's Sustainable development goals

2. DESIGN AND THE SUSTAINABLE DEVELOPMENT GOALS

Design is important because it affects every aspect of our daily life. But not serious use of design and industrialization brought us to this situation thus design should bring us to a better situation. Herbert Simon (2006) suggest that: “Design is the ability to move from an existing situation to a preferred one”. For Victor Papanek (2014), the planning and structuring of any act aimed at a desired and foreseeable end constitutes the design process. As we can see, both statements, the one from Papanek and the one from Simon share similarities, but John Heskett (2006), goes further when says that “if considered seriously and used responsibly, design should be the crucial anvil on which the human environment, in all its detail, is shaped and constructed for the betterment and delight of all.”

According to the United Nations (2019), sustainable development has been defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”... “Sustainable development calls for concerted efforts towards building an inclusive, sustainable and resilient future for people and the planet”. The UN states that in order to achieve sustainable development it is necessary to harmonize three core elements: economic growth; social inclusion; and environmental protection. These elements are interconnected and all are crucial for the wellbeing of individuals and societies.

2.1 design and economic growth

There is clear evidence that design contributes to the competitiveness of not just small, and medium sizes enterprises but micro and large companies too. One of the first books to address these issues was: *The Design Dimension*, written by Christopher Lorenz (1987); the second book is: *Winning by Design*, written by Walsh et al., (1992); other books are: *Design in Business* by Margaret Bruce and John Bessant (2003), and all the work developed by the Design Council, mainly the latest one called: *The Design Economy 2018* (2018). All this papers and books among others show how important design is for business performance, firms competitiveness and nations economic development.

Besides those documents, there have been important publications on the role of design and the environment,

one of the most important, as mentioned before, is: Design for the Real World, and the subsequent works published by Victor Papanek. Green Design, written by Dorothy Mackenzie, (1993), is probably one of the most important as it contains real case studies on the several types of design and how by systematic and rethinking approaches are possible to tackle environmental problems caused by previous designs.

Economic growth, is important to create welfare however, uncontrolled manufacturing, and a massive consumption of goods and services has driven to the actual situation we face today. According to data from the German Federal Agency for the Environment, 80% of the environmental impact associated with a product are defined in the concept. In order to stop this situation designers must have a systemic approach to design where all items, areas and impact should be considered. A trans-disciplinary and multi-disciplinary thinking is necessary. Actual designers and future designers should be trained on how a product and service design will impact in the area, and the planet and how to decrease its impact. This analytical thinking requires a new way of thinking; in other words, a critical and divergent thinking.

Despite designers are required and that the demand for design skills is expect to grow in some nations as the United Kingdom (2018), it is not necessary the same situation for other countries such as Mexico and south American nations. According to data from the National Association of Graphic Design and Visual Communication Schools of Mexico, every year ten thousand students graduate from universities where those studies are offered. This large number cannot get a job in companies where design is the core business, as neither in design studios. In the best situation, some of those fresh designers pursue a career as entrepreneur setting up their own design studio, however the chances of succeed are limited.

If economic growth is important for achieving a sustainable growth, the design industry must be able to grow as part of the creativity industries which in the case of Mexico, according to Tamayo (2017) contribute to the 7.4 percent of the Gross Domestic Product and generate two million of jobs, however with the right public policy there is a possibility of achieve the 12.0 percent of the GDP.

A research carried out by Frias (2005) found that design in Small and Medium Sizes Enterprises SMSE is not related to innovation and that design is not used by Mexican enterprises due to enterprises directors consider design services are expensive and unnecessary, and that factors such as quality are more important when selecting a product in the market arena. The challenge for Mexican designers, and probably for designers in other developing countries are the same, it means to communicate the value of design as a tool for responsible business innovation.

2.2 Design and social inclusion

According to the United Nations (2019): “Social inclusion means integrating all members of society into community life, regardless of their origin, social condition or activity”. If social inclusion is the tendency to enable people at risk of poverty or social exclusion to have the opportunity to participate fully in social life, and thus enjoy an adequate standard of living, design has many things to do with it.

In 2010, Tim Brown and Jocelyn Wyatt wrote the influential paper: Design thinking for social Innovation; in this publication, they argue that product designers traditionally focused on the look and functionality of products but recently designers have begun using design methodologies to tackle complex problems such as low-cost healthcare throughout the planet. Their argument suggests that companies were the first to embrace this new approach and that now nonprofits organizations are using it too. The paper brings up cases where designers as part of multi-disciplinary teams working together towards the solution of a complex and systemic problem. The work of Brown and Wyatt is not the only one that addresses the role designers or design thinking to solve a particular situation, already Victor Margolin (2017) and John Thackara (2011), among other academic and thinkers have written about these issues.

During the last five years, methodologies such as design thinking, human centered design and Jorge Frascara’s (2018) methodology have been used to tackle particular situations across Mexico, particularly in rural areas where local citizens are at risk of poverty or social exclusion. According to data from the National institute of Geography and Statistics almost half of Mexican population -which is about 125,000,000 (one hundred twenty-five million habitants)- are considered “poor people” and ten percent of the total population is considered very poor people because their daily income is less of five American dollars. In other words, Mexico has over fifty million citizens which are poor and almost ten millions which are considered very poor. To worry is that despite the billions of Mexican pesos government and non-government organizations have spent in programs to assist poor people the number of poor citizens is the same as twenty-five years ago.

How can design change this situation into a preferred one? It is clear that the strategies carried out, as well as, the corruption in Mexico are barriers to overcome this situation, and also is clear that there is symbiotic relationship between poverty and environmental situation. The United Nations (2019) recognize that ending poverty must go hand-in-hand with strategies to build economic growth to cover a range of social needs including education, health, social protection, and job opportunities while tackling climate change. Design has an important role to do in tackle all these problems.

2.3 Design and environmental protection

According to the United Nations (2019), climate change already affects public health, food and water security, migration, peace and security. The UN is clear to say that If climate change is not taken into account, it will roll back

the achievements made in recent decades in terms of development and prevent further progress and goes further when says: Investments in sustainable development will help address climate change by reducing greenhouse gas emissions and strengthening climate resilience.

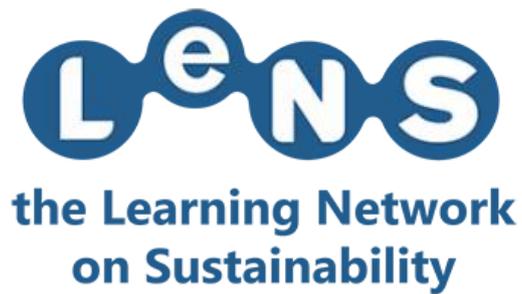
Since the seventies there has been a focus on the role of designers when developing new products, among the most influential literature is the work of Ulrich and Eppinger (1995); although the book presents an approach to product innovation through design, in the first editions it lacks on an environmental position a gap solved by the work of Carlo Vezzoli and Ezio Manzini in their book *Design of environmental and sustainable products* (2018). It has been large reviewed that during the conceptual phase of the product development designers are able to decide eighty percent of the components of the product that will have an impact to the environment, thus designers are responsible for not just the aesthetics and interaction of the product but the way it will be reduced, reused, and recycled. However, design along cannot solve this complex problem, a design culture, a design policy, an industrial policy, and a very constant and conscious campaign is required, but above all a global government commitment is needed.

3. CONCLUSIONS

In order to achieve the seventeen sustainable development goals proposed by United Nations a critical and divergent thinking is necessary, design plays a key role in all this situation, as it is one of the disciplines that drove us into this chaotic situation and one of the disciplines that will bring us out if it. Nevertheless, design along cannot solve all this complex and systematic situation, multi and transdisciplinary collaboration is needed and a new didactic method such as design thinking and problem solving learning techniques are required too. There are only eleven year to achieve these goals and we cannot leave anyone behind. Design matters because it pacts every aspect of our life and that is the way it has been from thousands of years. it is time to bring back the power of design to transform the actual situation into a preferred one.

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SOUTH AFRICAN KEYNOTE SPEECH FOR LENS WORLD DISTRIBUTED CONFERENCE DESIGNING SUSTAINABILITY FOR ALL

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Hello, Sawubona, Mholweni and Howzit!

I am honoured to represent the African continent as the invited keynote speaker in Cape Town for the first LeNS World Distributed Conference exploring ways of Designing Sustainability for All.

As you are all well aware, sustainability is regularly over-simplified and misused, which is unfortunate for what is an incredibly important and complex systemic consideration for the continuation of human civilisation. My conception of it has been developed over the last 21 years through personal reflection, active participation in design projects and through broader engagement in academic discourse. I believe one's concept of sustainability is inherently personal, but at the same time would like to take this opportunity to present how the Department of Industrial Design at the University of Johannesburg has grappled with framing sustainable design within one of the most unequal societies in the world. In this regard I will be exploring the themes of immersion & connection, lay designers & local experts, small & incremental, systems & networks and concepts & reality. I am well aware that many of you are experts in product service systems and distributed economies, but as is common in Africa, I will take a narrative approach, through a series of self-reflections on my past experiences as a means to engage with our approaches to Designing Sustainability for All.

IMMERSION & CONNECTION

The first aspect of sustainable design that I would like to explore is the immersion of the designer in a particular context and his or her connection with those he or she is designing sustainable outcomes for. In 2005 I participated in an ICSID Interdesign workshop focused on Sustainable Rural Transport. Led by the SABS Design Institute, in partnership with the South African Department of Transport, it was held over two weeks with about 100 designers and academics flying in from all over the world to explore issues of rural transport in the former apartheid homeland of Bophuthatswana, currently the North West Province. Participants were divided into teams focused on Animal-drawn Carts, Alternative Modes of Transport, Bicycles and Tricycles, and Communication.

The participants were bused into isolated communities where designers would disembark with camera in hand, clicking away, as they documented the lives of rural marginalised South Africans. The bus would then return to our conference venue in an upmarket hotel in Rustenburg to discuss and compare experiences in order to conceptualise solutions to the rural transportation problems we had identified.

I will never forget overhearing a Professor from a European design school exploring one of the participating communities asking, when the typology he was witnessing did not meet his preconceived ideas, "Where is the village?" After two weeks of furious yoyo design activities, the Interdesign came to an end with many of us aware that the time spent exploring issues of rural transport was insufficient to arrive at anything sustainable.

With two of the Department of Industrial Design's staff having worked on the bicycle & tricycles and donkey cart teams, a year later we decided to integrate a continuation of the project into our students' curriculum for the next 2 years. In order to overcome the superficiality of the first workshop we home-stayed with community members from Pitsedisulejang for two weeks with the support of the community's young and enthusiastic local chief. I was dropped off by bus with 5 students and no other means of transport. This embedded experience proved far more insightful. We ate the food that was locally available, walked where we needed to go, collected water from the communal standpipes and bathed in galvanised tubs at the end of the day. On one of the days we realised that we had forgotten to bring bolts for one of the prototypes, in this experience the lack of rural transport was crystallised with the realisation that this relatively simple task would require a full-day trip on municipal buses to a hardware store and back.

Being hosted by and living with people from the community lead us to develop much deeper relationships with them in comparison to the parachute design approach of the first Interdesign workshop. And even though the time period was similar in duration, being embedded meant that you were less of an outsider, and with your designers' eyes, practically better able to explore the lived-experience of those you were designing with. Additionally, in moments of connection, often over a meal, external designers were able to discuss and compare with our local hosts what seemed to be our completely different worlds. The relationships we built with some of the community members, were deep enough for me to continue to remain in contact with a few of them, even though I do not believe that the carts, or bicycles we prototyped for them were ever delivered by the Department of Transport. For deep connections with any person or community to be made, designers need to be open for them to emerge, from my experience this requires a deep self-reflection and mindful presence during engagements.

LAY DESIGNERS & LOCAL EXPERTS

The next aspect of sustainable design I will explore is the identification of lay designers or local experts in projects in order to arrive at outcomes that are firstly driven by local enthusiasm, and secondly, amplify existing local actions as opposed to imposing external ideas about what may need to be done. This results in endogenous or localised sustainable change.

An example of the importance of lay design happened on our final trip of the extended Interdesign project, which took place in 2008; this time to the community of Dwarsberg. We stayed with a local convenience store owner, with our time there kicking off with a collective bang at the local annual donkey cart race. Donkey cart owners

travelled from all around the area to compete for the coveted trophy. In the hive of activity, as they began to fill up the yard awaiting the beginning of the race, I became immersed in the pride and creativity the local donkey cart owners had for their carts. These were not basic carts, but the ingenious reuse of available resources creatively customised into South African chariots! This was sustainable rural transport made by lay designers - people without any training in design, but still following a clear design process to meet a need with the resources available to them. In line with Schumacher's concepts of appropriate technology what was also clear was that much of the manufactured design of our cart prototypes needed reconsideration to be able to be maintained locally. We also realised that if we had worked with these donkey cart lay designers right from the outset, we may have had more resilient design outcomes.

Another example, which shows the importance of identifying embedded knowledge took place in 2006 when I was provided with the opportunity to spend 2 weeks at Jahangirabad Media Institute in India. Here we worked with budding documentary film makers to explore local issues experienced by rice farmers. As South Africans we had no understanding of the inherent social complexities of having students from multiple castes within a single student group. Early in the project we brainstormed what aspects of rice farming were most pressing, as a means to focus the students' efforts. During this process a commotion arose in the back of studio with a group of students clearly aggrieved by our brainstorm process since the more privileged, English speaking students were hogging the input, and biasing the projects focus. We had to ask one of the English-speaking students to translate what was going on – all we could understand was the repeated mention of the word “seeds”. What emerged was that this group of students were all children of rice farmers, they therefore had the most experience to share with the group but were not in a position socially or in terms of the language of communication to share it. Thankfully they were brave enough, and felt comfortable enough, to ensure their voices were heard. We soon all learnt of their familial narratives around the problematics of the introduction of hybrid versus traditional self-seeding rice varieties in India. The new technology, coming up against tradition, ultimately led to crop failure for farmers who tried to replant seed only designed for one planting cycle. The impact of this was brought into stark reality when crop failures were ascribed to the largest majority of the 17 000 farmer suicides in India that year. This was a significant contextual issue, that we would have completely missed if it were not for the experts already in our student group. In our current student cohorts, we also have a very diverse group of students and it is important for us to create a safe environment for them to share their experiences, which may be very different to others in their class. A diversity of voices, although more complex to manage, will almost invariably result in more resilient outcomes.

The idea of working with lay designers or local expertise may seem obvious, but in practice it is not always so straightforward. A few years ago, I was taking a Professor from one of the world's top design schools through an urban farm we had been working with in Soweto. On viewing a few sparse vegetables, he asked me “... but, where is the design?” I was not prepared for the question, for to me it was clear. But for someone looking for design in a traditional sense, there was no visual marvel, but rather actions that merged much more subtly with the environment. In this particular case, it was a shallow hole, a few pieces of clear plastic, and come coir, all used to speed up seedling germination, ease watering and reduce water evaporation in a highly innovative and sustainable seedling growing system. Such an observation concurs with Paul Richards (1985) who acknowledged that many of the most successful innovations in food-crop production in the 20th Century had indigenous roots.

As per this example, in many cases the design is already there, as designers our role is therefore to develop our senses to carefully listen, and to look for it. Our design training can then be used to amplify local lay design endeavours. One of the difficulties that designers have with such an approach to sustainable design, is that in many cases it is not something that is going to win them any design award or stand out in their portfolio. Much of this work, for it to be sustainable, is inherently about starting small.

SMALL & INCREMENTAL

In 2008, we travelled with our final year students to Grupo Desportiva de Manica in Mozambique. They are an “integrated community [football] club that uses sport for social good”. One of the student teams focused on exploring the use and impact of charcoal stoves - the standard means of cooking in the community. Building on our prior positive experiences of working with local artisans, we easily found incredibly skilled local fugão or stove makers. They were utilising old steel railway sleepers and their bolts to fabricate their products, whilst the local government updated the provinces railway tracks to sit on concrete sleepers. The student team, partnered with Chris Bradnum from our Department, who is an expert on fuel efficient stoves, and together with the local artisans, began a process of refining their existing designs using basic emissions testing and temperature sensor equipment we had brought with. The scientific equipment was valuable to measure improvements in efficiency for us, but for the local stove makers, all they needed was to see a reduction in the time it took to boil a litre of water. With deforestation for charcoal becoming a major problem in the region, this small design intervention could help marginally reduce the need for charcoal. An additional benefit, with far greater impact, is that a more efficient stove can significantly reduce smoke and particulates, and hence create a much healthier cooking environment for those using it. Working with the local fugão makers meant that when we departed our knowledge remained.

Many large-scale collaborative design projects, particularly those that need external funding, such as the Inter-

design, are wasteful in their use of resources. Smaller, more targeted interventions require less and due to their focus are generally more successful in arriving at appropriately sustainable outcomes. Nabeel Hamdi beautifully explores *Small Change* (2004) through the example of the positive impact created by simply moving a bus stop to route through a community as opposed to skirting it. The reason that small interventions can have much wider impact is that they are embedded in wider human relations and technical systems.

SYSTEMS & NETWORKS

However, not understanding broader social, cultural, economic, political and environmental contexts can lead to projects completely missing the mark. One of the other student groups we took to Manica worked directly with the football players. They noted that the boots they used, which were designed for plush grass pitches, were completely impractical on African dirt. Partnering with local cobblers our students explored ways to re-sole the boots using discarded car tyres. This seemed a fantastic solution, reusing waste to make much more durable football boots with much improved grip. However, when they got to a final prototype, they could not get even one of the football players from Grupo Desportiva de Manica to test them on the pitch. What had gone wrong? Even though the students had followed a participatory design method of developing the new soles with the football players, what had not emerged in this process was the unseen power of social status and aspiration for these local sports stars. They would rather have gone to the local market with the little money they had to buy new football boots than repair their shoes in a way that only the poorest of the poor would do. The football players eventually told our students that if they wore their resoled boots on the pitch, they would be laughed at by everyone. What we all thought was a wonderfully sustainable and functional solution to the problem failed due to our lack of understanding of the broader social dynamics at play in the Manica community.

Another more successful example of how we used design as a means to facilitate broad systemic change is Izindaba Zokudla, or Conversations About Food, a project I helped conceive in 2011. It is focused on exploring ways to make the food system more sustainable in Johannesburg and began from a series of multi-stakeholder events bringing together academia, not-for-profit organisations, enterprise, government, and urban farmers to discuss the problematics of our city's food system. One of the key activities of the project is the Izindaba Zokudla Farmers' School, which is enthusiastically convened by Naudé Malan. It has run about once a month since 2015 and now also functions as an Innovation Lab. With over 1000 attendees in total, and on average 150 people per session, it allows for urban farmers, farming experts, food enterprises and innovators to converge at the University of Johannesburg's Soweto Campus. The power of the Farmers' School is that it is a platform for networking a whole host of stakeholders in the local food system. This benefits all those involved in terms of new connections, new and more sustainable farming knowledge, shared opportunities for funding, and new technologies. It also benefits us as designers in that disjunctions or contradictions in the food system become opportunities for design intervention.

Two such interventions were projects developed by final year Bachelor of Industrial Design students in partnership with local urban farmers. The farmers initially identified the need for something to keep their harvested produce fresher for longer and something to more efficiently convert seed into seedlings. The outcomes were an evaporative cooler and a self-watering seedling growing system. Both projects were funded by the National Research Foundation, however neither of them made it to market. The main reason for this was that although our University's Technology Transfer Office were interested in supporting the projects, neither of the students themselves were prepared to take the projects further; and such projects cannot easily be handed over to someone else without a personal investment in their success. This had the unfortunate result of the urban farmers, with whom we had developed such positive relationships, feeling as though they were used, since their time and effort did not lead to any direct benefit on their part. This is the crux of many of our student projects, even with all the great ideas towards designing a more sustainable tomorrow, many of them are unrealised. This happens in design schools the world over and we do not want to continue this trend.

CONCEPTS & REALITY

After many years of iterations, I believe we are getting to a point where our design research is finally resulting in appropriately sustainable outcomes. A recent example of this is the Beegin beehive. In 2015, Ivan Brown began developing prototypes for appropriate beekeeping technology for local urban farmers as a final year Bachelors in Industrial Design project. Honey is a valuable resource, which can add diversity and resilience to the livelihoods of small-scale farmers. Additionally, having hives on a farm improves productivity through the pollination of crops by bees and this is a major consideration for the long-term sustainability of food production in the world.

Initial prototype beehive outcomes from Ivan's project needed to be field-tested and further refined through their use, towards wider implementation. In order to do this, the project was expanded into a Masters' research project by providing 5 small-scale farmers and 6 expert beekeepers with beehives to test over one season. The small-scale farmers showed their interest in participating after a presentation by Ivan at one of the Izindaba Zokudla Farmers' School sessions. As part of the project Ivan became a licensed beekeeper to assist the emerging beekeepers to manage their hives and to share appropriate knowledge with them to continue their beekeeping activities after the project finished. Theories of Appropriate Technology, the Capabilities Approach and Designing for Outcomes were used to

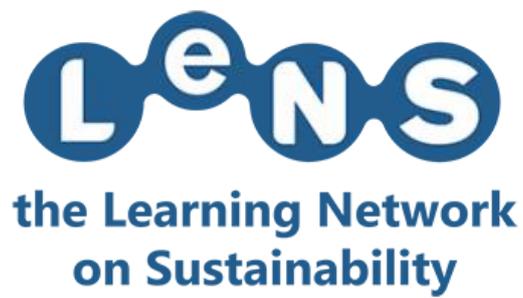
create a theoretical framework which positioned the project philosophically and encouraged the delivery of tangible benefits through the research. Following an iterative Human- and Bee-Centred Design approach, the appropriateness of the beekeeping technology was evaluated, and the hives improved. The final outcomes of the project were two lightweight concrete beehives and their moulding tools.

Beegin is now a registered company in South Africa with aesthetic and functional design registrations to protect the designer's IP through a business model that focuses on selling the mould, and ultimately distributing the means of production of the beehives. This allows for localized employment in what is a very widespread industry. The moulds enable relatively unskilled individuals to produce hives easily, at low-cost, using a lightweight concrete. This material improves both the safety and health of the bees, being fireproof and resistant to pests, but also increases the hives productivity by almost 40% due to its insulation allowing the bees to focus on making honey, instead of heating or cooling the hive. Nothing is perfect, and surprisingly Ivan has struggled with seed-funding to get his business off the ground, eventually resorting to selling his car to pay for the first container-load of moulds. The moulds themselves also had to be manufactured in China, since no local South African manufacturer had access to the material thickness needed for their vacuum-forming. However, all participants in the project still use their prototype hives, and the orders are rushing in for hives and moulds alike. This is a story of success both for Ivan as a graduating student immediately becoming a business owner, for the small-scale farmers who have diversified into beekeeping, for the beekeepers who praise the hives for increasing the bees' productivity, and ultimately, for the bees who seem far happier in their newly designed homes!

IN CONCLUSION

At the end of the day, this is how the Department of Industrial Design and my own ideas of sustainability have evolved.

If I had to choose an overarching philosophy that drives our approach to sustainability in our Department, it would be respect. Respect for the people you are designing for and with, acknowledging their knowledge, design expertise, and systems they already have in place. Respect for resources including the environment, finances, and the time and energy all participants have put into the process by making sure projects are taken to completion.



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THE CIRCULAR INDUSTRIAL ECONOMY IN A NUTSHELL

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CIRCULARITY IS THE PRINCIPLE HOW NATURE WORKS.

A circular economy is as old as humankind but it was a barter economy driven by necessity and a scarcity of shelter, materials and objects, and it was always accompanied by a circular sharing society. This situation still exists in some regions and anywhere in the wake of major disasters.

The industrial economy enabled society to overcome this situation of scarcity; and the used goods, made of wool, timber, leather and few metals were not waste, because they had a value for other people or were compatible with Nature's circularity.

A major break or discontinuity occurred in the 20th century with the invention of man-made materials, such as plastics and synthetic fibres, agrochemicals and pharmaceuticals, metal alloys. Manufactured products using these materials were long-lived yet often had no value to other people and were no food to Nature – they become waste.

Politicians recognised the problem and instructed municipalities to start managing wastes by closing the material loops. But politicians overlooked the challenge of the immaterial liability loops. If wastes of manufactured objects and materials have no value for Nature or man and no liable owner, two obvious solutions are to give them a value, for instance by adding a deposit at the point of sale, or to return them to the industrial producer, creating the industrial economy circular.

Looking at Europe, many young people demand from politicians that they have a future. This can mean to stop climate change (Greta Thunberg) and/or to find a paid job to make a living (Italian and Spanish students). For society, mining the potential of young people is an essential part of Europe's future.

A Circular Industrial Economy could provide such a future, as reports by Anders Wijkman and Kristian Sandberg on the macroeconomic impact of a Circular and Performance Economy in seven European countries have shown. National CO₂ emissions can be reduced by 66% and numerous new jobs created by shifting to a Circular Economy. And these jobs will be local and decentralised, where objects and their users are situated, not in China or Vietnam.

In a Circular Industrial Economy, the opportunities in the reuse and service-life extension of manufactured objects are well documented. Remanufacturing, for example, is one of the five priorities of the 2019 Circular Economy Plan of the People's Republic of China. In addition, a huge innovation potential of the Circular Industrial Economy lies dormant in the recovery and reuse of manufactured molecules. The latter is under-researched and under-exploited: reusing atoms and molecules in loops of highest purity, instead of recycling mixed wastes, is a challenge which involves chemistry on several levels, including the design of new molecules and of mini-mill technologies to de-link existing materials. Innovative non-destructive and non-mixing collection and sorting processes will also need to be developed.

My new book identifies six major challenges for a circular industrial economy of physical objects and manufactured materials:

- 1). CARING: motivating the owner-users of objects to enjoy the use of, and take care of, their assets in the case of organisations and belongings in the case of individuals, for as long as possible – what I call the era of R, of reuse and repair, which must include a right to repair,
- 2). Develop processes and technologies to solve the problem of the legacy wastes of objects made of synthetic (manufactured) materials – what I call the era of 'D', for de-bonding to recover atoms and molecules for reuse.
- 3). For objects with no value or owner at the end of their service-life, a legislation imposing an Extended Producer Liability, which clearly designates who has to solve the problem. It cannot be up to municipalities to solve problems created by profitable industrial producers.
- 4). Spread the technical and economic knowledge of the circular economy, which today exists in SMEs and fleet managers, to all classrooms, boardrooms and parliaments.
- 5). DARING: research and develop novel materials, components and systems solutions to prevent future legacy wastes from arising.
- 6). SHARING: a performance economy, where economic actors sell performance and goods as a service, means using many objects, which are owned by somebody else. This demands a stewardship attitude by both producer and user – no sharing without caring.

Recently, the Internet of Things has added a second break point, where ownership, liability and control of objects are disputed between hardware and software producers and users. The right to repair the hardware may now be infringed by the software producer.

Tackling the six challenges of the book is a holistic task; this means that the six challenges have to be confronted simultaneously, and it needs political vision and action combined with systems thinking in Science and Innovation.

Choose the book of your preferred language:

The Circular Economy – a user's guide, by Walter R. Stahel, with a foreword by Dame Ellen MacArthur, Routledge, Abingdon, June 2019. <https://www.routledge.com/The-Circular-Economy-A-Users-Guide-1st-Edition/Stahel/p/book/9780367200176>

Economia circolare per tutti. Concetti base per cittadini, politici e attori economici. Edizioni Ambiente, March 2019, www.edizioniambiente.it

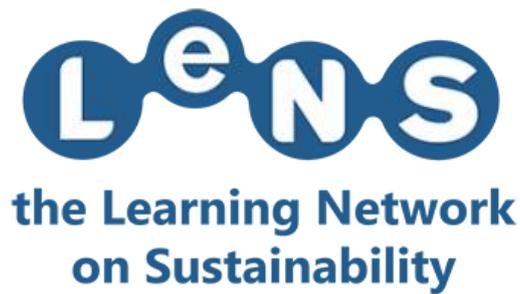
Sirkulær Økonomi – En handbook, by Walter R. Stahel, <https://www.sintefbok.no/> 3 June 2019

Economía Circular para todos- Conceptos básicos para ciudadanos, empresas y gobiernos, by Walter R. Stahel, Amazon.com, May 2010.

Further published reports and videos on the Circular Economy well worth studying:

- 'Nature' published Stahel's 'COMMENT' on the Circular Economy in its issue of 24 March 2016. http://www.nature.com/polopoly_fs/1.19594!/menu/main/topColumns/topLeftColumn/pdf/531435a.pdf
- Circularity and The Performance Economy, Walter R. Stahel in a 20 minute video by the Ellen MacArthur Foundation 2017, <https://www.thinkdif.co/sessions/the-performance-economy>
- A Swedish report on the failure of recycling to retain value in the Swedish Materials System: Material economics (2018) Ett värdebeständigt svenskt materialsystem. Report for the Swedish Recyclers' Association.
- Ness, David A. (2019) The Impact of overbuilding on people and the planet, Cambridge Scholars Publishing.
- Charter Martin (ed.) (2019) Designing the circular economy, Routledge, Abingdon,

2. PRODUCT-SERVICE SYSTEM DESIGN FOR SUSTAINABILITY



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SUSTAINABLE PRODUCT-SERVICE SYSTEM REQUIREMENTS IN FASHION RETAIL

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ABSTRACT

Product-Service System (PSS) arises as dematerialization strategy to consumption and reduction of firms' environmental impact. This paper aims to integrate requirements for designing a sustainable PSS in the context of department stores. We identified requirements for a PSS offer through a literature review and focal groups with customers and managers of department stores using the Value Proposition Analysis tool. To prioritize the requirements demanded, we carried out a survey in Southern Brazil with 160 department store customers. Technical and process requirements were prioritized using the Quality Function Deployment (QFD) and, based on the Product Service Blueprint, the PSS processes were designed. Among the requirements prioritized, the following were cited: the use of more sustainable fabrics and packages, and the absence of store lines. The prioritized processes of support, product use, and services were designed using the Product-Service Blueprint indicating the stakeholders involved, the integration points, and the sustainability reach point.

Keywords: PSS; Requirement integration; Sustainable PSS; Fashion retail

1. INTRODUCTION

The dematerialization of consumption is seen as a solution to reduce environmental impact. Several authors have studied the concept of product-service system (PSS) as a strategy of consumption dematerialization and a possible solution for the reduction of environmental impacts (e.g., Mont, 2001; Lee et al., 2012).

PSS is a solution based on the combination of products and services that focuses on delivering value to the customer generating less environmental impact than traditional offers, because what is commercialized is the right to use the good and not its property (Baines et al., 2007).

Most studies of the PSS literature have been developed in the manufacturing industry context (Kim et al., 2015). Research on PSS development focuses on integrating services into the main product-based offer through servitization. In this sense, service providers and, more specifically, retail can be an important link between industry and customers, making sustainable PSS offers possible.

The fashion industry perceived the need to innovate its business models with the aim to reduce environmental impact (Business for Social Responsibility, 2009). One way to innovate business models is through PSS. According to Heiskanen and Jalas (2003), PSS reduces dependence on natural resources and increases product quality and lifespan, as well as customer satisfaction.

The application of PSS in retail is still a novel subject with literature gaps (Armstrong, Lang, 2013; Hu et al., 2014). Niinimäki and Hassi (2011) indicate customers' interest in services such as leasing, participatory design, and repair services. However, because product ownership is important for status reasons, in cases such as high fashion clothing, the functional offers of PSS may not be attractive to customers (Armstrong, Lang, 2013).

Fashion libraries are a good example of collaborative consumption, such as the Albright Fashion Library in New York. Clothes, shoes, and accessories are lent at reasonable rates with a collection that grows and changes every week, thereby holding users' interest (Armstrong et al., 2016). Another example of PSS in the fashion industry is Mud Jeans from the Netherlands, which offers a rental contract for jeans made from recycled cotton. Additionally, it offers repair services for rented products. Another emerging business model is clothing exchange. An example is the Swap Meet Ups in New York where a fee is charged for exchanging items. Another option is the consulting service, which increases the lifecycle of clothes by giving customers tips on how to combine the clothes they already own and which, generally, have been unused for a long time because customers' do not know how to wear them. An example of such a model is the Coset Dash which offers individual style counseling by videoconference or in person (Armstrong et al., 2016).

Regarding PSS requirements, incorporating subjectivity, uncertainty, imprecision, heterogeneity, and fluctuation in requirement definition is still a challenge. The evaluation of PSS domain requires a specific focus with feedback loops in requirement engineering steps (Vasanth et al, 2015).

Literature still lacks studies and approaches of requirement engineering that consider the requirements of the product-service system in an integrated way considering the characteristics of PSS offers (Berkovich et al., 2011). Some initiatives propose the use of Quality Function Deployment (QFD) adaptations for PSS offers (eg Kim, Yoon, 2012, Li et al., 2016), but they present deficiencies. In addition to the QFD tools for identification and prioritization of requirements in the first phases of requirement engineering (elicitation and analysis), it is necessary to incorporate other tools for value identification, such as Value Proposition Analysis (Osterwalder et al., 2014) and for PSS offer design such as Product Service Blueprint (Geum; Park, 2011) and Sytem Map (Vezzoli, et al, 2017).

In this context, the objective of this paper is to identify and prioritize requirements for sustainable PSS offers in fashion retail services from the point of view of customers, focusing specifically on department stores. Based on the requirements mapped, the prioritized offer is designed considering the process and the concept of prioritized PSS offer.

2. METHOD

The research was carried out in eight steps adapted from Sutanto et al. (2015). In the first step, we conducted a theoretical review on the literature on PSS requirements to identify studies on requirement engineering for PSS, other studies on sustainable fashion retail and sustainable PSS in fashion retail. We did not find research papers addressing the requirements of Sustainable PSS in fashion retail.

In the second step, Value Proposition Analysis (VPA) was used to contextualize the problem and to identify both the needs of the stakeholders involved and the value proposition that would meet customers' demands in the context of fashion retail (Osterwalder et al., 2014). To this end, a focus group was held with 9 customers from fashion retail department stores selected by convenience. The voice of the customer was identified through the focus group. We organized it, eliminated redundancies, and ranked requirements at first-order level according to their similarities. Subsequently, an interview was conducted with two fashion retail department store managers to fill the second stage of the VPA.

In the third step, the quantitative research instrument was built for requirement prioritization. In addition to the questions regarding sustainable PSS requirements in fashion retail, we added questions related to the profile of the respondents, such as: age, gender, and frequency of service use.

Next, the quantitative research instrument underwent the evaluation of a specialist with academic background and a user of fashion retail department stores. Based on the feedback obtained in the evaluation of specialists, im-

improvements were made to the instrument and, afterwards, we ran a pre-test with four users to verify if the questions were clear and easy to understand.

In the fifth step, the instrument was applied with 160 users of fashion retail. The questionnaire was designed using Google Forms and sent via social networks and email. Sampling was non-probabilistic and by convenience, mainly covering respondents from Southern Brazil.

In the sixth step, the collected data were tabulated, and the descriptive analysis was executed to identify the prioritized requirements. Respondents' profiles were analyzed, and after that we calculated the prioritization of the quality items demanded by the customers considering the importance index defined by the users in the questionnaire (IDi), the strategic evaluation (Ei), and the contribution to sustainability (Si).

From the prioritized requirements, we applied the QFD tool (Ribeiro et al., 2001). In the quality matrix, the first quartile (25%) of the prioritized requirements was used. For each requirement demanded by the customer, we assigned corresponding technical requirements and, subsequently, the relationship of these technical requirements with the requirements demanded by the customer was evaluated. Based on the quality matrix, we built the process matrix. To that end, all the processes of the offer were deployed to evaluate the relation of the processes with the technical requirements. The definition of the technical requirements, the processes, and the filling of the matrices was conducted by specialists in the area.

Finally, in the last step, the necessary processes for the delivery of the prioritized PSS offers were designed using the Product Service Blueprint tool (Geum; Park, 2011). In the Product Service Blueprint, the critical processes that were prioritized in the QFD process matrix were highlighted. The design of the prioritized concept for the PSS offer was made using the System Map tool (Tischner; Vezzoli, 2017), which synthesizes the main stakeholders and their relationship in the new offer.

3. RESULTS

3.1 REQUIREMENTS PRIORITIZED BY CUSTOMERS

The requirements identified through the VPA were prioritized based on the customers' declared importance in the quantitative research. Customer importance was weighed based on the strategic market evaluation and contribution to the sustainability of the offer.

Among the prioritized requirements, the following sustainability-related ones were highlighted: use of fabrics that cause less environmental and social impact, use of sustainable packaging, possibility of returning the clothes to the store after use, and consulting to assist in the combination of old pieces of clothing.

Service requirements have also stood out, with three of them ranking among the eight priority ones: warranty for merchandise quality issue, repair and alteration service, and various payment options in the place and remotely. Priority requirements also include the absence of lines, which is a requirement of customer experience.

3.2 DEPLOYED PROCESSES

In the quality matrix, only the first quartile (25%) of the prioritized requirements was used. The requirements demanded by the customers were associated with the corresponding technical requirements, as defined by the researchers and a department store manager. For each requirement demanded, at least one technical requirement was defined. The main prioritized requirements were the number of service channels available, parts' lifecycle, fabric degradation time in the environment, number of consultants assisting in outfit matching and packaging degradation time in the environment.

After the construction of the demanded quality matrix, we designed the process matrix by relating the prioritized technical requirements from the quality matrix with the process steps of the department store offers. The following processes were prioritized: consulting in the combination of parts, raw material selection, recycling of fibers, selection of suppliers, employees' hiring and training.

3.3 DESIGN OF THE PRIORITIZED OFFER

Based on the requirements prioritized by customers, the prioritized offer was designed using the Product Service Blueprint tool. In the PSS offer, presented in Appendix 2, the whole process was graphically drawn, from production until the customer returns the clothes to the store for fiber recycling.

The prioritized processes in the process matrix of the QFD tool were highlighted, according to table label. The offer presented an economic point of value (the payment), four points of product-service integration and four points of sustainability.

In the designed offer, several services were added with the purpose of increasing product lifespan. The PSS offer also allows the customer to return pieces to the store, which becomes responsible for heading them to an outsourced company to recycle fibers, and afterwards use fibers to manufacture new products. This PSS model can be classified as product-oriented, since services were added to increase the lifespan, but the customer still holds the ownership of the product, as prioritized by customers.

Finally, the concept of the PSS offer was designed using the System Map tool (Appendix 1). In the concept, the relationship between the main stakeholders of the offer can be identified, namely: the customer, the department store, the manufacturer, and the distributor.

4. CONCLUSION

This paper addressed sustainable product-service systems in fashion retail, focusing specifically on department stores. The objectives were to identify the demands of the customers, prioritize such demands and, finally, to design the prioritized offer.

The work provides a methodology to design a prioritized PSS offer for fashion retail based on customers' demands, which is still a recent issue in the literature.

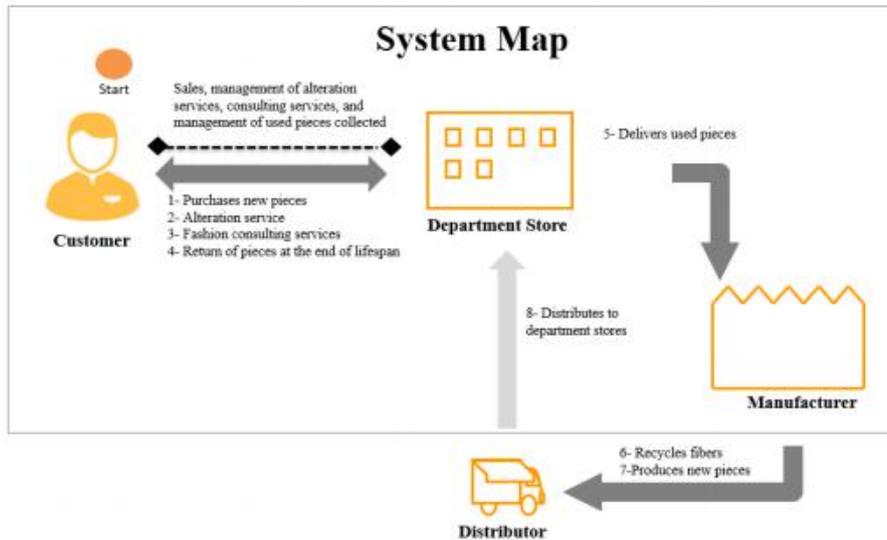
A limitation of our paper was that the requirement prioritization only considered customers' point of view and the strategic analysis based on a consensus among the authors, without the presence of fashion retail specialists. Future research could validate the requirements of other stakeholders of the offer, such as retailers, manufacturers, and distributors.

For future work, an analysis of economic and technical feasibility is suggested, as well as follow up on the development and implementation steps of the proposed PSS offer. Finally, another suggestion for future research is the application of this methodology in other segments of retail, such as home appliance retail, which already presents a tendency of consumption dematerialization.

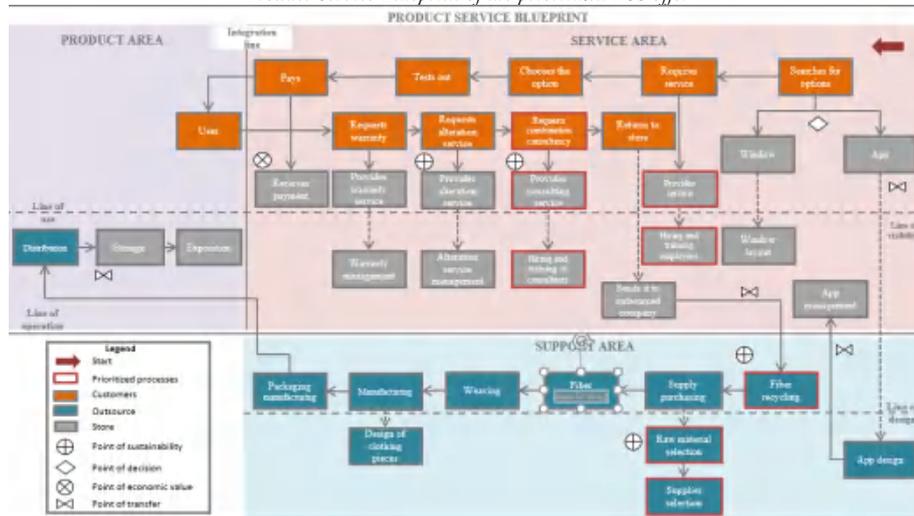
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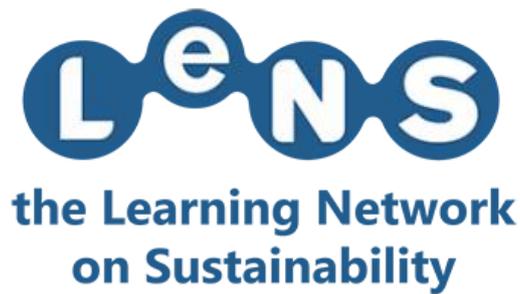
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APPENDIX 1
 System Map of the prioritized PSS offer



APPENDIX 2
 Product Service Blueprint of the prioritized PSS offer





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TRASTOCAR. INTERACTIVE ART-DESIGN TO MAKE VISIBLE ENVIRONMENTAL IMPACT

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ABSTRACT

The purpose of this collaboration is to offer elements for discussion on the role of intersections among art, design, and technology in the socialization of environment problematic. To do it concretely, it is appealed the case of an interactive piece called *trasTocar* (to disrupt) exhibited in Zanbatha, the municipal museum in the inner state of México.

The exposure scheme starts with the environmental situation addressed, particularly from the Anthropocene Crutzen's concept, to engage it with the pollution in the wetlands of the natural federal reserve next to the Lerma river's in Toluca Valley. Later, it is described the interactive object proposal based on cybernetic Lotman's communication theory which under the premise that human beings alter their environment use the digital art medium to participate in a dialogue through interaction. Finally, the results are shown.

Key Words: digital art, environmental impact, interactivity, reception.

1. ABOUT THE ANTHROPOCENE

The Crutzen and Stoermer (2000) concept is set in the interdisciplinary interstice. Its elaboration was the result of a conceptual projection from geology to ecology. Also, its transit through biology, sociology, anthropology, philosophy, education, and art, and others have contributed with distinctions, applications, nuances, relevance, and sense to the concept. Each discipline scope reality from the premise that Earth's crust has been transformed by humans.

The Anthropocene expresses qualitatively the human footprint in life's Earth (Maldonado, 2016). In an energetic standpoint, it is a geological force. Since the beginning of the Industrial Revolution in the XVIII century, this force has been increasing under the belief in the limitless natural resources that capitalism exploits. From design, Anthropocene; represents a scenario where the development of products means responsibility for the past learnings and the future options. Consumption and its disposal are not any more dismissed. Humanity doesn't need to dominate nature in a brute way but to control technological force to prevent damages and consequences of unthought actions.

Also, here art has something to say; rather to just represent reality in different modes, it is to highlight the theme, visualize the problem amid a super information landscape.

So, the Anthropocene transits in between disciplinary boundaries as design and art. In these two cognitive fields, its meaning turns towards questioning the span of human actions in future generations, but in different directions. In the design, the reflection focuses on the possibility of modifying the behaviours and imaginaries regarding consumption patterns that have impacted the environment on a global scale. For art, questioning focuses on re-thinking humanity as a species that coexists with others rather than dominate them, and on reflecting the intelligent use of resources. The first focuses on actions, the second on its possibilities. In the mutual collaboration between fields and epistemes, the Anthropocene as an interdisciplinary concept leads us to observe this stage as a long and intense sociohistorical process with long-term consequences.

2. THE WETLAND'S DREAM

Around the Lerma municipality,¹ there are several natural and potable water fountains. In the past, they satisfied the basic population needs set close to the shores of the lakes formed together with the runoffs of the surrounding mountains (Orihuela, 2011, pp. 26-28). Lerma is the same name for the river and these lakes that support diverse flora and fauna as well as villager since the indigenous epoch.

In the XX century the Lerma river and wetlands were stressed by two concomitants socio technological phenomena: the course of it was deviated to supply Mexico City's water demand; and, the government favoured the setting of industry in that very same place taking advantage of dried lagoon bed for its dumping (Orihuela, 2010, pp. 54-55).

Nevertheless, the local population takes water from their dwells without certainty in its quality to be drinkable (Ramos 2017). Mass media and authorities emit contradictory messages about this matter, since the odors, garbage, and sewage spilled on it are increasing as do its urbanization.

In 1990 state authorities created a commission -Comisión de la Cuenca Lerma, (<http://cuencalerma.edomex.gob.mx>)- that takes care of the zone and make continuous studies and statements about it, saying that odours and water quality are due to natural reasons and are not risky for human living. However, other research centres give their own versions, particularly on the High Lerma zone studied since 2001.

So, the National Institute of Nuclear Research (ININ) has been reporting the existence of heavy metals in water that surpass the accepted minimum international levels to sustain agriculture and aquatic life. As well they have found the excessive organic charge in the river due to uncontrollable industrial and residential sewage and dumping systems. Likewise, the bird hunting season is allowed without a clear regulation.

Along with this complex scenario, there's a biocultural component characterized by irregularities in land possession. Federal properties managed by communal interests have faced a gradual but continuous foreign invasion generating violence and pressures on land tenures, diminishing the wetlands area (Patrick-Encina 2016). As well, the bird hunting season is allowed without a clear regulation.

This information heterogeneity determined the course of data collection. As a first step, a street survey was done in Lerma de Villada city to identify the population perception of the ecological problem and to know about its wetland's imaginaries. In this sense, it was pick up people among 19 and 60 years old that inhabited the region since they were kids. They were asked about their knowledge, memories, and references on the Lerma river.

The survey was conducted on a drift scheme (Durán 2011, pp. 141-142; Debord, 1991, p. 17); a free walking that sketch a situation with the purpose to collect ambient information through different technics: fleeting interviews, unstructured interview, photography, daily entry. The people testimonies verified a progressive deterioration since they enjoyed their childhood amid that natural territory and how urbanization (rurban) changed it.²

¹ See the location of Lerma's wetland clicking on the link <https://goo.gl/maps/MbUf2cdK3eF2>

² Galimberti addresses the differences between urban and rural by reflecting on the concept of rurbano. She updates the term in the relation between the transformations of the ways of living together and the surrounding infrastructure. See Galimberti, Silvana (2011)

3. WETLAND MEMORIES

The findings among youngest people are memories of a polluted river, sewage and occasionally, litmus, although referred their parents or grandparents' comments on a once unpolluted river; some others don't know the wetlands or were there without noticing it or ignoring that they were a natural federal reserve. The older people remember a childhood with a river less polluted, with enough clear waters where they could play jumping on it either from a swing holding in a tree or from any border; one of them, an ophthalmology doctor, near 60's years old, told that in those times you could see recreative fishing; Marie, a 56 years housewife remember to have seen "stunned" carp fishes because of the pollution river but not like that in the near wetlands. It is reiterated an idealized description of the past.

In the past. For those, once children, were distraction places, coexistence and in some cases, usufruct nature from hunting or grazing. The wetland was not only a plain landscape but a social and biological substrate for a living. Nowadays the picture is different, just some zones have been protected because of its strategic relevance: the maintenance of aquifers charge that supply water to the municipality. Even so, it is under continuous risk that kind of life.

So, the common sense is a Lerma river highly contaminated by garbage and sewage without any interest or visible solution; authorities, population, and enterprises blame each other dissolving responsibility and, in this way, individual actions are covered up just transferring the problem to a macrosocial level where they have not choices to intervene.

Hence, it's relevance to communicate a state of things that emphasize the damages to nature due to human actions in a macro and micro social scale, questioning the local dwellers about the impact of their daily behavior. To meet this aim, it was explored a methodological pathway through a theoretical sieve of Lotman's semiotic culture based on a systemic communication view. Consequently, the chosen categories to operationalize the ideas and actions within a methodological order are four: frontier, text, translation, and language.

4. THE SYSTEMIC SEEING

During this indagating in the surroundings of the Lerma basin, were identified elements that allow conceiving the referred space as a sociobiological producer of sense, in which collective memory linked to the place and its daily references produce a heterogenic deep-rooted tradition. Lotman (1996) names to this space, *semiosphere* (16).

The theoretical approach was solved considering to sustainability immersed in the cultural hybridity of the basin in systemic terms; namely, differentiating society in communication spaces and therefore producing sense. So, because the Lerma basin contains culture is regarded as a semiosphere and the communication forms in it get a nuclear role.

So, let's work on the semiosphere constituted by these four elements. The first, is the delimitation, the *frontier* (Lotman, 1996, p. 12), where a set of points trace an inside and an outside. This is a filter whereby the text of other semiospheres crosses by. Here the translation operates combining different languages (Lotman, 1996, p. 13). It is a bilingual mechanism to translate texts external to the internal language. The interchange between subjects happens with texts and language sharing; because they are commons signs they can circulate and therefore are given form.

The second part is the *language*, a system of signs that is the ground for text creation. Obey to own rules based on a natural language. A language is a modelizer system that structures and organize text generation using the combination rules of signs (Lotman, 1982, p. 18).

The third element is the *text*. It functions as a message (Lotman, 1996, p. 54). Also, is the culture memory, since its forms' construction is marked by semiosphere footprints giving heed to a hologrammatic principle; the text is the brick which builds texts, macro texts and finally culture. In this way, the participant semiospheres of culture (or macrosystem) are made of texts developed in secondaries languages; when they circulate in a semiosphere may produce avalanches of texts (Lotman, 1982, p. 18). Because the text is made for exchanging its condition in communication is the misconception, when every participant tries to de-codified it: every subject has its own interpretation, vary depending on the context in which is assimilated or actualized. Thus, the text is the medium to translate.

Therefore, the central operation for understanding is the *translation*. This fourth element is characterized by mechanisms that ensure in time and space to produce sense during the messages exchanging. Normally, this happens in equal and reciprocal relations; in isomorphic terms; in each side, there must be twofold-looking, strange and familiar, noise and clarity. The untranslatable is treated as entropy to be selectable rather assimilable or disposable according to the understanding level achieved. The unknown has this same view: it is the extra-semiotic, the invisible in social life yet waiting for a form to be represented.

The four seen elements allow us to visualize our case presented as a complex problem, well demand to observe the biocultural polygonal like a web relationship intertwined by personal and collective experiences to communicability impact and disciplinary knowing's where design, digital art, and sustainability come together to produce texts problem.

Consequently, the proposal was to socialize a work of complex translation: the wetland data on an anthropogenic pollution basis directed to its local population supported in design and digital art to highlight this situation in a public space: the municipal museum.

5. ARTIFACTUAL TEXT

One step further was to elaborate a methodological pathway. To put it simply: to build a text for setting it in an exposition museum and to evaluate the translation the visitors did. This enterprise, of course, demanded the dialogue

of different bits of knowledge. The results were a kind of a secondary language that appeals to an incipient identity of an emergent semiosphere. Here, the recreation gives form to the frontier which is the junction place where language interplay and translation operates. Design and digital art working together to organize comprehension through text, bringing order to chaos and thus meaning to reality.

The shared inter and transdisciplinary knowledge based on discourse on the artefactual dimension is the digital art object. Clearly, this becomes the nucleus of the translation experience where individual, architecture and time find an identity and therefore a communication frontier. With the artefactual text, memory recreates daily life with the surroundings and the ambient theme in a reflexive moment. The distinctions inner/outside, intimate/strange, near/far, natural/artificial appear as a direct linking to a homeland origin and, finally defining a rurban culture.

So, the bet was to design an art object that could synthesize all the above ideas. The text to model the sense of translation through recreation. That implied a disrupting action, that is to say, a disturbance of the individual bio-cultural sphere to produce sense. This condition gave the name to the artwork: trasTocar (to disrupt).

The materiality of the corporal-visual text is a digital art installation in which the subject is asked along to interact with it. The factory is composed of two electronic screens fixed in the museum wall. Under it, there is a Kinect sensor that translates, thanks to an algorithm and a computer, the body movements of the person who stands up in front of it into a reflective image projected in the screens. On it, there's a mosaic with binary pictures of the Lerma basin showing alternatively polluted and unpolluted images that are distorted as bodies move.

The algorithm used to disrupt pixels was designed with Processing for Debian GNU/Linux. As subjects interacted with the piece their body movement was recorded in computer memory when the most disturbed area was projected. (See figures 1 and 2) In the end, all the images collected gave us a repertoire of the different people bodies' deployment and gradient disruption when they recreated their museum experience.



Figures 1 and 2. trasTocar. Right: screenshot of the most disturbed frame. Left: disrupting the screens with body movements.
Source: Own file, Rodrigo Rosales y Carolina Robles, 2018.

The place for a location was the municipal museum of Lerma named Zanbatha (Moon's valley, in otomí native language) inaugurated in 2015. It is inserted in the wetland concerned area and it has a diverse cultural agenda (<http://zanbatha.lerma.gob.mx>) attending since contemporary art, vernacular traditions, plastic arts, and craftsmanship's expositions among others. However, the constant texts appeal to the Lerma Valley life.

In this occasion, the frame event was the third edition (EAD.03) of the Digital Art career of the Metropolitan Autonomous University, campus Lerma, undertaken in autumn 2018 for three weeks. It was presented together with seven more artworks which were the final degree projects of the best students.

Once the exposition began, besides the programmed corporal register described earlier, other technics were used to collect data as questionnaires, guided tours and participatory observation to analyze, compare and interpret it. During the 21 days of the exposition, the artifact registered 1053 events (activations for a reading) noticing that a person could have activated it several times whether for accident or for exploratory reasons.

The questionnaires applied aleatorily picked up minimal sociodemographic useful data to identify visitor provenance, age, level of schooling, and knowledge background about digital art and museums. However, the guest book was known that most of the visitors proceeded from the polygonal proximities.

The "walk through" was offered by the investigator as a guide (participant-observer) to kids, adults and teenagers being the later who most demanded. But, speaking generally, there was a rejection of this accompanying.

From this experience, was observed direct conversations, expressions, movements, and behaviours, especially, around trasTocar that helped organize visitors' patterns of translation and interaction organized around their ages: kids and preteens, teenagers, adults, and senior adults. It was identified three moods of interaction adjacent to the text translation operation regardless of the grade distortion done to the landscape pictures: self-giving (kids and teenagers); reflection (adults and teenagers); and accustomed (adults). All of three giving form to a recreation mode.

6. RECREATION MODE AND INTERACTION MOODS

The moods or moments of interaction observed correspond with three kinds of corporeality identified within a sedimentary behavior museum canon since their creation as public spaces of art in the mid of XVIII century (Shin-

er, 292-293). While every actor has a different behavior respecting with the canon represented by the text “don’t touch”, every mood was described by different attitudes. Thereafter, the norm has been followed throughout straight or suggested advising signs or rather the tour guide surveillance. In this case, the direct participatory observation of the guide modified the norm observance.

Either way, the three moods of interaction were recognized. The highest incidence happened with the reflexive one, which represents the midpoint between the accustomed and the self-giving moods. It is convenient to note that all the three together are based on the recognition of the norm; its performative action and even in its sliding. That’s why these three categories embrace a diversity of interactions during the translation within the context; the deployment variety can accommodate in any one of the three options.

The first step is the self-giving, characterized by a free attitude that is an introduction before the text-artefactual, setting a confidence value with the actor. Lotman develops the same category to treat the semiotic and social contractual link. From his viewpoint, self-giving corresponds to a cultural archetype based on an ethic calling to the own treatment or commitment involving confidence with others (Mandelker, 2007: 67). According to Verenich (2007), self-giving comes from the religious sphere where devotion is a condition to the path calling of freedom.

So, within the self-giving mood even that some adults and teenagers were brought about slowly examining and moving around to turn it on, others did it by accident and others playing. All the cases show an incremental discovering in the process of opening of actors and artwork. Few deployed the fullness of their bodies and the kids were who showed no doubt during the interaction and about the theme.

The opposite pole of self-giving in this triad around the canon it is the *custom* which is based on the imaginary contention of corporality to avoid risks or punishments. Despite there are no surveillance devices in the museum, touching is not allowed because is interiorized in the actors; it is a habitus normed through repetition and custom, incorporated (Bourdieu, 1980), a history made up a body (Foucault 2010). Meanwhile, for Lotman the norm is concerned by the contract. It is a bilateral conditional act expressed during translation. The self-restraint reflects the hidden canon.

Although the visitors in this mood could verbalize the theme of *trasTocar*, they were not able to translate the interaction until the tour guide assisted them. Most of these actors were adults and just a few youngsters.

In the middle of the triadic moment, it is the third mood: *reflection*. Convention and discovery dialogues through the text-artifactual to express doubts, hesitation or curiosity whether individually or in a group. The interpellation varied depending on the link adults-kids, classmates, or in loneliness. From willingness or accident, all of them learned from actions for translating an artwork that incorporates different bits of knowledge to break the canon giving meaning to this aesthetic experience.

7. CONCLUSIONS

The socialization experience around the damaged environment through an artifactual text in a municipal museum was the result of the design + digital art practices conjunction: the aesthetic signals emitted by such experience communicating knowledge of science and technology.

The translation and its three forms to operate indicate different behavior according to age. The digital artwork disrupts the traditional contemplation stance of the public in a museum. However, this perturbation is associated with a close relation to an ecological problem. This happens in the frontier where semiospheres overlap: technology and science produce sense through an artifact which as well as a text makes, by isomorphism, identity. To sum it up:

a) Translation of *trasTocar* was successful due to the public recognizing their surroundings when speaking about the wetland and its threats.

b) The digital art-design partnership constitutes a device for intersemiotic translation dialogue; specifically, applicable to reproduce the socioecological emergency in contemporary communication.

c) The artifactual text throughout the capacity to recognize body deployment can dialogue with the public about the ecological theme.

It is also worth mentioning that the codes used in the municipal museum are different from others, like the ones used in science museums. The first mentioned has low resources to operate, that’s mean no to have hired people to attend and orient visitors during the exposition. So, the statements, set beside every artwork, although can be helpful, in fact, are scarcely used. In this sense, the translation operates in a recreation mode. Self-giving, reflection and accustomed moments are intertwined in the public behavior in front of the digital artwork.

The exchange of signs in transdisciplinary communication highlights the translation as a central operator in digital culture. The frontier becomes the channel through semiospheres overlap to produce alternative meanings of a reality dominated by conventional representations. In this way, art makes visible what is not existing; re-creates the world in relation to life bringing bodies to presence and present in the dialogical museum experience.

So forth, since the artifactual text (artwork) is conceived as an invariant structure to function as a data collector as well as a device for dialoguing between a nature problem and the public, then it is regarded as a product of design: the result of technological thinking. However, because it is deployed inside a museum and in a digital art exposition, it also is an aesthetic symbol for cultural identity.

The beforehand tells us that the frontier drew upon transdisciplinary knowledge and practices land over praxis.

It means that this experience calls us upon a close relationship between design-art/science-technology not only to enunciate novel ways to see reality but rather, an imbrication between theory and technic that design organizes to change it through education research, including other forms to inform as might be with popularization science.

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PRODUCT-SERVICE SYSTEMS DEVELOPMENT PROCESS: SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

This paper presents a systematic literature review on Product-Service Systems (PSS), focusing on its development processes. Product Service Systems (PSS) are a sustainable industrial solution, delivering an integration of products and services instead of products only – a model still not broadly recognized. A literature search encountered 87 non-duplicated papers, employed at identifying existing approaches on PSS development, according to its lifecycle stages. The main approaches per stage were presented, as well as those with a focus on sustainability. Since manufacturing companies need support on delivering PSSs solutions to customers, this research takes a step forward into a practical assistance approach.

Key Words: Product-Service System; Development Processes; Lifecycle Stages.

1. INTRODUCTION

Product-Service System (PSS) is a business model that sells not only products, but an integration of products and services in order to fulfill customers' needs and guarantee their loyalty through individual offers (Alix & Zacharewicz, 2012; Vezzoli et al., 2018). It's a process of servitization of products, close to functional economy for the sale of a function instead of physical products, found to bring more profit to companies than the offer of products only (Alix & Zacharewicz, 2012; Mont, 2002).

PSSs are seen as a solution related to sustainable development (Kim et al., 2015; Tran & Park, 2016; Vezzoli et al., 2018). With the uncovering symptoms of environmental decay, consumers have been pressuring companies to produce in a sustainable way. A service-oriented economy could be the direction to take on this matter (Mont, 2002; Vasantha, Roy, Lelah, & Brissaud, 2012). This servitization process is comprehensibly translated into the PSS business model, which has been emerging as a trend among industries (Park & Yoon, 2015).

As this process is not yet recognized as the traditional product-based manufacturing process, industries require support in terms of tools, methods and processes that assist them through the producing transition (Vasantha et al., 2012). They need help delivering solutions to customers that are not necessarily product-based. Some assisting development approaches have been proposed in the literature, but there's still a gap on practical approaches (Tran & Park, 2016) and on the ones directly related to sustainability (Vasantha et al., 2012).

Authors (Aurich, Fuchs, & Wagenknecht, 2006; Baines et al., 2007) have stated the importance of designing PSS through its lifecycle. Mourtzis, Fotia, and Vlachou (2017) express that there isn't an only stated cycle for PSS. For example, Wiesner, Freitag, Westphal, and Thoben (2015) proposed a PSS cycle based on Beginning, Middle and Ending of Life ideas, while Kim et al. (2015)'s work covers a cycle with five steps: design, production, sales, usage and disposal.

With that in mind, the purpose of this paper is to identify the main approaches related to PSS development, as well as the approaches that have a sustainable focus. The paper is organized as follows: this section presented a background on the subject. Section 2 presents the research methodology, while section 3 explores the approaches we gathered. Finally, section 4 states some concluding remarks.

2. RESEARCH METHODOLOGY

This paper encompassed a search for existing PSS development supporting methodologies. The search was conducted in Scopus and Web of Science academic databases, through the following key words: "product service system" AND (methodology OR tool) AND (development OR developing OR implementation OR implementing OR modeling). The key words were sought on the papers' title, abstract and key words, considering papers published from 2008 to 2017.

A total of 195 non-duplicated articles was found and skimmed, looking for those papers that would bring us the PSS approaches we were looking for. This analysis resulted in 87 papers, which were entirely read. The PSS development approaches mentioned on the 87 papers were congregated and classified according to the PSS lifecycle stage they attended and their emphasis – or not – on sustainability.

3. RESULTS AND DISCUSSION

We chose to work with a cycle proposed by Beuren, Sousa-Zomer, and Cauchick-Miguel (2017) that covers the phases of PSS requirements definition, development, implementation, monitoring, and destination after use. PSS requirement definition phase aims at attending consumer's needs by organizing a set of pre-requisites for the PSS (Beuren, Pereira, & Fagundes, 2016; Marques, Cunha, Valente, & Leitão, 2013). The development phase shows how a PSS must be developed, integrating products, services, actor's network and infrastructure (Beuren et al., 2016; Beuren et al., 2017). PSS implementation covers product installation and service implementation (Marques et al., 2013). PSS monitoring gathers data from the system and decides either PSS should continue operating or not (Beuren et al., 2017). Destination after use includes replacement, recycling, and/or product take-back (Zhu, Gao, Li, & Tang, 2012).

From the 87 analyzed papers, 133 PSS approaches were congregated. Those are related to any stage of the PSS lifecycle, although most of them were found to be related to the first two phases of the cycle – result probably explained by the key words employed on the search. Table 1 shows a few of the main approaches associated with each lifecycle stage. We chose to present two of them to each stage, selected by the amount of times they were cited as being employed on that specific stage of the cycle.

[Table 1] PSS Main Approaches per Lifecycle Stage

Lifecycle Stage	PSS Approach	Approach References ¹
PSS Requirements Definition	Service Explorer	(Bertoni, Bertoni, & Isaksson, 2013; McKay & Kundu, 2014; Park & Yoon, 2015; Pezzotta, Pirola, Pinto, Akasaka, & Shimomura, 2015; Tran & Park, 2016)
	Quality Function Deployment	(Cavalieri & Pezzotta, 2012; Haber & Fagnoli, 2017; Morelli, 2009; Pezzotta, Pirola, Rondini, Pinto, & Ouertani, 2016; Wiesner, Marilungo, & Thoben, 2017; Yoon, Kim, & Rhee, 2012)

¹ These are the references contained in our 87-paper library. The owners and developers of the approaches might not be on this list.

PSS Development	MePSS	(Dimache & Roche, 2013; Geum & Park, 2011; Sakao, Sandström, & Matzen, 2009; Yoon et al., 2012; Zine, Kulkarni, Ray, & Chawla, 2016)
	Product Service Blueprint	(Bertoni et al., 2013; Geum & Park, 2011; Kim et al., 2015; Lim, Kim, Hong, & Park, 2012)
PSS Implementation	FMEA	(Cavalieri & Pezzotta, 2012; Pezzotta et al., 2016; Yoon et al., 2012)
	PSS Board	(Lim et al., 2012)
PSS Monitoring	System Dynamics	(Lee, Geum, Lee, & Park, 2012; Lee, Han, & Park, 2015)
	Discrete Event Simulation	(McKay & Kundu, 2014)
Destination After Use	Practical Design Framework	(Tran & Park, 2014)
	Lifecycle Model	(McKay & Kundu, 2014)

From the same 87 papers, we also selected the PSS approaches with some emphasis on sustainability. Not every PSS developed brings environmental or social benefits, and, during development, the system needs to be carefully conceived toward that direction (Vasanth et al., 2012; Vezzoli et al., 2018).

The Methodology for Product Service System Development (MePSS) is a method to design PSS through customers' needs and strategic analysis (Park & Yoon, 2015; Zine et al., 2016), providing the involved ones with a practical approach and a big picture of the system's condition. Many authors (Bandinelli & Gamberi, 2011; Cavalieri & Pezzotta, 2012; Vezzoli, Ceschin, Diehl, & Kohtala, 2015) cite MePSS as one of the main approaches to design a PSS. Others (Dimache & Roche, 2013; Sakao et al., 2009) state the use of MePSS in PSS development as a sustainable approach.

Geum and Park (2011) developed a tool called Product Service Blueprint to assist on PSS development. They declare that the approach is an adaptation of Service Blueprint to PSS, aiming at reflecting PSS characteristics, i.e. customer value, economic value and sustainability (Geum & Park, 2011; Lim et al., 2012). Some authors (Bandinelli & Gamberi, 2011; Geum & Park, 2011) point to the application of a Sustainable Product and Service Development (SPSD) method related to developing PSS in a sustainable way. The method has a great focus on sustainability, as it measures environmental and social aspects related to the conceptual development of a PSS.

Lee et al. (2012) listed several studies on how to measure sustainability on a PSS and developed a dynamic and multidimensional approach for PSS, integrating the three pillars of sustainability with a simulation tool. Kim et al. (2015) describe a set of 94 evaluation criteria for PSS with a main focus on sustainability, quality and cost, presenting a background review on the need of developing the scheme.

4. CONCLUDING REMARKS

This paper presented a literature review on Product-Service System development approaches. The approaches were gathered from the literature and classified according to the PSS lifecycle stage they attended and their emphasis – or not – on sustainability. Some of the main approaches were displayed and exploited on the paper.

Most of the approaches were concentrated on the first phases of the cycle, probably from the choice of keywords employed on the search. As for future researches, it's suggested that the search would be expanded, in order to cover the final stages of the PSS cycle as well. As Product-Service Systems are emerging sustainable industrial approaches, this research is relevant as a step into covering the gap expressed by Tran & Park (2016).

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INTRODUCING SYSTEMIC SOLUTIONS FOR SUSTAINABILITY AT THE DESIGN COURSES IN UAM CUAJIMALPA. STUDY CASE: BOOK CLUB IN MEXICO CITY

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ABSTRACT

The case study presented in this paper, envisions a student project, which was undertaken at the “Design” bachelor program (also known as “Integral Design”) at UAM University. The main focus of the project involved the way in which design can help promote reading, through the particular case of the Bookclub Network in Mexico City, a heterogeneous group of spaces led by community work that has proven its relevance for 20 years, despite losing all support from the government. The methodological approach of the project supposed a paradigmatic shift regarding conventional practices, in order to avoid an “Integral Design” through the addition of particular design practices, so that a better articulation could be reached by means of an interdisciplinary systemic design that could also unravel a complex problem under the vision of sustainability.

Key Words: Design courses, Systemic Design, Sustainability

1. INTRODUCTION

In Mexico, it is common to analyze and solve a Design Problem from a particular Design Discipline or area (graphic, industrial, multimedia or architectural). The Design Bachelor program at UAM allows exploring Design without a particular focus, where complex problems are being undertaken during the final courses of the program. Previously, the solutions to those complex problems were developed through the incorporation of pieces of each particular design discipline to achieve an “integral” design. However, through an approach that methodically incorporates a systemic design, not only an articulation among all interventions at a system level is possible, but it also allows a more solid approach towards Sustainability.

The assimilation of a sustainability focus in this project, involved a deep understanding regarding the importance of economic autonomy from the government at local community-led cells, whose goal is the promotion of reading as a pillar of education in Mexico City. This way, a multidisciplinary approach was adopted at the research phase, including design, semiotics and cultural studies. Additionally, an interdisciplinary approach was needed in order to articulate different areas of design to offer a systemic solution to social, economic and environmental problems.

2. READING CULTURE IN MEXICO AND SUSTAINABILITY AS DESIGN PROJECT FOCUS

Although we do not have homogeneous figures, in general the reading indicators in Mexico are low in comparison with countries with similar development: according to the Reading Module (Molec) of the National Institute of Statistics, Geography and Informatics (INEGI) for 2018, each Mexican reads an average of 3.8 books per year, spends a little more than half an hour a day reading, but only 2 out of 10 readers fully understand what they read, while 6 out of 10 understand the majority and the rest comprise half or less. Those who read, prefer literature (40.8%), followed by academic readings (33.6%) and the rest prefer self-improvement books, religion, manuals or guides (25.6%). According to Molec research, although Mexicans receive some encouragement to increase their reading levels, half of the inhabitants said they do not have enough time to devote to reading. At least 1 in 4 said they do not read due to lack of interest and because they do not like reading, and 1 in 10 said they do not read because they prefer to do other activities.

In contrast to the average of 3.8 books read per year by each Mexican, the same indicator in Spain is 10, in Portugal 8.5, in Chile 5.4, in Argentina 4.6, in Colombia 4.1, and in Brazil 4. Although the government makes permanent efforts to increase reading among Mexicans, the situation has not improved significantly in the last 20 years.

Among these efforts, the initiative of the government of Mexico City stands out, which in 1997 launched the program of book clubs “Libroclubes”, to bring the population closer to books and reading. The Book Clubs are citizen spaces for reading, autonomous, with a neighborhood vocation. They facilitate unrestricted access to books, based in trust, without bureaucracy. They are also spaces for communitarian activities. Anyone can open a new Bookclub in any space: Homes, factories, unions, hospitals, institutions, squares, gardens and even in prisons.

In 1997, the government of Mexico City supported each Bookclub with an initial collection of books, training and institutional support. However, when the government changed four years later, the support ceased and the Book Clubs, which had not achieved real autonomy, quickly disappeared, to the point that by 2003, only 500 remained. At the start of our project in 2017, the local government claimed that 300 Bookclubs still worked, but our estimate is that they do not reach 100. However, many of these survivors have worked more than 19 years, thanks to the commitment of their managers, the support of the people who frequent them and the relevance of their service.

The academic Terminal Project Bookclubs, started from the assumption that a design intervention would help strengthen Bookclubs through multiplication and that if the Bookclub Network was consolidated as an independent initiative, any change in government support would not affect them.

3. METHODOLOGY

During the academic course denominated “Terminal Project”, at the Design bachelor program at UAM University, students develop a design project during one year at the end of their curricular studies. Book Clubs project was incorporated as the principal Topic, but a particular methodology was integrated, in order to favor a systematic approach through all research, problematization, discovery, proposal and communication phases of the project.

In order to provide a strong basis from which to start a Systemic comprehension of the complex context of Bookclubs thematic towards sustainability, S.PSS (Sustainable Product - Service Systems) methodological basis was incorporated from the beginning of the academic course, through the application of a series of tools for the observation and identification of key contextual actors, nexus, interconnected problems, among others. Also this approach provided a path to build a configuration of solutions, actors, interactions and scenarios, in order to ease an interdisciplinary and systemic design process. Some particular tools that allowed the configuration of the systemic solution involved the development of system maps, map of actors and interactions, Sustainability Design-Orienting toolkit (SDO), and SPSS Concept Description.

The S.PSS methodology was supplemented by methodologies from Semiotics, Rhetoric and Cognitive Sciences studies in order to detect user’s motivators and significant metaphors, with which a persuasive discourse could be constructed. In addition, a didactic instrumentation was also employed, in order to manage a systemic project divided by teams, where documentation, discussion, and analysis could support the collaborative work, in contradiction

of an individualistic and competitive inertia.

The project was divided into three main stages: research, design and adjustments, but not in a linear manner, since the results of the first design phase gave rise to new research and adjustments in an iterative process. The first research phase, focused in three main issues:

1. Documentary research on the context, focused on the state of reading in México and in the city from the quantitative and qualitative perspectives.

2. Activities on reading awareness to sensitize students, by collective readings, visits to the International Book Fair of Minería and to a theater play about the importance of reading. All activities were discussed in the group, to develop a critic point of view.

3. Field research in the Bookclubs program and visit to specific Bookclubs, where the students made interviews with those responsible, users and officials.

In this third phase, through the application of a questionnaire and in-depth interview techniques, an ethnography was developed in which motivations and identifiers were identified, as well as the identification of the metaphor that best describes the Bookclubs among the users. The first investigation outcome, showed that indeed Bookclubs are spaces of true interaction, which generate community welfare, through reading and books BUT only about a hundred remain in the city, there is no so-called Bookclub Network, as the relationship between them is minimal and this leads to a great vulnerability to government fluctuations.

4. RESULTS AND ANALYSIS

The evaluation of the design was made based on three perspectives:

a) As objects of design, functionality, materials, costs and aesthetics.

b) Based on the interactions that promote, as well as its sustainable dimension, the main social, economic and environmental factors and impacts.

c) As part of the general system, in the contribution it makes to the solution of the complex phenomenon.

Results

The project provided a system that articulates products and encourages services. It also attend important needs of the Bookclubs as spaces and also of the Network, as an organization. If implemented, the Network would be strengthened as a citizen instance, autonomous from the government, increasing its possibilities for sustainability.

Besides, the process with the students allowed comprehensive approach to reading as a phenomenon with cultural and social impact, gave transcendence to the design intervention, and it allowed for collaborative, non-competitive learning experiences for students and stimulated in their relationship and interaction skills that are difficult in competitive dynamics.

The overall results of the project achieved by the students, involved the development of specific design proposals of products and services, all of them interlaced between them in order to generate a general system that could lead to the solution of the identified needs of the Book Club program. In this way, not only the approach of the project required an important and complex process to interconnect the design proposals among the teams of students to create a system, but also the teaching-learning process signified an important challenge and paradigmatic change within the usual teaching practices at the University, enabling the development of an integral, interdisciplinary and systemic Design project.

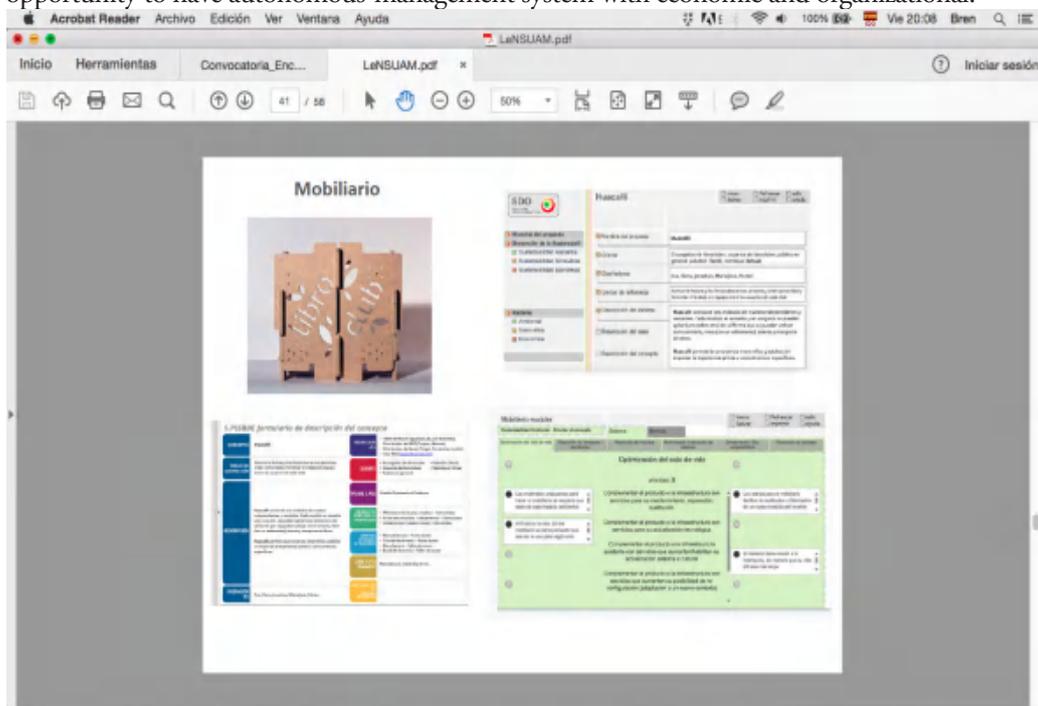


[Figure 1] Design Proposals by students, interconnected to offer a Systemic Solution, in which Distributed Production of furniture, installations and digital services were configured for Book Club coordinators

4.1. Impacts on Sustainability

A wide arrange of tools were used to analyze, anticipate and reduce environmental impacts of the different design proposals of each team of students, which involved a careful selection of materials, design of modular pieces, waste reduction of manufacturing processes, among others.

However, it is possible to identify that most of the design proposals offered a higher focus on the social and economic pillars of sustainability, enabling the adoption of a system that not only encourages reading as a cultural process, but also provides the opportunity to have autonomous-management system with economic and organizational.



[Figure 2] Array of Tools applied to one of the interconnected design proposals of Bookclub project, in which PSS and DE configurations, as well as Sustainability factors and scenarios were identified and tackled.

5. CONCLUSIONS

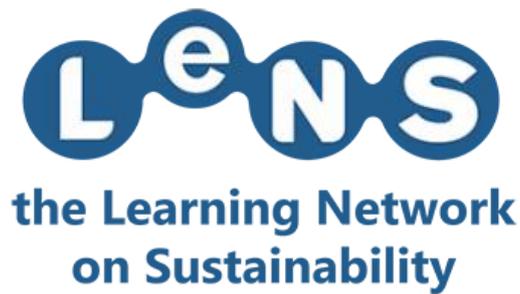
The systemic approach promoted in this project yielded integrated solutions, rather than the production of objects; opened the door to a teaching experience different from the usual, as an alternative for the institution, students and teachers, as well as raised a way to link the process with users, through collaborative sessions and feedback.

It also revealed important educational and institutional challenges: a) The need to analyze the profiles of the students that make up the teams to ensure that it is within their reach to carry out their project, b) implement the dynamics that foster productive collaboration and not competition among students, c) take care of the follow-up of the process, through an efficient documentation that allows the permanent and collective analysis, d) sustain the close, empathetic and committed relationship with the community that is served. All of the above requires a special teaching preparation that the institution must provide.

When the Ministry of Culture of the CDMX requested to present this project at the International Book Fair of the Zócalo, it was necessary to manufacture new prototypes. However, the real implementation requires the support and accompaniment of the university in the management of the project, the signing of agreements, the protection of the students' copyright and the support so that the prototypes presented in evaluation can be adjusted to the reproducibility needs.

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IMPLEMENTATION OF THE LENS PROJECT AT THE UNIVERSIDADE DO ESTADO DO PARÁ (UEPA)

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ABSTRACT

In the current context of high environmental degradation and bad living conditions for a large part of the population around the world, there is a great need to develop projects and research with a focus on sustainability. For this reason, LeNSin has emerged the International Learning Network on Sustainability, a project that is spreading around the globe with the aim of forming a new generation of designers and educators who can contribute to the transition to a sustainable society focusing on the models of Distributed Economy and Product-Service System. The purpose of this document is to present the process of implementation of the LeNS project in the Amazon region, specifically at the Universidade do Estado do Pará (UEPA - Pará State University) presenting the challenges faced, the solutions found, as well as the results achieved so far and perspectives for the future.

Key Words: LeNS, UEPA, Sustainability.

1. RESEARCH PROBLEM/ GOALS

The human's activities generate planet changes, such as natural resources paucity, climate change, nature's cycle and soil changes. These changes lead to a reflection on the future of the planet and then on how to move towards a more effective and sustainable development model (Vezzoli, Kohtala, & Srinivasa, 2018).

The LeNSin, The International Learning Network of Networks on Sustainability, is a project funded by the European Union through the ERASMUS + program to promote a new generation of designers and design educators who can contribute to the transition to a sustainable society. It aims to increase the internationalization, interculturality, and accessibility of higher education to Design for Sustainability, focusing on the Sustainable Product-Service System (S.PSS) and Distributed Economy (ED) applied to different contexts around the world.

Currently, the project has partnerships with more than 100 universities around the world, covering all the continents. In Brazil, it counts on the partnership of 16 universities in the states of Paraná, Pernambuco, Pará, Rio Grande do Sul, Rio de Janeiro, Alagoas, Minas Gerais, Santa Catarina, and São Paulo.

This current work has the objective of describing how it has been the process of LeNS project's implementation in the Universidade do Estado do Pará.

2. THEORETICAL BACKGROUND

The World Commission on Environment and Development (1991) provides a common definition for sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In this sense, Vezzoli et al. (2018) indicate that the Distributed Economy and the Product-Service System are promising models based on the ecological economy that proposes to reconcile the economic, environmental and social impacts. These authors also affirm that the union of these two models can promote the ecoefficiency, along with equity and social cohesion in the emergent and low-income contexts. For being the focus of the LeNS, these two models will be described next. Also will be approached the local context of this work, the Universidade do Estado do Pará (UEPA).

2.1. Universidade do estado do pará (uepa)- campus V

The Universidade do Estado do Pará (UEPA) is a public higher education institution that has five campuses in the capital, Belém, and fifteen in other municipalities of the state.

The campus V is located in Belém, called the Center for Natural Sciences and Technology, where the Design course works and the LeNS meetings take place. There are 8 other graduate courses on this campus: International Relations, Foreign Trade, Food Technology, Environmental Engineering, Forestry Engineering, Production Engineering and Systems Development Analysis Technology. The design course is also offered at Campus VI, in the municipality of Paragominas, Pará. However, there is not yet a group formed to carry out LeNS activities there.

2.2. Product Service System (PSS)

According to Vezzoli et al. (2018) the definition of S.PSS, proposed by the LeNS project, is an offer model that provides an integrated mix of products and services that together are able to meet a particular customer demand (to deliver a "satisfaction unit") based on innovative interactions between stakeholders production of value (satisfaction system), where the economic and competitive interest of suppliers continually seeks new solutions that are both environmentally and ethically beneficial partners.

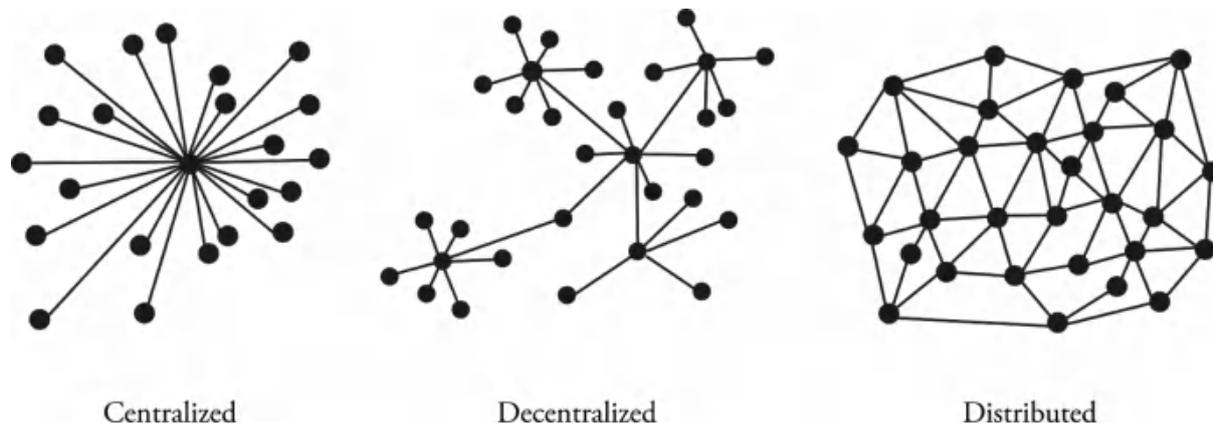
According to Tukker (2004), the SPS is divided into three categories: product-oriented, use-oriented and result-oriented. In the product-oriented, the customer takes possession of the product but maintains the relationship with the company through the provision of some extra services. In the use-oriented, the product still is the centerpiece, but the ownership remains with the provider and is available in different ways to the user so that the user has the possibility to use according to his necessity. The person in charge of the maintenance and product disposal after use, in this case, is the company. In the result-oriented PSS, the center is no longer the product, but it is agreed between the client and provider a result so that there is no predetermined product involved.

Among its benefits is possible to list: allowing closer relationship with customers; creating value for customers; preventing imitation by competition; being an alternative to mass production, generating differentiation in the offer; reducing environmental impacts through dematerialization; leading companies to take back and giving correct disposal to their products at the end-of-life (Mont, 2002).

2.3. Distributed Economy

According to the International Institute of Industrial Environmental Economics (IIIEE) (2009) there are several criticisms of the current economic system, arguing that workers, the community and the environment of emerging and developed countries have to deal with the costs of companies that do not are set in communities, but search the world for cheap labor and resources as well as low environmental standards.

Barauna, Souza, Trein and Razera (2017) talk about three types of economy: centralized, decentralized and distributed, defining them as follows (see Figure 1):



[Figure 1] Graphical representation of respectively, from left to right, a centralized, decentralized and distributed economy system. Source: IIIIEE (2009)

In a centralized economy structure, prevails the total control of the system. Already in the decentralized one creates new nodes of control, but still, the vertical sense of the power is maintained and with demands that go from top to bottom. In the case of a distributed economy, power comes from the community and local potentialities.

According to these authors, unlike the centralized economy, in distributed economy goods are produced locally, with value, in closed circuits, and in networks. For Vezzoli and Manzini (2006) more in general, in the way we live. The prospect of sustainability necessarily places the very model of development under discussion. In future decades we must be able to move from a society in which well-being and affluence are measured by the production and consumption of goods, to one in which people live better consuming (much, the term “distributed” should be considered as a network of autonomous interconnected elements, that is, elements that can act independently while being highly connected with the other elements of the system.

Some beneficial elements attributed to ED are described by IIIIEE (2009): to increase local use of renewable resources; wealth creation for a greater number of people; reduce the emission of pollutants and the generation of waste at the local level; keep value creation benefits locally; increase sharing of non-materials (such as information, know-how); diversity and flexibility of economic activities and communication; and collaboration between regional activities.

3. RESEARCH METHOD

The method used to implement the LeNS (Learning Network on Sustainability) in the university was the Case Study, which according to Yin (2001) is an investigation of an empirical topic following a set of pre-specified procedures. This type of method has a unique situation, in addition to being based on several sources of evidence, is considered a broad research strategy.

The case study may be unique, when no similar cases are reported, so it is not possible to have an approximate end result. The multiple case study was used, where the implementation of the Lens group in the university was based on the strategies of the other groups of the Brazilian universities and abroad, personalizing them according to the UEPA need.

The activities of the LeNS project at the Universidade do Estado do Pará (UEPA) began in August 2017. First, interested parties were called and then, a meeting in which the project was explained, the concepts of sustainability in the context of design, product-service system and distributed economy. Then, new meetings were held in which the next steps to be taken by the group were discussed, and some plans were drawn up, such as searching for edicts and writing projects. However, the team's low performance resulted in a long period without meetings.

In a new opportunity, the students were invited to a meeting to discuss the resumption of the project. This time, it was defined that a weekly meeting would be held with a fixed day and time. In the first meetings were repeated the actions already performed as there were new participants, and a lecture was held via SKYPE by a professor from the LeNS network in Alagoas state, Prof Priscila Ramalho Lepre, explaining what the Distributed Economy is. The group also had a lecture on the use of natural materials from the Amazon and Circular Economy, with a conclusion of the UEPA design course. In a new opportunity, there was a meeting via SKYPE with members of LeNS México, Prof Rodrigo Lepez vela, who reported their experience with the project at the Universidad Del Valle de Mexico (UVM). It is also intended to hold lectures of this type with members of the Lens of India, who should present local case studies.

The group is currently working on the implementation of PSS projects in UEPA, which should be sent for evaluation and possible publication at a sustainability conference. This work should be more developed, giving rise to extension projects.

In addition, it will be the assignment of the students to research and introduce or bring people to present new technologies, materials, processes, and ideas that can serve as a basis for the development of extension projects or for the production of knowledge in the context of SPS and ED. Also, the group will use the material done by the LeNS researchers worldwide, available on the LeNSin platform. Everything should be done within LeNS ideology, producing materials that can also be shared with the community around the world for learning, modification, and reuse.

A brief survey was carried out on the current activities of the LeNS network in other Brazilian universities,

bearing in mind the possibility of replicating them in the LeNS UEPA group. LeNS network leaders at each university have generally reported that the concept of PSS, S.PSS, and ED is being worked within the disciplines taught by them. Activities such as lectures on these subjects and LeNS, which are applied by the group in Belém, are also common in other universities, there are workshops that highlight the importance of Being Sustainable in relation to product and service development. There have been reports that the course and knowledge of LeNS are still very young, the idea is not yet fully structured, but this is being worked on to achieve the expected results.

4. RESULTS AND ANALYSIS

To date, the project under development is undergoing a structuring phase and its full completion will take place in April 2019. This initial phase already has its objectives achieved since it was wanted to establish a routine of activities to ensure the cohesion of the group and activities that engage the participants. It is expected that in the next phase research and extension projects will be designed for the development and dissemination of S.PSS and ED concepts, as well as their adaptation to the Amazonian reality.

It is hoped that professionals with a greater awareness of sustainability concepts will be trained and that they make use of this knowledge to provide better living conditions for future generations. It is also hoped that extension projects, graduation assignments, and scientific initiation researches will be generated and that these activities generate publications.

5. IMPACTS ON SUSTAINABILITY

The implementation of the LeNS project in Pará is in its initial stage, but the interest of many students, designers and professors can already be observed to advance the actions. The initial difficulty of keeping students engaged and producing continuous activities was overcome. The lack of a routine in the activities resulted in the dispersion of the students at the first moment. However, this problem has been solved by establishing a weekly meeting, which has been encouraging the group to keep moving forward. Furthermore, there is an increasing number of participants.

There is a great expectation of the project to yield good results in the Amazon region, since it is aimed at emerging countries and it can already be observed its success in similar realities, like India.

Once the LeNS project is implemented, it spreads the knowledge about Sustainable Product-Service System (S.PSS) and Distributed Economy (ED), helping to promote a new generation of designers and design's educators who can contribute to the transition to a sustainable society.

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INITIAL PROPOSALS FOR THE IMPLEMENTATION OF THE PRODUCT-SERVICE SYSTEM AT THE UNIVERSIDADE DO ESTADO DO PARÁ (UEPA)

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ABSTRACT

The Universidade do Estado do Pará (UEPA) is a public university located in the city of Belém (Pará, Brazil). It has adopted the Product-Service System (PSS) for car use which has proved to be effective and has brought benefits such as discharging the institution from bureaucratic issues regarding vehicle ownership. The adoption of the PSS at the university contributes to the advancement towards a more sustainable society. The objective of this work is to generate initial PSS proposals for UEPA, which will be the first step for its implementation. In order to reach the objective, a brainstorming and analysis of the conceptual elements of the PSS found in the literature were performed, generating at the end seven PSS proposals that may be better studied, generating new research and, in the future, implemented.

Keywords: PSS, suggestions, public university.

1. RESEARCH PROBLEM/ GOALS

The transformations that the planet is suffering in the past few years are notorious: paucity of natural resources, high pollution rates coming from industrial waste and excessive consumption. For this reason, countless conferences, laws, international projects, and actions have been created, aiming to sustainable development.

In this sense, the Product Service System (PSS) emerged as an innovative alternative that changes the way of consumption, without taking the economic bias and focusing on social satisfaction and on the sustainable development potentialization.

In the Universidade do Estado do Pará (UEPA) is already running a PSS project, which consists of car rentals. The car, that was previously an institution possession and generated constant problems due to bureaucratic processes for its repair or substitution, became to be rented by a company, which maintains and replaces whenever it is necessary, making UEPA responsible just for paying a monthly fee.

It is believed that there are other possibilities of a PSS implantation on the institution. Therefore, the objective of this research is to propose initial discussions of PSS implementation in other sectors.

2. UNIVERSIDADE DO ESTADO DO PARÁ (UEPA)-CAMPUS V

The Universidade do Estado do Pará (UEPA) is a public higher education institution that has 15 campus; campus V is the Center for Natural Sciences and Technology, located in Belém, capital of Pará State-Brazil, where there is a total of 9 undergraduate courses.

UEPA is a public institution, and as all Brazilian public universities, it is totally sustained by the government with money coming from taxes paid by the population, in a way that the students do not have to pay for any fee. However, this results in a higher level of bureaucracy, which occasionally ends in delays of supplying some needs.

This campus was chosen as research local context for being easily accessible for researches that already have familiarity with this local, making the needs analysis more viable.

3. PRODUCT SERVICE SYSTEM (PSS)

According to Vezzoli, Kohtala, and Srinivasa (2018), the LeNS project defines the sustainable PSS as a model that joins products and services to accomplish the client demand, from innovative interactions between stakeholders, where the economic and competitive interest of providers search continuously new solutions that are both environmentally and social ethically beneficial.

The PSS is classified into three categories: product-oriented, use-oriented and result-oriented. Being considered an ideal solution for this work the result-oriented PSS, which is focused on the product, but customer and provider agree a result, which there is no predetermined product involved (Tukker, 2004).

These are some of the PSS benefits: allowing a closer relation with costumers; creating values to costumers; hampering imitation by competition; alternative to mass production, generating differentiation in supply; reducing environmental impacts through dematerialization; conducting companies to retake and give a correct destination to their products in the end of life (Mont, 2002).

Nevertheless, the hard work to insert a Product Service System depends on cultural, social and business behaviors of consumption and production, besides having social and technological deprivation (Vezzoli et al., 2018).

4. RESEARCH METHOD

To elaborate the initial proposals of PSS in UEPA, the brainstorming tool, proposed by Baxter (2000), was applied which is recognized as a “shaking” of ideas made in group to initiate possible resolutions of the proposed problem., being based on the principle of “the more ideas, the better”. Then, from the opportunities found, were elaborated the proposals that were refined through the application of two proposed initial questions by Yip, Phaal and Probert (n.d.), which are:

- What problem(s) the company is/are attempting to tackle with this new PSS?
- What values the new PSS aims to bring to the company’s customers and their customers’ customers?

Finally, the definitions of requirements of the PSS proposals were made as proposed by Beuren, Sousa-Zomer, and Cauchick-Miguel (2017). These authors affirm that the PSS can be developed, considering all the elements involved in the offer that are specific for each PSS type. In the conceptual elements analysis it was sought to generate only result-oriented PSS proposals, since, as in the case of the successful implementation of car rental, the objective is to reduce as much as possible the possession of the institution on products, saving it from managing them.

5. RESULTS AND ANALYSIS

Eight opportunities of PSS implantation were identified through brainstorming: rainwater harvesting; solar energy generation; buildings rental; furniture rental; air conditioning; computer; projector and printer.

The rainwater harvesting’s proposal consists of hiring a company that would be responsible for providing a PSS

that would guarantee the rainwater harvesting; the solar energy generation's proposal consists of hiring a company that would install and be responsible for the maintenance and/or supply of solar panels; the buildings rental proposal consists of hiring a company that would be responsible for building more classrooms and research laboratories and maintenance of some of the spaces of the institution, as a way to reach UEPA expansion; the furnitures rental proposal consists of hiring a company that, initially, would do the actual UEPA's furniture maintenance for a period of two years, after that, it would have the product ownership and be responsible for its maintenance and/or supply, and likewise would be the air conditioning, computer, projector and printer's proposal.

As answers to the first of the two questions proposed by Yip, Phaal e Probert (n.d.), about the problem that the PSS would solve, altogether, the proposals would be solving problems associated/related to costs, water and energy expenditure, bureaucracy and the consequent waiting of problems resolution, necessity of products and their destination in end of life. Regarding to the second question proposed by the authors, associated/related to the value offered to PSS costumers and to costumers of the costumers, generally, the proposal would show as value, mainly, reduction of costs and bureaucracy; image improvement of IES, reduction of environmental impacts, supply of adequate products and spaces.

In the final stage, definitions of requirements, it was aimed to make the ideals proposals; therefore, all of them were result-oriented. Regarding the conceptual elements proposed by Beuren, Sousa-Zomer e Cauchick-Miguel (2017), the defined requirements common to all proposals were: planning the payment for an outsourced activity (services); planning the product property belonging to providers of services; outsourcing a service in which the provider delivers an outcome; and meeting the consumers' offering personalized results without purchasing the products. These defined requirements helped to understand the application of a PSS.

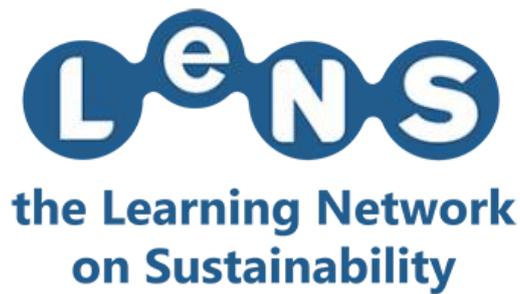
In general, the application of the used methodologies aimed at meeting the needs of the university through the use-oriented PSS. Thus, it will be discussed with the university's management to verify which proposals arouse interest to be applied.

6. IMPACTS ON SUSTAINABILITY

The developed research intends to solve the current university problems also aiming sustainability. If some of these proposals are implemented by the university, this will serve as model and inspiration to other institutions and companies. However, it is necessary to in-depth develop the topics listed as possible PSS applications, because the study focus was restricted to only the analysis of requirements. In this sense, it is intended to give continuity to this work with extension projects to the effective and qualitative implementation of such a system, ensuring the resolutions of problems in the local of study and potentializing the search for a more sustainable future. It is suggested as future works the replication of this one in other national public institutions that have a similar reality to the one studied in this case.

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ASPECTS OF THE PRODUCT-SERVICE SYSTEM IN BRAZILIAN LITERATURE

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ABSTRACT

The Product-Service System (PSS) in Brazilian literature is a theme that has a wide variety of definitions, which focus on different aspects of the theme, generating different approaches. These PSS aspects analysis will contribute to discussions development on the subject. Thus, the objective of this work is to define which approaches Brazilian researchers use to conceptualize this theme. To achieve this goal, a Brazilian literature review was carried out, collecting and grouping the definitions used in each article. As a result, a table was obtained with six groups of PSS concepts: Environment; Innovation; Integration/ Combination; Use-oriented/ Manufacturer's property; Service-oriented; and Value. It is concluded that there is no universal concept of this theme in Brazilian literature, but its definition varies depending on the focus of each research.

Key Words: PSS, Definitions, Brazil.

1. INTRODUCTION

The Product-Service System has been extensively investigated in recent years; in particular, there is an increase in publications of great relevance to this topic at the national level since until the year 2000 most of the publications were in foreign literature (Reis & Braga Jr., 2015).

However, still necessary to fill many gaps, especially on its characterization, and there are still inconsistencies in the works with this objective (Braga Jr., 2017). One possible justification for this is the fact that there is no consensus regarding the definition of this, and there is a great variety of concepts for the subject in the literature, which often differ in some respects, generating divergences of opinion among researchers (Haase, Pigosso, & Mcalooone, 2017).

Thus, in defining PSS, some researchers may follow a more environmental or economic aspect, for example. In this context, Zancul et al. (2011) argue that the issue of sustainability is not really a consensus in the PSS literature.

It is also known that the success of the PSS depends on the culture of the population since this influences its acceptance (Beuren, Ferreira, & Cauchick M, 2013). This culture interference can be in the acceptance of proposals as the types of PSS use-oriented and result-oriented. Therefore, it is interesting to help Brazilian consumer in understanding this type of approach, by conducting a study restricted to Brazil, instead of the inverse, which would impose on this a model in which there may be a difficulty of acceptance.

Therefore, the objective of this work was to identify how Brazilian researchers of the Product-Service System conceptualize this theme.

2. THE PRODUCT-SERVICE SYSTEM (PSS)

According to Vezzoli, Kohtala and Srinivasa (2018), the definition of Sustainable PSS, proposed by the LeNS project is: "An offer model that provides an integrated mix of products and services that together are able to meet a particular customer demand (to deliver a "satisfaction unit") based on innovative interactions between stakeholders, production of value (satisfaction system), where the economic and competitive interest of suppliers continually seeks new solutions that are both environmentally and ethically beneficial partners".

An example of PSS, as pointed out by Zancul et al. (2011), is the Brastemp water filter where the product is the water filtering agent and the service is the maintenance of the product, which results in continuous provision of filtered water to the user, who only needs to pay a monthly fee for the use of the product and its maintenance. At the end of product life, the company determines the correct destination, which is 99% recyclable.

There are divisions of the PSS into categories, Tukker (2004) presents the following three main ones: product-oriented, use-oriented and result-oriented. From the first to the last, the value ceases to be in the product and becomes in the service, and there is still the presence of both. Braga Jr. (2017) explains that this does not mean that the focus becomes being in service, but rather that there is "a coexistence that leads to a new positioning of the product in the value chain and an increase in the importance of service in the same chain" (p.16).

Baines et al. (2007) called the aggregation of services to products in the PSS of Servitization of products and the aggregation of products to services of Productization of services. Since the product is the tangible part and the service is the intangible part of the offer.

Among the main benefits of PSS are: to allow a closer relationship with clients; create value for customers; impede imitation by competition; alternative to mass production, generating differentiation in supply; reduce environmental impacts through dematerialization; leads companies to take back and give the correct destination to their end-of-life products (Mont, 2002).

3. METHOD

In order to identify how Brazilian researchers of the Product-Service System (PSS) conceptualize this theme, it was carried out a literature review on PSS. Then, the definitions used were collected and grouped from similarities that presented among themselves.

For the collection of articles of the PSS, articles from national sources were considered as of 2008, and the sources considered for this research were:

- Congresses: "Brazilian Congress of Product Development Management" (Congresso Brasileiro de Gestão e Desenvolvimento do Produto- CBGDP) and "National Meeting of Production Engineering" (Encontro Nacional de Engenharia de Produção- ENEGEP), as well as the digital collections of the respective institutions that organize these events, namely the "Product Management & Development" (PMD) newspaper and the online library of the "Brazilian Association of Production Engineering" (Associação Brasileira de Engenharia de Produção- ABEPRO);
- Scientific journals: "Produção Online", "Gestão e Produção", "Produção e Engenharia", "Produção em Foco" e "Produto e Produção". These sources were chosen because it would be possible to find in them a relevant number of publications in the researched area.

As keywords, for the search of the articles, the following were considered: sistema produto-serviço, sistema produto serviço, product service system, Product-Service System, PSS, productization, produtização, servitization e servitização. Although the concepts related to Servitization and Productization are not interesting for this work,

these terms were used as keywords in order to find more concepts of PSS, since these three terms are closely related to each other.

The title and summary of each article found were read, in order to identify if they were actually related to the PSS, to be collected or not.

The accepted articles were read, in order to identify the PSS concepts used by the authors. For the organization of these concepts, it was used a worksheet organized in three columns for each paper: Concepts; Observations; and Access Link to the paper.

In order to generate criteria to define accepted concepts for this work, first it was discarded the excerpts that presented repetitions. They also went through filtering from the format as written. The considered criterions of exclusion were:

- To present only the advantages of the PSS, as in the excerpt: “It is a strategy that seeks the dematerialization of consumption, contributing fundamentally to the reduction of the environmental impacts related to the consumption of tangible products”;
- To be very generic, that is, to present characteristics that can refer not only to the PSS, as in the sections: “A product-service system (PSS) is an adequate way to defend the idea of sharing”;
- Conceptualize something else, as in the excerpts: “They define Servitization as offering an integrated package of products, services, knowledge and customer support in order to add value to the main business of the company”;
- Be inserted in another, that is, a concept that is an identical repetition of part of another concept.

Then, for the grouping of the accepted concepts, a diagram of affinities was made. This tool has the objective of grouping a large number of ideas and information according to the affinity they present to each other. The definitions that fit into more than one group were allocated to the one that represented its more emphasized PSS aspect. Similar passages also went through filtering, giving preference to the older, for avoiding redundancy.

Finally, the groups were nominated according to the PSS aspect they presented.

4. RESULTS AND DISCUSSION

In the “Congress CBGDP 2017”, 7 papers were found, all of which were accepted. In the “PMD Journal”, 6 were found, all of which were accepted. In the ABEPRO digital platform, 31 articles were found, however, one gave an error when accessing, resulting in 30 papers from this platform.

Regarding the collection carried out in the magazines, in the “Produção Online” the research returned 18 papers, of which, after reading the title, abstract and keywords, 8 were accepted. The “Product and Production” magazine returned only 1 paper in the search, which was accepted. The other journals added for research in this survey did not return any results with the insertion of the string.

Altogether, this collection yielded a total of 52 papers.

In these papers, it was found 83 passages that seemed to conceptualize the PSS. From which, after the filtering and grouping, it remained 31 concepts, considered as PSS definitions for this work.

The grouped concepts were called Aspects of the PSS, which consisted of six: Environment, Innovation, Integration / Combination, Use-oriented / Manufacturer’s property, Service-oriented, and Value.

In the environment group, all the definitions that mentioned the benefit to the environment or to sustainability as a criterion were added. In the Innovation group, all the definitions that presented the PSS as an innovation strategy for the company were added. In the Integration / Combination group, all the definitions that emphasized the integration between product and service were added. In the Use-oriented/ Manufacturer’s property group, all definitions that focus on the non-transferring of product ownership from the company to the customer were added. In the Service-oriented group, all the definitions that emphasized the service offering added to the product were added. And in the Value group, all definitions that presented the PSS as an opportunity to generate value were added.

From the constituent concepts of these groups, 6 are authorial from the papers found in the Brazilian literature review carried out in this work. Only 1 concept is a citation from a national paper not included in the collected ones from this work. And 24 concepts are a citation from foreign literature.

It is noticed that the PSS can be approached from several points of view, and has several aspects to be taken into account, which can be emphasized depending on the researcher or on the focus of the research. However, it is also noticed that there are a very small number of Brazilian researchers’ definitions for this theme, and thus, an even smaller number of national works’ citations.

5. CONCLUSION

Through this literature review on PSS, it is concluded that this theme can be conceptualized following six different approaches, which are Environment, Innovation, Integration / Combination, Use-oriented / Manufacturer’s property, Service-oriented, and Value. In addition, some Brazilian researchers use different concepts, which fall into more than one of the groups mentioned. It means that there is not a unique concept of this theme in Brazilian literature, and it may vary depending on the researcher or on the focus of each research.

This study may contribute to the advancement of the Product-Service System as a research theme, once it helps its definition understanding in Brazilian literature.

As future research, it is proposed to continue this work carrying out a survey with Brazilian researchers to identify which of these groups of aspects they consider more important in defining the PSS. It is also proposed that Brazilian researchers develop studies using their perspectives and experience in their research sites to develop concepts for PSS that reflect the Brazilian reality and point of view.

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“LIBRARY OF STUFF”: A CASE OF PRODUCT SHARING SYSTEM PRACTICE IN TURKEY

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ABSTRACT

Sharing behaviour patterns have inspired and have been formalized into different service systems and these sharing systems have gained attention recently. With the rise of (Information and communications technologies) ICTs and peer to peer (P2P) services enabling collaborative consumption have been supported with more developed web sites and easy to use mobile applications.

Since Turkey has uniquely rich and multifaceted cultural heritage flourishing from many different traditions, “sharing” in different cases is one of these oldest rituals embedded in Turkish cultural DNA. This habitude has been turned into product sharing systems where members share their underused belongings with other members. This paper specifically focuses on a product sharing initiative in Turkey (Library of Stuff) as a single case to examine its infrastructure, its design, strengths and weaknesses.

Key Words: use-sharing, service design, sharing systems, sharing services.

1. INTRODUCTION

In the pursuit of alternative and more sustainable forms of consumption; collaborative consumption has been chosen instead of individualistic overconsumption as a subject of inquiry. As Botsman & Rogers (2010) put it, collaborative consumption is constructed by proposing "access to usership" instead of "permanent ownership". These alternative consumption models include sharing, swapping, renting or trading products and services. Economic benefit of collaborative consumption systems is be another reason for preferring sharing product and service systems instead of owning them.

Economist Juliet Schor (2011), highlighted the increase in many types of alternative consumption types in society as a "wave of social innovation" supported by the sustainability movement, brought into the mainstream by the economic downturn and enabled by digital technologies. After Weitzman (1984) has coined the term sharing economy, many sharing schemes have being presented in different fields (car-sharing, bicycle sharing systems, local tool renting-lending facilities, local toy libraries, house-room sharing sites, etc.)

When "collaborative consumption" is discussed, it should be remembered that the behaviour of participants of the system rely on relations with the community, and the relational dynamics within the community. According to Belk (2007), "sharing" could be identified as "the action of giving our possessions to others for their use and taking other's possessions for our use volitionally". Schor (2015) has highlighted that today's sharing concept is quite different than what has been used to. It is open to total strangers, not limited to family members and close kin. Belk (2007) believes that relations of community would be developed with the synergy that sharing actions create while less resources are deployed. There are examples showing some hints of evolving of communities out of the emotional bonds rooted within sharing systems. In this paper, we try to provide a sharing system example from the Turkish context that which can have positive social and environmental impacts on the society when they are supported and proliferated.

2. "LIBRARY OF THINGS": SHARING PRODUCT SERVICE SYSTEMS EXAMPLE

Sharing different kinds of "products" at libraries in the US have been a normal event as they were the centers for "sharing" information open to public before digital times. As libraries lose their popularity with the digitalization of information, these occasional sharing events were forgotten also. Sacramento Public Library started a sharing scheme of tools that people don't want to own but they need once in a while. The community decided the tool is to be purchased within a certain budget (Hasan, 2015). Mainly UK based "Library of things" (LoT) – with the most popular name used for "borrowing centers", "borrowing shops" or "item libraries" – are hubs where household items and tools are set mostly as non-profit volunteer cooperatives or initiative groups. According to Dymont (2017) more than 80 tool libraries around North America, Europe and Oceania and almost a dozen LoT stores are working all over the world. The general working scheme of LoTs all over the world is renting the tool or product from the library for a short period of time with very low renting rates. Also in some LoT hubs there are DIY corners where you can use the tool or learn how to use the tool you rent if you need.

Motivation of formation of LoT initiatives in general could be summed up in three pillars of sustainability; economic, environmental and social. People can use the so many kinds of hand tools such as lawn mower or a drill that are only needed for a couple of hours or days in a whole year or month. There are many studies proving that (Wrap 2010) the energy and virgin material for making most of the equipment and household items we have at our homes are mostly impair investments from an economical and environmental perspectives because they are not used as they are supposed to be in their their life span. Shared use of underutilized stuff via enabling platforms is a way of increasing resource productivity and a path to shift to circular economy. In addition to the economic and environmental benefits, almost half of the LoT centres are also centres for small DIY projects where DIY enthusiasts can meet, gather, use the tools, learn and teach how to use several equipment. Hence, the places become a social centre.

Still, "library of things" is not a well adopted movement. With all the positive dimensions of LoT stated above, there should be something holding people back from lending and borrowing stuff from these libraries. The study of ING-DiBa (2015) revealed that there is a considerable gap between what people want to share their belongings and people who actually participate a sharing system in the context of LoT. Literature about the reasons of "not participating a collaborative consumption platform" and "not using LoT platforms or centres" are being built up recently as new LoT centres are founded each day.

Unlike the problem stated above, "LoS" was well appreciated and functioned in Turkey because it has reached a remarkable amount of users that was not expected at the beginning. Within this framework, it is aimed to examine the Turkish case of LoS, its similarities and differences of working schemes to reveal how the platform enlarged the scope of environmental consciousness, grew social bonds via p2p sharing actions and related collaborative events.

3. METHODS OF THE STUDY

Firstly, the literature about "library of things" and borrowing centres" all over the world was scanned thoroughly via digital technologies. The case research is done on a single case study because it was a unique example in Turkey.

With a semi-structured face-to face interview with one of the LoS initiative Turkey co-founders - Ayşe Gokce Bor, the platform was analysed thoroughly from service design perspective. Cofounder- Aysu Erdoğan Miskbay

joined the discussions about the design and the phases of the platform via emails reciprocally.

The website of the LoS initiative was analysed from the screenshots saved to <https://web.archive.org>". At each change of the platform, UI changes were screened and differences were investigated comparatively to understand the reasons and design decisions taken to achieve the related problems.

The Facebook and Twitter accounts were also investigated with – netnography method – which is defined by Kozinets (1998) briefly as an adaptation of ethnography to the cyber world. The content and the frequency of collaborative consumption events and community gatherings were analysed specifically to evaluate impact for the sharing system.

4. THE CASE OF "LIBRARY OF STUFF" IN TURKEY

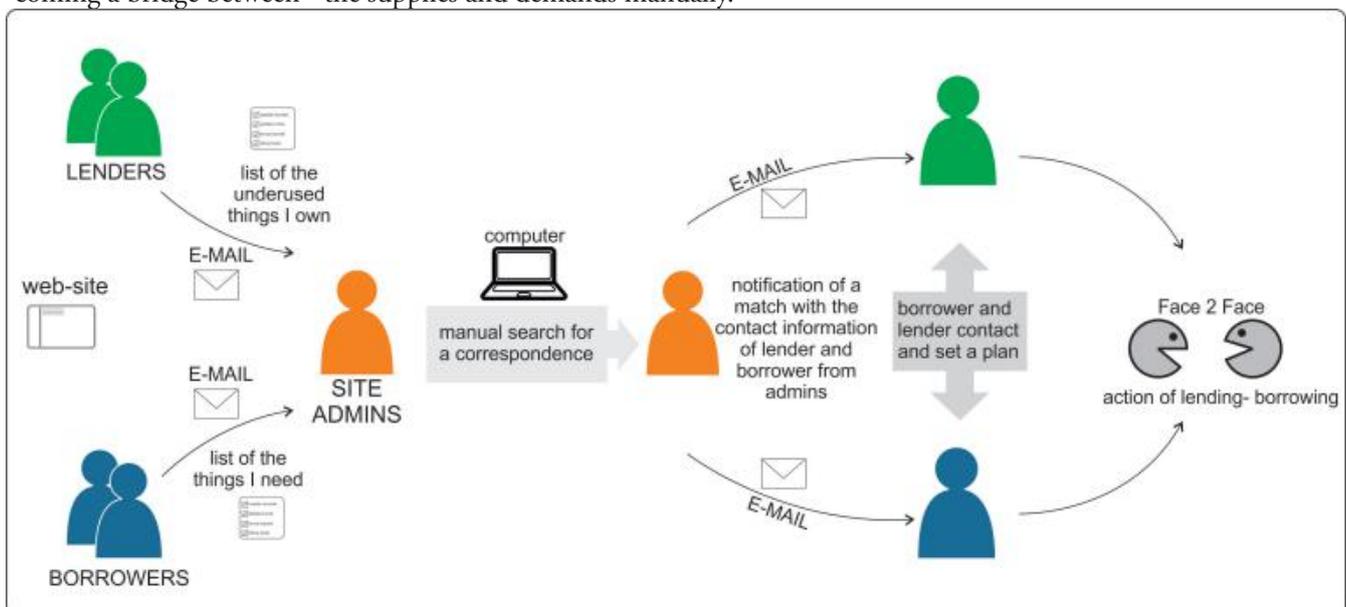
The main idea of LoS (Library of Stuff) is rooted from a lesson in master classes of one the cofounders, Ayse Gokce Bor (at that time, living in Sweden). After a call of her friend Aysu Erdogan Miskbay from Istanbul, she had an opportunity to present her idea at a start-up weekend event of Ozyegin University in 2012. At the end of the workshop sessions, their idea came in first within all proposals in Startup Weekend Istanbul; then they decided to continue with the project. At that time, they both were not aware of the already existing similar systems abroad. But as they focused and researched more about the project background, they saw similarities as well as differences between the platform they wanted to create and existing examples. And they decided to continue because none of the existing platforms at that time were what they have thought of to build up. The social media channels were also built with the name: "EsysaKutuphanesi" (meaning Library of Stuff in Turkish) almost at the same time.

The basic motivations behind the "Library of Stuff" initiative in Istanbul were mostly about reducing the amount of products we use in our daily lives and the carbon footprint by reducing excess consumption. It supported the maximum use of products until the end of their life cycle and created awareness to the environmental crisis.

4.1. Design of the Service

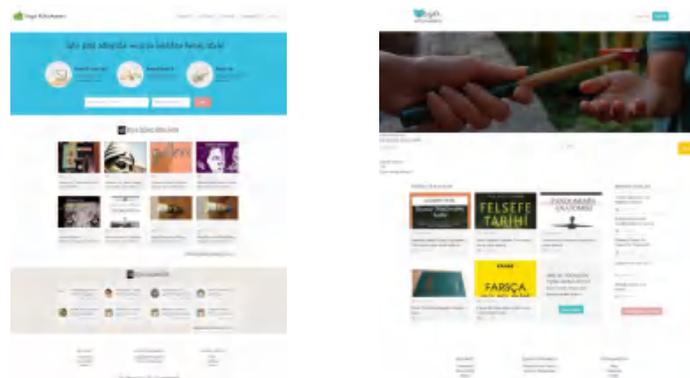
The system proposes sharing the products we own but not frequently use instead of buying new stuff each time we need them. The connection platform between prospective lenders and borrowers was designed to be a closed web site. A person who wanted to be a member of the system had to fill out a short application form and email it to the website administrators. If the applicant wouldn't give reliable answers, a second inquiry was sent. Administrators had the authority to approve the membership depending on the answers of the applicants.

When the membership was approved, one would list down the things that s/he could share and list the things s/he required then sent it to the website. The owners of the web site received all these mails coming from the members, put all these shared things and required items into separate lists in their own servers. They were continuously cross-searching both the shared stuff list and requirements list. When they found a match they were sent e-mails to both members – the one who shared the stuff and the one who needed it. Basically, they were trying to match - becoming a bridge between - the supplies and demands manually.



[Figure 5.1] How the Library of Stuff works

But in order to reduce the effort and time to answer the same questions from members on a regular basis, a FAQ page has been prepared and the system was explained thoroughly. The explanation was enhanced with the user experience (UX) improvements. It was firstly lists of questions and answers: simple text without any additional graphic elements. Differentiation was done by differentiating text format. At further revisions the narrative of the first pages were supported with graphical elements while FAQ has reached a more modern look with the change of format of text and kerning details. All the web page was revised with simpler "flat design" concept.



[Figure 5.2] Web page revisions

4.2 Building up on a Sharing Community.

The systematization of sharing activity via web site in the community was new for Turkey when the system was introduced. The administrators were cautious about keeping the platform safe while trying to expand it as much as possible. According to the answers they got in the membership forms, the most frequent reasons of application they have encountered were mostly about environmental concerns such as “reducing waste”, “reducing consumption” and “reducing carbon footprint”. Also answers like “being a part of the system that I believe in” and “this is what it has to be, so logical, I want to support” were also very common. There were even some participants who had participated just to support because they sympathized with the main idea and wanted it to sustain as long as possible.

At the first months after the web site was launched; besides the technical infancy phase, the founders faced mostly questions about the “sharing process” which related the social motives of “sharing” in deed. These questions rooted from prejudgments of the participants would be listed as follows:

- 1). “People would like to have so much but wouldn’t give anything to share”,
- 2). “What happens if any of my stuff is damaged during the use? Do you have guarantee?”

All these questions were answered by administrators (who were always the cofounders) of the website and mostly answered with the examples from daily routine sharing activities.

Time has proved the judgments were wrong; more people were listing their stuff to lend than the ones listing their requirements, 617 items were listed to be shared by 235 members in first year period.

Bor stated (personal communication, 2017) that while working on the technical improvements and solutions for the problems about “trust” issues at the core, it is proved that complexity of sharing is more about people’s relations than the action itself. As people get connected, the sharing action was built easier and connection of the products was just built automatically. The lending-borrowing encounters and how the action would take place were left to the participants to be planned. After the first months FAQ questions were dropped down dramatically (with the support of frequently updated posts on Facebook and Twitter accounts).

In 2014, the initiative was honored with the support of Tecno-Entrepreneurship Award from Ministry of Industry and Technology with the project of “CO2 calculation platform website for the household items” and Didem Yeni has joined the founder and administrator team when the initiative legally became a start-up company.

The administrators were always keeping the social media accounts alive with the infographics and explanation of sharing rituals rooted back our Turkish cultures via photographic explanations.



[Figure 5.3] Post examples from twitter account of Library of Stuff

From the user feedback and comments to LoS, the ideas of an insertion platform emerged. In the first quarter of 2016, with the support granted from of Ministry of Industry for entrepreneurs; another version of Library of Stuff was put into action on web with the name “Ferris Wheel” (Dönme Dolap). It was constructed on donation of an item from one member to other who needs it. Instead of a payback scheme, the new owner would make a donation to a third party (proposed by the platform) who needs support. The members who were donating to own

the items listed on the platform were free to choose the channels that they like to donate to. So they were actually crowdfunding people while having the item from a second hand. The donators at the first phase were freeing their homes from piled up products and letting the underused items into the material flow again. The donation from the members was mostly from generosity. But some of them wanted to give away the unused products from their houses for good to have more space.

The main impediment that kept the LoS back from growing and becoming what it was planned by the co-founders was the real distance between them. They were living in different cities, one of the cofounders were living abroad. So, the management and development processes of the system and web site became very difficult and time consuming while working in different time zones. Because development of the new concepts needed frequent gathering and brainstorming sessions, wire framing studies, user researches and research result analysis phases were very difficult and slow. They also needed technical support for website maintenance and automatization of most of their manual actions. It was not only hard to make real-time connection but also have the synergy and motivation at both ends all the time. As a result of these "technical" barriers and lack of emotional vigour to sustain the platform, on 8.11.2016 they have closed the activation of LoS web site, informing beforehand via social media channels they had in addition to the website.

4.3 Experiences for New Beginnings – Insights from the Case

The biggest motivation behind the system was to increase the period of active use-phase of the underutilized products. From a 4 year of process, the initiative gave us a large source of information. It was believed that if the system was well-integrated within daily life through a mobile application and location services for unplanned even accidental needs, the use rates would increase radically. Such as; you would find the nearest computer mouse that would be used for a couple of hours wherever you were when you forgot yours through the mobile application of LoS. Thus, the sharing would get easier and the flow of the products would be at higher rates, more than just seasonal use and planned uses.

LoS Istanbul was introduced to the public in such conditions that were fairly immature for "sharing" related activities in Turkey when compared to European examples. Nowadays these ride sharing systems have been an element of popular culture, the number of users of the web sites have reached a hundred thousand. So, it is believed that a considerably larger community has been constituted at many different fields with different motivations for sharing recently which LoS would have grown easier, bigger, wider if it was still active.

After the web-site closed, the cofounders have found traces of unexpected. The analysis of the personal messages between members proved that there had been much more item sharing than it is seen publicly. Not because of secrecy, but being more convenient and faster than the emailing the system and waiting for reply the personal messaging area has been turned into another sub-platform of sharing web site. The members have even improved certain accustomed behaviours at the phases of delivery such as members having a cup of coffee or tea at the moment of interaction and the one who requested the item was paying the bill. However, nothing has been dictated from the administrators to the members. Also, the personal private messaging area between members has cut off the administrative control over the community. The lack of control of the messaging reduced the awareness of the actions which has been taking place via platform. Yet, the interactive relations with the members and the relations between the administrators (co-founders in this case) have direct effects on the sustainability of the platform itself.

The platform has been sparked from a synergy between the co-founders and was kept alive mostly with the motivation of the member-admin relations and was refreshed each time a new branch website developed and a new platform added to the main Library of Stuff idea but it had ended mostly because of the lack of physical interaction and economic support to technically develop and sustain the platform.

5. CONCLUSION

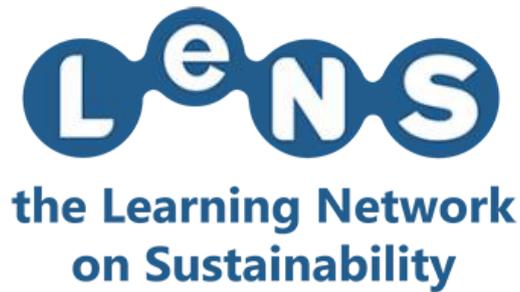
From the first findings of the interview and in depth research of web site material, it was proved inevitable that an interaction was created between the members who were giving and borrowing the items from the sharing platform and the interaction increased with the frequency of the use of the web site accordingly. Findings of McArthur's research (2015) on user- motivations for using land-sharing systems shows similarities with general motivations of participants in sharing schemes in LoT initiatives as well; establishing and belonging to a community, politics of production and consumption collaboratively, adventure and financial benefits. As reported by Bor (personal communication, October 20, 2017), the members who applied for LoS have given similar motivations for their application such as; to be a member of sharing community and reduce the unnecessary consumption. The motivations have been in the same track with the research result of Hamari et al. (2015) as well. These are sustainability and joy of the activity as well as its economic benefit.

Service design is co-creative by the terminology and practice. This case proved that definition also. (A. G. Bor & A. E. Miskbay (November 12, 2017) have emphasized the importance of reaching directly to the source of information -feedbacks and comments- from the users of the platform. The more face to face interactions occurred between development team of the platform, the more realistic and deeper information was gathered. These direct interactions with the users of the platforms were a source of inspiration and motivation. The lack of these relations with the community gathered around the platform was a drawback effect on both administrators. To be close to

each other and to be able to work together was another source of synergy and motivation which was strongly required for having brainstorming, developmental and organizational work. Also, codification of routine sharing actions of neighbours, relatives and people who know each other into a structured platform where people share their products with people they do not know needed other kind of synergy. In this regard, besides having an inevitable effect on decreasing excess consumption with its different characteristics from other LoT initiatives around the world, the LoS experience taught a substantial body of knowledge. Although LoS is not active now, it has created a core community ready to emerge in new alternative sustainable life practices and sharing experiences to alter the unsustainable ways we live in.

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RESEARCH ON SERVICE SYSTEM DESIGN BASED ON VISUALIZATION OF SUSTAINABLE PRODUCT CARBON FOOTPRINT

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ABSTRACT

The environmental impact of product production and consumption is gradually receiving attention. Visualization of carbon footprint is one of the main methods for promoting and developing sustainable products, and it is gradually receiving widespread attention from the international community. This paper first summarizes the current research status of carbon footprint and carbon footprint identification at home and abroad, and finally proposes a design method and implementation approach of carbon footprint visualization service system based on the product life cycle.

Key Words: Sustainable Design, Carbon Footprint, Visualization, Service design

1. INTRODUCTION

In recent years, with the deterioration of the ecological environment and the increasingly prominent environmental problems such as the resource crisis, they have become one of the important obstacles to human survival and economic development. The international community has begun to pay attention to environmental issues. To fundamentally resolve the contradiction between resources, environment, and economic development, we must start by changing the traditional production methods of producers and the consumption habits of consumers. And we should design a service systems for the product cycle to reduce their environmental impacts at all stages of the life cycle, "Procurement. - Manufacturing - Distribution - Use - Recycling - Disposal - Waste, etc.", to reduce the environmental costs of the product over its life cycle (Ljungberg L Y., 2007), and exploring the promotion of sustainable products and its conceptual approach, attempting to bring the concepts of "environmental attributes", "sustainability", "carbon footprint", "carbon labeling" into the marketing system of goods and the factors that influence consumer consumption decisions.

2. RESEARCH ON CARBON FOOTPRINT AND CARBON FOOTPRINT IDENTIFICATION

The United Kingdom proposed the concept of carbon footprint in 2006 (Carbon Trust, 2007). Carbon Trust in the United Kingdom defines the carbon footprint as a method and technique for accounting for greenhouse gas emissions in the supply chain of products in terms of carbon equivalents (Carbon Trust, 2007). The Environmental Technology Action Plan defines carbon footprint as greenhouse gas emissions from human activities (calculated as carbon dioxide equivalents) (BP, 2018). The Global Footprint Network defines a carbon footprint: the amount of carbon dioxide produced by humans while harvesting energy from fossil fuel combustion (GFN, 2007). The more authoritative definitions of Thomas Wiedmann and Jan Minx, the carbon footprint is the amount of greenhouse gas emissions generated during human activities or product life cycles and expressed in terms of carbon dioxide equivalents (Wiedmann T & Minx J., 2007). The carbon footprint is based on life-cycle analysis and evolved from the ecological footprint (Wiedmann T & Barrett J., 2007). Life cycle analysis is the systematic assessment of the environmental impact of a product or service throughout its life cycle from manufacturing to consumption (Hammerschlag R & Barbour W., 2003). The life cycle also includes the entire process of mining, refining, manufacturing, transportation, distribution, use, maintenance, recycling and final disposal of raw materials (Wackernagel M. & Rees W.E., 1996).

The carbon footprint identification is a concrete manifestation of the product's carbon footprint, which shows the amount of greenhouse gases in the process from production to transportation to sales (some carbon footprint markings also include consumer use and disposal processes) (Wiedmann T & Minx J., 2007). One of the purposes of the identification is to enable companies to better communicate with their consumers about product information, to show consumers the contribution of companies in reducing emissions, and to provide consumers with carbon footprint information for consumers to compare products (Foran B et.al., 2005). As shown in Figure 1, many countries and regions around the world have their own carbon footprint identifications.



[Figure 1] Carbon footprint identification in different countries and regions

At present, there are few studies on the design of carbon footprint and carbon footprint identification service system at home and abroad, and most of the research focuses on the impact of the carbon footprint identification itself or the influence on consumers of carbon footprint identification itself. In addition, many are researching on certain factors, such as product packaging and factors affecting consumer spending, etc. Joseph Murphy (2007) in his research on the adoption and use of carbon footprint identification products, he studied the factors that influence consumers' adoption of carbon footprint identification products as income, education and

socioeconomic status, and factors affecting consumers' use of carbon footprint identification products. For product type and revenue. Beattie (2008) in a project study on carbon footprint identification information and consumer response, pointed out that providing carbon footprint information for products is conducive to promoting consumers' green consumption behaviour. At the same time, in the sub-project of the project, Beattie also studied the attractiveness of the carbon footprint identification products to consumers and suggested that the company should put the carbon footprint identification information in the position of product packaging design that is more likely to cause consumers to resonate emotionally (Geoffrey Beattie, 2009).

In the product marketing process, visualizing products from raw materials to finished products to recycling production processes and carbon dioxide emissions throughout the life cycle is one of the effective measures to guide environmental consumption. With the introduction of environmental issues such as "climate change" and "white pollution", more and more consumers are beginning to pay attention to sustainable product design, and there are many consumers who are willing to change their purchasing behaviour to protect the environment. Consumers are gradually increasing their environmental awareness and beginning to pay attention to the environmental attributes of products. The gradual preference for sustainable products with environmental attributes will enable companies to develop sustainable product design processes and implementation specifications, improve product sustainability and enhance corporate image. In turn, it promotes the development of sustainable consumption, which will form a sustainable closed-loop ecology, making sustainability one of the important factors affecting the social, economic and ecological environment. Through carbon footprint visualization, companies enable consumers to have a quantitative understanding of the environmental impacts of product production and use, thereby guiding their consumption decisions. Therefore, it is of great practical significance to study the design of service systems for carbon footprint visualization and carbon footprint identification.

3. DESIGN AND IMPLEMENTATION OF SERVICE SYSTEM FOR PRODUCT CARBON FOOTPRINT VISUALIZATION

Today, "products (including physical and non-material products) are platforms for providing services" and "services are the main source of profit" (LUO Shi-jian & ZHU Shang-shang, 2011). Services can create value without wasting material and continuously create value through the product's complete life cycle (LUO Shi-jian & ZOU Wen-yin, 2018). The essence of service design is to design an effective model for organizing and planning people, infrastructure, communication, and various components of tangible materials in the service system (Vargo S.L. et.al., 2008). Product Service System Design (PSSD) is based on PSS, mainly for the strategies, concepts, products (material and non-material), management, processes, services, applications, recycling, etc. involved in product service systems for systematically planning and design (LUO Shi-jian & ZHU Shang-shang, 2011).

3.1. Carbon footprint visualization

The company's carbon footprint analysis is the first step in sustainable development. By visualizing the production process, material structure, recycling method, and energy consumption and visualizing the carbon production savings in the process "selection - manufacturing - use - recycling - reuse - disposal", then applying them to all phases of the product lifecycle, which in turn manages and optimizes production and transportation processes, reducing CO₂ emissions, and creating sustainable product service system designs for producers and consumers. Through product carbon footprint analysis, the company visualizes the carbon footprint of products to achieve better communication with consumers. It can not only serve as a social responsibility measure for enterprises but also improve internal operations and save costs. Marketing strategies help companies gain a competitive advantage. In addition, it is an effective way to meet market demands and meet international requirements. They are a bridge to promote communication and cooperation.

Marketing incentives are divided into products, prices, distribution and promotions. Carbon footprint visualization is the stimulus that is reflected in products or distribution in marketing stimuli (Xue Qiang et.al., 2003). It stimulates consumers by showing consumers certain attributes of the product, thereby causing the consumer's psychological activities, forming an attitude toward the product and ultimately leading to changes in behavior. According to existing research, product information has a significant impact on consumer attitudes and behavioral changes (Loureiro M., 2003). As a product or distribution information stimulus, carbon footprint visualization affects consumers by providing offline consumer information, product packaging design, and online merchandise details, product parameters, etc. Product attitude. Today, when online shopping is so developed, it is one of the marketing strategies that companies promote to buy. Carbon footprint visualization provides consumers with an extension of product information that allows consumers to understand the carbon footprint of their products throughout their life cycle, from material extraction and material selection to product manufacturing, use, recycling and reuse to disposal. The complete process and process can help consumers to have an intuitive understanding of the environmental impact of the product and the product itself, to better evaluate the product and make their own choices. As shown in Figure 2, the eight Coke bottle backpacks released by Weilai in 2018 will focus on product production processes, innovative processes and carbon footprint emission reductions. The visualization allows consumers to visualize the low carbon properties of this product, which is also the marketing strategy of this product. This kind of marketing method can also be borrowed into more commodity fields and become the main marketing strategy for sustainable products in the future.



[Figure 2] NIO Life, 8 Coke bottle backpack product introduction

3.2. Carbon footprint identification

Product carbon footprint identification is an innovation in communication between enterprises and consumers (Munksgaard J & Pedersen K A., 2001). The carbon footprint identification is the stimulus that is reflected in the product through marketing stimuli (Xue Qiang et al., 2003). It also stimulates consumers by showing consumers certain attributes of the product. As a product information stimulus, the carbon footprint identification on the product packaging provides consumers with information about the product's interests, which influences the consumer's attitude towards the product, and is also one of the marketing strategies that the company promotes. The carbon footprint identification is also an extension of product information that shows the amount of greenhouse gases produced throughout the product life cycle. Its deeper meaning is to reveal that the company pays attention to the use of resources and the improvement of the production process at all stages of designing and producing the product, so as to optimize the production process and reduce the greenhouse gas emissions of the products. This indicates to a certain extent that the carbon footprint identification product is not only an environmentally friendly product but also its quality will be improved due to the optimization of the production process. The core attributes that consumers consider when selecting products are quality, brand, etc. Therefore, the carbon footprint identification becomes one of the important attributes that consumers consider when selecting products.

3.3. Government guidance and publicity education

Government policy support and guidance are indispensable key elements in the low carbon process. The guidance of policies and the improvement and supervision of laws and regulations can promote the rapid promotion and development of product carbon footprint. Carbon footprint visualization is not limited to carbon footprint identification or green packaging. The government should promote the development of carbon footprint and carbon footprint identification from the product life cycle and global perspective. For example, the Japanese government began implementing a carbon footprint system in 2009 to comprehensively record the carbon dioxide emissions of the product life cycle. Through the visualization of carbon emissions, the carbon emissions of commodities are clearly displayed in front of consumers, which provides an important basis for consumers to choose low-carbon products so that the low-carbon consumption concept is transformed into actual consumption behaviour and passed. We will play a guiding role in demand and supply, and promote low-carbon technology innovation in the production field, thereby promoting the low-carbonization of the entire society.

It is also crucial to the cultivation of low-carbon awareness in the whole society. Cultivating public awareness of energy conservation and emission reduction, guiding the direction of mass consumer behaviour is conducive to environmental protection, and has become an important challenge for implementing national sustainable development strategies and safeguarding measures to address climate change. Enhance the awareness of low-carbon people in the society, give them a deep understanding of low-carbon sustainable products, and promote their development

of low-carbon living habits; improving the recognition of top management is an important factor in the successful implementation of carbon footprint visualization. It can promote low-carbon education for employees and suppliers, so that design developers can deeply understand the relationship between products and the environment, analyze the impact of the various stages of the product throughout the life cycle, and find breakthroughs in reducing carbon emissions point.

4. CONCLUSION

In recent years, with the development of the economy, the contradiction between resource and environmental issues and human social development has become increasingly prominent. Climate change has also become the focus of global attention. People are paying more and more attention to sustainable design, and consumers are addressing key players in climate change action. The service system design that visualizes the carbon footprint of the product throughout its life cycle allows consumers to have an intuitive understanding of the environmental impacts of the product. It is one of the effective measures for enterprises to guide consumers' consumption decisions on environmental protection, the government to cultivate public environmental awareness and consumers to develop environmental consumption habits.

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INNOVATIVE SCHEME RESEARCH OF SHIMEN CITRUS' LIFE CYCLE BASED ON PRODUCT-SERVICE DESIGN THINKING

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ABSTRACT

Shimen County is famous for its citrus, but Shimen citrus is deadly unmarketable. Many research teams and government departments are trying new models of agricultural production and sales. They hope to find new ideas which fit Shimen's conditions for agricultural development. The article tries to use sustainable product-service system design thinking to solve the problem.

Product-service system design (S. PSSD) considers the sustainability of an industry from the three dimensions of economy, society and environment. It attaches importance to the whole life cycle of the product. The article uses blueprint to analyse each step of Shimen citrus' life cycle first. Then the article uses service design method such as SWOT and Cluster to help with the design process.

Key Words: Shimen; citrus; life cycle; service

1. AGRICULTURAL DEVELOPMENT IN SHIMEN

Shimen is famous for its citrus, and citrus is the main source of income for residents of Shimen. However, because of the unsalable products, the income of residents in Shimen County is not high, and the income of some farmers is even difficult to maintain the simple processing of citrus.

2. PRODUCT-SERVICE DESIGN THINKING(PSDT)

Sustainable product-service design considers the sustainability of the industry's development from three dimensions of economy, society and environment. Product-service design includes product design and service design. The article will use Blueprint to analyze the life cycle of Shimen citrus, and use service design tool such as SWOT and Cluster to find solutions of the system.

3. CASE STUDY OF SHIMEN CITRUS

3.1 Product life cycle thinking

The article uses blueprint to analyze each step of Shime citrus life cycle from multi-dimensions [Figure 1].

Value Chain of Agriculture	Production	Package	Storage	Transportation	Wholesale	Retailing	Consumption	
Activity			Package	Storage	Transportation	Wholesale	Sell	Purchase
Key Stakeholder	-Farmer -Pesticide Provider -Seed Provider -Worker		-Farmer -Worker	-Farmer -Management -Government	-Farmer -Driver	-Wholesaler -Retailer -Customer	-Retailer -Customer	-Customer
Touchpoints	-Over-production -Waste of water -Pollution of pesticide -High labor cost -Non-differentiated fruit -Yield lost during harvesting		-Plastic bag -Waste of package	-Warehouse -Yield lost during storage -Waste of unsold fruits	-High Transportation cost -Yield cost during transportation	-Over production -Waste of unsold fruit	-Fake product -BI-packaging -Waste of package -Waste of unsold fruits	-Waste of uneaten fruit -Waste of orange peel
Opportunity	-Shared Machines -Shared information about market -Different types of orange		-subsidiary products -Making Fertilizer -Shared warehouse (Maybe Provide by government or wholesale)	-Shared transport cars or trucks		-Farm tour -Lucky Draw -QR code -Extra info -Tutorial	-Tell Customer information how to saving	

[Figure 1] use blueprint to analyze product life cycle

Production Problems are as follows: 1. Overproduction of citrus. 2. Waste of water. 3. Water, soil and crop pollution caused by insecticides. 4. High labor costs. 5. Single species. 6. Soil erosion. 7. High production costs. 8. Lack of resources in the same off-farming period. There are some possible solutions: 1. Share production and processing machines to reduce the cost of machine and improve machine efficiency. 2. Find new ways to quickly share market information. 3. Plant different types of orange. It can improve the overall competitiveness of citrus.

Package The plastic bags used in the waxing and packaging process of orange products bring environmental pollution. But for the preservation of fresh fruit, bagging is an essential operation. After bagging, the carbon dioxide generated by the breathing increases, and the oxygen is reduced. So the aerobic respiration is gradually suppressed.

Storage The biggest loss in this part is the waste caused by the unsold fresh fruit, and the damage caused by improper storage conditions. The best way to solve it is to process some fresh fruits into subsidiary agricultural products such as canned food and dried fruit which can be easily preserved and transported. The rotten fruit can easily affect the quality of other fresh fruits. The best solution is to process the rotten fruit into fertilizers. In order to provide better storage conditions and to ensure scientific and efficient storage conditions at low cost, the government or contractor could provide a shared warehouse to store the fresh fruit in a unified standard.

Transportation The transportation costs of cold chain during transportation, as well as the high transportation costs including travel expenses, toll fees, and truck rental fees, keep transportation costs at a high degree. The shared transportation method that has been influential in the past years may reduce transportation costs in a way.

Wholesale In the traditional sales process, fresh fruit is delivered to the fruit wholesale markets in other places. Local fruit wholesalers, retailers and a small number of customers will go to the fruit wholesale market to buy fresh fruit. The losses are mainly caused by the damage caused by the terrible preservation of fresh fruit and the waste caused by the unsold fresh fruit.

Retailing Small-scale fruit shops sell fresh fruit to the fruit wholesale market, and then sell it to customers, or other retailers. Customers often need to identify whether the Shimen citrus sold in the fruit shop is really produced in Shimen, or whether it is of high quality. Some fruit shops may repack the fresh fruit to have a better appear-

ance, and bring waste and pollution. But the main is the waste of unsold fresh fruit. The system considers selling fresh fruit locally through agricultural tourism, and solve the problem of storage and waste of fresh fruit. In addition, the fruits will be packaged with QR codes in the primary plantation. It provides a platform for information and feedback.

Consumption Rotten fruits and peels bring much waste. The system will take into account the preservation and peel reuse information after the fruit is sold.

3.2 Service design thinking

3.2.1 Analyze based on SWOT

Strengths are sweet taste and low retail price.

Weaknesses are limited sales channels, single planting structure, lack of money for advanced processing equipment, high transportation cost, lack of product diversity, lack of brand, outdated processing technology, and limited market information.

Opportunity is subsidiary products.

Threats are as follows: 1. Many other inferior fruits on the market are sold as Shimen Citrus, which damages the reputation of Shimen Citrus. 2. The same harvest season of the same species leads to the fierce competition between farmers. 3. Labour and transportation costs are rising. 4. Inflation will influence the fruit market. 5. Export policies limit exports.

3.2.2 Analyze based on Cluster

The problems are mainly concentrated on production, package, storage, transportation and platforms. The article uses the Cluster method to classify all the key points found in SWOT into production, package, storage, transportation and platform. Then gather the similar points and get a new point. The members of the research team then score each point to determine the priority.

Production 1. Plant different types of oranges to reduce the competition between farmers. 2. Produce different types of subsidiary agricultural products to reduce overproduction, and create more employment opportunities. 3. Make rotten fruit into fertilizer to reduce waste. 4. Use shared machines and unify production standards to improve production efficiency. 5. Promote the development of tourism in Shimen through agricultural tourism, which drives the local diversified production and enhance the interaction between producers and consumers.

Packaging 1. Found the brand of Shimen Citrus and enhance the competitiveness in the domestic and foreign markets. 2. Apply QR code to the orange product as an electronic ID card. Customers can query information of the orange product. And it can carry additional information like the story of the Orangery, fresh-keeping coups, do-it-yourself(DIY) tutorials, etc., bringing added value to the orange products. 3. Use recyclable package. Use environmental friendly materials, or the package that can be formed into other tools to bring secondary use value. 4. Sell mixed fruit boxes to guide consumers to buy a variety of orange products. And consumers' feedback on different orange products can guide farmers to adjust the production scale of Shimen Citrus.

Storage and transportation 1. Use a shared warehouse to reduce storage costs. 2. Shared traffic like UBER can reduce transportation costs. 3. Unify distribution, unify management, and unify transportation. 3. Establish an online mall to retail the Shimen orange products. to reduces the middlemen in the retail process. And the online mall is also an information platform for feedback.

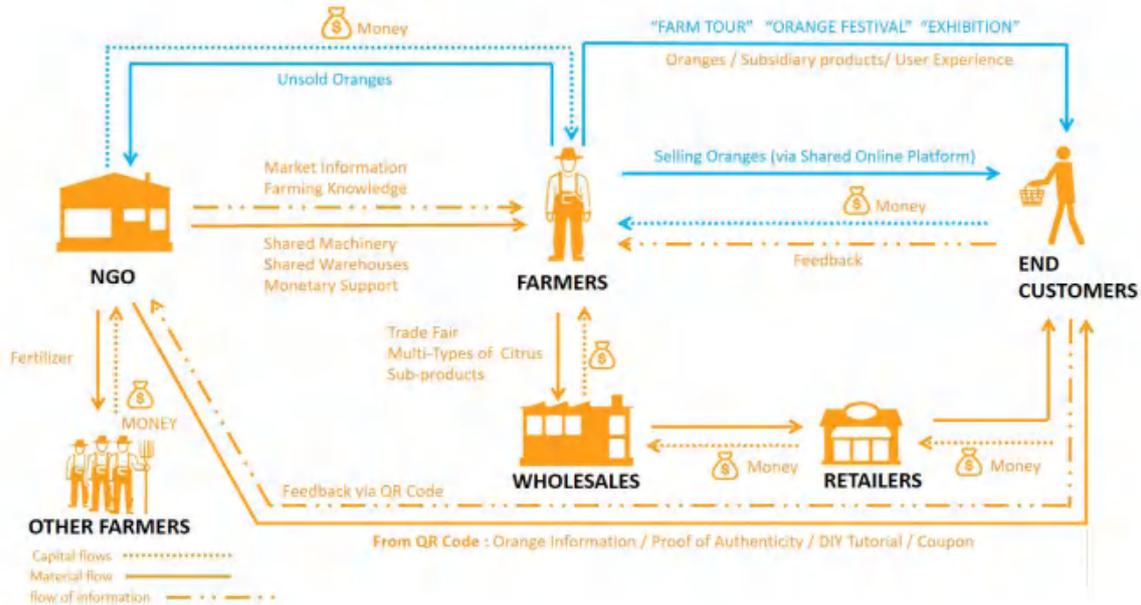
4. INNOVATIVE DESIGN OF SHIMEN CITRUS PRODUCT SERVICE SYSTEM

The new system takes System Map from PSDT as the logical base. It improves the value chain of Shimen citrus by adding sales channels and increasing the diversity of orange products.

4.1 Increase sales channels [Figure 2]

Usually, wholesalers from other places seek local agents to purchase fresh fruit, and then transport to designated markets. The new system has a non-governmental organization (NGO) established by companies. NGO assists farmers in large-scale production. The new system combines online and offline sales to expand sales channels. In the online sales pattern, the company builds and manages the online mall of Shimen Citrus. The sales information is displayed on the official website. Consumers can purchase products on the official website and give the feedback on it. NGO purchases orange products from farmers for sale, and it reduces middlemen. So farmers have gained more profits.

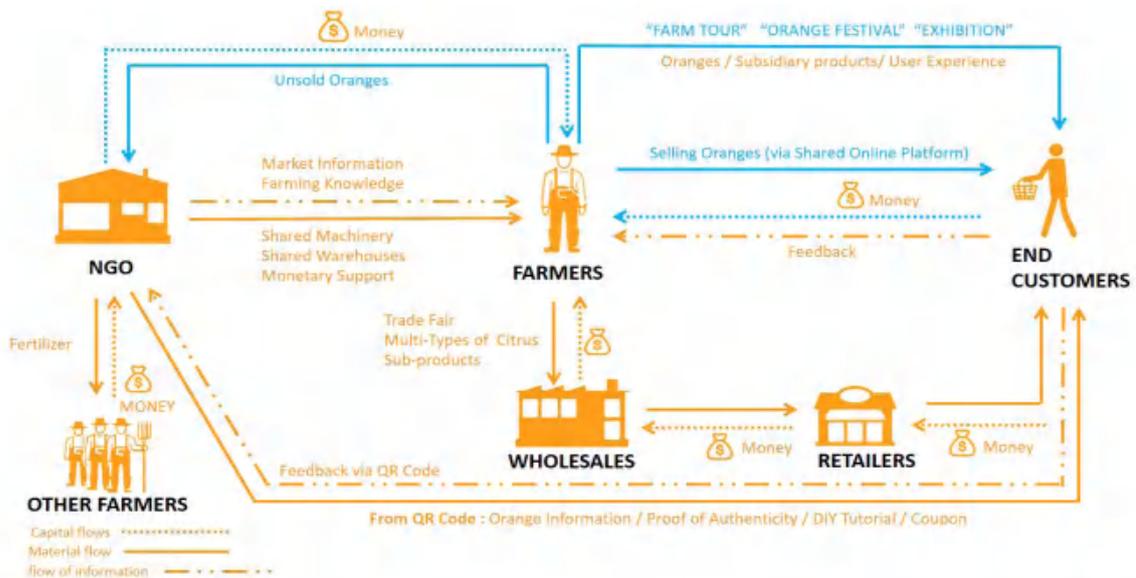
There are two methods to sell offline in the new system. First, wholesalers from other places go to Shimen to wholesale orange products, and then transport them to other cities for retail. Second, in the form of farmhouse party, the system promotes the experience system in the orchard. Tourists nearby could enter the orchard to pick fresh fruit and enter the workshop for DIY. The Orange Festival and the Orange Products Exhibition will be held to attract tourists to the local area for experience. Unsold oranges will be processed by NOG to produce fertilizers.



[Figure 2] increase sales channels

4.2 Promote products diversity[Figure 3]

Increasing the diversity of products is mainly considered from the three aspects of planting, processing and waste disposal. Based on feedback from online platform and offline wholesalers, NGO demands different types of orange products and made acquisitions to guide orange farmers to grow different types of fresh fruit and produce diversified subsidiary agricultural products. The planting and processing zones are planned through agricultural tourism maps designed by NGO. Different types of fruit are planted in different orchards in Shimen Agricultural Zone. Visitors can pick the fruits they want in designated areas according to the guidelines of the map. The agricultural tourism area also contains jam workshops, dried fruit workshops, and canned products workshops, etc. Visitors can purchase ready-made subsidiary products in the workshop, or they can make their own fresh fruit into subsidiary agricultural products. In the agricultural tourism area, there are waxing areas, bagging areas, storage areas, fertilizer production areas, etc. Visitors can check the production process.

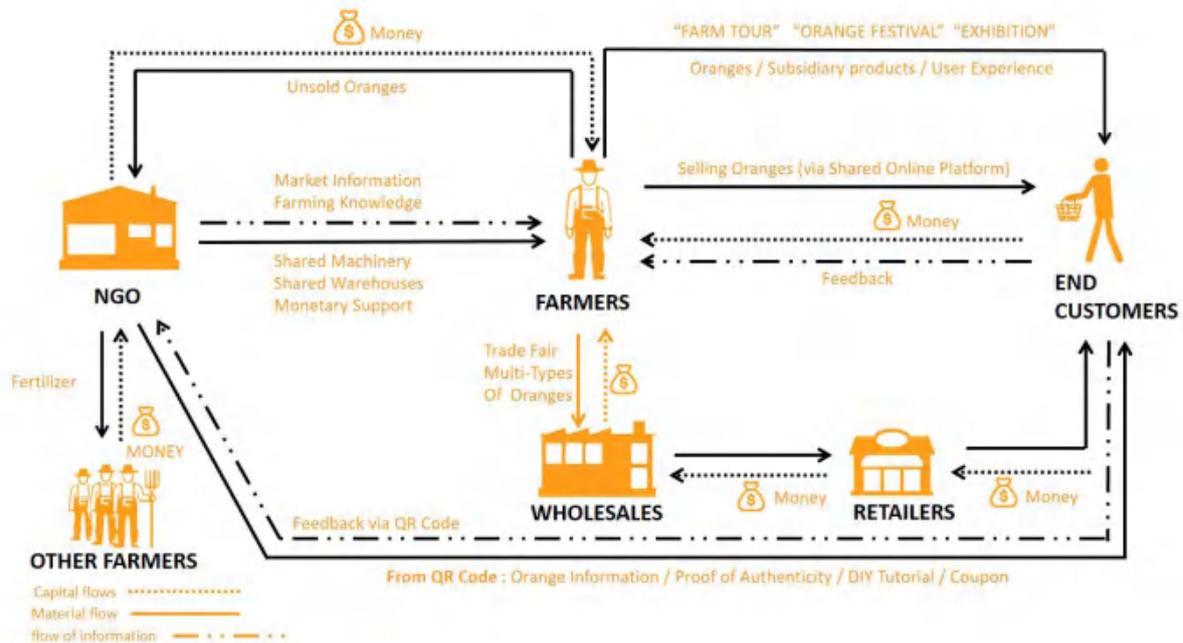


[Figure 3] promote products diversity

4.3 New pattern of Shimen Citrus product-service system[Figure 4]

At beginning, the government and investors build the brand of Shimen. NGO assists the government in the development and management of Shimen agriculture and tourism. NGO provides farmers with scientific knowledge of agriculture, and lease production machines and shared warehouses. It organizes farmers' cooperation, and unifies production. The unsold fresh fruit will be processed into fertilizer by NGO. NGO manages online malls. It purchases agricultural products from farmer households, and adjust production, according to the feedback. NGO also contact other wholesalers to develop offline wholesale-retail channels. NGO provides technology and equipment for farmers, as well as production guidance. And farmers provide high-quality products for NGO to manage and sell. With the help of the government, NGO plans the planting area in Shimen, and the whole county will become an agricultural tourism area. Tourists visit and travel there according to the guidelines of tourist maps, pick and buy

fresh fruit on the spot, and experience their own production of subsidiary products . Farmers also grow and process products according to the planning of tourist maps. Shimen can also hold orange exhibitions and other activities in the harvest season to attract tourists to pick fresh fruit, reduce the picking pressure of orange farmers, and speed up the sales of orange products.



[Figure 4] new pattern of Shimen Citrus product-service system

5. FEEDBACK

The article evaluates three dimensions of society , economy and environment in the new system . In the social dimension, the new system brings advanced technology and equipment for local agriculture. The living standards of local farmers can be significantly improved. Meanwhile the new system has strengthened the link between orange farmers and consumers. In the economic dimension, the value of local products is enhanced by the influence of the brand. And the income of the orange farmers has increased. In the environmental dimension, the new system reduces the waste and pollution of unsold fruits. And the utilization of local resources has increased.

But the system still has some problems that need tradeoff . On the one hand, increasing sales channels and the types of products needs more manpower and capital investment, and the management model is complex. So operability needs to be tested . On the other hand, the system relies on the support of NGO, but in the long-term development, NGO relations are not stable. So the system needs to be constantly adjusted according to the actual situation.

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PRODUCT-SERVICE SYSTEMS (PSS): THE USE OF PRINCIPLES IN THE CREATIVE PROCESS OF PSS

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ABSTRACT

The process of creating PSSs has several characteristics that make it complex, since it involves not only tangible and quantifiable products, but also services, typically qualitative, with several variables and actors involved. Most of the tools currently used in PSS assist the structuring process of the system, but explore the creation process just intuitively, based on the designer's experience. Some authors emphasize the heuristics and principles use as cognitive strategies that lead to high potential creative thinking. Thus, the following study identified some prominent authors who propose principles focused on the quality and sustainability of products and services, in order to explore their potential. The method used included a theoretical study, followed by an exploratory case study. The present article, besides contributing to the detection of emphases and gaps in the literature, demonstrates by means of practical application, the designer's interaction with inventive principles in the process of creating PSSs.

Key Words: Product-Service-System, Creativity, Sustainability, Heuristics principles.

1. INTRODUCTION

The Product-Service System (PSS) presents itself as an innovation strategy, changing the focus of businesses from the design and sale of physical products only, to the sale of a products and services system that are able to meet the specific demands of customers (Manzini, Vezzoli, 2002). In this context, it is important to highlight the importance of the service sector in relation to other economic activities that compose the national GDP. In 2018, the sector represented 75.8% of Brazil's GDP (IBGE, 2019). In this way, the strategic importance of the service sector in the economic development is highlighted, which, in addition to generating value, better living conditions and jobs, enhances the competitiveness of companies.

However, according to Manzini and Vezzoli (2002), companies face barriers in designing, developing, delivering PSS and implementing the necessary changes in corporate culture to support more systemic innovation and business-oriented services. According to the authors other barriers faced by companies include the lack of knowledge and experience in terms of: Methods and tools for designing services; Tools that can be used to evaluate and implement PSS; Service management systems; Skilled entrepreneurial personnel in the development and provision of services, and life cycle cost calculation methods.

Marques (2018) also points out that the adoption of PSS business models by manufacturing companies still represents a complex transition. Since these companies adopt approaches based on a traditional perspective to design and develop their integrated solutions, that is, they project the “tangible” part of the product and adopt intuitive processes and methods to develop the “intangible” elements (services). In this context, Pinhanez (2009) states that innovation in services based on science and technology suffers from lack of research, with very superficial studies being carried out. From this premise, one way of deepening the ideas generated for the service sector would be, for example, through methods and tools of creativity. One method recognized by having a logical structure, with patterns and repeatability is the heuristic method. Heuristics can be defined as cognitive strategies applied to project problems that lead the designers to a space of diverse, unexplored solutions, generating more creative ideas of high potential (Yilmaz et al., 2010).

The main goal of heuristics is not only to generate several solutions by pure trial and error or brainstorming. The heuristics work as devices that contribute to reduce the average number of solutions to be sought, helping to generate ideas with greater potential for innovation and finding a way to solve complex problems (CHU et al., 2010) and drawing attention to the most relevant aspects of the problem (Renkl et al., 2009).

The following study aims to highlight some tools for developing PSSs that use or do not use heuristics, in order to perform a comparative analysis of the interaction of beginner designers in PSS with these tools. The intention is to highlight emphases and gaps in the creation process. The research refers to an exploratory case study that had the participation of twelve Design students. The context of analysis occurred within an intensive course (Pilot Course) of two weeks (30 hours), offered to undergraduate students. The Pilot Course was formulated as part of an initiative of the LeNS (Learning Network on Sustainability). This network has obtained funding from the Erasmus+ Program to implement an action plan on curriculum development aimed at promoting a new generation of designers (Design Educators and Researchers) capable of developing Design for Sustainability (DfS), Sustainable Product Service System (S.PSS) applied to the Distributed Economy (DE). The method used in this article is of qualitative nature and counted on an asystematic bibliographic research, followed by an exploratory case study and analysis through the application of a questionnaire.

2. PSS, TOOLS AND HEURISTICS

A PSS can be defined as the result of an innovation strategy, which consists of a combination of tangible products and intangible services designed to be able to meet the needs of final customers (Tukker and Tischner, 2006). Vezzoli et al. (2018) adds the perception of the sustainability potential of the PSS approach, emphasizing that this business model is mainly aimed at decoupling value creation from increased resource consumption.

Vasantha et al. (2016) highlight several elements that influence the PSS, such as: Actors from different areas and with different levels of involvement in the PSS; The environment, considering the multiple points of contact and interactions; Several activities at each stage of the PSS life cycle; Innovation and the addition of value (economic, social and environmental); among others. The synthesis and management of contexts involving numerous elements and actors is a complex task and demands a holistic view of all PSS interactions.

According to Forcelini et al. (2018), techniques that involve heuristic principles can support when dealing with complex systems, generating solutions at the time and place where they are necessary, independently of spontaneous creativity, which allows manifesting the creative potential of each member of the team. In addition to promoting a better interaction between the components of a creative team, they standardize the creativity, making the success of the project not depend on the people considered naturally creative.

Tassi (2008) developed in his thesis, through the cooperation between research groups of the Department IN-DACO (Polytechnic of Milan), an open platform of knowledge that describes several tools of Service Design Tools¹. According to the author in recent years, several tools that have been implemented are able to face the highest level of

¹ Platform Online: Service Design Tools. Disponível em: <<http://www.servicedesigntools.org/about>> Acesso 19 jan 2019.

complexity and also communicate the intangible aspects of the project, such as time and experience. Some tools appear several times with different objectives and in different categories, indicating, for example, that some characteristics of the tools used in the first part of the process can be taken and used later to communicate the project in the implementation phase or even during the delivery. For example the blueprint tool, which according to the author's classification can be a useful tool in the "Invisioning" and "Implementation" stages. The use of heuristics is proposed by Tassi (2008) only once in the "Prototype Testing" phase of the idealized system.

In the unsystematic bibliographical survey, other tools were found in the PSS that make use of heuristics, it is possible to emphasize here the SDO-MEPSS tool (Sustainability Design Orienting-Product Service System Methodology). This is an online platform that has as general objective of guiding the design process for sustainable PSS solutions. The tool, in addition to the principles, integrates an analysis and checklist roadmap, which guides designers in the analysis of environmental, social and/or economic priorities (Vezzoli, 2010).

As a starting point for the adoption of PSS solutions for more sustainable scenarios, Vezzoli (2010) proposes principles directed to the three dimensions, social, environmental and economic. The principles are usually accompanied by guidelines and examples of how to apply them.

Another relevant tool is the Matrix DM+PSS, which presents a diagram that visualizes potential areas where Distributed Manufacturing (DM) can contribute to improve the development of PSS. The tool has a set of 35 scenario cards/principles that show the potential benefits of applying DM to the PSS. The tool makes it possible to generate ideas with each card. The DM principles presented in the scenarios can be integrated into the PSS project considering all stages of the life cycle (Petrulaityte et al., 2017).

3. METHOD

The present study follows a qualitative approach of interpretive nature. According to Polaine et al. (2013), quantitative data do not reflect the subjective reasons why people cease to use certain services. Firstly, an informational phase was developed, in which a bibliographical survey was made aiming contents related to: Concepts of PSS; Creativity tools directed to PSS; Heuristic methods in the creative process, and others related to these issues. The study also had practical observations carried out in an exploratory case study, focusing on the direct observation of the use of the creativity tools in a pilot course, which occurred between October 16th and 27th, 2017 in the Graduation Course of Design in the Federal University of Paraná. According to Yin (2004) the exploratory case study is a strategy that aims to analyze real-life situations. Data collection consisted of direct observations, video recording and gathering of documents produced by the students before, during and after the creativity sessions. In the analysis phase, after using the creativity tools, the students were instructed to respond to a previously structured questionnaire, recording their perceptions regarding the methodology used and the application of the tools.

4. RESULTS OF THE APPLICATION OF CREATION TOOLS FOR PSS

During the exploratory study in the classroom, the SDO-MEPSS tools (Sustainability Design Orienting-Product Service System Methodology) proposed by Vezzoli (2010), and the Matrix DM+PSS (Petrulaityte et al., 2017), have been applied based on the heuristics principle. Six other tools were also applied (which do not use principles in their structure). These are briefly described below (table 4.1):

[Table 4.1] Synthesis of tools applied in the PSS course / Exploratory Study (Font: Silva et al (2012); Segura & Vidal (2016); <mepss-sdo.polimi.it/mepss>; <servicedesigntools.org>; <lens-brazil.org/course> (2017)

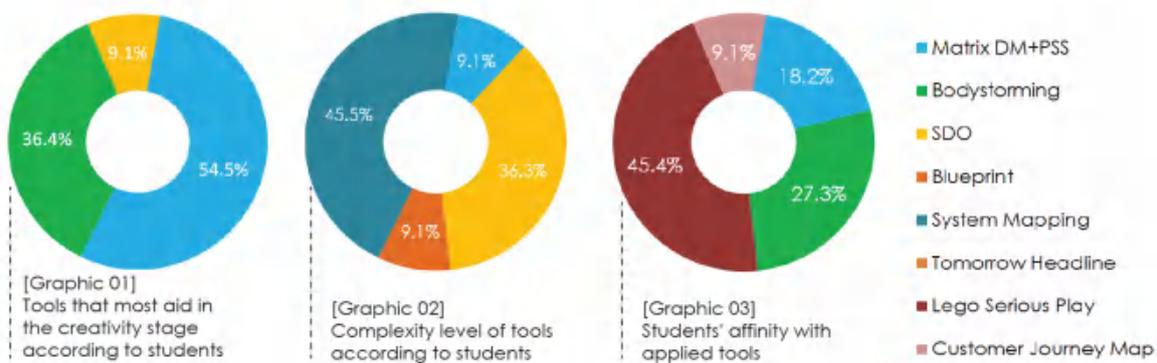
Tools	Description
Bodystorming	A technique in which designers and other stakeholders use their body language to create or represent ideas about interactions and settings around a given experience. The technique allows real situations to be simulated by real people, so one of its advantages is the possibility of immediate feedback on how a specific idea would fit into the target context (SEGURA & VIDAL, 2016)
System Mapping	A visual description of the technical organization of the service: the different actors involved, their mutual relationships and the flows of materials, energy, information and money through the system (SERVICE DESIGN TOOLS, 2014).
Blueprint	It is a matrix that represents visually and schematically the complex system of interactions that characterize a service provision. In this representation, the different points of contact of the service are mapped, that is, the visible and/or physical elements with which the client interacts, and also the client actions and all the interaction with the company from the visible operations to those that occur in the backstage (SILVA et al, 2012).
Lego Serious Play®	A method that facilitates the process of meeting, communicating and solving problems. Each participant or team constructs their own 3D model using specially selected LEGO® elements. These 3D models serve as a basis for group discussion, knowledge sharing, improving group problem solving, using visual and kinesthetic skills (Official Site, LEGO® SERIOUS PLAY®).
Customer Journey Map	It is a graphical representation of the customer relationship stages with a product or service, which describes the key steps taken before, during and after purchase and use (SILVA et al, 2012).

Tomorrow Headline	Consists of fiction articles published in magazines that the designers create. The “fake” article makes possible a future projection in order to understand the kind of impact that the service will have on society. This tool is also a way to visualize the idea and make it more tangible, more real and more univocally perceived between the team and the stakeholders (IDEO, 2002).
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In order to evaluate the creativity tools, a questionnaire was developed with ten multiple choice questions in which students should justify each choice. The completed questionnaire was answered by eleven of the twelve students who participated in all the activities proposed during the course.

The course was divided into ten sessions, as follows: (i) General introduction to the fundamentals of PSS and classroom objectives; (ii) Understanding the problem through the Blueprint and System Mapping; (iii) Definition of the satisfaction unit with the development of Personas and the principles use of Sustainable Design Orienting Toolkit (SDO); (iv) First creation session with application of Matrix DM+PSS tool; (v) Second creation session with the application of Bodystorming techniques and Tomorrow Headlines (vi) Mockup with Lego Serious Play®; (vii) Contact with the user and feedback from stakeholders (viii) PSS detailing with Storyboards; (ix) Preparation for final presentation using Customer Journey Map; and (x) Final presentation.

Thus, in order to understand the student’s perceptions regarding the different tools used, the questionnaire involved all the tools applied during the course, not just those used in the creativity sessions. It was assumed that the creative process does not only comprise the creation phase, but the whole discussions made during the two-week course. The following chart shows the tools that students consider to be the key to the creative process (Graphic 01 - Figure 1).



[Figure 1] some graphs with the result of the survey questionnaire (Font: Authors, 2019)

The most voted tool was the DM+PSS Matrix (54.5% - 6 students), followed by Bodystorming (36.4% - 4 students) and SDO (9.1% - 1 student). The students justify their choice by highlighting that the DM+PSS Matrix was the one that enabled the generation of alternatives with greater detail and definition by the team. The tool helped them to think “outside the box” and have “unusual” ideas for the project. The principles and examples presented on the 35 tool cards were also considered to be of great help in the generation of alternatives. However some students point out that not always the examples seemed to fit the reality proposed by the course. The second most voted tool, Bodystorming, was described by students as being of a rapid understanding and use, allowing a greater comprehension of the real scenario. They highlighted that the tool permits to think of solutions to a problem as it happens, having you as an active participant in the experience. It was also noted that the tools make possible to see if a solution thought in paper would be possible to apply in real life.

The SDO tool stands out in the students’ perceptions by enabling different views regarding sustainability that would go unnoticed in the concept creation process. However, SDO-MEPSS tools ranked second in order of complexity to be applied. Students stressed that the site is not very intuitive, which makes it difficult to use (36.3% - 4 students), as shown in Graphic 02 - Figure 1. The System Mapping tool was considered the most difficult to apply (45.5% - 5 students). The greatest difficulty identified was to understand the whole process, taking into account all stakeholders, not only those who are direct and easier to notice. Then align all the relationships between each of these characters on a single map, in an intelligible way, was also highlighted as a process hard to understand.

Students also ranked the tools according to affinity (Graphic 03 - Figure 1). The Lego Serious Play tool ranked first (45.4% - 5 students), followed by Bodystorming (27.3% - 3 students), DM+PSS Matrix (18.2% - 2 students) and Customer Journey Map, with 9.1% (1 student). The interactivity and ability to easily view and change the PSS scenario with Lego Serious Play meant that most students had a greater affinity with the tool. They highlighted that was much easier to visualize and modify the service they were designing through this tool. The process was considered dynamic and stimulating for the generation of ideas. However, through the observation made, it was noticed that some scenarios built with Lego elements, ended up not including some key interactions for the effectiveness of the PSS.

In order to understand the need for improvements in the tools for the creation stage, students were asked about the need to add examples and principles that would indicate reference paths (examples for the application of the tool). All the answers were positive and some students justified that one of the factors that helped apply the DM+PSS Matrix was to actually have principles and examples on the cards. These principles and examples facilitat-

ed the understanding of the process and allowed more ideas to be created, reducing the time and amount of numerous extra explanations and frustration when using the tool. Therefore, it is understood that the existence of check lists, cards or even principles guiding the creation with the Lego elements, for example, could make this tool considered by the users the most effective in generating ideas, in addition to being the one that brings more affinity.

As a conclusion of the questionnaire, the students were able to write, in a discursive and optional way, suggestions for the future disciplines. The most recurring factors in this phase were: the duration of the course and the use of principles and examples in each tool. The students indicated an interest in having more time to dedicate to the research of each of the tools and also to the interviews with the users of the proposed services. In addition, they indicated that the presence of principles with examples of application of each of the tools would greatly facilitate the understanding and generation of ideas, especially when the time dedicated to each tool is short.

5. CONCLUSIONS AND DISCUSSIONS

Considering the complexity of the development of PSS (Product-Service-System), whose creative process must consider the several points of contact and actors, as well as tangible and intangible systems, among other factors involved, it can be concluded that the development of strategies and tools that guide the creative thinking in a systematic way, as proposed by heuristics, is essential for raising creativity and innovation potential.

The Pilot Course demonstrated the importance of tools that use and do not use heuristics for PSS creation. However it was reported by students that the inclusion of properly exemplified heuristic principles aided in the generation of unexpected ideas considered of high creative potential. The conceptual accumulation of the tools that occurred during the course has clearly provided more confidence to students to generate a variety of ideas with an adequate understanding of the problem and possible solutions scenarios.

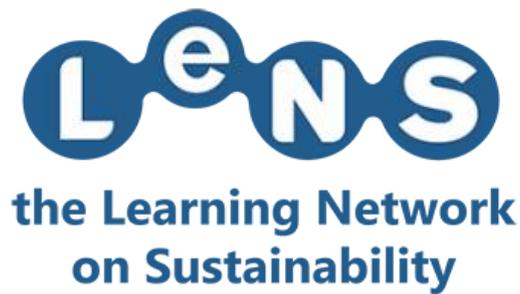
It was also observed in the questionnaire that the tools that applied principles and examples stood out in the process of creating ideas. As emphasized by Forcelini et al. (2018), the use of heuristic principles promote a better interaction among the participants, and when they are exemplified with external cases, the knowledge of everybody involved is uniformized, so that the success of the project does not depend on the people considered naturally creative. However, it is also clear the need and importance of the process of analogy and abstraction in order not to get stuck in the same existing idea.

It is also possible to highlight the results achieved in the questionnaire, the SDO-MEPSS tool, for example, was considered by users as the third most helpful in the process of generating ideas due to the use of heuristics, however it was also considered the second most complex. That is, the ability of a tool to support the creation is not related to its ease of application or the affinity that the user has with it. However, the difficulty in dealing with the tool may distract the designers, being important to use tools that bring this balance between playfulness and systematics. The use of these tools provided greater collaboration among design students, teachers and users. Future initiatives should be undertaken in order to expand the study and increase the reliability of the research.

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STUDY ON THE SERVICE DESIGN OF URBAN YOUNG DRIFTERS COMMUNITY

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ABSTRACT

This paper aiming at the housing problem of urban young drifters, this paper explored the community service mode which conformed to the needs of urban young drifters from the perspective of service design. Based on the Service Experience Engineering method, this paper took “YOU+ International youth Community” as the research case and studied the demand trend research through context research, user research and demands analysis. Moreover, this paper studied the service value network in terms of the stakeholder, the business model research and completed the service prototype through the service blueprint and the service contact. With the study of the present living situation of young drifters, this paper grasped the value of young drifters, synthesized various design means, constructed a ‘habitation plus living’ community service model which conformed to the characteristic of young drifters. In this way a sustainable circle of value creation would be created, and the mutual benefit of the young drifters, the community and the city would be finally realized.

KEYWORDS: Young drifters, Service design, Lifestyle, Youth community

1. INTRODUCTION

In the process of urbanization, large numbers of people continue to gather in cities. According to the data in China's Mobile Population Development Report 2016 released by the National Health Commission of the People's Republic of China, the number of mobile population in China reached 247 million in 2015, with the population of young people (1980 and beyond) accounting for about 51.1%. Although young people are the most active and potential group in urban development, they are still confronted with the housing problem for a long time due to their unstable initial socio-economic base and unaffordable high housing prices, during the nearly ten years from the time they graduated and work hard in the first or second-tier city to the time they start their own families.

In view of the living situation of urban youth, Huang Ying (2008) tried to solve the urban youth housing problem through the improvement of the housing rental system, low-rent housing system and the increase in the income of urban new immigrant youth. Given to the economic factors Miao Guo (2010) explored the root in the pain of 'ant tribe' (referred to as low-income college graduates somewhat resembling ants, because they are relatively weak, gregarious and hard-working.) from the perspective of home ownership concept and behavior changes. Based on the theory of social stratification, Song Jian et al's (2015) paper analyzed the sources and influencing factors of urban youth housing, and put forward that the government could solve the urban housing problem by expanding the market of housing sources, formulating safeguard policies and providing "low-rent housing".

In the field of architecture, Wang Wei (2011) studied Youth container apartments from the perspective of environmental protection economy. Zhang Jiankun (2012) proposed to build "youth apartment" based on PPP model to solve the "ant tribe" housing problem in various aspects. Zhang Yanlai (2017) based on the transformation of existing buildings, the design of youth apartments was studied from the angle of reorganization of space structure, intensification of residential units, community of public space and combination of old and new elements. In addition, Gai Qi (2017) used the academic grammatical system of scene theory to sort out the construction path of urban youth public culture space in China. According to the behavior characteristics of young people and the existing problems of youth apartments, Zhao Xiaozeng (2018) argued that the design of communication space for youth apartments is not only to meet the needs of living, but also to create more social possibilities for young people.

The reference shows that, at present, in view of the residential problems of urban youth, the sociological research focuses on the study and analysis of the realistic needs and living ideals of the urban residence of the youth group. Although the support policy guidelines are put forward, the vitalizing function and sustainability are lacking. While the field of architecture mainly aims at the behavior characteristics and living habits of youth groups, from the point of physical space design and transformation, the spiritual needs of youth groups are not paid enough attention to.

From the perspective of service design, this paper attempted to explore the community service model that conformed to the needs of urban young drifters on the basis of the research on their current living situation.

2. SERVICE DESIGN AND METHODS

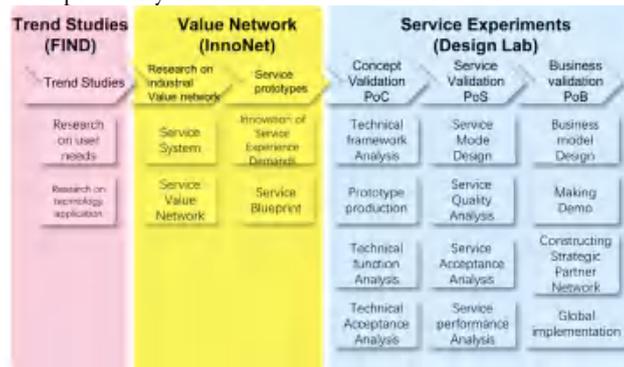
2.1 Service Design

Service design is not a new, independent academic field, but a cross-domain study combining a variety of expertise. At present, the definition of service design has not been unanimously explained but can be divided into two categories: (1) Service design is regarded as a purposeful output result, often directed to the improvement of service quality design. For example, the design Dictionary (2008) defines that the service design is to set its functions and forms from the customer's point of view, with the goal of ensuring that the service interface brings effective, efficient and recognizable information to the customer¹. (2) Service design is considered as a design method and thinking, such as the Copenhagen Institute of Interactive Design, which defines service design as a discipline designed to design holistic, global systems and processes for users. Combining multiple points of view, the author believes that service design is user-centric, and that it collaborates with multiple stakeholders to guide elements of innovation and integration such as people, environments, facilities, information to improve service experience, efficiency and value through global optimization and system innovation of service delivery, processes and contacts.

2.2 Service Experience Engineering

Service Experience engineering (short for SEE) originated in 2007 and was formally proposed as a framework for the development of design innovation services in 2008 by the Taiwan Institute of Innovation and Applied Services in collaboration with Fraunhofer IAO, a German research institute with extensive experience in service Engineering. The Service Experience project aims to establish a suitable service model through a complete set of processes and tools, and to systematically carry out service design innovation. As shown in Figure 1, this set of SEE methods consists of three phases: 1) Trend Studies (foreseeing innovative new Digi services). This phase includes two tasks user requirements research and technical application feasibility, focusing on the analysis of user behavior, market status and other contexts to gain insight into user needs and potential design opportunities. 2) Service Value Network Research (innovation Net): This stage is divided into two parts: service value chain and service model building. The goal of the service value chain is to find the right partner for the Enterprise and construct the innovative service value network through the new value conception. The goal of a service prototype is to exploit the key points in the service needs and design an experience that impresses the user. 3) Service Experiment (Design Lab). This phase in-

cludes three parts: concept validation, service validation, and commercial validation. The focus of concept validation is to judge the technical feasibility of the service. Service validation is a review of the value of the service that will be delivered and business validation is primarily evaluated for business models.



[Figure 1] Innovation process for service experience engineering

3. TREND STUDY: TRENDS IN DEMANDS OF YOUNG DRIFTERS

3.1 Contextual Studies

First of all, through contextual research, the relationship between young drifters and community was established, then the user focus of youth community was found. The selected main information collected included a total of 80 pieces from official websites, WeChat public accounts, official Weibo accounts, and 27 groups of clustering data; 116 pieces from newspapers and magazines and 15 groups of clustering data; 150 pieces from video and social media and 23 groups of clustering data; a total of 295 pieces directly retrieved from the Internet and 61 groups of clustering data. According to the data collected, the clustering results were divided into the physical conditions of the residence environment i.e. ‘habitation’ and the spiritual needs of residence i.e. ‘living’.

The results of contextual studies showed that, for the physical aspect of living environment, their living ideals included a reasonable community space, convenient and complete space facilities and a healthy and unique living environment. For the spiritual aspect it included a creative and active community experience and a quality and ensuring neighborhood. From the community perspective, there was a need to provide safe and standardized community management, professional community service personnel, efficient and timely quality of service, open and transparent charging standards. The logical relationship between the user’s focus and the community was shown in Figure 2.



[Figure 2] Logical diagram of user focus and community

3.2 User Research

The main methods of surveys were questionnaire, observation and in-depth interview, which were used to investigate the users, and the three methods were carried out in turn and infiltrated each other. 1) The questionnaire included two parts i.e. the user’s basic personal details and housing information so as to understand the characteristics, ideas and feelings of young drifters. 2) Through long-distance observation was mainly carried out in the public areas for the young drifters’ daily activities, such as office areas, leisure and entertainment areas and so on. 3) The purpose of the in-depth interview method was to obtain information in direct contact with young drifters and observe the user’s body language and facial expression and other details in the course of the interview.

In this part, information about the high frequency and controversial behavior in the covert observation would be questioned. 1) The study found that young drifters want to have an independent, private personal space. 2) They eager for emotional space to communicate with people and grow together. 3) They maintain a unique temperament and a free life. 4) Due to their inner loneliness, they are longing for the warmth of like-minded friends and home. 5) They pay attention to the quality of life and pursue superior material conditions and life experience. 6) They eager to realize self-worth and social identity.

This paper made a comprehensive analysis of the user research, summarized the needs and significance of young drifters’ “habitation” (privacy, individuality, hedonism), “living “ (sharing type, sense of belonging, sense of value) from different angles, and provided reference for the community service mode that met the demands of young urban drifters.

4. SERVICE VALUE NETWORK RESEARCH: A CASE STUDY OF YOU+ INTERNATIONAL YOUTH COMMUNITY

4.1 Stakeholders

The target group in the research is young urban drifters, so they are the center of the stakeholder analysis. Moreover it is conducive to understanding the different claims of all parties so as to meet the needs of drift youth and allocate resources. The core stakeholders of the community include young drifters' groups from different occupational backgrounds, and direct stakeholders include cleaning staff, maintenance personnel, reception personnel, security personnel, and other individuals or organizations that directly affect the residential experience.

Indirect stakeholders include operators, design teams, entrepreneurs, investors, and other individuals or organizations that indirectly influence the young drifters living experience. According to the needs analysis of young drifters, clarifying the relationship network of stakeholders: 1) Residential Space Service group to meet the demands of the young drifters for the privacy of the basic residence. 2) Life supporting service group to meet their requirements for high-quality life. 3) Social sharing group. It includes operators, design teams, etc. so as to meet their needs for the personalities and sense of belonging. 4) Value networking groups to meet their needs for personal value and the ideals.

YOU+ International youth community based on the integration of residential space service groups and life Services group, and it also provides a loft style of independent living space and supporting facilities. It is equipped with 24-hour security commuting and has set up access agencies and other personal space services so as to make up for the lack of private space. Life services such as package pickup, takeaway food pickup and intimate Butler are also provided for convenience. Integrating social sharing groups and value networking groups for the purpose of innovation, YOU+ provides community activities such as birthday parties, festive parties, outdoor activities to form a young community culture.

It also provides networking resources such as entrepreneurial salons, entrepreneurial exchange and sharing meetings for the entrepreneurial users as incubation help. Take the value networking groups as an example. YOU+ provides users with shared space for life services, learning, leisure and so on, so that they can make full use of time, space and networking resources and participate in the teaching or learning activities according to personal skills or interests.

4.2 Business Models

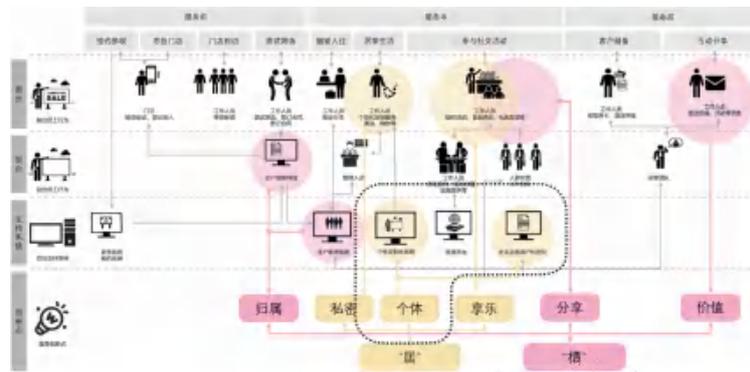
The innovation of the business model is to maximize the realization of the different demands of stakeholders. First of all, "co-habitation+ sharing" community service model can be formed and a living + socializing platform can be established through the integration of residential space service group, life service group, social sharing group and diversified user base. In the end the social circle of the young drifters would be formed. On this basis, value networking group is introduced for young drifters to provide a multi-field industry exchange and resource docking services, and a "co-habitation + sharing + co-creation" community service model can be established. Finally, a mutually beneficial entrepreneurial community system would be formed. These values and lifestyles are further delivered to the customers in the way of actual business such as the management and operation of the youth life circle. At the same time, multi-channel and continuous value transfer and cross-border cooperation should be carried out to explore new profit points.

YOU+ International Youth Community used cross-border cooperation with the government, enterprise groups and the Internet, YOU+ has increased the resources link and sharing, and it has established an innovative incubation base for residential + entrepreneurship. At this stage a series of mutually beneficial and profiting business models that serve the community such as mysterious stores, JUBA (a socializing app based on location and personal interests) and TFIT sports center has been derived from the innovative YOU+ mode.

4.3 Service Blueprint

According to the order of service delivery, the using process of the community can be divided into 3 stages i.e. pre-service, service, after service. This is shown in Figure 3. 1) The focus of the pre-service phase is to create a life circle of young drifters and form the "homogenization" of the youth community so as to make up for their lack of sense of belonging through the establishment of a screening mechanism for community residents. 2) The focus of the service phase is to provide a comfortable and livable community model and meet their needs for privacy, individuality, enjoyment and sharing through the precise system of the household management, personalized space customization system, omni-directional resource link platform, and the participatory community operation model. 3) The focus of the post-service phase is to reserve a sustainable user resource base, maintain contact with the retired tenant, reserve value link resources and meet the user's needs for value realization.

Using service design thinking and the means of space, product and visual design as well as the artificial intelligence personalized interior design system, YOU+ International youth Community customizes the core home service of personal space and has developed an app called APP-WITH, a digital platform aiming at online notification and social services offline for users. What's important it organizes regular interpersonal services such as creative and fun community activities, and it has transformed the traditional residential service model into a new model of the youth community with living+ socializing+ entrepreneurship by organizing activities and accurately docking the resource link of the entrepreneurial incubation platform.



[Figure 3] Service Blueprint of Urban youth community

4.4 Service Contacts

According to the service mode of urban youth community, the contact points in service design are classified into physical contacts, digital contacts and interpersonal contacts. 1) Physical contacts includes rental appointment forms, contracts, community supporting facilities, room cards, access control, elevators, housing facilities and public facilities. 2) Digital contacts includes advertising, community apps, WeChat public accounts and posters. 3) Interpersonal contacts are primarily interpersonal touch points among all stakeholders mentioned above. Different types of touch points form “fused contact points (multi-touch point)” from different dimensions such as time, shape, and experience, and these fused points can be transformed into each other.

For instance, YOU+ International youth community Service model employs personalized customization system and community user labeling to meet the young drifters personalized needs of service contact transformation. When the user signs the contract, the staff will take down the user’s personal information such as professional background, hobbies even constellations. Then the user and the operator label the user together in visual form so as to speed up the familiarity among the young drifters, which completes the transformation from interpersonal contact to the digital contact and back to the interpersonal and satisfies the unique demands of youth for “living”.

5. CONCLUSIONS

Considering young drifters in metropolitans are faced with enormous housing pressure, the main initiative of this study is to explore how to make up for the gap between their residential ideals and reality. Although most of the existing solutions to the young drifters housing problem focus on policy support, physical space design and renovation, the spiritual needs of youth groups are still not paid enough attention to. Therefore this paper proposes to meet the demands of young drifters for privacy, individuality, hedonism, sharing, belonging and value, clarifies the blueprint of urban youth community service, and constructs a service model and presents a lively lifestyle to the drift youth.

In the process of the community construction, the “homogenization” of the urban youth has formed a very creative community economy. The diversified forms of space provide the young drifters with space to communicate. Similarly the multi-channel resource link provides them with the co-creation network resources and the homogenized community provides a wealth of intellectual resources for young drifters as well. On the basis of resource sharing, combined with the service concept of user participation in the design, a number of emerging business models, such as “mysterious shops”, have been derived from the urban youth community.

Due to the limited space, this paper mainly aims at the analysis of the living needs and living ideals of young drifters, so the influence of the value of drifters on the youth community and the development of the city needs further discussion. I hope that this paper can provide reference for the design research of the relevant urban youth community.

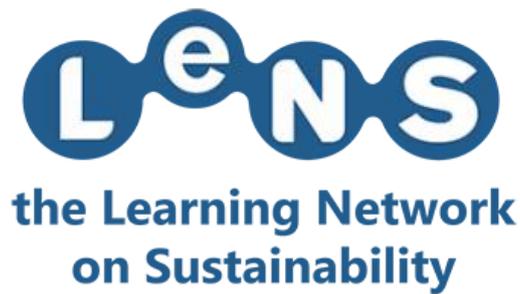
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URBAN AGRICULTURE STARTUP CASE STUDY FOR SERVICE DESIGN IN BRAZIL

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ABSTRACT

The startup Favo Tecnologia was founded in Curitiba (Brazil) with the mission to enable the practice of urban agriculture. Although the main focus of the company is the artefacts, their selling number is limited. Service design is a interdisciplinary field that involve strategies that creates and improves services for the company and their clients. This paper uses the case study as a method for the holistic comprehension of the company's context and the connection of the users with the urban farming culture. Besides, it utilizes service design tools with the main goal of solving the problem detected. The satisfaction unit that guided the strategy of the PSS focused on the preventive health and care of people between 35 to 80 years old and the valorization of the knowledge exchange between the stakeholders in the support to healthier and more sustainable eating habits.

Keywords: urban agriculture, case study, startup, service design.

1. INTRODUCTION

This article presents a service project carried out during the Sustainable Service Design class, which is part of the Design graduate program at UFPR (PPGDesign), in partnership with the startup Favo Tecnologia founded in 2016 in Curitiba (BR). Therefore, the proposal here described is hypothetical. As a result, a concept of service oriented for use is presented and focused on the final consumer.

According to the corporate website and interview carried out with the CEO Marcelo Pinhel (2018), the company has as its mission to make urban agriculture feasible for sustainable development. The products offered by Favo meet the needs of young adults and the elderly, living in urban centers. At the moment, Favo markets two products: (i) Regaê, consisting of a water tank and hoses with automated tips, which, when connected to the company's app, controls the amount and frequency of irrigation; (ii) Hortinha, a wooden stand for plant pots, held up by two easels and three shelves, with a linked irrigation system, enabling its monitoring through a mobile app. According to the interview with Pinhel (2018), some challenges have to be considered. One of which is the ability to deliver a scalable solution so the company is able to broaden its activities, conquering new markets. Another challenge is to aggregate value to the business in a way to increase the chances of Favo becoming one of the main global urban agriculture technology companies.

Thus, this article narrates the development of an eco efficient PSS (product-service system) proposal, demonstrating the diagnostic, definition and development phases. The challenge of this process is to keep the company's values directed to the sustainable development through urban agriculture, while broadening the reach of its actions.

This article adopts the concept definition of PSS according to the LeNS (Learning Network on Sustainability) global network:

"A model of supply which provides an integrated mix of products and services, which in conjunction are able to satisfy a particular demand from the consumer (allowing for the delivery of a 'fulfilment unit') based on innovative interactions between the performers (stakeholders) in the value production system (fulfilment system), where the economical and competitive interest of suppliers continuously looks for new environmentally beneficial solutions." (Vezzoli et al., 2018, p. 65)

The Vezzoli et al. (2018) study indicates that innovation applied to the PSS has in its origin the concern about business, being seen as a way to aggregate value without increasing the consumption of resources. This characteristic meets the objectives of this article, since the company in focus seeks to contribute to environmental sustainability.

To better comprehend this interaction between a PSS and the final user, three main approaches must be considered: (a) product-oriented PSS; (b) use-oriented PSS and (c) result-oriented PSS. In the three PSS orientations, the designers' creative focus change, such as the role of all involved stakeholders, including the consumers. This interaction comes to through the convergence of interests, and will be considered in this article.

2. URBAN AGRICULTURE

It is defined as the agricultural or livestock activity done inside or around urban centres. It includes the duties of cultivation, production, processing and distribution of a variety of food products. Simultaneously employs and offers human and physical resources, also employing products and services amongst the same urban area (Mougeot, 2000), in other words, it is highly integrated to a city's ecosystem.

According to Arruda & Arraes (2005 apud Duque Júnior, 2014) an important differentiation parameter to distinguish urban agriculture from rural agriculture is the space said activities are conducted at. Urban agriculture happens inside a perimeter defined by municipal laws (even if inside metropolitan or peripheral areas) and the rural activity is performed in areas external to the urban perimeter. Other differentiation points are presented in chart 1:

	Rural Agriculture	Urban Agriculture
Farmer's occupation	Main activity with exclusive commitment	Often it is a secondary activity / with partial involvement
Area usage	Specific and distinctive area	Area is disputed between agricultural and non-agricultural use
Public policies	High priority in political agendas	Often presents vague or inexistent policies
Logistics	Usually happens away from consumers	Happens close to consumers, which favours the cultivation of perishable products

[Chart 1] Differentiation points between rural and urban agriculture (Source: Adapted from Campilan et al. 2002)

The promotion of this practice contributes to making cities more productive and self-sufficient, since it has the potential to reduce the need to transport food from other regions and encourages the occupation of unused areas such as unproductive land, sidewalks and backyards (Madaleno, 2002 apud Aquino And Assis, 2007). Particularly in Curitiba, the Urban Agriculture Law was approved in September 2018, which aims to "regulate and encourage the production of healthy food in the city, in urban gardens, squares and sidewalks" (Caldas, 2018, web).

This practice is beneficial from the point of view of environmental sustainability, for regaining the communion of the human being with the earth, with the natural biodiversity and with farming, even if it is a secondary, or of partial involvement, activity. It also contributes to a more complete and healthy diet, since it enables the production and stimulates the consumption of quality food, natural and organic (Aquino and Assis, 2007).

3. METHOD

This article presents a case study carried out with the startup Favo Tecnologia as a research strategy. The case study is used to explore situations where elaborate interference does not have a single set of results, given the complexity of the sources of the case analysed (YIN, 2010). To understand the company's objectives, or, the elicitation of its strategy, a desktop research was carried out amongst its online communication channels. In order to obtain data not explicit to the public, an open interview was conducted with the company's CEO, in the space where the startup is located.

Other devices for understanding the data are brought to the project in order to make offering solutions possible. For this article, it was utilized such tools:

- a). The persona refers to the creation of an archetype through the observation of the target audience. The tool seeks to represent the characteristics of a specific social group, incorporating characteristics such as habits, wishes and culture (Service Design Tools, 2018).
- b). The application of card sorting can be done while in conversation with the consumer, using pictures cards as help. During the conversation, the participant is asked to arrange the cards in a way they think makes sense semantically (Padovani & Ribeiro, 2013). The individual invited for the application of the card sorting should represent the service's target audience, an important step in the planning phase of the technique.
- c). The act of storytelling can be used to plan out a service, being used as a Design technique, it allows to connect the various details of the environment in which the consumer's experience happens; helping to create specific scenarios and contexts for the service. This tool can be used to implement services and touchpoints focusing on customer problems (Kankainen et al., 2012). Storytelling focuses on the consumer journey, enabling the discovery of the multiple paths they can take while interacting with the service.
- d). Lego Serious Play is an experimental resource designed to aid rapid prototyping of innovative alternatives. This tool is based on the use of Lego pieces for shaping the service's settings and stages (Service Design Tools, 2018).
- e). The service blueprint tool functions as a map for the service project, from the point of view of the company and also from the point of view of the consumer, enabling the visualisation of the necessary partnerships and links for the thorough operation of the service in all its layers. (Bitner; Ostrom; Morgan, 2007).
- f). The system map is a tool that allows the holistic understanding of flow paths through the entire service system and how the different parts involved influence each other. It is based on representations and infographics, which should allow the participants to understand the service design process (Service Design Tools, 2018; Lens, 2018).

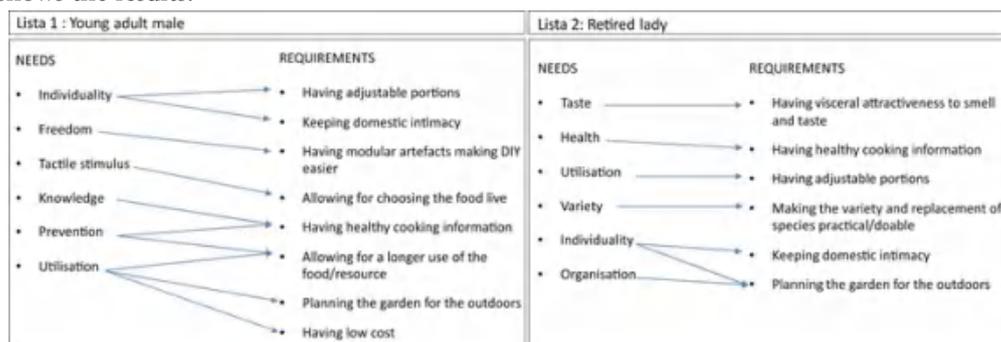
4. RESULTS

With the tools' application it was possible to understand both the consumer's needs and wishes, as well as the opportunities to add value to the startup through new services. The results obtained from the service design tools are described below.

4.1 Card sorting with the assistance of personas and storytelling

To select the consumer fulfilment unit, the information about the company's target audience was cross-referenced with the profiles on the Serasa Experian website (Serasa Experian, 2018), in order to foster the characterisation of personas and the application of card sorting. Therefore, two real people with the same characteristics as the personas created, were selected to be interviewed through card sorting.

For the application of this tool, pictures consisting of various different vegetables were selected, simulating a few consumption categories idealised by the authors such as: home gardens, retail, presentation/packaging, workshop, app, food preparation, residue handling and access to nutritional information. During an unrestricted conversation at separate dates and locations, each participant was led to choose, in order of preference, which situations they identified with. After selecting the cards, the interviewed subjects were directed to create a story about how they would handle the presented situations. Thus, the answers generated keywords: possible situations that could be provided by a PSS and relevant touchpoints. Thereby, tangible and intangible needs were identified, generating a list of requirements that could aggregate value to the PSS to be proposed, according to the problem identified above. The chart below shows the results:

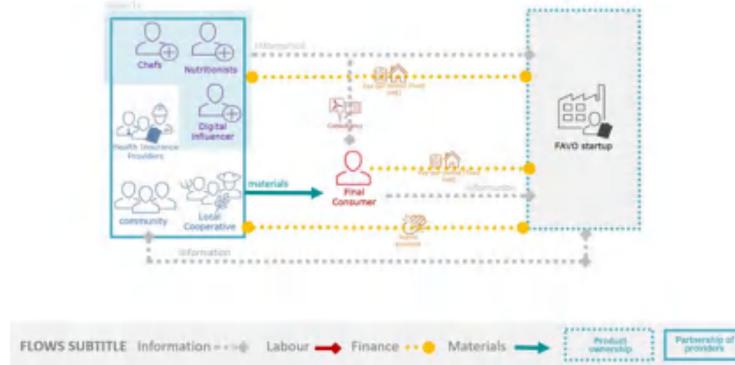


[Chart 2] List of the consumer's needs, after the application of card sorting (Source: Authors, 2018)

Needs related to prevention/health, individuality/freedom, achievement/organisation and to touch and taste were highlighted. Therefore, the requirements of being customisable, being modular and containing nutritional information became relevant. Being aware of Favo's business strategy and its know-how on digital technology for garden maintenance and the gathered needs and requirements, it was decided to focus on an eco-efficient PSS oriented for use and the fulfilment unit was defined: "decision support for sustainable and healthy eating".

4.2 System Map and Lego Serious Play

Based on the requirements survey carried out with the user, the system map was elaborated with the understanding of the other parts necessary for the delivery of the conceived service. The need to create an ecosystem for the interaction between local parts was noticed. The possible partnerships identified happen between Favo and professionals in the area of health or gastronomy. In this ecosystem Favo would play a bridge role, managing the platform that allows the flows' interaction and exchanges between stakeholders, the graphic representation of the flows is in figure 1 below:



[Figure 1] System map - supporting the decision of a sustainable healthy diet (Source: Authors, 2018)

In the system, Favo becomes the receiver and manager of the information, with its know-how in digital technology. Partnering with experts may result in a fixed income source for Favo in exchange for the advertising and publishing of work directly or indirectly, according to pre-established contracts. The advantages for professionals who access the platform would be obtaining data from their customers and further earnings. Producers/cooperatives have the advantage of enhancing their earnings from the partnership, providing at home support and maintenance. The platform also provides a marketing opportunity for products and surplus production from user's gardens or community cooperatives.

There are advantages for the consumer in purchasing a service plan, which provides, besides information and maintenance, access to all the data shared in the platform. The flow of information happens from both the single consumer and from the experts and community to feed information on the platform. According to the flows established between the stakeholders, three scenarios were elaborated with the help of the Lego Serious Play tool, which represent the service stages and their prototyping. The first scenario created for the service takes into consideration the user's actions, such as interest in the platform and account creation on the system. In the second one, the actions are perceived from Favo's point of view, presenting the startup interaction as a bridge between the parts and as a manager of the ecosystem. And in the third stage, the delivery of the service to the consumer is represented.

4.3 Service Blueprint

The relations between frontstage and backstage actions, support services, points of contact and user actions involving the different phases (or acts) of the service journey were repeatedly made explicit, to envision its complete functioning in its different layers. The completed tool is shown in figure 4 below:

BLUEPRINT	ECOSYSTEM IMPLEMENTATION	FIRST CONTACT	DECISION SUPPORT	ACQUISITION	MANUFACTURE	INSTALLATION	USE AND MONITORING	MAINTENANCE
TOUCHPOINTS		Waiting rooms, at medical offices, partner websites, tablettop displays, social media		Mobile phone and computer		Maintenance team's uniforms	App digital community	App and kits
USER'S ACTION		Interest in the offering		App downloaded	Schedule an appointment for the installation... specification of the user with partners	Creating the maintenance team	User reads the platform with information (e.g. recipes, tips, garden, nutritional properties etc.)	Garden status through the gamification of maintenance (properties etc.)
FRONTSTAGE	Stakeholders meeting	Advertising in fairs, medical offices, restaurants, social media, health insurance websites and sharing incentives	Ease of access and payment. Sales availability, humanised relationships (e.g. reference advisors), comfort	Registration in the data bank		Delivery and installation	Shared knowledge exchange between experts and users	Maintenance status
BACKSTAGE	Mapping local partners (e.g. health and nutrition specialists, horticultural producers)				Product the garden's size - contact with stakeholders		Data gathering and analysis	
SERVICE SUPPORT	Partnership with stakeholders	Trainings with the stakeholders				Deployment of partner companies for installation		

[Figure 2] Service Blueprint (Source: Authors, 2018)

The service blueprint was essential to map, among other interactions, the actions of the user throughout the service's use journey, describing (i) first contact through one of Favo's advertising points; (ii) app download; (iii) actions to schedule and set up the home garden; (iv) actions to input tips and interactions with other users on the platform, and to check recipes and advice from specialists (nutritionists, chefs, etc); (v) access the garden's status and requesting maintenance if necessary.

Once the user journey was clear, the team sought to review the fulfilment unit's relevant touchpoints. For this PSS, the following stand out: (a) The app, which already exists, but also requires adaptations to allow for more care regarding content and information support, creating value in interactions with experiences relating to gamification. (b) The website, which also requires adaptations in order to make it more attractive, in the sense of being less corporate-like, with videos that make use of storytelling to explain how the service works and with an easy access to app download and to request the service; (c) The maintenance of team's uniforms and equipment, artefacts to be developed since there are no such stakeholders at the moment, it's relevant for them to demonstrate cleanliness; here the redesign of the plant pots and vegetable gardens calls for considerable attention to maintain modularity and other practical functional characteristics coupled with the most significant symbolic aspects to the public and the brand; (d) The tabletop, wall or totem displays for partnering stakeholders: health and nutrition specialists' offices, restaurants and organic vegetable producers, which require easy to understand information, highlighting the advantages of accessing the service.

4.4 Use-Oriented Service

Based on the Favo startup case study and the process of collecting data from the target audience, the use oriented service option was considered more appropriate, because it employs a product already marketed by Favo, allowing delivery of more value to the consumer. Value is added through the services of rent and maintenance of the necessary infrastructure for the home gardens, managed by digital technology, which allows remote control of the environment conditions. In addition, the creation of the ecosystem supported by the digital platform stimulates the exchange information about health and sustainable diets between users and specialists. The service aims to provide a more complete experience for the user who's looking for a healthy and sustainable diet.

5. FINAL CONSIDERATIONS

The case study method took part in this research, in the understanding of existing problems in a business, as well as in relevant subproblems, such as the know-how and visualisation of the organisation, target audience and the context. It was also possible to experiment in a more credible way, with the application of the tools and the conceptualisation of a PSS. The card sorting, system map and blueprint tools were quite adequate for the purposes they were used for in this project, respectively: disclosing the needs of the consumers to find the fulfilment unit to be delivered by the service; understanding the stakeholders and system flow to identify the type of PSS orientation (product, use or outcome) and understanding the user's journey and key touchpoints to mark the action of designers and other parts as well as interactions. Other tools such as persona creation, storytelling and Lego Serious Play were used in conjunction with the above mentioned ones, as described in the results. The main tools used and concepts generated for the service were presented to Favo Tecnologia in a meeting between the class, teacher and members of the startup. These have recognized the value of the project with enthusiasm. Therefore, it is considered that it was possible to transmit to them some knowledge and inspiration about PSS creation based on the company case study.

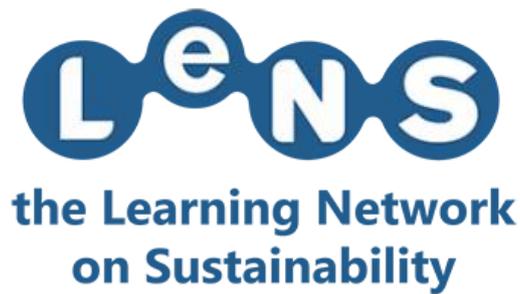
6. ACKNOWLEDGMENTS:

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DEVELOPMENT MECHANISM ON CHINA'S INDUSTRIAL DESIGN PARKS THEMED DESIGN ENTREPRENEURSHIP

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ABSTRACT

China has been dedicated to carrying out the innovation-driven social development policy and boosting economic restructuring in the past decade. Design has become a highlight in the context of this policy. China has witnessed the rapid growth of the number of design innovation parks mainly driven by independent innovation, and the gradual improvement of innovation activities and abilities thanks to regional advantages and a good industrial environment. Through a survey of Chinese design innovation parks in the Circum-Bohai-Sea, the Yangtze River Delta and the Pearl River Delta regions, we found out that a hybrid venture & investment operation mechanism capable of incubation and cultivation is the most dynamic development mechanism in the future. Through a survey of the development situation of typical parks in various regions, data gathering and field interviews, this article analyzed and compared different types of park operation mechanisms, and proposed a new mechanism that views design parks as the subject of entrepreneurship and offers venture incubation and industrial supporting services. This new development mechanism on design parks is aimed at guiding local policies and inspiring the design innovation strengths based on regional industrial ecologies. This new type of parks start to get rid of the conventional economic model depending on the rent and policy support, regard venture incubation as development potential, and actively serve as an important hub of social industries. Despite the lack of supporting and integrated in-depth information about the industry chain, these parks have already become a new engine that drives economic transformation and industrial upgrading based on national conditions.

Keywords: Industrial design, design innovation, sustainable economy, design industrial parks

1. INTRODUCTION

China's reform and opening-up policy since the 1980s has changed the production mode and economic structure of the entire society. Notably, the forms of social production based on industrial production have been increasingly enriched. Guided by national strategies, China has constantly explored how to adjust the organizational forms of social production under different conditions, making it a secret weapon that has enabled the whole society to continuously gain new growth momentum and development strengths. By means of such an intrinsic opening mechanism, China has created its status as "the world's factory".

In the Chinese society today, enterprise innovation is no longer a concept based on a production organization. Enterprise innovation contains a concept of high-tech entrepreneurship, involving how to integrate regional advantages to obtain the innovation in forms of social organizations, and how to utilize scientific and technological achievements to form emerging industries with entrepreneurs at the core.

Among them, design industrial parks, one of the forms of social organizations, have developed rapidly in many regions over the past decade. How to obtain entrepreneurship and innovation capabilities has become the main problem that these parks are urgently seeking and actively exploring.

2. BODY

2.1 Design Park Development Process In China

Design innovation parks are a new form of business that has gradually emerged in China's coastal areas with relatively developed industrial production since the early 21st century.

The first phase dated from 2000 to 2006, when major cities such as Beijing, Shanghai, Guangzhou and Shenzhen and several typical cities in coastal regions with rapid economic development built a few "base-type" design parks or centers. These design parks or centers, relying on the background of strong manufacturing, were created with the investment or policy support of the government. Then, the business form of design talents in Beijing, Shanghai, Shenzhen, Guangzhou and other major cities was effectively activated, and a large number of well-known parks, such as the TIT Creative Industry Park in Guangzhou, the Beijing Industrial Design Center, the national design innovation park in Wuxi and the Hefeng Creative Square in Ningbo, sprung up. These parks are very active even today.

The second phase roughly started from 2006 to 2011. In this phase, local governmental departments responsible for economy and science & technology started to value the organic combination between industrial design and local industries, so as to vigorously promote the landing industrial design parks in these regions. At that time, industrial design parks presented features of the service industry, enabling design firms to be associated with the innovation upgrading of local industries and enterprises. Besides, the construction path, approach, policy support and orientation were all centered on design service resources they have received. Some superior design companies, design entrepreneurship programs and platforms, and design education resources got together and played a big role in promoting regional industrial upgrading and transformation. In the late days of this phase, industrial design parks mainly had two features: First, the promotion and display of design resources, as a new driving force for the development of local enterprises, were highly valued by local governments, so that design companies and local enterprises successively established joint development programs; second, local areas started to vigorously dig urban industrial heritage as the physical basis of design parks, and integrate the functions of design culture with those of urban culture, so as to build more comprehensive cluster platforms under the background of urbanization functions, and create a park environment with a thick creative design atmosphere in local cities.

The third phase basically lasted from 2012 to now. At this stage, industrial design parks started to expand their extensions, with functions such as design & culture, design & entrepreneurship and design & talent conversion massively integrated. Driven by local economic and information technology commissions and cultural industry authorities, many cities also started to integrate local economic development goals into the functions of industrial parks. With the investment of high-tech industries and new urban functions, industrial design parks started to combine the connotations such as culture, entrepreneurship and innovation, thus forming new opportunities for policies.

2.2 Industrialization Development Layout In China

The Circum-Bohai-Sea region is a key economic area that has focused on the functions of Beijing, the capital of China, linked northeast China and north China, and covered the Jiaodong Peninsula in the past decade. As a whole, major industrial design parks in this region have developed rapidly.

An obvious feature is the collaborative relationship between a highly active capital and a few platforms in some cities. Beijing has almost outshone other cities with regard to the development of industrial design parks, and led the surrounding cities. The turning point that broke the state of quietness in the surrounding areas was the issuance of the post 2015 Beijing-Tianjin-Hebei joint development policy, when innovation-driven enterprises and start-ups in this region witnessed rapid growth, leading to the association between design resources and the functions of various cities. In this regard, the policy is the key to substantially promoting the development of industrial design parks in this region.

The Yangtze River Delta is the earliest region that developed China's industrial design parks. Due to the huge energy of industrial production, urban agglomerations with Jiangsu, Zhejiang and Shanghai at the core have all built

similar design parks to different degrees. The most obvious feature is that local industrial design parks are highly integrated with the forms of those cities. Industrial design parks in this region concentrate on resources in major cities, such as Shanghai, Suzhou, Wuxi, Nanjing, Hangzhou and Ningbo, and are not subject to the limitations of local industries in terms of the association between design and industry. Building parks as new functional areas or cultural landmarks of a city is the highlight of the construction of industrial design parks in this region. The policy plays a role of auxiliary promotion.

Major industrial design parks in China's central and western regions emerged around 2010. A few major cities along the economic corridor of southwest China, such as Changsha, Wuhan, Chongqing and Chengdu, successively set up parks which were dominated by private investors and supported by local governments. With the proposal of China's Belt and Road Initiative, another important development factor has also been injected into the vision of industrial design parks. Between 2013 and 2017, industrial design parks further drew high attention from all walks of the society, which had broken the relatively lagging look and pattern of China's central and western region. Steadily connecting industrial design parks with urban and industrial functional positioning is the main trend for the development of industrial design parks in this region in the future.

The Pearl River Delta region is also the earliest economic belt since China's reform and opening-up. The construction of industrial design parks in major cities and regions such as Shenzhen, Guangzhou, Foshan and Shunde has been speeding up. Particularly, Shenzhen has integrated urban functions, innovation and entrepreneurship functions and cultural functions, and converted design innovation talents into local industry talents. This city has imported diverse art, cultural and design resources to comprehensively serve regional economic construction. Taking towns and neighborhoods as the unit as well as districts as the basis of construction planning is a highlight of the development of industrial design parks in regions such as Shunde and Dongguan. These industrial design parks have deeply associated with regional industrial development, and highly satisfied the innovation needs of local enterprises and gained the vitality from it. Besides, they suit local conditions and have pragmatic scales. By combining specialties, sectors and industries, they are good at forming industrial design landmarks in local areas, and teaming up local industries to achieve collaborative development. From the perspective of the overall development mechanism in the past decade, the injection of design innovation function into traditional production enterprises still has profound impacts on industrial upgrading and enterprise innovation in Guangdong province.

2.3 Problems for Design Park

Industrial design parks are currently facing some problems in development mechanisms. Firstly, the in-depth development of industrial design parks is not consistent with the policy. Through the survey, we found out that industrial design parks in various regions have already entered the in-depth development stage, which means they have accomplished the gathering of basic factors and the construction of infrastructure, and started to step into a phase of how to form the "self-hematopoietic function".

The development mode that fully depends on subsidy policies has been increasingly questioned, and the development of parks is facing transformation because the initial government-dominated construction has been completed. Due to the over-reliance on governmental support, some parks have already lost their actual radiation energy, and become an empty shell. Other parks are actively exploring further development, and in terms of policy appeal, they prefer to obtain energy and space for the effective expansion of design undertakings from the society. These energy and space will effectively promote ecological development and construction of parks. So far, targeting this appeal, there are few subsidies and support policies capable of improving their information activity. In recent years, policies have become more segmented, but few of them can guide parks to get rid of the subsidy-based economic mode, and encourage them to actively dock with local industries.

Besides, local policies today are still extensive and of the subsidy nature. For instance, a latest policy that financial rewards will be granted as long as parks win world-renowned design awards has sparked heated discussions, which explicitly criticized policy flexibility and guidance issues, as the policy has objectively led to the design indexing. This goes against the objective of improving the ability of design to serve local industries. Furthermore, some incentive policies for design talents issued by local governments only support design talents and their undertakings after they settle down in these regions. This has significantly weakened design parks as a value and role of importing design talents and combining and transferring design resources. The localization of industrial design parks as well as the role of guiding them to be associated with local pillar industries are more important than attracting one or two designers. In addition, a good community life is as equally important as urban space, and should adapt to policies allocated by these cities. But for design parks, these requirements tend to be complicated, and they face different rules of survival in different regions. The promotion will and construction consciousness of policies should be highly consistent with the economically sustainable function of industrial design parks, which is the best choice. This is a key difficulty for the time being.

Secondly, the collaboration between industrial design parks and regional development requirements needs to be enhanced. China's industrial design parks are of strong social construction values and serve as a key task of the government. Having experienced two development phases and entered the third phase, industrial design parks today start to seek separate operations as an economy. To gather the comprehensive capacity and the effectiveness of major construction subjects, industrial design parks must closely combine local development strategies without losing the design innovation consciousness of the whole society as well as the energy of key tasks implemented by policies. A

more flexible intermediate conversion mechanism with powerful convergence is very necessary.

Under the guidance of policies, the key is to promote the formation of organizations in multiple channels, or allow local industrial design parks to convert into such functions. The collaborative development between local development requirements and design parks will facilitate the convergence of design innovation capabilities in local areas in the long run. If design policies are focused on pushing forward the undertakings of such nature, it will cater to the strategic requirements that integrate design into overall regional development.

Finally, the industrial synergy mechanism between industrial design parks and advanced manufacturing is a blind spot of the policy today. If industrial design separates itself from the mode of production, the core of the age, its significance and value will be marginalized. Currently, most policies supporting the construction of industrial design parks are concentrated on attracting excellent design enterprises, and introducing entrepreneurship and innovation programs and subsidies, but few are designed to achieve collaborative development of future industrial architecture of advanced manufacturing. The value of industrial design parks is not simply to serve local areas and promote the upgrading and transformation of traditional enterprises. They should also serve as a pioneer of strategic expansion in face of advanced production requirements and development in the future. The key task is to drive industries with advanced manufacturing and the information industry at the core to form aggregation with design, so as to embrace the future, and promote the development of emerging industries in local areas.

By combining design with advanced manufacturing and their enterprise-oriented development, China's industrial design parks will become a new development model that is able to lead development goals of the age and make them excel in design circles worldwide.

5. CONCLUSIONS

The number of enterprises landing in national industrial design parks tended to get saturated around 2015, when the earliest enterprises basically finished infrastructure building, and economically a few parks had preliminarily explored a new mode of growth featuring design-based enterprise incubation.

Thanks to a good park environment, these enterprises in industrial design parks have witnessed excellent development. In turn, these enterprises have also advocated the reputation and role of parks. Thus, social construction and design culture have obtained a win-win effect. This symbiotic effect should be further deepened. As time went by, these enterprises raised more requirements to physical space. The space of parks is limited, so supportive elements for a virtuous cycle and deep development of these enterprises are new energy for future development. To gain the energy in this sector, they still need to rely on external forces. This is exactly a new opportunity for the development of industrial design parks. They should work together with settled enterprises to become better no matter in mechanism or philosophy. The design energy used in industries will be amplified at geometry levels.

Design Studies is a major humanities discipline in today's society, and its meaning and value are more concentrated on defining and creating the way of living and the quality of survival in the future. This requires talents studying in this discipline to possess profound quality, character and abilities. To achieve this objective, China's education mode cannot simply rely on degree-level education. A long-term and socialized lifelong learning mechanism is the best answer. An operation system that is highly collaborative with innovative talents is a new tendency of modern information functions. A relay-type industrial design talent cultivation park that can meet more requirements from institutions of higher learning and social requirements will become an important weapon that supports China to become an innovation power. Utilizing urban functions, combining industrial needs and integrating talent cultivation will become very explicit characteristics and requirements for the development of industrial design parks in the future. They will form a new platform for shared development. Industrial design parks should regard new design talents as the incubation object of innovation undertakings, attract design talents to serve industries, and promote the adjustment of regional industries as well as the emergence of new forces for industrial innovation. In this way, they can play a role in talent running on such a newborn mechanism.

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RESEARCH OF SUSTAINABLE PRODUCT SERVICE SYSTEMS ON CHINESE MINORITY BRAND CONTEXT

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ABSTRACT

The purpose of this study is targeted poverty alleviation for the Youzhou Miao Embroidery by the service design which aims for analysing the potential customer and developing new retail marketing strategy. This study use design thinking and methods of service, through the analysis of stakeholders, business SWOT (Strengths Weaknesses Opportunities Threats) model, to extract users' potential preference and promote the transformation of corporate positioning. It is proposed that Youzhou Miao Embroidery should transform from a physical store model that focuses on the production and sales of local tourism market into a new retail model that integrates online and offline. Through the research of the Sustainable product service system for minority brands, the same type of enterprises can absorb in quantity of ethnic minorities women and disabled employees who live in a depth of poor rural, by which the local economy and sustainable development in Ethnic Areas can also be promoted.

Key Words: service design; minority brand; user experience; new retail

1. INTRODUCTION

China is a multi-ethnic country with 56 nationalities with rich cultures and long history. The development of modern society has had a game-changing effect on economy in this ancient area, Although the sustainable development of national culture has received a growing amount of research attention by the community and the government, it is still an open research question whether and how national culture transform resources into products and services.

The following case study come from Youyang Minority Areas in Chongqing, China and authors of this paper was intensively involved in setting up the collaborations with ethnic partners and implementing a unique design process with minority cultural associations. By analysing and locating potential new user groups, this project considers the “Youzhou Miao” brand in Chongqing Youyang as an example to formulate new retail marketing strategies, and conducts research on minority brand sustainable product service systems. The paper is structured as follows:

Section 1 researches the significant changes of minority culture under the environment of information and service economics.

Section 2 discusses a theoretical framework and methodologies with service design and brand management.

Section 3 describes the key findings related to the improvements of Youzhou Miao Embroidery.

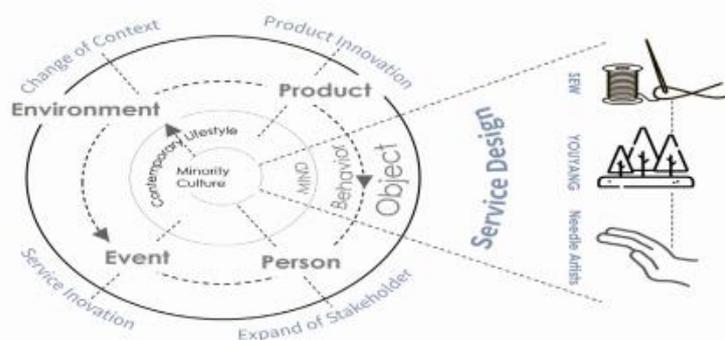
Section 4 presents the sustainable product service system(SPSS) of the minority culture.

Located in the south-eastern part of Chongqing, the Youyang Tujia and Miao minority is the area bordering Liang and Jingzhou. It’s the juncture of the states of Ba and Chu during the Spring and Autumn period; it belongs to Qianzhong County around Qin dynasty and the Youyang County in Han dynasty. In the hinterland of Wuling Mountain. Given this factors of the long history, there are 18 ethnic groups gathered in Youyang dominating by Tujia and Miao.

In order to inherit national folk traditional arts and crafts of local extinction in Youyang, the company, Youyang Ziyue Miao Culture Communication Co., Ltd., has found opportunities for the local thriving tourism industry, by producing cultural products such as Miao embroidery and XilanKapu, a kind of Tujia brocade. It is a brand of minority products of “Zhuzhou Miao Embroidery” which integrates production, processing, publicity and marketing.

2. RESEARCH FRAMEWORK

Youyang Miao Culture Company was established in March 2013, aiming to excavate and inherit the Tujia and Miao cultures with local characteristics of Youyang. Most of the employees of the company are female needleworkers and the physically challenged from poverty-stricken villages in Youyang, which is this employment allowed them to practice as professional art workers according to that poverty relief definition – they supported themselves monetarily through artistic work without government aid. Since the company was established, hiring and teaching these workers to do needlework has made significant contribution to the social and economic development in traditional handicraft industries. The company was also highly commended by the SEAC (State Ethnic Affairs Commission of China) for what it plays an exemplary role in poverty alleviation in the cultural industry and in inheriting traditional culture.



[Figure 1] Analysis of Science of Human Affair in Youzhou Miao Embroidery

2.1. Service Design Strategies

With the methods of service design thinking and Science of Human Affair (Liu, 2018), this paper explores how traditional culture's creation design in the context of modern life changes the use scenario and presents a new form of service mode, which changes as the expansion of stakeholders; how to actually do service design to improve the quality and the interaction between service providers and customers (Stickdorn et al.,2018). Learning Science of Human Affair theory, which takes the products of embroidery as the object, Youyang Ancient City as Usage scenarios and needleworkers as participant, has great theoretical and practical significance for the construction of establishing Zhangzhou Miao embroidery brand sustainable product service system.

The existing service framework of the brand is interpreted in the study by analyzing the value structure of products. Based on the methods of service design thinking, we clarified the stakeholders of the “Youzhou Miao Embroidery”

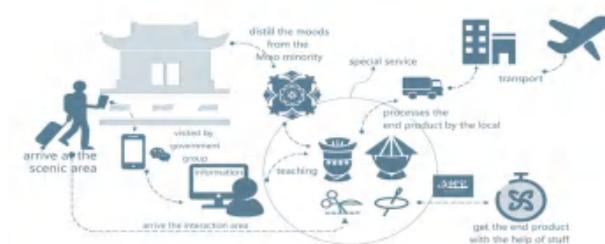
brand and defined the company's product positioning and consumer Personas, which can be useful for keeping the storyboards focused on a very specific user involvement in the process and user context and goals, including both consumers and producers. Collectively, use context, scenarios, and personas constitute a powerful design approach for consumer-centric analysis and design.

The activities of tourists and female-run embroidery agencies have been systematically digested to the design a map of the user journey experience of the existing brand services. The essence of the user journey map is to recombine ancient city tourism resources and knowledge-structure. It is also the essence of innovation for traditional industry. The core of Youzhou Miao Embroidery product is the handmade embroidery cultural product which is different from the machine embroidery product and exquisite workmanship in the market. It is very competitive in the tourism market.

2.2. Strategic Brand Management

The notion of the stakeholder is intimately linked to a conception of the business firm as an entity founded on negotiated governance, in which the maximization of value for the shareholder is not the ultimate criterion (Bonafous-Boucher & Rendtorff, 2016). The relationship of the stakeholders has been clearly clarified by the impact an interests of the "Youzhou Miao" brand. The company's employees and different types of consumers are internal stakeholders; government and scenic spots management organizations are connected stakeholders; social welfare organizations are external stakeholders. The three elements of products include user, usage scenarios and the value that can bring to the user. "Youzhou Miao" brand products mainly serve the internal stakeholders, who are interested in traditional national culture and tourist souvenirs.

Social innovations are changing the world as these changes unfold--an expansive open co-design process in which new solutions are suggested and new meanings are created by diffuse design performed by everybody and expert design performed by those who have been trained as designers (Manzini, 2015). The needleworkers can design traditional patterns of embroidery, while expert designers can support these collaborations--making their practice easier, their diffusion and their convergence in the Internet are more effective.



[Figure 2] Tourist Experience Trip of Youzhou Ancient City

For the users, embroidery not only meets their needs for manual embroidery and traditional culture, but also has the value of collection and use. The pre-brand product positioning mainly focuses on tourism products, and the recent sales of high-end products have increased. Target consumers are mainly targeted at middle-aged people, mainly women. Based on the investigate and survey above, we draw the user experience map of Youzhou Miao embroidery brand.

3. DESCRIPTIVE FINDINGS

Through SWOT analysis of internal and external factors of Youzhou Miao Embroidery brand enterprise, we find out pain points and opportunities of product service in the existing service system of the brand, and sort out the problems faced by consumers during their consumption in the current commodity trading model.

3.1. Disorder Product System

Youyang Miao Embroidery has more than 600 kinds of products, divided into fashionable accessories, hand-woven fabrics, hand-woven fabrics combined with Miao embroidery, Tujia brocade and seedlings. There are 15 series of products such as embroidered home accessories etc. Classification of products is not standardized and product hierarchy is confused. The lack of comprehensive combing of various needs of users causes the development of new embroidery products are incoherent and unsystematic, which failed to devote to delivering premium shopping experience to young consumers, and satisfy demands of various users in different scenarios.

3.2. Non-unified VI (visual identification) System

According to different product categories, the company has applied for registration of "Youzhou Miao Embroidery", "Ziyue", "Zhuzhou Bizika", "Tao Embroidery", "You Embroidery" corporate trademarks. Too many trademarks make Youzhou Miao embroidery lack a unified image. According to the survey, the products of Chongqing Youzhou Gucheng Store and Hunan Zhangjiajie Store are marked with "Zhangzhou Miao Embroidery", and the "Qin Embroidery" logo is adopted for the requirements of the scenic spot in Chongqing Taohuayuan Scenic Spot. The brand

lacks overall and systematic planning, which is difficult to form a unified brand image of the company. From the perspective of consumers, it is not conducive to their understanding of Youzhou Miao Embroidery and build loyalty and connecting with this brand. In particular, in highly competitive marketplaces, brands are often be linked to other entities, for example, people, places, things, or other brands, as a means to improve their brand equity(Keller, 2003).

3.3. Indistinct Customer Types

In the time when the online sales are attracting widespread interest in fields such as retail and shopping for information and service economy made the Internet related industries a viable remunerative business, numbers of connections to the internet world access to a market for traditional brands. This phenomenon was demonstrated by the advent of the information age and service economy, the new generation of consumers who have grown up in the mobile Internet environment have brought new opportunities to the development of minority brands.

“Youzhou Miao Embroidery” needs to pay more attention to the changes of consumers in a timely manner. By Analysis of the impact of the user demand diversity on the traditional handicraft platform, the paper put forward the demand fashion trends, social focus. A steady growth in the popularity of the young’s love for the derivatives of characteristic national culture will combine the traditional products with their lives.

3.4. Adjustment of Market Strategy

The company has rich experience in offline sales channels, however the relatively single marketing model restricts consumers and tourists who arrive at off-line stores. The scale of users is not too large, the user’s overall consumption experience supported by the traditional enterprises is not enough to meet the needs of users in different scenarios. Faced with the threat of e-commerce impact on off-line stores, the brand of “Zhangzhou Miao Embroidery” needs to adapt and adjust in time. On the one hand, existing market strategies and sales methods are still insufficient supply to meet demand, and it is difficult to effectively increase sales volume; on the other hand, Channel selling strongly support online selling based on the young’s new consumptive habits and the Internet, moreover, expanding online sales can create better user experience. So the transforming the Chinese traditional handicraft industry from commodity trading to brand service will be furthered by means of this kind of brand upgrading based on new retail (online and offline sales) that takes place through flexibly.

After entering the commodity market, most embroidery products are transformed into tourism products sold in local tourist attractions, attracting tourists with traditional embroidery techniques and ethnic patterns. With the development of information age and service economy, the “new retail” mode integrating online and offline has been developed, which brings challenges and opportunities for national brands.

The target users of the “new retail” model are expanded from tourists to the post-80s and 90s of the “new middle class”, who have higher requirements on the quality of life. Compared with price, they attach more importance to quality. The “science of human affair” of products and services for consumers will inevitably change as the consumption situation changes.

4. MINORITY CULTURE IN SPSS

“New middle class” is the main consumer group of Youzhou Miao embroidery brand positioning after upgrading, and most of them accept the cashless consumption mode, and pay more attention to the experience consumption in physical stores and online shopping. The main character of Affairiology is to emphasize the relationship, notelements; the whole, not the parts; the process, not the status. therefore, according to the user changes and the situation of use, the overall experience of “ human affair” planning and design, is the key to the new retail bureau of Youzhou Miao embroidery. The management and culture can be optimized by building a clear brand identity and system and it is conducive for enterprises to enhance corporate reputation and image in public or consumers’ mind, which leads the enterprises to adapt to the ever-changing market environment.

4.1. Brand System Upgrading

Brand perception is based on consumer psychology and marketing science combined to form a level of trust as rather than a basic trademark (Goodson, 2012). Due to the self-operated products and the cooperation with other brands, we classify and sort out the products of “Youzhou Miao Embroidery” brand, which can categorize the handicraft products according to whether products are produced independently by the company or not, Products are classified into three categories: high-grade double-sided embroidery, middle-low-grade tourism products and Tujia brocade; products produced in cooperation with other companies can be divided into three categories of furnishings, wearing apparel and luggage products. On the basis of category, the brand image has been streamlined and redesigned from the 15 existing trademarks. Three trademarks were selected to represent products of different grades and categories.

The company should plan the brand system and adopt the unified brand image of “Youzhou Miao Embroidery” brand to increase brand recognition. The high-end Miao embroidery products are mainly used in the “Youzhou Miao embroidery” brand while the low-end tourism products in “Qin Embroidery” brand to meet the requirements of the dynamic changing market and personalized products for different consumers. In addition, the company will expand its product portfolio with other brands and product categories continuously, adopt multi-brand strategy, and use the “Ziyue” brand as the expansion brand to build the Youzhou Miao embroidery brand system.

4.2. New Retail in Service Development

Traditional substantial economy has been strongly impacted by e-commerce, however, in recent years, due to the widespread popularity of the Internet and mobile Internet terminals, the user growth and traffic dividend of traditional e-commerce have gradually shrunk, while the “new retail” mode of online and offline integration has been developed (Du&Jiang, 2017). The new retail is aimed at the “new middle class” of the post-80s and 90s, who have higher requirements for the quality of life. Compared with the price, they pay more attention to quality, they usually use the cashless consumption mode and also pay more attention to the experience of consumption in physical stores, “new middle class” is the main consumer group of upgraded Youzhou Miao embroidery. Therefore, the overall experience of the planning and design, is the key to Youzhou Miao embroidery new retail bureau.

Due to the sharp decrease in the number of tourists, these stores have been transformed from a traditional physical sales store relying on tourism into a place for display and production, which is in urgent need of expanding new products and services. Thus, according to the store’s geographical location, convenient transportation, accommodation features, we further expand the traditional culture collection, display, experience, education and training function.

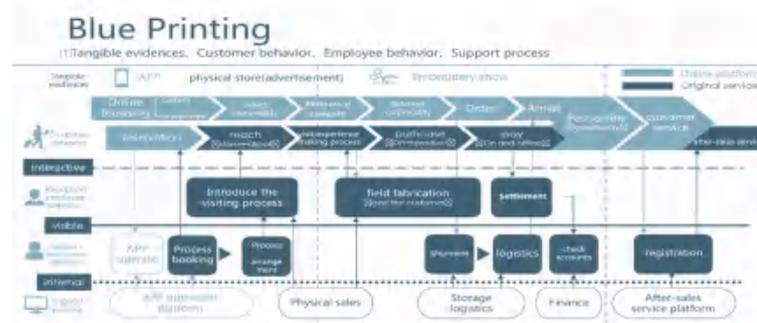
Often these goods are in the form of a tangible product that must be manufactured and moved to the user the traditional retailing business, yet China’s commodity circulation into the new retail era that go far beyond tangible products, and incorporate various services, information and even culture into the scope of retail enclosure. Goods are tangible products, while services are intangible products. The boundaries between products and services are blurring (Schneider & Stickdorn, 2012) and this an iterative design process and innovation in service content can also exactly meet the actual needs of new consumers at the level of user value.

From the traditional physical store sales model to online-to-offline service delivery, Youzhou Miao embroidery derives customized services not only focus on the product itself, but also based on different users and consumption scenarios, giving the diversification and individuation of consumers. On the whole, consumers represented by the “New Middle Class”, groups of the urban, the young and the culture-loved, live in an age of connectivity, mobility and individuation, which have become the important features of the daily life and work to them. As achieving what we proposed above, our team has designed a Wechat applet and APP demo for Youzhou Miao embroidery to provide one-stop service for consumers. The Wechat program has the “Miao culture community”, users can enjoy the collection of the enterprise Museum online and understand the Miao culture; buyers can see other’s selection in this community when making decisions on whether to buy.

4.3. Brand Sustainable Product Service System

Based on the service design thinking, the consumers are positioned precisely after the brand upgrading, what the consumer became the core in the service supply chain, and promote the transformation of the national enterprise from commodity trading to brand service. Wechat applet and APP demo can be the connection between the consumers, needleworkers and Patterns Designers. Online Customer Experience Service will be the extension of Offline Entity Store Service.

By creating online and offline linkages of personalized products, the online connection of physical stores will achieve a unified data platform to support the online, wholesale, different sales channels. After the upgrade of user experience is completed, consumers can not only visit the production process of traditional embroidery boutiques in physical stores, but also learn embroidery technology and participate in customizing their own products. This evolving object of participatory design is potentially binding different stakeholders together (Bjögvinsson & Hillgren, 2012) The integration of online and offline experience is far greater than pure product sales. At the same time, the Internet can also help companies accumulate user data, dig deeper into user value, and provide guidance for improving services.



[Figure 3] The Blueprint of the New Service System

5. CONCLUSIONS

The research on the sustainable product service system of Youzhou Miao embroidery brand have addressed the importance of exploring how national brands can attract young consumers. Expounding the product strategies for them in different stages of life cycle from the perspective of users can promote digital upgrades of national brands through service design. In service economy era, minority enterprises transformed the service model of new retail and built a sustainable product service system. Drive off-line physical stores through the Internet, so as to optimize the

supply chain to achieve brand transformation and upgrading. Through the Internet, offline store can optimize the supply chain to achieve transformation and upgrading; expand the production and sales scale of ethnic enterprises. This service system can encourage the traditional national enterprises such as “Youzhou Miaoixiu” absorb more the physically challenge and workers in poverty-stricken area, that targeted poverty alleviation policy will be effectively implemented.

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CHILDREN'S TOY SHARING SYSTEM FROM THE PERSPECTIVE OF SUSTAINABLE COMMUNITY CONCEPT

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ABSTRACT

This paper mainly adopts the shared sustainable design method and theory to carry out research and design on children's toys in the community, in order to promote the sustainable development of the community, analyse the current situation and existing problems of children's toys in the sustainable community, and then make corresponding design solutions and design evaluation. At last, this paper summarizes and forecasts the expected sustainable lifestyle of the toy sharing system for children based on sustainable community. Through the research and design of sharing children's toys, this paper points out that sharing design of sustainable community, especially the sustainable lifestyle described in children's toy-sharing design, has a promising future.

Key Words: idle toy; shared design; sustainable design.

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1. INTRODUCTION

Community is the basic unit of urban management, and family is the basic unit of community management. Cities, communities and families are inextricably connected. The problems of families are also the problems of communities. The topic of sustainability is the focus in the field of design. This paper hopes to solve the problems of sustainable communities through design.

“Community and network” has become the basic unit and condition connecting people and society[1]. By using the method of system design, the circulation of children's toy products in the community and the community environment in China are comprehensively taken into consideration, so that the community residents can achieve the effect of reduction of the quantity of materials by means of resource replacement relying on the network, replacing the “ownership” of products with the “use” of products. It is hoped that the consumption mode of children's toys will be developed towards a mode of environmentally friendly and sustainable life.

The design of children's toy sharing system based on sustainable community promotes sustainable consumption mode at the level of CCD (community-centred design). Firstly, the invisible public needs of residents in the community are explored from the level of human beings. Secondly, the environmental sustainability of the community is considered comprehensively from the environmental level, which includes the sustainability of children's toy resources in the community and the sustainable consumption of residents. Finally, on the level of interaction, we should examine the relationship between the various elements with a comprehensive attitude, observe the interaction among people, environment and community, and inspire residents to participate in the system practice together. Circulate children's toys in the community, reduce the pressure of excessive consumption of toy products on the living environment, promote the rational allocation of toy resources, and transform the sustainable lifestyle from bottom to top into the lives of community residents.

The author expects to transform the sustainable community at the level of CCD, and recycle the children's idle toys in the community through sharing, so that the idle toys can be recycled in the community, which creates a friendlier community environment and closer relationship between neighbors. so as to provide reference for creating an open and diversified sustainable sharing community.

2. RESEARCH ON THE STATUS OF SUSTAINABLE COMMUNITY AND PROBLEMS OF TOY SHARING AMONG CHILDREN IN COMMUNITY

In China, the planning, governance and construction of sustainable communities are faced with various challenges[2]. These problems are concerned by the state, social organizations and design academics. The state, social organizations and design academics have made corresponding countermeasures and governance measures for the problems of sustainable communities. This paper mainly aims at the problems of children's idle toys in sustainable communities. Therefore, this paper investigates and studies the current situation of children's toys in the community and the needs of users.

2.1 Research Status of Sustainable Communities

Sustainable communities have different explanations from the perspectives of ecology, economics, sociology, high technology and other disciplines, but the commonalities of their discussions mainly include promoting sustainable life, planning and reforming communities from the aspects of environment, economy, infrastructure, social equity, etc. [3]. In 2015, the United Nations set 17 global sustainable development goals (SDGs), including SDG11 (Sustainable Cities and Communities), aimed at building inclusive, safe, responsive and sustainable cities and human housing[4]. Countries have established relevant sustainable development goals and evaluation systems for sustainable development goals, while China's SDG11 (Sustainable Cities and Communities) faces rigorous challenges[5]. China's sustainable community issues mainly include housing quality, housing conditions, public facilities, community management, community services, environmental quality and neighbourhood relations, etc.

In terms of the problems mentioned above, the state has issued the “13th Five-Year Plan” and other community governance plans, committed to building “smart communities” for Chinese communities. In response to the national policy, non-profit social organizations such as the Special Fund of the China Children's and Adolescent Foundation, the Children Friendly Community Working Committee of the China Community Development Association and the Children Friendly Community Research Institute of the China Children's Center have been in cooperation to create the “Promotion Plan of Chinese Children Friendly Community” which upholds the principles of children's priority, inclusive equity, children's participation and maximization of community resources, making a friendly community for every child to live in[6].

Sustainable community is the focus in the field of design. In order to build a sustainable lifestyle, the design community has done a lot of design practice and research. For example, Yongqi Lou, Dean of the School of Design and Creation, Tongji University, explored sustainable community through the “mode of three innovations in community” [7] and strategic design of sustainable community in Chongming Xianqiao [8]. Professor Ji Tie, School of Design and Art, Hunan University, through the design and social innovation of community and network, proposed the transition from user-centered design (UCD) to community-centered design (CCD) in the development of sustainable design [9]. Therefore, sustainable development, as an international development trend, has also become one

of the basic principles of design innovation, and is the core issue of future design development. Sustainable design can solve the problem of community children's toys.

2.2 Problems of toy sharing among children in community

Until 2016, among the 1.4 billion people in China, children under 14 and infants accounted for about 400 million. Toys are indispensable playmates in the process of children's growth. The toy market has a huge development and consumption power in China, such as Figure 1 the annual sales of toy industry. At the same time, China's toy manufacturing industry makes China the largest toy producer in the world. China's toy market is well developed. Nowadays, China's material life is more and more abundant. Toy industry also develops and keeps pace with the increasing national living standards and needs, making toy products of various types and functions complex. Children's toys on the market can almost meet all the needs of children's growth and entertainment. But it also causes a series of unsustainable problems of children's toys in the family, and then has a certain impact on the sustainable community.

Problem 1: Children are apt to develop a psychology of setting aside old toys and seeking new ones. Children are in an unstable period of growing up. With the rapid changes of their physical, psychological and emotional needs, they have different hobbies at different ages. According to Euromonitor International, 95.3% of children can only maintain a feeling of freshness with a toy for no more than six days.

Problem 2: Families spend too much on children's toys. Compared with the past, most families have better economic conditions to invest in children. Parents, as participants in the process of children's toy consumption, or even decision makers, often buy too many toys for their children.

Problem 3: Children's toys are easy to pile up idly, occupying space and difficult to deal with. Children's love for new toys and dislike for old ones and parents' uncontrolled consumption of children's toys have resulted in the over-accumulation of toys in the family. According to the survey, many parents suffer from the dilemma of "keeping the toys but taking up space at home, throwing them away but too wasteful and giving them away but not presentable". The dilemma of disposal of idle toys lies in that no after-sale service from stores, no recycling from recycling station and not being easy to resell. As a result, idle toys can only be dumped as garbage.

As for a series of problems caused by idle toys, the author conducted a poll on the acceptance of idle toys through online interviews and the "hot mom gang" network platform, and obtained the survey data from 148 users, 64% of whom said they could accept the transformation of idle toys. These users believed that the use of second-hand toys could protect the environment, be economical and meet children's iteration needs for toys. Updating the fast demand of iteration and participating in the transformation of second-hand toys can better solve the problem of disposing idle toys, thus saving the indoor space of the family. 30% of users choose to selectively accept second-hand toys mainly because of concerns about the safety and hygiene of second-hand toys. Such users also say they can accept idle toys from acquaintances. 6% of the respondents could not accept second-hand toys. This part of the respondents believed that they had the ability to buy new toys for their children and did not need to buy second-hand toys.



[Figure 1] Annual Sales of Toy Industry [Figure 2] Resident acceptance

3. DESIGN OF CHILDREN'S TOY SHARING SYSTEM BASED ON THE CONCEPT OF SUSTAINABLE COMMUNITY DEVELOPMENT

Sustainable community development should not only meet the needs of contemporary people, but also not endanger the ability of future generations to meet their needs. Therefore, in terms of the unsustainable problems caused by idle toys, the design of children's toy sharing system needs to meet the needs of community residents at the level of human beings to solve the needs of old toys. The design of children's toy sharing system based on sustainable community mainly uses sharing mode as the design strategy of children's toy system in sustainable community, and uses four sharing factors of network platform, idle resources, participants and trust mechanism as the realization path of

children's toy-sharing design of sustainable community. According to the sharing factors of sustainable design, the environmental sustainability of the community, the circulation of children's toy resources in the community and the sustainable consumption of residents are comprehensively taken into consideration, and the relationship among people, environment, community and other factors is studied in depth, on the basis of which the children's toy sharing system of sustainable community is designed.

3.1. Design strategies of toy sharing system for children in community

As a sustainable business model, shared model has been defined and described by many scholars in the industry. The content of its definition has always centered around three core factors: network platform, idle resources and participants. The toy sharing design concept based on sustainable community solves the toy problem in community by sharing.

The concept of toy sharing design relies on the main network platform as the basis of sharing design, idle toys as sharing content and community families as sharing participants. In addition, it is expected that toy sharing design can enhance the friendly relationship of residents and help communities return to the friendly neighbourhood relationship like the old days through mutual trust among residents. Therefore, another important factor of sharing is trust mechanism, because besides relying on network platform, the biggest factor driving the behavior of both participants is trust, which is advocated by sharing mode. It is an economic activity that meets daily needs and establishes relationships with others, so establishing a mechanism of mutual trust among participants can ensure the success of toy sharing. Therefore, as shown in Figure 3 idle toy sharing design framework, the basic path of toy sharing design mainly includes the following four basic factors.

Network Platform: The main supplier and demander of toy sharing design is individual family. This requires the network platform to act as a manager and integrate and manage the huge number of families in the community. Its purpose is to provide trading opportunities for both suppliers and demanders, or to give idle toys to others for free. In addition, the network platform is the circulation channel of all elements in toy sharing, which is the basis of establishing rules, trust and resource trading in toy sharing design. Therefore, the network platform is the core condition for toy sharing design.

Idle toys: toy sharing needs idle toy resources, or we can say toy sharing design differs from collaborative consumption which simply emphasizes the sharing, exchange and transaction, because it is mainly based on idle capacity as share, exchange and transaction. The goal of toy sharing design is to redistribute the idle toys in the community. Therefore, providing various idle children's toys by different families is the precondition and material basis of toy sharing design. Meanwhile, the existence of idle toys also determines the sustainable operation and development of sharing design.

Resident participation: Toy sharing design requires community residents to play roles as participants in toy sharing design. They are not only the supplier, but also the demander depending on their actual needs. In addition, feedback and innovation should be given to the sharing economy so as to improve customization and individualization of sharing. That is to say, these participants are not only the initiator and the terminator of toy sharing, but also the source of optimizing toy sharing design.

Trust mechanism: Trust is the biggest factor for the smooth transaction of toy sharing design and driving the behavior of both suppliers and consumers. Toy sharing design needs to establish a mechanism of mutual trust among community residents who are relatively unfamiliar with each other in order to ensure the success of sharing. Traditionally, commercial transactions are only for each side to get what they need. In toy sharing design, because the transaction is a single idle toy or second-hand toy, the buyer bears certain risks, so the establishment of reputation mechanism is the guarantee of obtaining trust from strangers. Therefore, the more developed the social capital with trust as the currency, the more easily the shared economy will develop [10], and it can help residents build up their beliefs in community neighborhood life. Toy sharing design is a business model developed on the basis of mutual trust among members of unfamiliar communities. Through supervision, the network platform builds a reputation evaluation system for participants, and the reputation evaluation system will become the guarantee for the operation of the network platform.

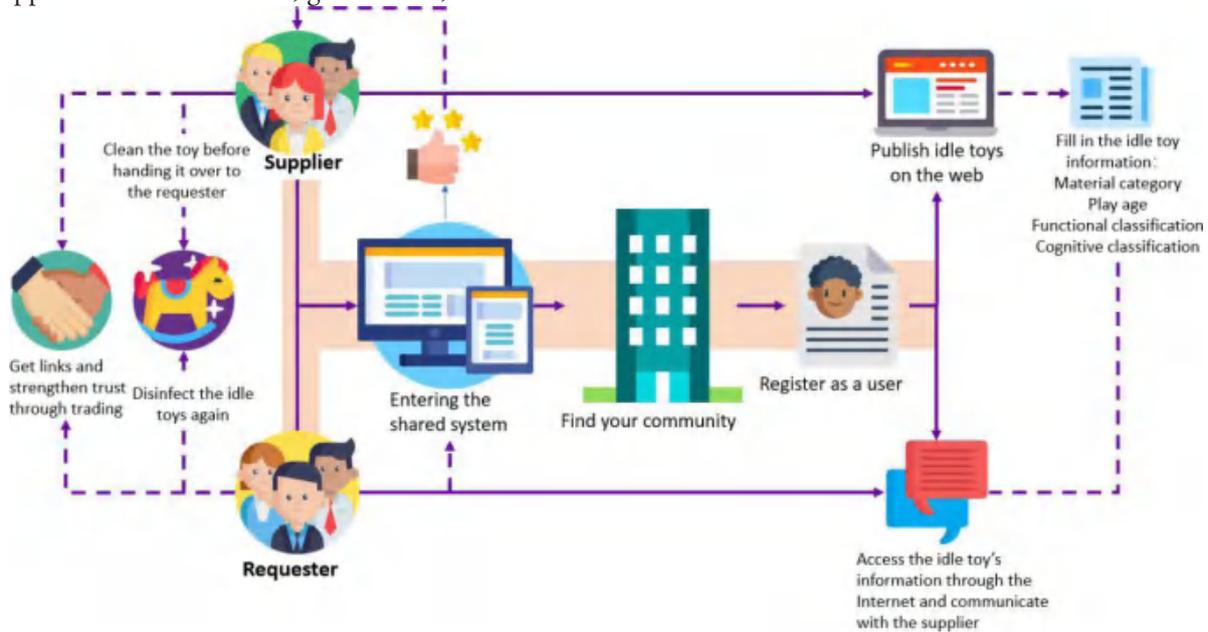


[Figure 3] Idle Toy Sharing Design Strategy

3.2. Design and Implementation of Toy Sharing System for Children in Community

To achieve sustainable community toy sharing for children, we need to consider not only from the level of the design of sharing mode, but also the design of toy sharing system in terms of sustainable community needs, residents' needs, environmental sustainability, sustainable consumption and participant interaction.

Just as shown in Figure4 System Design Implementation Path for Idle Toys, first of all, from the level of people, residents need to join the toy sharing system as participants, and as the supplier/demander of toy sharing, enter the shared network platform to become the users of toy sharing. The supplier will release the information of idle toys to the network platform as a product for sale, and the demander browses to the desired idle toys through the platform. After contacting the supplier online, the demand side get the detailed information and delivery mode of idle toys through communication (choose door-to-door pick-up or delivery in person). The supplier needs to clean the idle toys before completing the transaction. After the demander gets the idle toys, the toys are cleaned and disinfected twice, so as to solve the residents' concerns about the hygiene of the idle toys. The sharing system needs to limit the excessive damage of idle toys, infant chewing idle toys and plush idle toys cannot participate in the toy sharing system. After the transaction is concluded, the demand side evaluates the supplier according to the status of the idle toys received and the transaction service. The system receives the evaluation from the demand side and gives the supplier the credit value. With the completion of the transaction of idle toys, the residents of the community, the supplier and the demander, get to know, contact and trust each other.



[Figure 4] System Design Implementation Path for Idle Toy

3.3 Design and Evaluation of Community Toy Sharing System

Sustainable communities require us to construct and transform communities from the perspectives of environment, economic and social equity, so the transformation of sustainable communities needs to be considered from these perspectives. This paper constructs sustainable communities through the design of children's toy-sharing system, mainly through the value orientation of egoism, altruism and biosphere [11] to evaluate children's toy sharing design.

This paper hopes that through the design of children's toy-sharing system, community residents can get the value orientation of egoism, solve the problems caused by piling up of children's toys in their families through toy sharing, help the residents possess value benefits through toy sharing; obtain the value orientation of altruism, and reduce the toy consumption expenditure of residents and children's demand of fast renewal of new toys through toy sharing, thus relieving the economic burden of purchasing children's toys continuously for residents; obtain the value orientation of biosphere, which pays attention to the environment and the welfare of biosphere. The design of children's toy sharing system is a sustainable design based on old toys to circulate in the community, which can reduce the generation of toy garbage and release the pressure of urban environment, which protects the ecological environment to a certain extent.

4. CONCLUSION

"Pursuing a sustainable lifestyle means gradually reducing our consumption of the natural resources of the earth and ensuring that everyone can enjoy goods and services fairly" [12], and the change in consumption patterns depends to some extent on our lifestyle. Therefore, the design of children's toy sharing system based on sustainable community expects to integrate the concept of sustainable consumption into people's daily life, using the way of sharing to change the way community residents treat the consumption of children's toys in the long run. The toy sharing system is designed for everyone in the community, in order to convey the concept of sustainable consumption into the daily life of each resident.

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PRODUCT SERVICE SYSTEM APPLIED TO AIR-ENERGY PRODUCT BUSINESS MODEL INNOVATION

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ABSTRACT

The air-energy water heater is applied with an environmentally-friendly innovative technology with great development value. The product service system is imported into the air-energy water heater to innovate the meaning of the product, change the consumer's consumption habits and cultivate their environmental awareness, in order to promote the popularization and promotion of energy-saving products. From leasing products to purchasing services, the paper proposes future application scenarios and explores the future business model innovation of air-energy water heaters from the perspectives of discovering value, creating value and realizing value. The introduction of the use-oriented product service system will become a major opportunity for the development and innovation of air-energy water heaters in the future, providing exploratory design and research for marketing and sustainable development.

Key Words: Air Energy, Product Service System, Design-Driven Innovation, Sustainable Design

1. INTRODUCTION

As a technically disruptive product, the air-energy water heater has failed to attract consumers' attention and enter the public life with a subversive effect. The air-energy water heater market in foreign countries has been well-developed. However, in China, the market share of air-energy water heaters is still quite small. From the perspective of design-driven innovation (Roberto Verganti, 2009), air-energy water heaters have achieved breakthrough innovation in product technology, but products have simply been positioned as energy-saving water heaters. Air-energy water heaters cannot be differentiated from other water heater products. At the same time, the high cost and high selling price brought by new technologies are not conducive to the market promotion of products and the recognition of consumers, and it is also difficult to promote the overall development of the industry. With the change of the competitive environment, the future role of the enterprise cannot be limited to a certain link such as manufacturers or distributors, but should be the organizer of resources. Only a three-dimensional combination of product resources and service resources can meet the increasing customer demands and the corporate profitability needs (LIU Yu-xi & XIE Jia-ping., 2015). Therefore, this paper aims to innovate the intrinsic meaning of the product of air energy water heater from the perspective of product service systems, that is, to expand the product form concept and the product semantic dimension. In order to promote the popularization and promotion of energy-saving products, this paper will build a new product service system to meet user needs and raise their awareness of sustainable consumption, and explore the future business model innovation of air-energy water heaters.

2. PRODUCT SERVICE SYSTEM FOR AIR-ENERGY WATER HEATERS

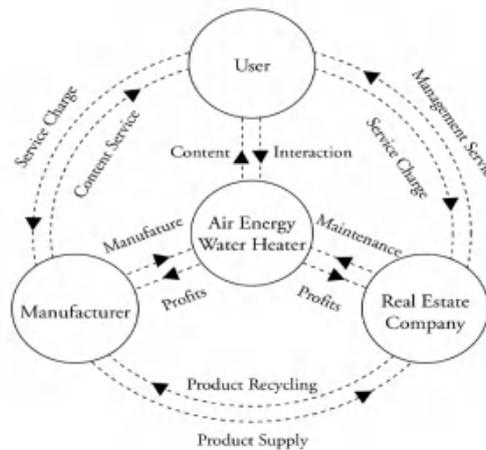
Based on "market-driven innovation" and "technology-driven innovation", Verganti (2009) proposes a third innovation strategy: design-driven innovation, which is to innovate the intrinsic meaning of consumers in the way of subversive innovation. Chen Xue-song and CHEN Jin (2010) believe that design-driven innovation defines the intrinsic meaning of products as the reason for consumers to purchase specific products. This reason is conveyed by designers using product language. The research by Tischner et. al. (2002) clarifies the connections and differences between the product service system and traditional products and services. Product service system can be divided into three types, namely product, use, and result-oriented product service systems; Stahel believes that product service system is an effective way to improve the efficiency of product use, and it is an extension of producer responsibility and an innovative business model.

The traditional air-energy water heater uses a product-oriented PPS, providing product installation and after-sales service and charging corresponding service fees. However, the service range of the traditional mode is too narrow, and only the installation service has been charged. Part of the reason why air-energy water heaters are not widely used is the expensive price, but considering long-term economic efficiency, air-energy water heaters have higher product value and economic returns. The product-leasing model under the use-oriented PSS does not require the user to purchase the product in full, and only pays a small fee for each service. First of all, the customer does not need to own the product, thus avoiding the risk of holding a large amount of fixed assets; secondly, the customer only uses the product within a certain period of time, and does not need to take responsibility for the maintenance and handling of the product later (YANG Cai-jun et. al., 2000). The low threshold product service will bring a large number of potential customers to the enterprise, and the long-term supply and demand service will bring continuous and stable capital income to the enterprise. At the same time, the evolution between product service systems can provide possibilities for new product semantics. Therefore, air-energy water heaters can be innovated from the perspective of the use-oriented PPS.

With the improvement of people's living level and the development of high-end technology, bathing is going to become a more enjoyable behaviour. The bathroom should not be just a functional area for cleaning. Instead, the bathroom should be fresh, modern, healthy, stylish and entertaining. Throughout the bathing process, the user can interact with the air-energy water heater by means of touch screen, voice, gestures, etc. The user can also view and set the water temperature mode and other information at any time. The human-machine interface also provides various content of game entertainment and social contact. Often, after the user enters the bathroom, actions performed by the user before, such as watching a program, socializing online, sending an email, are interrupted. The air-energy water heater added to the human-machine interface can ensure the continuity and expandability between the user's behaviours, which means the user can continue the last behaviour during the bathing process. This breaks the boundaries of functional divisions and gives bathing a new meaning, while air-energy water heaters play a leading role.

In the external environment, the government provides green energy subsidies for air-energy water heater enterprises and residents. The manufacturer cooperates with real estate companies and provides air-energy water heaters. The real estate company provides supporting services as an agent, while residents rent products through leasing. The manufacturer provides hot water and content service through the air-energy water heater and charges relevant fees, and part of the capital belongs to the real estate company to provide management and maintenance service. The product service system of air-energy water heaters has expanded from traditional single-time sales to multiple service supply. Therefore, the manufacturer is able to provide users with stable services and earn sustainable profits. The product service system of air-energy water heaters develops from "no service" to "with service" in breadth, and "single service" to "multiple service" in depth.

In this sense, the air-energy water heater is a service provider that integrates the bathing needs of hot water, game entertainment, social interactions, etc., and makes the business model that the air-energy water heater enterprise provides rental and content service, and the real estate company is responsible for maintenance and management. Air-energy water heaters with new meanings enter the public life at a lower price and are easier to be accepted by the public.



[Figure 1] The use-oriented product service system of air-energy water heaters

3. INNOVATIVE BUSINESS MODEL FOR AIR-ENERGY WATER HEATERS

The academic and business research on business models is nothing more than to provide theoretical support to enable enterprises to enhance their competitiveness in the market and obtain sustained positive profits (Stewart D. W. & Zhao Q., 2000). The core logic of the business model is to use customer needs as the orientation and starting point for creating enterprise value, considering who to provide products and services, what products and services to provide, and how to obtain value by means of discovering value, creating value, and realizing value (CHEN Wenji, 2012). The emergence of new business models is usually to be the result of new technologies and new ideas. The user needs discovered under the innovation of technologies and meanings will in turn promote the advancement and renewal of technologies and meanings, and the ultimate goal is to explore a more competitive business model.

3.1. Discovering Value

The use-oriented product service system innovates the intrinsic meaning of the air-energy water heater, and the extended content service explores the potential value of new user needs during bathing. The leasing and recycling of air-energy water heaters expand the use of the products. The regular and effective maintenance of air-energy water heaters can increase the working period of the products. Therefore, reasonable resource allocation improves the utilization of resources and energies, enabling users to obtain better quality products and services at a lower cost, and manufacturers to provide higher quality products and services at a lower cost.

3.2. Creating Value

The high-frequency use of hot water in the home life and bathing process creates a long-term stable relationship of supply and demand between the customer and the manufacturer. At the same time, new meanings and functions broaden the scope of product services and help promote more stable customer relationships. However, the customer can choose whether to continue to use the service according to the quality of the service and the individual's willingness. Therefore, in order to ensure long-term and stable customer relationship, both the manufacturer and the real estate company need to provide stable and high-quality products services to increase customer satisfaction and brand trust.

Manufacturers actively seek cooperation with real estate companies and decoration companies to provide air-energy water heater products and services for demanding housing customers and develop home hot water supply market. The redefinition of bathing space and the sustainable concept of environmental protection can also become a major point for new residential sales, and the development of the real estate market can in turn promote the development of air-energy water heaters.

3.3. Realizing Value

The introduction of human-computer interaction has created more entrance flow, which means that users can easily access environmental protection concepts. After getting the benefits of energy-saving products, users may become loyal supporters of new ideas and spontaneously promote energy-saving products. The cultivation of environmental awareness will affect the consumption and living habits of users in a subtle way, which is a very important basic condition for realizing the popularization and sustainable development of the air-energy water heater market.

The company can maintain a stable value output only when it obtains the value, and can better realize the sustainable product service system brought by air-energy water heaters, creating value for human beings, the environ-

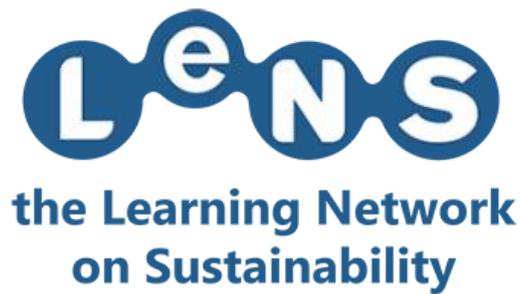
ment and the enterprises. The use-oriented product service generates revenue through product leasing and service charges, while product recycling and re-manufacturing save manufacturing costs. Finally, the value investment in the early stage is truly transformed into stable value acquisition.

4. CONCLUSION

From the perspective of product service system, the above explores the potential intrinsic significance of the air-energy water heater under technological innovation, innovates its product service system and redefines the meaning of bathing space, and analyses the business model behind it. The introduction of product service system will become an important entry point for the product innovation and market development of future air-energy water heaters.

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DESIGN AND RESEARCH OF RESOURCE RECYCLING SERVICE SYSTEM IN TOURIST ATTRACTIONS: TAKING INTERNATIONAL CRUISES AS AN EXAMPLE

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ABSTRACT

The rapid development of traditional tourism has seriously affected the ecological environment of tourist attractions, causing many negative impacts. The high-density use of land, water pollution have affected the living patterns of local residents. The existence of these problems has accelerated the over-exploitation of tourism resources in tourist attractions and affected the ecological balance of tourist attractions. Based on the exhaustion and non-renewability of tourism resources, this paper designs the resource recycling service system which based on the theory of circular economy and sustainable development. This article will take a number of cases as an example to study the operation of the circulatory system in different places, reasonable classification of domestic garbage, reuse of food, water resources and other wastes, so that China's tourism industry in the process of construction and development, not only promote economic growth, but also in line with sustainable development design.

Keywords: Ecological environment, Tourism resources, Circular economy, Sustainability

1. CURRENT STATUS OF RESOURCE PROCESSING IN TOURIST ATTRACTIONS

At present, there is still a lack of systematic research and analysis on the development of circular tourism projects in domestic tourist attractions. In general, it is still in its infancy, and its concept is only scattered in eco-tourism and public green consumption. It is not enough to use the existing concepts to guide and practice the tourism development of tourist attractions, especially the research on the development of different types of tourism projects.

In the tourist season, due to the excessive carrying of tourists, traffic congestion and garbage are everywhere in the tourist attractions, which will increase the pressure in the region in the absence of control. For example, after the end of the Golden Week in 2018, the original landform of Danxia was trampled by tourists (Fig. 1); the beautiful flower sea was stepped on the ground; the garbage in the Emei tourist attraction was full in the mountain (Fig. 2). The resource recycling service system is inseparable from the tourist attractions' management, so the resource recycling service system should be taken into account when planning in the scenic area.



[Figure 1] The landscape is trampled by tourists [Figure 2] : garbage can be seen everywhere in mount Emei

2. RESEARCH ON THE RECYCLING PROCESSING MODE OF TOURISM SITE RESOURCES

2.1. modes and characteristics of international cruise resource processing.

As cruise ships are floating cities on the sea, many cruise lines have joined the “Save the Waves” wave protection project, and through 6 RE (Reduce, Reuse, Rethink, Recycle, Recycle, Repurpose given new USES), they have classified and treated household garbage in detail to maximize the utilization rate of resources.

Disposal of cruise waste:

(1) classified recycling:

Catalog	Example	The color of the bin
Combustible rubbish	Paper, plastic, rubber	Blue
Glasses	Bottles, glasses, bags, plates	Gray
Metal	Aluminum and metal cans	reen
Food	Raw and cooked food	Yellow
Drug	Blood bags, bandages	Red
Oil	Used kitchen oil	Black

[Figure 3] : Cruise waste sorting directory

(2) Partition processing

The waste treatment area of the cruise includes: incinerator area, waste sorting and storage area, waste cold storage room.

Combustible waste will be crushed before incineration and then incinerated in the incinerator area;

Unclassified garbage will be classified in the classification area and stored in the storage area;

Classification and treatment of wastewater: Waste water classification and treatment:

	Define	Source	Recycling way
Grey water	Lightly polluted water	Wash your hands, shower, and wash your clothes	Biofilm filter
Yellow water	Lightly polluted water	Biofilm filter	Filter
Black water	The toilet sewage	feces	Filters and bacteria

	Define	Source	Recycling way
Chemical water	Chemically contaminated water	Photo studio, copy shop	Separate collection
Harmful fluid	Oily fluids such as heavy oil and diesel oil	Engine generation	Separate collection

[Figure 4] Classification and treatment of cruise wastewater

2.2 Orange Island tourist attraction

After investigating the garbage disposal center of the Orange Island Scenic Area and the health status of the scenic spot, it was found that the garbage in the scenic spot is mainly composed of the following four parts: food, plastic, paper products and other garbage generated by tourists outside the scenic spot; Plant waste; kitchen waste and other disposable waste generated by the service industry in the scenic spot; paper waste generated by the office in the scenic spot. In response to the management requirements of smart cities, the Orange Island Scenic Area is now equipped with one intelligent driving small electric sweeper and two sanitation intelligent working robots, etc., engaged in watering and garbage cleaning.



[Figure 5] : Plant waste [Figure 6] : Kitchen waste bin

2.3 Case summary

According to the above case study, most of China’s scenic spots are connected to the external geographical location relative to the cruise ship. Although space is limited, the continuous external connection allows it to accommodate more visitors. At the same time, the flow of tourists has also brought about a rapid increase in garbage. As the cost of garbage sorting, equipment maintenance and manpower has far exceeded the simple incineration and landfill, the general scenic spot does not have the ability to dispose of garbage, but only the garbage. Simple classification, then transported out of the scenic spot by garbage truck.

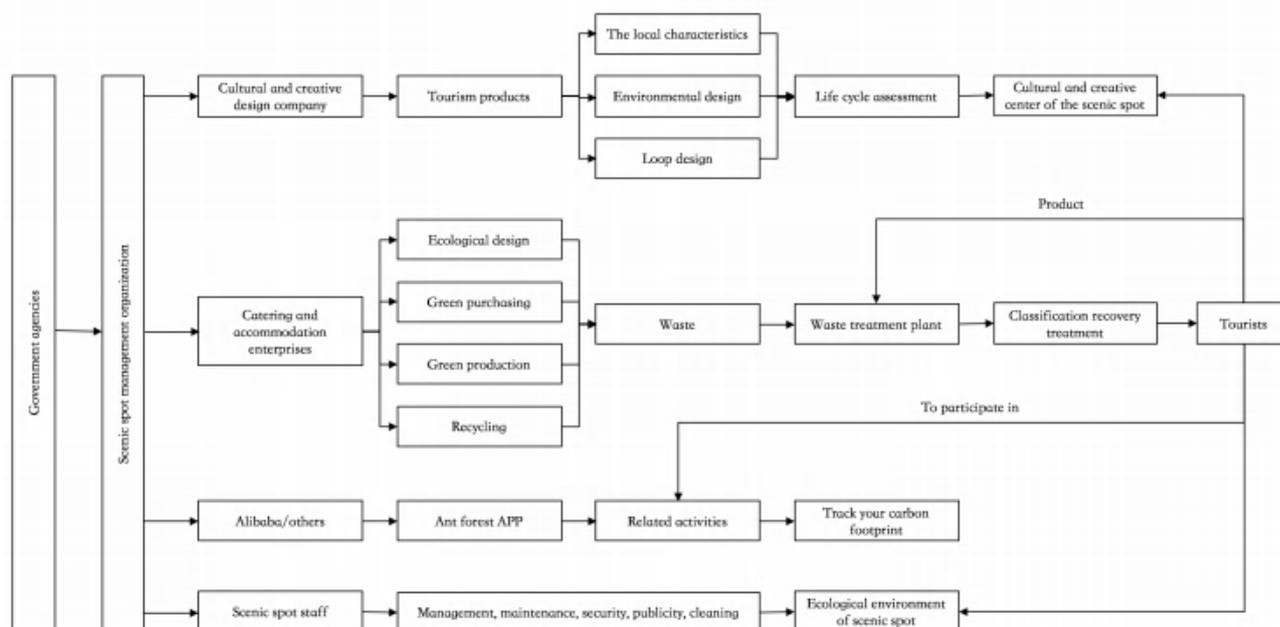
At present, cruisers are the majority of tourists from North America and Europe. Most of the tourists are middle class, with an annual income of 100,000-200,000 US dollars. In 2018, the Orange Island Scenic Area received a total of 7.38 million tourists. From the data of tourists in most scenic spots in China, it can be seen that the overall income and quality of cruise tourists are higher than those of domestic scenic spots, and the environmental awareness is strong.

3. SYSTEM DESIGN

3.1 System design of scenic ecological environment

The system takes the government and scenic spots as its leading role, and cooperates with cultural and creative enterprises, catering enterprises, accommodation companies, and Internet companies to integrate green design, green production, green purchase, green use, and recycling into all links. The negative impact on the scenic environment and other aspects is minimized, ensuring the rational use of resources, the normal circulation of natural systems and the right of human survival.

The United Nations Framework for Climate Change defines a “carbon footprint” as a measure of the total amount of carbon dioxide and other greenhouse gases released in human activities or accumulated throughout the life cycle of a product or service. The Orange Island Scenic Area is currently constructing the Orange Island Smart Cloud Platform. In the process of building a smart scenic spot, the scenic spot can cooperate with relevant Internet companies such as Alibaba to improve the carbon footprint of tourists by using the behavior of tourists in the scenic spot to encourage tourists to classify garbage.



[Figure 7] Tourism scenic spot resource cycle processing service system

3.2 Waste Disposal Mechanism

The waste in the scenic spot can be divided into five categories. The five kinds of garbage are divided into three treatment methods. (1) The rotten garbage and liquid garbage can be composted, and finally the compost is applied to the park; (2) the general kitchen waste passes the food. The pulverizer processes and finally composts are applied to the park; (3) The bones, shellfish, combustible garbage and harmful garbage in the kitchen waste are collected and stored in the garbage center of the park, and finally transported out of the park by the garbage truck.

3.3 Relationship between various stakeholders in the scenic spot

Government: The government plays a leading role in model building. The government plays a decisive role in the protection and promotion of all aspects of the entire cycle model.

Tourist attractions’ managers: Scenic area managers play a major role in model building. Responsible for the ecological environment construction, contact facility maintenance, service quality management, coordination of various activities and emergency handling of scenic spots.

Masses: The masses are the main body of implementation in the eco-environment model. For example, people with a high degree of education are more able to understand the meaning of waste sorting and are willing to start garbage sorting from their own.

Garbage disposal manufacturers: The construction of the cycle requires the construction of infrastructures such as composting plants and biomass fuel plants. The later research and development, service and training require standard processes, and the ecological cycle can be smoothly cycled.

Enterprise: Enterprise is a strong support in the eco-environment model. As a social role with certain economic strength, enterprises have the responsibility to contribute their own resources to the recycling of resources.

Designer: The designer plays an important role in propaganda and guidance in the planning of the scenic spot, guiding the tourists to classify the garbage, and also considering the design of the later garbage recycling process.

4.SUMMARY AND OUTLOOK

This paper studies the service mode of the scenic area resource recycling system and analyzes its application in the scenic area management. There are three aspects to the conclusion: (1) The construction of the service model of the scenic resource recycling system requires the government to support and actively guide all parties to participate in the green construction of the tourist attractions; (2) the stakeholders involved in the construction of the scenic spots need to comply in various fields. The policy of green production and resource recycling; (3) The waste treatment system of the scenic spot can learn from foreign advanced treatment methods and combine local characteristics to improve.

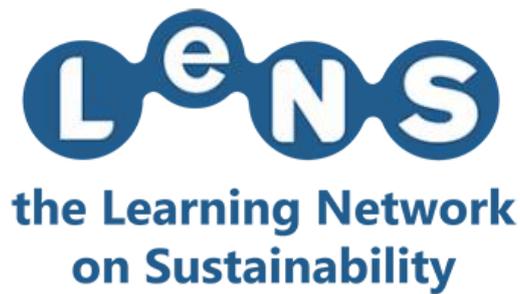
As China does not have a complete system for the research on the recycling of scenic resources, this paper is still not deep enough in the research on the feasibility and negative impact of the proposed scenic resource recycling system. These need to be applied, verified, and implemented in practice. Improvement and improvement.

Nowadays, the concepts of smart city and smart scenic spot are gradually becoming reality and deepening into the life of the masses. Therefore, the scenic spot management organization should actively cooperate with domestic

advanced Internet technology companies to establish an ecological cycle of government, enterprises, scientific research institutions, tourists and natural resources. system. Because our country of scenic spot resources circulation processing research has not yet have a complete system, in this paper, the resource circulation processing system to carry on the preliminary study and exploration, to put forward the scenic resources circulation processing system can be sexually, negative effects and operational research aspects, such as to establish the system of evaluation is not enough in-depth, these all need to be done in practice application, verification, improved and perfected.

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RESEARCH AND PRACTICE ON INTELLIGENT AGRICULTURAL MACHINERY PRODUCTS AND SUSTAINABLE BUSINESS MODEL DESIGN

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ABSTRACT

Under the new situation, the transformation of China's agricultural machinery field is imminent. Facing the challenge, it is necessary to improve the intelligence level of agricultural machinery equipment, design sustainable business model of agricultural machinery services, and promote the transformation and upgrading of agricultural machinery industry. This paper designs an intelligent agricultural machinery product based on the development pain point and market trend of intelligent agricultural machinery products. Starting from the theory of sustainable design, product service system and shared economy, this paper establishes a sustainable business model of intelligent agricultural machinery products under the new situation, and explores the way of realizing sustainable development of intelligent agricultural machinery service system model in Chinese market.

Key Words: Sustainable Design, Agricultural Machinery, Intelligence, Product Service System

1. INTRODUCTION

China is a big agricultural country. The healthy development of agriculture is related to the national strategic security. With the application of many agricultural machinery, the level of agricultural production in China has been greatly enhanced. However, the development level of agricultural machinery in China is not sufficient. The shortcomings of the existing agricultural machinery products, such as high cost, heavy environmental pollution, low power efficiency and poor user experience, have been criticized by consumers. At the same time, the utilization rate of agricultural machinery resources in China is not high, which will cause a large number of agricultural machinery idle. Only in the underdeveloped northwest of China, the idle period of agricultural machinery reaches an average of 4-6 months per year, while long-term idle and short-term high-intensity work will bring difficulties in the maintenance of agricultural machinery. At present, the after-sales service of agricultural machinery is not at the same level as the sale of agricultural machinery. Many agricultural machinery can not be guaranteed after-sales, which is very unfavorable to the development of agricultural mechanization. In this context, we need to improve our agricultural products and service system in order to constantly adapt to the development needs of the times.

2. ANALYSIS OF THE DEVELOPMENT AND MARKET SITUATION OF AGRICULTURAL MACHINERY PRODUCTS

2.1 Development Status of Agricultural Machinery Products

Agricultural mechanization in China has gone through four stages. They are: 1) the initial development process from 1949 to 1980; 2) the process of institutional transformation from 1981 to 1995; 3) the process of market guidance from 1996 to 2003; 4) the process of rule of law guidance since 2004. In this historical period, China's agricultural machinery has been fully developed, the level of development of agricultural machinery from scratch, from big to strong, is growing step by step.

In the new era, China's agricultural machinery development is not perfect, its development still faces many problems. One is the high cost of use. Existing agricultural machinery is powered by internal combustion engine, which has high energy consumption. Taking 18 kW tractor as an example, the average traction specific fuel consumption is 344.4g/kWh [4], that is, the rated working hour consumes about 7.3L diesel oil, which is about 46.8 yuan (standard: 6.42 yuan/L diesel No. 0, Beijing, February 26, 2019). The high use cost is not conducive to the sustainable development of agricultural machinery. Secondly, the environment is seriously polluted. Internal combustion tractors emit exhaust gas continuously during operation, which seriously pollutes the air environment. It is one of the biggest sources of air pollution in rural areas. Thirdly, the internal combustion engine is defective. For every 1000 meters above sea level, the power loss of internal combustion engine is about 10.8%. This means, for example, in the Qinghai-Tibet Plateau, the tractor with power of 18 kWh can only exert about 10 kWh, resulting in serious power loss. Finally, it is extremely unfriendly human-computer interaction, complex buttons and gears, ordinary farmers are difficult to get started, and need professional agricultural mechanics to drive.

2.2 Market Demand

The transformation and upgrading of agricultural machinery and equipment can not be separated from government policy support. The Ministry of Agriculture and Rural Areas, the Ministry of Industry and Information Technology and the National Development and Reform Commission jointly issued the Action Plan for the Development of Agricultural Machinery and Equipment (2016-2025), which clearly defined the guiding ideology, basic principles and action objectives for the development of agricultural machinery industry in the next 10 years. December 21, 2018. The State Council promulgated the Guiding Opinions on Accelerating the Transformation and Upgrading of Agricultural Mechanization and Agricultural Machinery Equipment Industry.

From a series of policy measures of the government, the transformation and upgrading of agricultural machinery and equipment is imminent. The government hopes to promote the transformation and upgrading of agricultural machinery and equipment through policy guidance and market promotion to attract the investment of state-owned capital and social capital. Moreover, the rapid popularization of new energy vehicles since 2015 has stimulated the enthusiasm of related industries, and the trend of new energy will gradually extend to the field of agricultural machinery and equipment.

3. PRODUCT INNOVATION IN THE INTELLIGENT AGE

With the severity of environmental pollution and oil shortage, electric drive system has been studied by many enterprises, universities and scientific research institutes at home and abroad for its advantages of environmental protection, low transmission power loss, wide speed range and easy to realize intellectualization. John Deere SESAM, Fenter E100 and New Netherlands methane power tractors represent three development directions of environmentally friendly new energy tractors in the past 50 years.

In addition, Keith Magnum concept tractor represented by Keithner Netherlands Industrial Group, T8 NHDrive concept tractor and Oriental Red LF1104C unmanned tractor represent the development direction of agricultural machinery in the field of intelligent driving.

	New Energy for Environmental Protection			Intelligent driving		
	John Deere SESAM	Finland E100	New Netherlands Methane	Case Magnum	New Netherlands T8 NHDrive	Dongfanghong LF1104-C
Tractor						
Field	Field farm operation	Small and medium-sized farm	Small and medium-sized farm operations	Field farm operation	Field farm operation	Small and medium-sized farm
Power	Pure electric	Pure electric	Methane	Internal-combustion engine	Internal-combustion engine	Internal-combustion engine
Horsepower	380	68	180	367	340	110
Endurance	4hour	5hour	A day	No data	No data	No data
Charge	3hour(100% Electric quantity)	40minutes(80% Electric quantity)	Same as an internal combustion engine	Add fuel	Add fuel	Add fuel
Discharge	0	0	20% of internal combustion engines	Diesel Engine Emissions 80db+	Diesel Engine Emissions 80db+	Diesel Engine Emissions 80db+
Noise	70db+	50db+	50db+			
State	Prototype	Test	Test	Concept machine	Concept machine	Prototype

[Figure 1] Contrast chart of Tractor Products

The above products have made beneficial exploration on the development of agricultural machinery and equipment, but each has its own limitations. In summary, from the practice of Tractor Research and development in the above enterprises, it can be concluded that the development of agricultural machinery in the future should be toward the two major trends of environmental protection, new energy and intelligent driving, but the existing conceptual models do not have both of these two trends at the same time. Therefore, on this basis, the design and manufacture of an agricultural machinery product with environmental protection, new energy and intelligent driving is also the inevitable trend of the development of agricultural machinery in the intelligent era.

4. DESIGN OF INTELLIGENT AGRICULTURAL MACHINERY PRODUCTS

Designing an agricultural machinery product that can meet the needs of energy saving, environmental protection and intelligent driving, and can be accepted by the market, it is necessary to visit farms around the country and conduct field research on various agricultural participants. The team consisted of eight people, who went to farms around Changsha City and rural areas such as Shanxi, Anhui and Hebei. More than thirty farms were surveyed and more than ten farm workers were interviewed in depth, and a series of research materials were obtained.



[Figure 2] Farm Survey

According to the actual use of farms and network information, the project team conducted in-depth analysis of their needs, extracted the relevant pain points, and summarized these pain points. The results are shown in the table below.

[Table1] Summary of Tractor Pain Points

Pain Point	Problem Solution
Pollution discharge	Use clean energy (e.g. methane) or clean power (e.g. electricity)
High cost of use	Reducing energy transfer process
Defects in Internal Combustion Engines	Replacement of power system, independent of air replacement
Poor user experience and high learning threshold	Reduce gear and control button
Scarcity of farm machinery	Using Intelligent Driving Technology
The shape of tractor is not beautiful	Increase investment in industrial design
Electric power is needed in the field	Tractor built-in power supply
Pedestrians do not know the intention of the tractor	Adding Pedestrian Reminder Device
Vehicle driving is unsafe	Using new technology can ensure vehicle safety

From the qualitative results of the research, we basically define the design category of a new type of intelligent agricultural machinery. That is, a fully functional and innovative intelligent agricultural machine, which can solve the core pain points of users, such as: lower cost of use, the average cost of use is less than one third of the traditional agricultural machinery; zero pollution and zero emissions, extremely friendly to the environment, in line with the

trend of environmental protection; extremely high power efficiency, even for plateau users can use normally; excellent user experience, ordinary farmers People can also start with ease and so on.

The following are the functional parameters according to the design:

[Table 2] Tractor Functional and Parameter

Function			
Pure electric drive	Excellent Interaction Design	RTK, ZGBEE RSSI Ranging and Location	Charging and discharging functions
Front LED Display Screen	4G and 5G remote control	10 kwh super high power	6-hour tillage time limit
Parameter			
Model			F 01
Contour dimension (mm)	long	3100	
	wide	1240	
	high	1310	
	Wheelbase	1440	
Front wheel spacing (mm)			930
Rear wheel tread (mm)			1020
Minimum turning radius (m)			2.8
Tractor quality (kg)	Structural quality		930
	Minimum quality of use		1160
Motor power (kw)			5
Battery capacity (kwh)			10
No load endurance (hour)			12
Working life (hour)			6

To sum up, a new industrial design scheme of intelligent agricultural machinery has been developed, as shown in the following figure:



[Figure 3] Derivative diagram of tractor industrial design

5. DESIGN OF SUSTAINABLE BUSINESS MODEL SYSTEM BASED ON AGRICULTURAL MACHINERY SERVICES

According to the innovative intelligent agricultural machinery products, it is necessary to explore and create a sustainable product service system around it. In the face of product service system, designers must link the interaction between people and products, people and people, people and society through various means including program innovation. The development of sustainable business model of agricultural machinery service in China can be divided into three stages: product, platform and system. In this business model, first of all, we design and manufacture intelligent agricultural machinery products, provide basic and reliable agricultural machinery, improve the basic performance of products, and make them become the basic tools to serve the vast number of agricultural workers. Secondly, it provides value-added services such as sharing farming and maintenance of farm machinery to meet the needs of farming and maintenance among users of the platform. Finally, it promotes effective interaction among multiple groups, creates a sustainable business model in the field of farm machinery services, and supports the transformation and development of China's agricultural machinery and equipment industry.

5.1. Firstly, a closed-loop sales system for tractor products is established.

China is vast and rich, so it is impossible to set up shops in villages and villages. In order to make driving test more convenient for users, it is necessary to develop an Internet car-buying platform, which allows users to test with 5G remote control. Customer satisfaction after logistics transportation, direct distribution to the village to home, to minimize the cost of distribution.

5.2 Then enter into the shared agricultural machinery market.

In 2018, the domestic agricultural machinery service market will reach 650 billion yuan. By 2020, it will exceed 10 billion yuan. Relying on the unique intelligent farming, navigation, positioning and remote control functions of

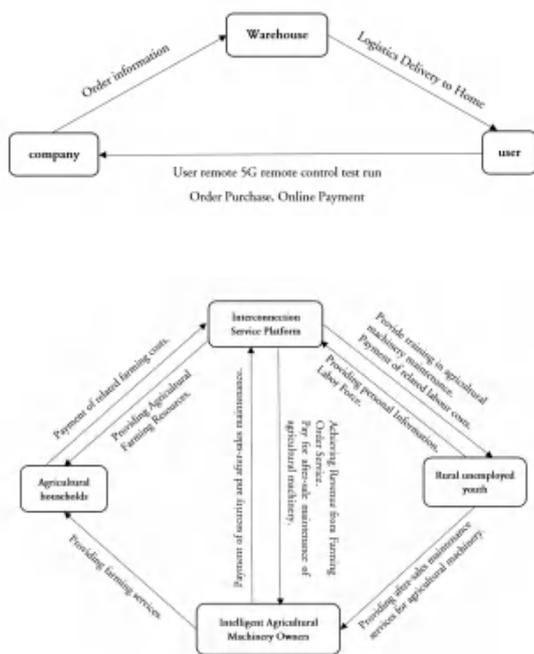
the company's intelligent agricultural machinery, it can solve the current service pain points of sharing agricultural machinery, develop the sharing platform and expand the market share in the field of sharing agricultural machinery service. At the same time, it can also create "shared maintenance" agricultural machinery services. There are a large number of unemployed young people in rural areas in China who have received basic compulsory education. The company gives them the basic maintenance skills of intelligent agricultural machinery, and they can use their maintenance skills to help the company establish after-sales maintenance system, not only to solve rural employment, but also to solve the worries of intelligent agricultural machinery users.

5.3 With the expansion of platform scale and the increase of user groups, resources need to be integrated.

Figure captions and table headings should be sufficient to explain the figure or table without needing to refer to the text. Reasonable use of interconnected service platform, the strength of companies and factories will effectively integrate all members of the agricultural work, so as to build a relatively perfect sustainable agricultural machinery service network. In this commercial ecological network, each member is responsible for different links, and interrelated and collaborative.

Based on the commercial network, the purchasers of agricultural machinery purchase intelligent agricultural machinery through the interconnected service platform and obtain after-sales service information; the company can obtain profits and use large data of agricultural machinery through the platform, while updating the management of the interconnected service platform; rural unemployed youth only need to provide personal information and labor force to obtain agricultural machinery maintenance skills and remuneration; intelligent agricultural machinery users In order to obtain farming orders and after-sales maintenance services; agricultural farmers can obtain farming services; warehouses, factories can obtain agricultural machinery sales orders.

Members do not exist alone, they create value for each other, thus driving the effective cycle of the whole agricultural work. It can be seen that through this business model, each member can play its maximum value, make full use of resources, improve the efficiency of agricultural cultivation and resource utilization, and form a sustainable service network based on agricultural machinery.



[Figure 4] Tractor Sales Process [Figure 5] Tractor Shared Service Chart [Figure 6] Tractor Business Ecology Network Diagram

7.CONCLUSION

The green revolution of low-carbon farming of agricultural machinery and the technological revolution of automatic driving of agricultural machinery are the main trends of the development of agricultural machinery in the future. Sharing agricultural machinery services is the embodiment of the maximum value application of new energy intelligent agricultural machinery. Based on the theory of new energy intelligent agricultural machinery and product service system, this paper gradually realizes the deep integration between interconnected services and products. On the one hand, innovating intelligent zero-emission farming tools is conducive to protecting the environment and promoting the transformation of China's agricultural machinery industry. On the other hand, it provides diversified value-added services for users, farmers, unemployed youth and so on.

Of course, the sustainable business model of the whole agricultural machinery service is a new business model with strong innovation and risk. Internet interconnection is the future development trend of smart agriculture industry. Whether technological innovation or business model innovation are facing many unknown challenges, and there are many contents worthy of in-depth study.

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THE CORPORATE SOCIAL RESPONSIBILITY (CSR) AND STRATEGIC MANAGEMENT FOR THE MEXICAN SPECIALIZED PUBLISHING SMES

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ABSTRACT

The research had as objective to identify how sustainability, translated into organizational management, can incorporate the principles of corporate social responsibility (CSR) as a practical guide to redesign organizations, and as a strategy to promote the generation of economic and intangible value. It is proposed in order to foster the development of Mexican specialized micro, small and middle (MSME's) enterprises in the publishing sector; extend the horizon of sustainable management in the creative and cultural businesses beyond the environmental care of their production systems and their final products (circular production and eco-design), bolster the cultural information disseminated through them and strengthen the importance of the triple bottom line integrated in the organizational culture as a driver of the interrelations between all of the stakeholders involved throughout its value chain and within the whole local system.

Key Words: CSR, sustainability, value generation.

1. INTRODUCTION

The publishing industry is part of the oldest creative, intermediary and magnifying industries, as it is responsible of the generation, communication and perpetuation of information as well as paradigms (Bhaskar, 2014). In Mexico, this industry is going through a strong crisis, originated by the perpetuation of an obsolete system focused on the paradigm of the Industrial Age¹. Which is not an isolated phenomenon, but a reflection of global transitions that challenge complex systems, especially those strongly linked with the generation of abstract, qualitative and subjective value (Thompson, 2013)

This research was contextualized by a brief analysis of the current Mexican publishing industry, focused on the characteristics of micro, small and medium specialized companies (SMEs), and strengthened through conversations with a recognized expert of the industry, Carlos Anaya Rosique, President of the National Chamber of the Mexican Publishing Industry (CANIEM for its acronym in Spanish). By developing a method for analyzing the ways that cultural and creative organizations can identify the opportunities to integrate organizational strategies that take the values of sustainability as guiding principle into their operations, publishers play as generators of sustainable value. The later understood as acknowledging and harnessing the abstract and economic value of their activities as well as the responsibility within the strong socio-cultural influence and ecological impact of the internal dynamics of their value chain.

The scope of the present research was limited to the analysis of the companies' internal stakeholders' perspectives, leaving open the possibility for future research on the external stakeholders in the value chain, widening the spectrum of possibilities to redesign the organization.

It is crucial to clarify, that as there is no general "magic recipe" for all MSME's, entrepreneurs must be capable to identify their unique opportunities and embrace sustainable management as a tool for transforming their companies and impacting the society they serve.

2. METHODOLOGY

In order to delimit specific indicators that allow the necessary feedback for increasing the flexibility of organization in the face of change, as open systems; as well as facilitating the analysis, planning, implementation and evaluation of tactics in accordance with a sustainability-oriented strategy as a fundamental value proposition, a CSR instrument was developed after an extensive research on existing models for organizational sustainability and CSR, linking the global goals of sustainable development with the four areas or axes of CSR².

The relationship between the management and the sustainability of a company is of complementary nature, as it enables the introduction of the Triple Bottom Line (TBL), or the three axes of sustainable development in its commercial operations the objective is to achieve a win-win strategy. This will be accomplished by shifting from the industrialized approach to the value generation strategy, preponderating the benefit achieved through a positive vision such as Net positive (Norris, 2015) and Handprint (CSCP, 2016) in the evaluation of indicators and methodologies to complement the control of impacts companies. Putting together both methodologies, the handprint (positive impact development) and footprint (negative impact reduction) provide a holistic and systemic understanding of the actions' nature.

3. CASE STUDIES A, B & C

3.1. Similarities

Although the three analyzed organizations are very different, they share the following similarities:

Being part of the Publishing Industry, they are being directly affected by the same crisis.

They are located in Mexico City.

They were founded by people related to graphic design, communication and arts.

The Directors do not have much knowledge or interest in the formal aspects of the administration, except for the General Director of case B who has a diploma in management.

Currently none of the three is financially self-sustaining. The more stable is the case C, but it is barely surviving, and has already presented red numbers in their finances.

Prior to this research, none of the companies mentioned below had formal organizational documents in a written and structured manner, hence this work also served to enable companies to formalize their information.

3.2. Differences

Case A, which has been operating for 7 years, has 5 employees, its work strategy is internalization, works on printed format for bibliophiles, collectors, art lovers, cultural and academic institutions; its value proposition is to enrich the

¹ It can be summarized the paradigm of the pursuit of great profits in the short term for the owners and investors. Translated into mass production of publishing products like any other non-cultural product, market grabbing through competition for distribution points and saturation of advertising in the media. High production costs, storage and distribution as well as a great environmental impact.

² Quality Of Life In The Company (Worthy Employment), Linkage And Commitment With The Community / Development Of The Local Community, Care And Preservation Of The Environment (IMPACT Control) & Business Ethics / Generation Of Wealth / Competitiveness Of The Company And Its Relationship With Its Involved Partners (STAKEHOLDERS).

book-object-content- reader experience by creating collectible works and co-editions.

Case B also has 7 years of existence and a small number of employees (2), having outsourcing and part-timing as its work strategy. Its value proposition is on of original and serious research quit great quality of content and presentation, and, unlike the other two companies, they work on digital and multimedia formats too.

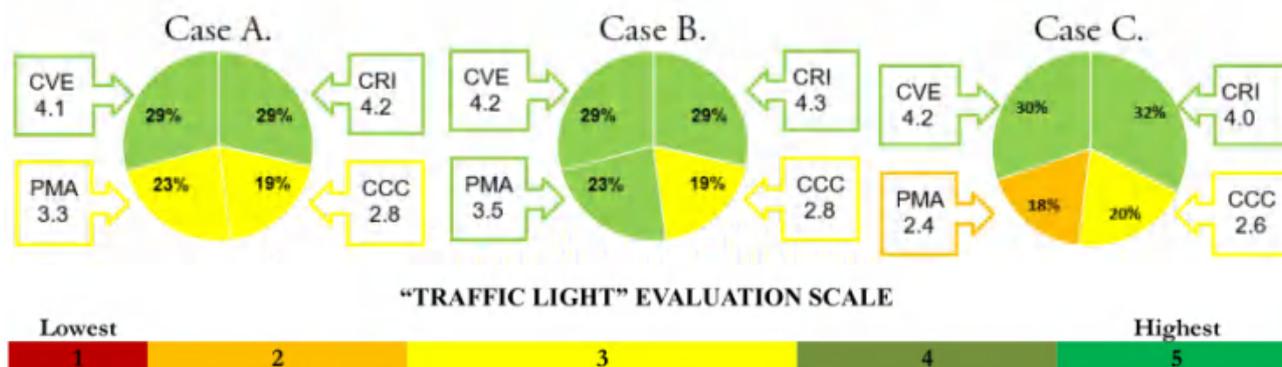
Case C is the largest (31 employees) and oldest of the companies (30 years), its strategy mixes internal, outsourcing and part-timing. It manages only printed format as its target audience is people interested in learning about Mexican art, crafts and traditions, they propose great quality of content, processes, presentation and customer service as well as bilingual work as part of their value.

3.3. Case Studies' Results

A comparative analysis was chosen to facilitate the drafting of general proposals for the three cases studied. This methodology, instrument of measurement and analysis can be a reference for other similar publishing businesses, adapting them to their particular contexts. The average results of each of the case studies are shown on Chart 1. Case A's high scores present the possibility of implementing measurements that balance the 4 axes of CSR with out risking the company' s survival. This company has the opportunity to have CSR as a value generator and be recognized for it. It can increase the employees' wellbeing whilst being self-sustained and environmentally sound in its operations.

It is interesting to note how the average results of case B show the highest scores. This is because the company consists of only two people, company B also relies mainly on outsourcing, a strategy that prioritizes on cost reduction for diverse functions.

The company that has been in the market for the longest period of time, is the largest and most economically sound, has the lowest scores, mainly in the axes of environmental protection (EP) and commitment to the community (CC). This is a reflection of the visions of traditional publishing companies, aligned to the practices and paradigms that have led the publishing industry to its current crisis.



[Chart 1] Averaged Results Per Company (employees and management)

CVE: Quality of Life in the Company, CC: Community Commitment, EP: Environmental Protection, CRS: Competitiveness and Relationship with Stakeholders.

4. PROPOSAL OF GUIDELINES

4.1. Quality of life in the Company

Evaluation and rethinking of the value proposition: It is the core of the success of the company, it must be consistent with the values of it.

Formalize the administrative management: Founded both the philosophy and the strategy on the values of sustainability. Make a comparative analysis of the before and today of the company, within, throughout its value chain and the indirect external environment, in order to maintain the veracity of the updated information, allowing effective strategic decision making. Having the support of an external consultant or fascinator will help maintain objectivity in the analyzes.

Strengthen internal communication and feedback: It is very important that all members of the company and feel they are actually taken into account. The internal and external communication of the organizations is the source of nutrition that allows the development of the same, to avoid falling into sedentary habits that diminish the flexibility and speed of response, as well as the use of opportunities and reduction of threats.

Physical spaces for communication: Have an isolated space specifically dedicated to relaxation and coexistence between areas, as well as specific moments of coexistence and interaction platforms (opinion mailboxes, internal chats, etc.). They contribute to the improvement of the organizational environment Take advantage of exponential technologies: For an optimization of information management both at an operational level and for strategic management, it is recommended to use these technologies in all activities within each business model and in the relationships with the different participants or members of the value chain.

Security and Wellbeing: If a person is in an altered state due to fear, stress, anxiety or fatigue, their creative and attention capacity diminishes, which affects their productivity and social skills and facilitates the generation of conflicts that alter the collaborative dynamics required for MSMEs to prosper.

Reduce uncertainty: One of the most effective ways to reduce uncertainty is to focus attention directly on human relationships and individual concerns. For example, it is important to formalize the contracting and benefits systems, as well as the evaluation systems, the profile of responsibilities, etc., in order to have a flexible reference that allows to easily evaluate and decide what is most appropriate for the entire organization, not only from the particular interests.

Make work schemes more flexible: Each individual differs and works in different ways, so it is important to take this into account when it comes to making work forms more flexible, negotiating with each individual and by work teams, always respecting the agreements reached. This increases well-being, allowing them to lead a more balanced, complete, dignified and diverse life.

4.2. Commitment with the Community

Organizational commitment with the local community development: The community that makes up the entire geographical, demographic and cultural environment of an organization is an important source of support for it in very different ways and can serve as a primary source of valuable information. A good relationship and mutual support with the members of the local community can result in a strong encouragement for the self-realization of each member of the company in terms of well-being obtained by meaning, by transcendence, a source of motivation to see reflected directly the influence of his work in the near reality, palpable.

Local public presence: It is in the local community where you can land or embody many value-generating proposals belonging to the other three axes of CSR. Through partnerships, collaborations and / or active participation, programs can be created for the improvement of the urban ecological environment, generating a great benefit to the public image of the organization, the implementation of ecoactivism, and social marketing.

Involvement of employees with the community: If the organization lacks physical facilities, the local community will be the environment of each one of its members, generating micro communities. You can also talk about a local digital community that may or may not be part of the value chain of the company, but that provide support to those involved and the organization.

4.3. Environmental Protection

Eco-efficiency and resource optimization: This axis, allows economic savings for the company, invites to make more efficient its internal and external processes and positively influence the way of life of all those involved. In addition to talking about eco-design editorial and organizational eco-design, there are already several innovation alternatives related to the life cycle of products, the daily operations of organizations, as well as changes in individual habits that impact the environment positively or negatively.

- **Energy:** Actions to reduce and control energy consumption, as well as investment in renewable energy.
- **Water:** There are many ways of how to take care of this precious resource. It is about reducing, reusing, recycling and renewing. Avoid unnecessary use, leaks, contamination, etc.

Waste and emissions: Differentiate solid and / or liquid waste on the one hand, and emissions of noise, light and soft drinks on the other. Avoid or reduce the consumption of toxic materials.

Environmental control of production processes and their impacts: In this part, systems such as C2C and circular economy are put into practice. The responsibility in the selection of suppliers of products and services that share a vision in CSR and / or sustainability is fundamental.

Eco-activism: Promotion, design, participation and support to programs of protection and ecological recovery in general, non-profit that seeks to support society and the environment through the activities of the company, especially those directly related to your proposal of value.

Legality: It refers not only to compliance with the laws of health and basic environmental care, but to be informed about the possibilities of obtaining different certifications, which serve to verify the commitment of the organization, improve its public image, but above all to be a guide consistent and constant in compliance with all CSR principles.

4.4. Competitiveness and Relationship with Stakeholders

Legality: Compliant compliance with the minimum requirements to carry out commercial activities according to regulations and laws at national and international level. Take advantage of opportunities to access other types of opportunities, links, knowledge, approaching collaborative societies, with governments, companies, and individuals consistent with the paradigm of CSR and sustainability.

Prevention of illicit businesses and fight against corruption: Maintaining the firmness of convictions, not overlooking actions of injustice, disrespect, corruption and illegality is crucial, so it is a fundamental strategic responsibility to investigate and keep informed about the actions of those who make up the company's value chain, in the same way that the members of the organization are investigated and selected.

Corporate governance: All proposals that are generated from within the organization must be put in writing and disseminated in each of the levels. It is important that all those involved are informed about these new practic-

es, that they are participants, agents of change, that provide feedback to the organization. Organizations must have clear systems for evaluating the performance of their suppliers, distributors and business partners, as well as creating and reinforcing the means of communication, registration, control, analysis and strategic use of the information obtained through contact with their customers.

Maximization of added value: The maximization of the added value will arise from the process of total redesign of the organizations, from the proposal of value until each of the daily operations, to the interior of the company starting from the active participation of each individual, and also throughout its external value chain, as well as in direct contact with its direct and indirect environment.

These are broadly the main guidelines that must be analyzed, disaggregated and adapted in a coherent manner to the particularities of each organization, regardless of the size of these.

5. CONCLUSIONS

It is important to emphasize that the problems presented in the Mexican editorial MSMEs are also typical of the global editorial crisis. The mediating role of the editors, as well as the strong influence on the generation of abstract value and symbolic capital of the creative industries through their power for socio-cultural transformation, already requires the rethinking of the paradigm of all systems where the publishing companies are developing, based on the five sustainability objectives proposed by the UN in the 2030 agenda: people, planet, prosperity, peace and associations (collaboration).

The sustainable management in organizations, specifically the editorial MSMEs in Mexico, can be achieved, considering corporate social responsibility as a means to achieve it, using as a benchmark its indicators to create a dynamic strategy that gradually integrates the principles of sustainability at all levels of the organizations, affecting in a positive way those involved in its value chain directly or indirectly. The change cannot and should not be imposed.

Sustainable management can hardly be achieved in a period of organizational survival; the ideal is to consider as a medium or long-term objective. Placing the main objective in a first stage of economic self-sufficiency, through the challenge of total transformation of paradigms and beliefs (mainly of managers), as well as its strategy, its value proposition, its daily operations, and therefore its business model.

Exponential technologies, especially digital media, the internet with its social networks and Big Data, among others, opposed to the belief of being a threat to the publishing industry, are fundamental in taking advantage of opportunities to generate value for companies.

Regardless of the size of the organization, the importance of incorporating sustainability into the business model of publishing companies as a transversal axis, is more than a differentiating factor, it is a necessary and urgent requirement to ensure the generation of value.

There is not a “one fits them all” solution for the MSMEs and it is important that the entrepreneurs identify their unique opportunity areas and ways in which different elements of sustainability can be a tool to transform their operations, their companies and have a wider impact on the environment and the societies they serve.

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SLOC MODEL BASED SERVICE DESIGN STRATEGIES AND PRACTICE ON ECOLOGICAL AGRICULTURE

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ABSTRACT

Based on the SLOC mode and the Wangjingbeishu Farm, this paper aims to explore the specific design strategies and practices of SLOC mode in guiding eco-agricultural enterprises represented by ecological farms to establish more sustainable service and business models. Through the research and the survey, three strategies of service design for the Wangjingbeishu Farm are putted forward: (1) creating the brand culture including brand images and brand stories; (2) building the Internet platform and the information management platform; (3) extending the service and continuing the experience through products. According to the strategies, the product service system is designed for the Wangjingbeishu Farm, including the system map, business model canvas, service blueprint, user journey and touch-points design that include the logo, packages, app image, app interfaces, webpage, planting box for customers and planting frame for cooperative farmers.

Keywords: SLOC mode, Service design, Ecological agriculture, Social innovation

1. INTRODUCTION

Food safety is an important social issue related to human survival and health. Agricultural safety is the premise and guarantee of food safety. In today's China, where food safety is a frequent problem, as an environment-friendly agriculture focusing on agricultural safety and sustainable development, more and more agricultural organizations or enterprises have been involved in ecological agriculture in different forms including ecological farms, organic restaurants, agricultural education and so on. Among them, ecological farms are more popular and representative in China at present. The concept "Sustainable Farming" advocated by ecological farms is easier to be accepted and recognized by the public through high quality agricultural products. However, in the process of promoting the concept and developing the model, it also faces some difficulties and dilemmas. How to make its own services and business models more sustainable while upholding the concept of sustainable development has become a challenge for many social innovative agricultural organizations or enterprises that are practicing ecological agriculture. SLOC mode may provide the guidance. SLOC mode is pioneered by Professor Ezio Manzini, a well-known Italian expert in design for sustainability and design for social innovation. It means a small, local, open and connected mode (Manzini, 2015) and it is an ideal reference for social innovation organizations to establish sustainable developing models. Wangjingbeishu Farm is the object of design research and practice in this paper. It is a small ecological farm that has been committed to ecological agriculture for 5 years in Wuxi, China.

2. SLOC MODE AND ECOLOGICAL AGRICULTURE SERVICES

2.1 SLOC mode

A small, local, open and connected mode means social innovation organizations should maintain a smaller scale to ensure the flexibility and the capability to resist the risk (Manzini, 2015); should have good local attributes to solve local problems relying on local environment and resources; should have enough openness, acceptance and inclusiveness to external resources; should be connected with other partners and stakeholders to form networks or systems of distributed production (Manzini, 2015).

2.2 Ecological agriculture services in SLOC mode

The current popular ecological agriculture service modes mainly include ecological farm, community support agriculture, urban agriculture, Internet fresh platform, organic restaurant and so on. These different modes of eco-agricultural services are actually new solutions to the problems of environmental sustainability and food safety. They have the external form and value connotation of social innovation. In the form of desk research and field research, the author analysed the cases of these different eco-agricultural service modes respectively. It was found that these different service modes have great room for improvement in utilization of local resources, construction of brand identity and common culture, design of service process and user experience, replication and promotion of service modes. In view of the above, the author putted forward an ecological agricultural service mode with characteristics of SLOC mode which is flexible and easy to be replicated. It has service content from local resources that is adapted to local demands, as well as highly participatory service experience. It can form a systematic and connected service network through replication and promotion of the mode.

3. SURVEY OF WANGJINGBEISHU FARM

3.1 Field research

The original intention of Wangjingbeishu Farm was to provide people with safe and reassuring seasonal ecological agricultural products produced by sustainable planting, and to promote the spread of healthy and sustainable way of life and values. The farm currently serves about 50 local customers and the main services include organic agricultural products produced in the current season by farms in local and some foreign cooperative farms. Wangjingbeishu Farm does not have its own website. The staff contacts with customers by instant messaging software. The farm usually distributes agricultural products to customers on Tuesdays and Fridays after the ordering requirements sent to them. Another type of customer of Wangjingbeishu Farm cooperative farmers. These farmers are authorized to use the planting technology from Wangjingbeishu Farm and their agricultural products will also be incorporated into the product system of the farm.

3.2 User research

By means of user interviews and focus groups, the author made a survey of some farm's customers. The farm's customers come mainly from local citizens who agree with the core values of Wangjingbeishu Farm. All of the customers in survey were satisfied with the high quality of agricultural products from the farm. Some busy customers thought that the farm can be more flexible in the time of distribution and some customers who had children hoped the farm could hold some activities on agricultural education and experience in the future. Some young and long-term customers wanted the farm to set up its own official website for getting information and ordering. After the survey of farm's customers, the author also conducted a survey on the service and experience of eco-agriculture among the public in the form of online questionnaires.

3.3 Design opportunity

Through the field research, the author considered that for the Wangjingbeishu Farm, it needs to enrich its service content and improve its service process to enhance its service quality; build its own brand identity and operation platform to facilitate brand promotion and user experience; create a flexible service and business model which can be a product service system to help the farm spread its technology and replicate the model in order to expand product offerings and extend service scale. The author found that both the customers of Wangjingbeishu Farm and the public in survey were interested in personalized and customized services, as well as the farming activities that can be personally participated in and experienced by both the young and the old.

4. SERVICE DESIGN STRATEGIES FOR WANGJINGBEISHU FARM

The ecological agricultural service mode with characteristics of SLOC mode is the essential principle of service design for the farm. Smooth user journey is the key to service design. The target of service design is to establish and cultivate mutual trust between farms and users by improving service experience. The author divided the user journey of the farm into three phases: service contact, service consumption, service extension and experience continuation. These three phases need different specific design strategies.

4.1 The brand culture

Wangjingbeishu Farm needs to design its own brand images and brand stories. In the phase of service contact, brand image is the primary impression left to customers. If the farm could attract the customers to comprehend the story behind the brand and realize the sense of mission, responsibility and quality of the brand in this phase, it will arouse the customers' empathy, make them generate the sense of recognition on the brand and the common view with the brand. Recognition and consensus are prerequisites for establishing consumption relationship between the farm and consumers.

4.2 The Internet platform and the information management platform

Wangjingbeishu Farm needs to design its own website, webpages and app as Internet platforms to improve the user experience of information browsing and ordering. These will also become a method to advertise and communicate with customers. With the popularity of the Internet and mobile devices, people are more accustomed to browsing information and purchasing goods on their mobile phones, tablets or laptops, especially the young. So it is also a way to attract the young and to help the farm excavate and develop potential customers. The management platform will help the farm respond to the demand for the management of customers after the growth of the users and grasp the operations.

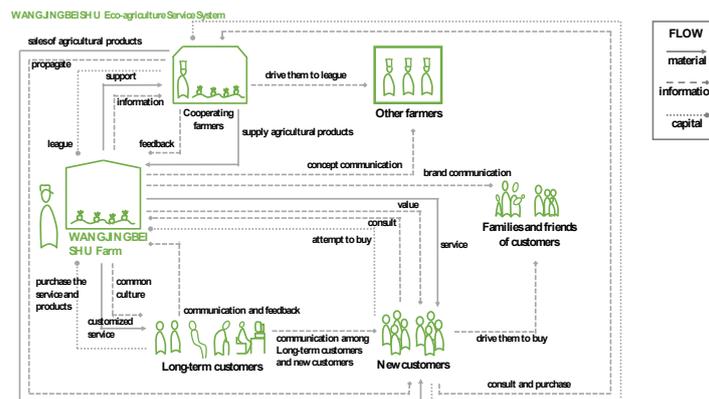
4.3 Extend the service and continue the experience through products

Wangjingbeishu Farm needs to design continuously service content and user experience to strengthen and consolidate the relationships with customers and promote the continuation of the consumption. Combined with the physical truth of the farm and demands for the farming experience from the customers, it is possible to design a domestically eco-agricultural planting experience product which is low-cost but highly operable. Customers can experience the planting at home through this product and get the guidance in the knowledge and technology of planting from Wangjingbeishu Farm.

It is possible to design standardized and modularized supporting products for planting to help the farm spread its unique concept and technology to more farmers in order to develop cooperative farmers. Cooperative farmers will learn the technology more quickly and increase productivity by this product. Even schools and communities can carry out activities such as children's agricultural education and urban community agriculture through it, so that the brand culture and service experience of Wangjingbeishu Farm will be extended to more scenarios and form a network layout.

5. PRODUCT SERVICE SYSTEM DESIGN FOR WANGJINGBEISHU FARM

The product service system design for Wangjingbeishu Farm is the practical methods according to the design strategies. It includes the system map, business model canvas, service blueprint, user journey and touch-points design that include the logo, packages, app image, app interfaces, webpage, planting box for customers and planting frame for cooperative farmers.



[Figure 1] System Map

5.1 Service system and business model

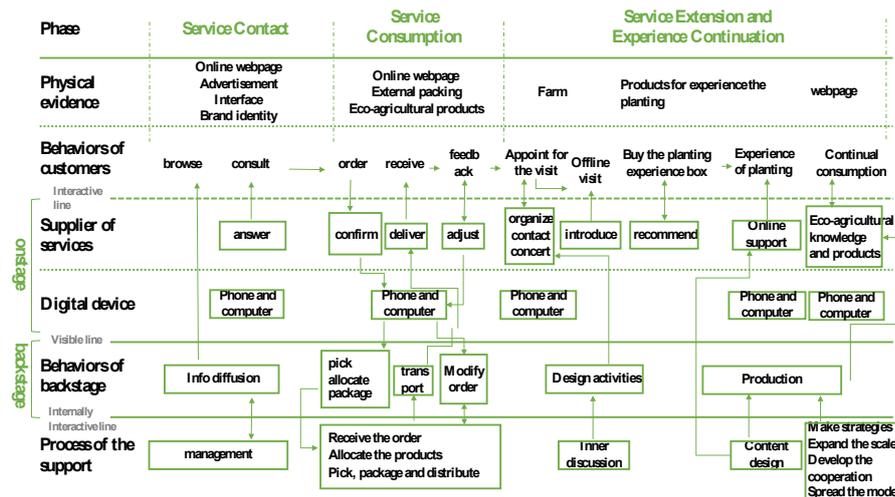
The figure 1 shows the stakeholders of Wangjingbeishu Farm and the relationships among them. The farm forms a small and flexible service system with them. In this service system, the farm and its stakeholders constitute a closed service cycle. The other farmers and customers out of this system are the potential users that can be developed by the farm in the future.



[Figure 2] Business Model Canvas

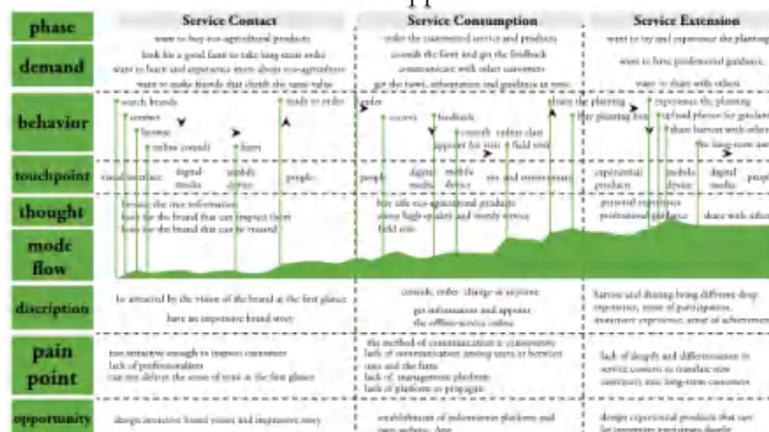
The figure 2 details the service base of Wangjingbeishu Farm, which is mainly based on local environment and social resources.

5.2 Service procedure and user journey



[Figure 3] Service Blueprint

The figure 3 depicts the interactions among different roles in the phase of service contact, service consumption, service extension throughout the whole service procedure, the physical and digital touch-points involved in the user experience, and the behaviors of customers and service supplier.



[Figure 4] User Journey

The figure 4 displays the different demands, behaviors and pain points of users in three phases of experience.

5.3 Touch-points design



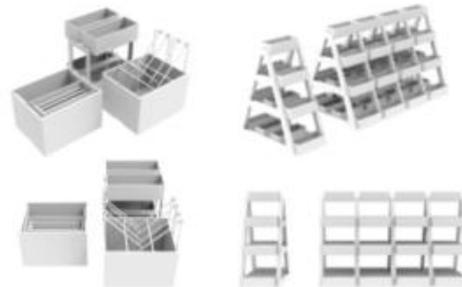
[Figure 5] Logo, Packages and App Image Design for Wangjingbeishu Farm

The figure 5 shows the design of the logo, packages and the app image for Wangjingbeishu Farm. They will leave customers the first impression of the farm.



[Figure 6] App Interfaces and the Webpage Design for Wangjingbeishu Farm

The figure 6 is the design of app interfaces and the webpage for Wangjingbeishu Farm. The app and the website will help customers consult information, contact with the farm and order agricultural products more convenient.



[Figure 7] Planting Box for Customers and Planting Frame for Cooperative Farmers

The figure 7 shows the design of a domestically eco-agricultural planting box for customers and a modular planting frame for cooperative farmers and other partners like schools and communities. The box can be assembled in two containers for different crops and in one box when not in use. It will be more convenient for customers to experience the planting at home by this product. The planting frame for cooperative farmers can be assembled in a planting array for more crops if in need. It will help farmers or other partners plant more crops in less space to improve the productivity. The planting technology from Wangjingbeishu Farm will be easier and more quickly to be learned and experienced through the planting box and the planting frame. The ideas and the mode of Wangjingbeishu Farm will also be spread wider by these two products.

6. CONCLUSIONS

The design research and practice in this paper are the tentative exploration of using SLOC mode in guiding eco-agricultural farm improve and optimize its service process and business model to a sustainable state. The process and results of the design research indicate that it is instructive and productive when using SLOC mode to guide social innovation organizations in developing sustainable modes. For the Wangjingbeishu Farm, the strategies and practices will help it adjust its method of operation, promote the quality of the service, the quantity and the satisfaction of customers. It also provides referable ideas and methods for the future research on analogic issues. For the SLOC mode, this paper verifies its practicability and provide a reference and a potential method for the future research and practices on the service design, design for sustainability and design for social innovation. It is also possible for more and more enterprises or organizations that concentrate on the sustainable developing to combine the SLOC mode with the current situation and practices when they meet difficulties in operation.

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APPLICATION OF THE CARD SORTING TECHNIQUE ASSOCIATED WITH THE STORYTELLING APPROACH IN A PSS FOR SUSTAINABILITY

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ABSTRACT

Conventional data collection methods in design projects, such as questionnaires and interviews, often result in inaccurate data, which is sometimes superficial for comparison and analysis. Therefore, the use of more empathic techniques can contribute to the collection and analysis of in-depth and real data. The purpose of this research is to describe the application of the card sorting technique associated with storytelling in a Product-Service System project for sustainability. As a result, these techniques contributed in understanding the preferences of the user regarding the proposal of a sustainable urban garden PSS, with an automated irrigation system. In this way, the application of the card sorting associated with storytelling allowed the identification of opportunities and challenges of the feasibility of implementing a service that offers an urban garden Product-Service System with a focus on sustainability.

Key Words: Card Sorting, Product-Service System, Urban garden, Sustainability.

1. INTRODUCTION

The development of new Product-Service Systems proposals, especially those related to Sustainability, requires the involvement of potential users not only in the validation and implementation phases but from the initial stages of design. Conventional data collection techniques, such as questionnaires and interviews, often result in inaccurate and superficial data for comparison and analysis and do not favor the understanding of user perceptions.

For Mukhtar, Ismail, and Yahya (2012), customer roles have evolved from passive consumers to users who contribute to successful innovations. We can observe this in the proliferation of user-centered methodologies applied to capture customer needs and requirements in order to incorporate and deliver value (in the product or service) to users. This change in the role of consumers, from passive users to collaborators in the creation and extraction of business value, allowed the improvement of customer co-creation techniques and value-creation models (Mukhtar, Ismail, & Yahya, 2012). This empowerment of the user can also bring benefits to Sustainability, since people are more aware of what they eat, wear, and manufacturing processes in general (Dick, Eden, Fischer, & Zietz, 2012). Therefore, more than ever new techniques of user involvement are essential and necessary.

New possibilities and techniques have arisen, albeit experimental ones, that allow a greater approximation with the user, in order to understand their perceptions, expectations, and sensations when enjoying a service. Techniques such as card sorting, storytelling, shadowing, paparazzi, some of which are already applied in product design, but are being adapted to the context of services and PSS.

Thus, this paper aims to describe the application of the card sorting technique associated with storytelling in a Product-Service System project for sustainability. We emphasize that there is no quick recipe since the technique can be adapted to each context and project, but here we describe the practice through its application. The techniques were used to contribute to the understanding of the preferences of a user with apartment manager activity regarding the proposal of an urban garden PSS, with an automated irrigation system, applicable to condominiums with a focus on sustainability.

2. COCRIATION TECHNIQUES IN SERVICE DESIGN

According to Wetter-Edman, Sangiorgi, Edvardsson, Holmlid, Grönroos, and Mattelmäki (2014), service design is a creative, human-centered, iterative approach to serving innovation, exploring the consumer experience to generate new service solutions converted into prototypes, tested and implemented. It was born as a conscious discipline that there is a dominant economic vision in the service sector and that there is a lack of intuitive and creative design culture (Maffei, Mager, & Sangiorgi, 2005). The service design is a multidisciplinary field that involves marketing, human resources, operations, organizational structure and technological disciplines (Ostrom, Bitner, Brown, Burkhard, Goul, Smith-Daniels, Demirkan, & Rabinovich, 2010), and orchestrates service elements such as physical environment, people (clients and employees) and the process of service delivery to help clients co-create their desired experiences (Teixeira, Patrício, Nunes, & Nóbrega, 2012).

Co-design is a way of integrating the consumer co-creation practice, characterized by some distinct characteristics. For Steen, Steen, Manschot and Koning (2011), co-design is critical for service design because different perspectives and a productive combination of these are necessary to understand both the demand side of a service, ie the needs of users and customers, as well as the supply side, that is, technologies and processes, in order to develop successful services. Co-creation techniques can be applied to contribute to co-design and use clients as a resource for ideas or as partners in product development or co-development (Mukhtar, Ismail, & Yahya, 2012). Although they are most commonly used in the generation of ideas and prototyping, these techniques can also be applied to contribute to the research and initial data collection with potential users. Next, we explain two techniques applied in this study: card sorting and storytelling.

2.1. Card Sorting

For Spencer (2004), card sorting is a reliable and inexpensive method for finding patterns of how users would expect to find content or functionality. It is a technique that prompts users to organize items into groups and assign categories to each group. This method can be applied in the development of new services, in an interview with visual support, that allows the user to expose their perceptions, reactions, and preferences, and to the developers to approach more the expectations for requirements and criteria of a new service.

2.2. Storytelling

Services are dynamic because the customer and the service provider influence the service experience that is co-experienced and experienced in the interaction. Services can be compared to theater, as pointed by Mossberg and Nissen Johanssen (2007), where the system functions as a performance staged: trained actors populate the stage, customers experience performance, and the backstage provides invisible support. This complexity poses challenges to designers and decision makers to visualize and prototype services. Narrative techniques, therefore, such as storytelling may be useful tools to deal with this complexity (Kankainen, Vaajakallio, Kantola, & Mattelmäki, 2012).

The storytelling technique has several advantages, such as:

- User stories are brought together to inform and inspire design. The most commonly used methods include observations, design tests, and interviews. Interpretations of user data are also communicated to be projected

through narratives such as personas and current action scenarios.

- For storytelling in service prototyping, storytelling is used as a means of formulating a design driver that facilitates the overall style and design of a service. A story serves as a liaison thread to connect various details of architecture and the design of the environment to communication, marketing, and customer experience.
- Storytelling can be used to create and manage contexts in which experiences happen. Storytelling is, therefore, a tool to create a specific image, to differentiate it from other similar services, and to create and maintain an attraction, an experience that triggers the imagination.

Authors such as Kankainen et al. (2012) point out that the storytelling technique combines the collaborative construction of scenarios and discussions in focus groups. It contributes to service design by providing different types of user information: users tell real stories about their service experiences, or users can create new service ideas and are also asked about their opinions and attitudes in a type of focus group discussion.

3. METHODOLOGY

For the application of the card sorting technique associated with storytelling, we surveyed potential users for the urban garden PSS. Considering the focus of the PSS project in the company-to-company (B2B) relationship and for condominiums focused on sustainability, we selected an apartment manager with experience of more than 5 years in the activity to understand the role of this user, their behavior and motivations, both in their professional function and in relation to the PSS proposal.

We developed seventeen cards, separated into four groups, with images illustrating varied conditions and characteristics that stimulated the development of the interview. We presented the cards to the interviewee in four steps, according to the cards of the same group, and in one each of these steps the interviewee's perceptions were collected according to the focused feature. During the application of the card sorting technique, the syndic was encouraged to talk about her impressions and memories about the images and cards, thus associating the technique of storytelling.

3.1. Card Preparation and Development

We created four categories of cards with the colors: blue, yellow, green and lilac. The group of blue letters, out of a total of three (Figure 1) sought to understand the role of the respondent in her role as a syndic of a condominium. Therefore, the cards sought to gather information about their responsibilities, how to deal with compliments/complaints, and about the condominium environment, especially green and shared areas.



[Figure 1] Cards from the first group (blue), translated (left to right): Responsibilities; Compliments; Ambience (Font: The Authors, 2019).

The yellow cards (Figure 2) aimed to capture information regarding the syndic behavior and activities, from their daily routine, but also in activities of leisure, fun, and moments of rest. We also sought to identify how the interviewee uses the technology (applications, computer, smartphone) to perform their tasks or entertainment.



[Figure 2] Cards from the second group (yellow), translated (left to right): To Relax; To Amuse; Fun; Routine; Apps and Technology (Font: The Authors, 2019).

The third group, with 9 cards in green color, aimed to obtain information that could serve as possible motivations to have an urban garden in the condominium. The cards presented aspects about sources of information (how and where the syndic seeks information), plants, floriculture, condominiums, agrochemicals, organic, urban garden, garden maintenance, and plant cultivation. This group of cards sought to verify the interest of the syndic in the cultivation and care of plants and urban garden, and to know if the proposal would be well received by the residents.



[Figure 3] Cards from the third group (green), translated (left to right):

Information Source; Plants; Flower shop; Residents, Agrotoxic; Organics; Urban Garden; Maintenance; Farming (Font: The Authors, 2019).

A final group with 4 cards in lilac color (Figure 4), aimed to obtain information about the reaction of the possible user to the proposal of the service, with information related to an automated garden, information shared among the members, commerce in the condominium (sale or exchange of organic products produced on site) and assistance provided by the company to the client.



[Figure 4] Cards from the fourth group (lilac), translated (left to right): Automated garden; Community; Trade in Apartment complex; Assistance (Font: The Authors, 2019).

3.2. DEFINITION OF THE SCRIPT FOR THE APPLICATION OF TECHNIQUES

For each stage and group of cards, a semi-structured interview script was elaborated, only to guide the beginning of the dynamic and to help the interviewee. As we presented the cards, the interviewee was allowed to explain her speech as she wished. We took notes and records throughout the application, including the order in which the syndic chose to talk about each card, which she considered more important and why. The results of the dynamics are reported in the next section.

4. RESULTS

After applying the card sorting session associated with storytelling, we verified that the individual with the role of an apartment manager could be one of the target audience of the PSS proposal, for having greater knowledge about the management of the condominium and dealing with routine activities of care and maintenance. For this, we verified that the assignee must show an interest in cultivation, to “buy the idea” and be motivated in installing such a system in his condominium, as well as “sell the idea” and also encourage the residents to join the cause.

However, we found that only the interest of the apartment manager in some cases is not enough. Residents themselves should also present a profile on these practices, primarily aimed at stimulating shared activities, using common areas of the building and willingness to implement new practices that promote urban agriculture and more sustainable and conscious habits.

5. DISCUSSION

This paper aimed to describe the application of the card sorting technique associated with storytelling in the development of an urban garden Product-Service System in condominiums with a focus on sustainability. The explanation of the techniques was carried out based on articles already published and based on the report of experience of the application of the two associated techniques. We highlight that there is no quick recipe since the technique can be adapted to each project context.

We consider the importance of broader dissemination of these techniques, especially for designers, whether for product or services. The use of more empathic techniques allows a better understanding of the perceptions and needs of potential users, which can contribute to projects that better meet customer expectations and satisfaction.

As a suggestion for future research, we recommend experimenting with these techniques in other project con-

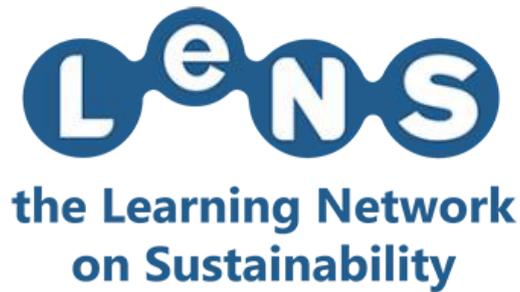
texts. In this research, we applied the technique in the form of an individual interview, but it could also be done in a focus group with more participants. Each project has different requirements, so the importance of knowing the various techniques and possibilities of application, to adapt them according to the project.

6. ACKNOWLEDGMENTS

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EMOTIONAL DESIGN IN FUNCTIONAL ECONOMY AND PSS TOWARDS BEHAVIOR CHANGE

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ABSTRACT

Despite Product-Service Systems (PSS) research being largely developed lately, applications are still limited in parts by implying changes in consumer practices. One of the main barriers is in the change of perception since some types of PSS propose the satisfaction of needs without product ownership, which highlights emotional aspects and involves a change in social behavior. This paper aims to characterize the contribution of Emotional Design in the Functional Economy and PSS. We discuss the concepts of Functional Economy, PSS and Emotional Design. We developed a bibliographic research for the definition of the theoretical background and applied the content analysis method to collect and analyze data. The results show that the contribution of Emotional Design in PSS for Functional Economy is of four distinct natures: (1) Strategies in Product Design (visceral, behavioral and reflective levels); (2) Emotional, psychological and cognitive aspects; (3) Experiences; and (4) User-centered design.

Key words: Emotional Design, Functional Economy, Product-Service System, Behavior Change.

1. INTRODUCTION

Several studies related to Product-Service Systems (PSS) have already been developed in recent years, allowing a greater understanding of the advantages, guidelines and barriers of their global implementation (Afshar & Wang, 2011; Mont, 2002), but their applications are still limited, in parts by counteracting current consumer practices and implying changes in the society behavior. For consumers, one of the main barriers is in the change of perception, since some types of PSS propose the satisfaction of needs by using products without ownership (Demyttenaere, Dewit, & Jacoby, 2016). Buclet (2005) considers that the transition to a Functional Economy, focused on the function and not the possession, cannot be done without a behavior change, especially of the consumer, while Vezzoli, Ceschin, Diehl and Kohtala (2015) consider the importance not only of new models of production and provision of services but also the redesign of patterns of consumption and lifestyles.

These changes can present challenging implementations and not be accepted by the consumers, as they are contradictory to the culture of consumption of the industrial society, which links wealth and well-being with the consumption and accumulation of products (Afshar & Wang, 2011). Besides, this shift in focus introduces a new relationship between consumers and products, since in some cases the user is no longer the legal owner of an artifact. The possession of a product can generate an attachment on the part of the user, which creates an emotional bond with objects, resulting in behaviors that stimulate their responsibility with that artifact (Demyttenaere, Dewit, & Jacoby, 2016; Baxter, Aurisicchio, & Childs, 2015). Norman (2004) points out that there are three levels of Emotional Design: visceral, behavioral and reflective. They can be considered to understand the objectives of consumers and users, helping them to understand their journey by consuming products and/or services, as well as providing a structure to be used by designers in the design of new services that can promote, even partially, the dematerialization of the consumption of physical artifacts (Costa & Santos, 2016).

Thus, this article aims to characterize the contribution of Emotional Design in Functional Economy and Product-Service Systems as a way to enable behavior change. This study aims to show the relevance of Emotional Design for sustainable development, in environmental, economic and social aspects, for the possibility of promoting behavior change for more sustainable habits and in the transition from an industrial-based economy focused on the consumption of material goods, to an economy focused on the offer of functionality and value in use.

2. THEORETICAL BACKGROUND

2.1. Functional Economy and Product-Service Systems

For Stahel (1997), Functional Economy proposes to optimize the use or function of the goods and services and contribute to a better resource's management. Economically, it aims to create the highest use value possible, for as long as possible, while consuming the least amount of resources and energy. One of the main issues of the Functional Economy is the transition from an industrial economy geared to the production and sale of goods and material goods to an economy and a new consumption model centered on services and functions, where products are only means to provide functions and satisfaction (Buclet, 2005; Stahel, 1997). This involves moving to an immaterial economy, which considers intangible resources such as trust between the actors and new skills involved. Also, Functional Economy proposes a new model of consumption and disruption in the way consumer and supplier relationships are considered (Huet & Choplin, 2012).

A concept that can be related to the Functional Economy is the Product-Service Systems (PSS), characterized by the sale of the use of a product instead of the product itself, in a system of products, services, networks of actors and supporting infrastructure that seeks to meet consumer needs and remain competitive, with fewer impacts than traditional models (Mont, 2002). Thus, we can relate it with the Functional Economy, in which the user pays for the use of the solution or the function of the product, and not for its ownership. Tukker (2004) proposes three types of PSS, differentiated between them by the property issue: (i) product-oriented - ownership remains with the consumer and the provider sells additional services; (ii) use-oriented - the ownership is the provider's, and the consumer's rights of use are sold; (iii) results-oriented - the functions of the product are sold, which meet directly the demands of the consumer. In these definitions, the issue of commercial transactions is not the delivery of goods and/or services, but the production of value-for-use (Gidel, Huet, & Bisiaux, 2016).

For Vezzoli, Kohtala and Srinivasan (2014), PSS are design strategies for sustainability, which aim to integrate a system of products, services, and communication based on new forms of organization and reconfiguration of the roles of consumers and other stakeholders, with medium and long-term sustainable objectives. In this context, the design process should broaden its approach, not only considering functional issues, but also terms of satisfaction and emotional aspects, shifting the focus of a product to a broader system that satisfies a specific demand (Vezzoli, Kohtala, & Srinivasan, 2014).

2.2. Emotional Design

Emotional Design is a field that emerged in the international Design scene in the late 1990s. For Norman (2004), Emotional Design consists of projecting beyond the mere functional performance, exploring the relationship between the logical and emotional aspects of a product, considering usability and emotional appeal issues (Beltagui, Candi, & Riedel, 2012). Although Emotional Design is more addressed in Product Design projects, services involve

more emotional contact points, because of the higher and more frequent interaction with clients (Beltagui, Candi, & Riedel, 2012). Therefore, the importance of positive experiences of use should be considered to fully satisfy the consumers' functional and emotional demands (Demyttenaere, Dewit, & Jacoby, 2016).

In his studies on emotion, Norman (2004) suggests that human behavior results from three different levels of brain processing, each playing a specific role: visceral, behavioral, and reflective. The first level, visceral, is automatic and immediate. Related to direct perception, it is responsible for quick judgments of what is bad or good, dangerous or safe, and sends signals to the motor system and alerts the rest of the brain, initiating affective processing. The second level corresponds to the part that controls the processes of daily behavior and learned responses, called behavioral. It is where most human behavior is concentrated, and its actions may stimulate or inhibit the lower (visceral) layer, but at the same time, it also has its actions stimulated or inhibited by the above layer. The highest layer is that of reflective thought, the contemplative and conscious part of the brain. What Norman (2004) proposed is that these three levels correspond to three different design strategies: design for appearance (visceral); design for comfort and ease of use (behavioral); design with reflective (reflective) meaning. These three levels influence human behavior and can be considered in the development of projects, for marketing and use of products.

Vezzoli, Kohtala, and Srinivasan (2014) relate the concept of product attachment to Norman's (2004) reflective level of Emotional Design since this link between product and user can be created by memories, positive emotions, and special meanings at the reflective level. Norman (2004) also considers that people create attachments to artifacts that have a significant personal association, but mainly if they refer to moments of pleasure, satisfaction, and comfort. In some cases, an attachment may not necessarily be with an object, but with the meanings and feelings it represents. Baxter, Aurisicchio and Childs (2015) consider the concept of psychological ownership, in which there is an attachment without necessarily having the physical possession, that can occur with shared objects or abstract feelings.

For Demyttenaere, Dewit, and Jacoby (2016), the feeling of being emotionally attached to an object causes the consumer to postpone their substitution and take better care of the object. These authors consider the importance of adding special meanings to new PSS models, including in their design emotional and non-purely functional characteristics, and stimulating recurrent interactions, so that attachment is also present between a consumer and an PSS, even if as a temporary attachment (Demyttenaere, Dewit, & Jacoby, 2016). For Zhou, Ji, and Jiao (2012), by incorporating affective and cognitive needs that can be described as perceptual user preferences, designers can enhance and increase the added value of experience (Zhou, Ji, & Jiao, 2012).

Lilley (2009) considers that design can be used to influence users' behavior towards the adoption of more sustainable practices. Identifying and evaluating the use of a product, as well as the designer's intentionality in designing new products, can prevent potential or predictable consequences resulting from misuse. For Beltagui, Candi, and Riedel (2016), PSS designers are increasingly recognizing and signaling the importance of emotion in projects. Companies can no longer rely solely on the provision of core products as a way of delivering superior value but should consider mastery of the management of consumer experience by creating long-term emotional links through the co-creation of memorable experiences involving a set of goods and services. Beltagui, Candi, and Riedel (2016) point out that memorable experiences have the potential to create an emotional bond and encourage the consumer to become loyal, which is why it is vital to design services that offer symbolic and emotional value. To this end, these authors consider the importance of a service economy with a focus on experience, and even an experience economy.

Beltagui, Candi and Riedel (2016) also consider that to understand services and experiences one must understand a change in the perception of the concept of value. Value can no longer be understood as created by companies and consumed by customers, but it is co-created when the resources of consumers are combined with the value propositions of the companies, to form an experience. These authors believe that services should be co-created with consumers, resulting in experiences that are unique to each customer (Beltagui, Candi, & Riedel, 2016).

3. METHODOLOGY

The methodology conducted in this study was based on bibliometric research for an initial survey of scientifically indexed publications, followed by systemic analysis to identify the authors to form the theoretical background. For data analysis, we used the categorical and thematic analysis based on the content analysis method from Bardin (2011).

The preliminary bibliographic survey was carried out based on bibliometric research, suggested by Ensslin, Ensslin and Pinto (2013), to deepen studies in the area and verify the state of the scientific production, through a process that allows a search for relevant articles, besides finding the more cited authors in the field.

The analysis techniques adopted were based on the categorical and thematic analysis, based on the Content Analysis method and the contributions from Bardin (2011). Content analysis consists of an empirical and mixed method, involving quantitative and qualitative approach. The quantitative analysis essentially considers the frequency of certain elements in the content, while the qualitative analysis focuses on the presence or absence of a characteristic in a message fragment. It aims at inference, through interpretive attitudes based on raising evidence and indicators, supported by a technical validation framework (Bardin, 2011).

Content analysis process can be detailed in three stages: pre-analysis, content exploitation (categorization) and results analysis. The first phase, of pre-analysis, consists in organizing the material. In this research, it consisted of the collection of documents and the critical reading that helped in the article's selection.

The phase of content exploitation consists of a categorization, which is subdivided into 4 groups:

- Context Categories: encompasses the content, as they are broader and related to the research objectives;
- Analysis Categories: subdivision of context categories into smaller parts to allow the analysis;
- Registration Units: words/word that explain the category of analysis;
- Context Units: phrase or fragment that explains the registration units.

In this research, to assist with defining the categories analysis and the registration and context units, we conducted a quantitative and qualitative analysis for each of the selected references from the theoretical background. The quantitative analysis was carried out by determining the five most frequent words present in each article, thus identifying the most cited words in all articles. Next, we carried out a qualitative analysis based on reading the documents, considering expressions in common which did not necessarily appear in the word frequency. The words and expressions resulting from the quantitative and qualitative analyzes, were grouped considering frequency, as well as associations and equivalences. After this grouping, we set out to define the analysis categories, based on the definition of the registration units and context units (words that explain the analysis categories). We made several groupings and exclusions, considering that the final categories come from the progressive regrouping of categories with a weaker generality and that a good set of categories should have the qualities: mutual exclusion; homogeneity; relevance; objectivity and fidelity and productivity (Bardin, 2011).

Considering the objectives of this research, we defined Emotional Design as main the Context Category, since it's the broader expression that encompasses the whole content. The final categories are shown in the Results section.

4. RESULTS

After the definition of the final Categories, we were able to perform the results analysis. We compared the defined Analysis Categories with the Functional Economy and PSS literature, thus being able to suggest strategies for PSS in the Functional Economy that consider Emotional Design in their conception and development. Based on this analysis, we understand that the contribution of Emotional Design to Functional Economy and PSS is of four distinct natures: (1) Strategies in Product Design (visceral, behavioral and reflective levels); (2) Emotional, psychological and cognitive aspects; (3) Experiences; and (4) User-centered design.

- 1). The three Emotional Design strategies (visceral, behavioral and reflective) suggest by Norman (2004) should be considered because they contribute to incorporate not only aesthetic and functional aspects but also user's emotional aspects. Although the visceral level is significant, allowing a first response to the attributes of design, we consider that the behavioral and reflective levels of Emotional Design can contribute to propose conditions of emotionally pleasant and positive experiences, as an alternative to fill the lack of property (Vezzoli, Kohtala, & Srinivasan, 2014).
- 2). Addressing the emotional, psychological and cognitive aspects, Emotional Design can contribute to the satisfaction of needs and desires (Norman, 2004) when offering a proposal of psychological possession, and not necessarily physical (Baxter, Aurisicchio, & Childs, 2015). Also, temporary ownership can result in greater flexibility for users, according to the type of PSS (Tukker, 2004). The Functional Economy proposes a new consumption model (Huet & Choplin, 2012), and Emotional Design can encourage the change of consumer behavior by emphasizing aspects of flexibility, reduce costs, maintenance and after-use solutions.
- 3). Emotional Design also presents its role by focusing on experiences, where Functional Economy solutions offer complete services that meet the demands (Beltagui, Candi, & Riedel, 2012). Focusing on positive and differentiated usage experience (Zhou, Ji, & Jiao, 2012) can provide better consumer satisfaction by offering a complete package of solutions that the user would not find or would not have their needs fully met just by purchasing a product.
- 4). At last, Emotional Design also contributes to show the importance of including the user, in a process of co-creation of new solutions of Functional Economy and PSS (Beltagui, Candi, & Riedel, 2016). By applying a user-centered Design, designers are provided with more information to contribute as one of the stakeholders in the network of stakeholders. Besides, the existence of a well-established network of partners contributes to complementing their skills and offering a complete solution. Table 1 shows the summary of the results of the analysis.

[Table 1] Analysis of Strategies for PSS in Functional Economy based on the Emotional Design Analysis Categories

ANALYSIS CATEGORY	REGISTRATION UNITS	PSS STRATEGIES IN THE FUNCTIONAL ECONOMY
Product Design Strategies	Visceral Design	Visceral appeal perceived in the first contact, not only in the design of the products involved in the PSS but also in the other supports.
	Behavioral Design	Meet the functionality demand not only in the products involved but in all the artifacts that make up the PSS.
	Reflective Design	Allow awareness and contribute to users with more conscious habits. Feelings of accomplishment when using cleaner models. New status, modernity related to awareness.

Emotional, Psychological and Cognitive Aspects	Needs and Desires	Seek to meet the demand when solving the need (ex.: mobility, practicality, results). Desires may vary according to culture, country, age group (young people more flexible and open to new proposals).
	Psychological Ownership	Ownership is temporary and occurs at the level of shared objects. Encourage users to take care of artifacts not only to allow use by other users but also because they can use again, also allowing customer loyalty.
	Consumption Behavior	PSS proposals should encourage users to change their attitudes and propose new consumer behaviors. Offer advantages and differentials such as savings, flexibility.
	Attachment	Attachment does not have to be by ownership and physical attachment, it can be the result of an experience and a felt emotion when using a PSS, creating a user bond with the brand.
Experiences	Emotional and functional aspects	Provide positive experience addressing the functional aspects related to needs (mobility, practicality, results). Also consider emotional aspects (safety, comfort, flexibility, happiness).
	Products + Services	In PSS, experiences are felt by the combination of the Product + Service Systems, which can be in three modalities: Product Oriented; Use Oriented; Result Oriented.
	Added value	Complete solutions that offer beyond the obvious, not just the use of a PSS, all the supports also uphold the offer.
User-centered Design	User evaluation	User participation in the development process. Meet the interests expected by the individual, to be well evaluated by him, besides offering feedback and constant implementations.
	Stakeholder Network	Partner network working together to deliver customer satisfaction. Multidisciplinary team.

As indicated in the table, each category points out strategic approaches that aim to consider Emotional Design in the design of new PSS. Thus, it can contribute to a change in consumer behavior concerning product acquisition, by proposing new functional and emotional experiences which maintain attachment, even if temporary and psychological, but also bring more conscious and sustainable attitudes.

5. DISCUSSION

This paper aimed to characterize the contributions of Emotional Design in the Functional Economy and PSS. Based on the definition of the analysis categories, performed through the content analysis method, we understand that the contribution of Emotional Design to Functional Economy and PSS is of four distinct natures: (1) Strategies in Product Design (visceral, behavioral and reflective levels); (2) Emotional, psychological and cognitive aspects; (3) Experiences; and (4) User-centered design.

We understand that Design has the potential to contribute to people's behavior change, especially in promoting attitudes that allow more conscious and sustainable consumption. One of the strategies that can be used is Emotional Design. The change in user behavior in adopting more sustainable practices can come from the experiences felt in the PSS, which, even offering temporary ownership, are capable of allowing an emotional bond. They show us that it is possible to maintain the emotional attachment without physical ownership and products purchase, and still be able to offer a memorable experience that satisfies the users' needs and can allow consumer loyalty. By applying these concepts in PSS projects, they can contribute to the adoption of more sustainable practices by consumers and users, besides contributing with the generation of complete solution that offer added-value experience to consumers.

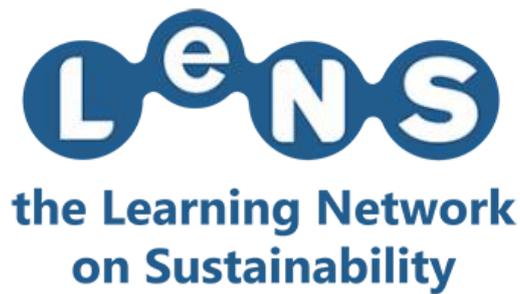
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SOUTH-TO-SOUTH SOLUTIONS: AN EXCHANGE OF AUSTRALIAN AND LATIN AMERICAN DESIGN APPROACHES TO THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS

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ABSTRACT

This paper reports on the Design-for-Sustainability (DfS) approaches practiced in Australia, Brazil, Argentina, Colombia and Peru to help achieve the United Nations Sustainable Development Goals (SDG). The study is part of a project funded by the Council on Australian Latin American Relations (COALAR) titled 'South-to-South: activating Australian Latin American Cooperation through Sustainable Design Education', which is a collaborative endeavour of DfS educators from 8 universities in the above-named countries. The current phase of the project involves an initial collection of 60 case studies of products, services and systems that deliver positive impacts to society, the environment and the economy in the Australia and Latin America. The SDG case studies will be shared, discussed and built on during the upcoming LeNS South-to-South educators' symposia, students' workshops and research collaboration dialogues.

Keywords: Design for sustainability; United Nations Sustainable Development Goals; sustainable solutions.

1. INTRODUCTION

Apart from experiencing seasons opposite to those in the Northern Hemisphere, countries in the Southern Hemisphere share many similarities in the sustainability challenges that they face. Containing some of the largest countries in the world both by area and by population, the Southern Hemisphere also has countries which have the world's largest biological capacity reserves to regenerate renewable resources and to absorb wastes.

This paper reports on the Design-for-Sustainability (DfS) approaches practiced in Australia, Brazil, Argentina, Colombia and Peru to help achieve the United Nations Sustainable Development Goals (SDG). The study is part of a project funded by the Australian Government's Council on Australian Latin American Affairs (COALAR) titled 'South-to-South: activating Australian Latin American Cooperation through Sustainable Design Education', a collaborative endeavour of DfS educators from 8 universities in the above-named countries. Participants are also members of the LeNS (Learning Network on Sustainability), an association of DfS educators from 125 higher-education institutions in 27 countries, working to diffuse sustainability capacity through innovative curriculum development.

The current phase of the project involves an initial collection of Australian and Latin American case studies of products, services and systems that deliver positive impacts to the society, the environment and the economy in the Southern Hemisphere. This SDG case study collection will be disseminated, shared, discussed and built on during the upcoming LeNS South-to-South educators' symposia, students' workshops and research collaboration dialogues.

The South-to-South project is ongoing, and its progress will be presented during the LeNS World Conference.

2. CASE STUDIES

Sixty case studies were collected and categorized according to the 17 global goals which they contribute towards. Due to space constraints only a sampling of the cases are presented below.

2.1 SDG 1: No Poverty

Despite being amongst the world's 20 richest countries, Australia has a homelessness problem, with over 13,700 'rough sleepers' who live on the streets, sleep in parks, squat, stay in cars, or live in makeshift dwellings (AIHW, 2018). The 'Backpack Bed' from the Melbourne-based social enterprise Swags for Homeless Ltd is an attempt to give dignity and emergency relief to people who are sleeping rough. This weatherproof tent with padded mattress, made of lightweight street-tough material, offers full-body protection year-round against mosquitoes and winter chills. It has lockable storage pockets for valuables and can be easily rolled-out then rolled-in to a rucksack after use.

2.2 SDG 2: Zero Hunger

In 2004, OzHarvest Ltd was launched in Sydney to stop the food from the hospitality industry going to waste and to redistribute them to people in need; it thus became Australia's first food rescue organisation. Now partnered with over 3,500 food donor businesses nationwide, OzHarvest collects perishable surplus food and delivers it directly and free-of-charge to over 1,300 local charities (OzHarvest, 2017). Their food rescue vans collect fruit and vegetables, meat, cooked meals and prepacked vacuum items, dry goods, cakes and baked goods, drinks, dairy and eggs, as long as they're still safe to consume and in good condition. In 2017, it opened Australia's first surplus food supermarket, the OzHarvest Market in Sydney, based on a 'take what you need, give if you can' philosophy, making the food available to those having difficulty in making ends meet.

The City of Curitiba in Brazil's south is internationally acclaimed as a world leader in urban sustainability. It has been running its 'Câmbio Verde' (Green Exchange) initiative since 1991. Catadores (informal waste pickers) wheel their carts of salvaged recyclables, plastic bags and used cooking oil to the trash collection centres and trade these for fruit, vegetables or eggs: 4 kg of recyclables buys 1 kg of fresh produce. About 10,000 catadores participate in this program to earn their living; however other Curitiba residents can also access this 'trash-for-food' exchange service. Câmbio Verde helped reduce the litter from waterways as well as the incidence of mosquito-borne diseases.

2.3 SDG 3: Good Health and Well-being

When Australia's Royal Flying Doctors Service (RFDS) began its operations in 1928, it became the world's first air ambulance. Ninety years later, it has become one of the largest and most comprehensive aeromedical response organisations in the world, providing emergency and primary health care services for people in rural, remote and regional Australia. In 2018, with its 71 aircraft and 124 healthcare vehicles in 23 air bases, the RFDS doctors, dentists and nurses travelled 27 million km to deliver vital health services and transport 113,375 patients by air and road; provide 21,828 dental care episodes; conduct 16,209 clinics; and provide 88,188 telehealth consultations.

From 7 am to 2 pm on Sundays and public holidays, over 120 km of Bogotá's main roads are temporarily closed off to private cars and opened only to cyclists, runners, skaters, pedestrians and public transport. Known as the Ciclovía (Cycleway), this Bogotá tradition started in 1974 and approximately 2 million people participate weekly. An offshoot of the Ciclovía is the Recreativa (Recreation), wherein aerobics and yoga instructors and musicians engage the people in the car-free streets in dancing, physical exercise and sports activities. Bogotá's Ciclovía as an approach to engage the public in weekly fitness and health activities in pedestrian- and cyclist-priority city streets has been replicated in many other municipalities and cities in Latin America.

2.4 SDG 4: Quality Education

In 1951, the School of the Air at Alice Springs broadcast its first lessons by two-way radio to students in the vast Australian outback. Using a transceiver, teachers in major inland towns discussed the mailed-in learning materials with the remote primary and early secondary students. After the one-hour lesson on air, the students work through their assignments with their parents or older siblings, which will be submitted to the teacher by post or via the Royal Flying Doctor Service. Almost 70 years later, over a dozen more branches have opened in other regional towns, and the School of the Air continues to help geographically dispersed learners reduce their educational disadvantage. Just like in a physical classroom, there is daily contact between students, home supervisors and teachers, but remotely through the constantly evolving technologies for distance communication; often the school serves as the remote student's avenue for socialization outside their family. Covering an area greater than 1.3 million square kilometres, the School of the Air has been dubbed as 'the world's largest classroom'.

2.5 SDG 6: Clean Water and Sanitation

Australia is the driest inhabited continent on Earth, with 70% of the land surface desert to semi-desert. Water resources are scarce, so in 1989, Australian sanitaryware manufacturer Caroma Industries Ltd patented the 'dual-flush' toilet to cut water usage in half compared to traditional toilets. Dual-flush toilets are now mandatory for all new buildings in Australia and are exported to over 30 countries worldwide.

2.6 SDG 7: Affordable and Clean Energy

The Australian Government's Small-scale Renewable Energy Scheme offers householders and small businesses financial incentives to purchase and install solar photovoltaic (PV) panels, wind turbines, hydro systems, solar water heaters, and air source heat pumps. As a result, more than 2 million Australian homes have rooftop solar, with an average of 6 panels being installed per minute (Clean Energy Council, 2018). Rooftop solar work like decentralized mini-power stations and help reduce demands on the electricity network.

2.7 SDG 8: Decent Work and Economic Growth

The Brazilian social enterprise Escama Studio social enterprise produces are bags, jewellery, belts and over-garments, hand-crocheted by local artisan women from underprivileged communities, using mostly of 100% post consumer aluminium-can pull-tabs supplied by recycling centres in the neighbourhood. The hangtag of each product bears the photo, bio and signature of its artisan (www.escamastudio.com).

In Peru, the 'ponchila' – a backpack ('mochila') with a built-in poncho – represents a community attempt to redirect plastic packaging away from landfilling or ocean dumping. Citizens were invited to return their plastic bottles for recycling; in 2017 the collection produced 6,000 ponchilas, each being made from 80 PET bottles. In the hope of reducing school dropouts, the ponchilas were handed out to poor children in the Andes who travel to school in often inclement weather.

2.8 SDG 9: Industry, Innovation and Infrastructure

In 1988, the Reserve Bank of Australia issued the world's first polymer banknote as currency, a commemorative 10 AUD note. Co-developed with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the University of Melbourne, the polymer banknotes were developed to combat forgery. The polymer banknote had see-through panels and embedded holograms as anti-counterfeiting features; they were also more durable, more environment friendly, and less likely to carry dirt and disease. In 1996 all Australian banknotes switched to plastic and now more than 50 countries use polymer banknote technology on more than 150 denominations.

2.9 SDG 10: Reduced Inequality

In 2014 Orange Sky Australia – the world's first free mobile laundry service for the homeless – was launched in Brisbane. A van fitted out with two large washers and dryers, an electricity generator and water tanks, to visited homeless hotspots, offering free clothes washing services. By 2017 Orange Sky had 17 vehicles around Australia, and completed 34,508 loads of washing for the homeless. Through these actions, the homeless are given dignity and respect apart from the clean clothes.

2.10 SDG 11: Sustainable Cities and Communities

Curitiba is highly-regarded a world leader in public transportation innovation. Their success in this area is mainly due to the bold and visionary political leadership of Jaime Lerner, who served as its mayor for three terms. In 1974 Lerner pioneered the first-wide scale use of the Bus Rapid Transit (BRT) concept, which is like a 'surface subway', consisting of dedicated bus lanes with fast and frequent services, and enclosed transit stations with platform-level boarding and pre-boarding fare payment, essentially emulating the performance and amenities of high-capacity railways but at a fraction of the cost. In 1992 Curitiba became the first city to use 'bi-articulated buses', which are triple-length buses with two linked trailer sections that can carry up to 270 passengers and equipped with five doors to enable passengers to quickly enter and exit; these features allow the city to move a ridership of 10,640 passengers per hour per direction in its 7 BRT corridors of busways totalling 74 km. The Linha Verde (Green Line), opened in 2009, have buses running on 100% soybean biofuel while the Interbairros 1 (Inter-neighbourhood) line have been using hybrid diesel-electric buses since 2012. A uniform 'tarifa social' (social fare) is charged regardless of distance or transfers made; thus the shorter journeys subsidize the cost of the longer journeys of the low-income residents who

live further away, making the system accessible to all. With 70% of Curitiba's population commuting via the BRT, the city enjoys the cleanest air amongst the large Brazilian cities, largely due to its BRT. To ensure the fleet remains clean, safe and comfortable, BRT buses are retired after 3 to 4 years and repurposed into mobile libraries, job skills training classrooms, soup kitchens, health clinics, and day-care centres that are free for low-income citizens.

Curitiba's achievements and experience inspired many cities in Latin America and other developing countries to adopt BRT as a mass mobility option to move large volumes of passengers at high speeds and with low infrastructure cost. To date, 55 cities in 13 countries in Latin America have 171 BRT corridors spanning 1,816 km and moving 20,506,977 passengers per day (www.BRTdata.org).

The City of Medellín, once feared for being the most dangerous place on earth, is now celebrated for their many transport innovations, including the Metrocable gondola lift system. Intended to provide affordable mobility to the informal settlers living on the steep hills surrounding the city, this is the world's first cable-propelled system dedicated for urban public commuting. Inaugurated in 2004, the Metrocable has been carrying 30,000 people daily.

2.11 SDG 12: Responsible Consumption and Production

The REDcycle program is a national retailer-operated initiative to recover soft plastics from consumers, with collection bins placed outside Australia's largest supermarket chains, Coles and Woolworths. The collected plastic bags are processed by Replas Products Pty Ltd into various recycled-plastic products, including outdoor furniture, bollards and signage. Since REDcycle Pty Ltd started in 2011, over 542 million pieces, or 2.1 tonnes, of flexible plastic have been prevented from getting into landfill, the beaches or the waterways.

Boomerang Bags is a grassroots community initiative which offers an alternative to plastic bags by providing durable fabric bags for shoppers to use for free. Community groups come together to sew bags out of donated or found material. These bags are made available in shopping centers and the public are encouraged to take a bag and return it (like a boomerang) when they are finished with it. Started in 2013, the Boomerang Bags movement has since grown to 860 communities worldwide, with 205,603 fabric bags created. The movement hopes to shift society's throw-away mentality towards repurposing and reuse. In South America there is a Boomerang Bags group in Rio de Janeiro.

In Repair Cafés volunteer repairers meet up to help their neighbours fix their bikes, clothing, appliances and other broken household goods. Grounded on their slogan – 'Throw out? No way!' – patrons and volunteers at Repair Cafés attempt to extend and optimize the useful life of possessions and delaying their final disposal into the environment. First established by Martine Postma in Amsterdam in 2009, the Repair Café model can now be found in over 1500 sites in more than 30 countries (Postma, 2013). There are currently at 30 Repair Cafés around Australia and 3 in New Zealand; in South America they are found in Santiago de Chile, and in Porto Alegre and Santos in Brazil.

MobileMuster is the product stewardship initiative of the Australian mobile phone industry, voluntarily funded by all of the major handset manufacturers and network carriers. MobileMuster accepts for recycling all brands and types of mobile phones, batteries, chargers and accessories, without charging any fees. Its extensive collection network provides 3,500 public drop off points at post offices, mobile phone retailers and other shops, workplaces, schools, local councils, and repair stores and service centres, as well as a free post-back option. Since its launch in 1998, MobileMuster has collected and recycled 1,412 tonnes of mobile phone components (AMTA, 2018).

'Clean Up Australia' was the idea of Ian Kiernan, after he was appalled by the pollution and rubbish in the oceans while yachting around the world. In 1990 Kiernan launched 'Clean Up Australia', and 300,000 volunteers turned up. The first Sunday of March was designated as 'Clean Up Australia Day', and the movement has become the largest community-based environmental action in the country. Every year, Clean Up Australia publishes 'The Rubbish Report', which provides a snapshot of the types of rubbish collected on the day. This information was used to advocate for container deposit legislation, after seeing that the PET bottles, glass bottles, and aluminium cans are consistently in the top 10 items found (CUA, 2017). In 1993, with the support of the United Nations Environment Program, Kiernan launched the international campaign 'Clean Up the World' and this is now held every 3rd weekend of September worldwide; over the last 25 years, 35 million people have joined in the effort, in 48,792 environmental projects in 130 countries. The Clean Up the World movement proved that this simple Australian idea has enough universal appeal to mobilize millions of people around the globe to take responsibility for their own environment.

2.12 SDG 14: Life Below Water

The Return Unwanted Medicines (RUM) Project is an Australian Government funded scheme that enables community pharmacies to retrieve unwanted and out of date medications from consumers without any cost. Unwanted medicines pose the danger of being misused, abused, or pose harm to children. They are often also thrown into the bin or disposed down the sink or toilet, which could endanger marine life. The RUM Project minimizes these social and environmental consequences and destroys the medicines by high temperature incineration.

2.13 SDG 16: Peace and Justice Strong Institutions

License plate theft is on the rise in Australia. In Victoria alone, the number of vehicle registration plates stolen has risen from 16,075 in 2016 to 21,000 in 2017, a 40% increase (CCPU, 2018). Offenders use the stolen plates to mislead authorities when committing petrol theft, drug trafficking, burglary, robberies, ram raids, and toll evasion. To combat this, State Police departments in Australia regularly conduct 'Operation Safe Plate Day', in which mo-

torists are provided with tamper-resistant one-way screws to replace the regular screws on their number plates. Once these security fasteners are installed over the vehicle registration plate and tightened, they can only be removed at the local Police station or through authorized mechanics.

Midnight Basketball Australia as a national 'harm prevention' charity whose social-inclusion programme combines team sports, education and civic participation to develop skills, confidence and work readiness. Through high-energy, fun and engaging community-based activities, 'at risk' youth aged between 12 to 18 are steered away from the cycle of disadvantage and coached to identify and embrace positive opportunities and pathways in their lives and in their community. Volunteers engage the youth in free tournaments on Friday or Saturday nights for 8 weeks, which includes a hot nutritious dinner, compulsory life skills workshops, basketball games from 7:30 pm until midnight, and a bus ride home. Midnight Basketball's motto is 'No Workshop, No Jump shot'. Workshop topics include nutrition, wellbeing; substance misuse, self-harm; anger management; decision making; self-esteem; and financial literacy. Since its launch in 2007, Midnight Basketball Australia has involved over 80,000 teenagers in 13 cities in 5 states. This initiative is based on the Midnight Basketball model in the USA from the late 1980's, where it has been successful in keeping youth out of trouble and off the streets and giving them a positive outlet away from drugs and crime (Hartmann & Depro, 2006).

2.14 SDG 17: Partnerships to achieve the Goal

The C40 Cities Climate Leadership Group is a partnership amongst 90 large and engaged cities worldwide, where 650 million people live and collectively contribute to one quarter of the global economy. C40 cities commit themselves to bold climate-related actions locally amongst their citizens so as to have meaningful positive results in the global climate. Twelve cities in Latin America and 3 in Oceania are amongst the C40 cities. Acknowledging that cities use up over two-thirds of the world's energy and generate 70% of global CO2 emissions, C40 governments agree to facilitate the reduction of carbon emissions and optimizing energy consumption in their cities.

The Australian Government's Council on Australian Latin American Relations is supporting the LeNS South-to-South project, wherein Design-for-Sustainability (DfS) educators from Australian and Latin American universities belonging to the Learning-Network-in-Sustainability (LeNS) will jumpstart collaborative relationships in DfS education and research and share expertise and experiences in a two-way knowledge exchange.

3. DISCUSSION & CONCLUSION

The 60 case studies in this collection show strong evidence that Australia and Latin America are hotbeds of sustainable innovations that have strong potential to address the various targets and indicators of the UN Sustainable Development Goals within our regional contexts.

Some solutions show direct transferability to other countries, almost like plug-and-play. Typically, within the same cultural region, the innovation might require little modification to fit, and sometimes transplanting the idea from developing world to developed world (or vice versa) could require more tweaking and deliberate adaptation to be acceptable to the new context. At the same time history shows that many excellent solutions have been transplanted into completely different cultural scenarios without much change in form, perhaps due to the universal applicability of the innovation. For instance, AirBnB, Uber, carsharing, bike-sharing and social media platforms exist in virtually the same form anywhere in the world.

Curitiba's Bus Rapid Transit has become the model for many modern BRT systems not only in Latin America but in other regions: TransJakarta, which is Asia's first BRT and currently the world's longest, is a case in point. Bogotá's long-running Ciclovía-Recreativa has inspired other cities worldwide to hold special weekend events that promote 'fun runs', walkathons, cycling, dancing or 'street parties' in car-free streets. Versions of Medellín's Metrocable gondola lift can now be seen in Caracas, La Paz, Mexico City, and Bogotá. The 'Clean Up Australia' movement has scaled up to 130 countries and became 'Clean Up the World'.

Showcasing innovations can help inspire design thinkers, changemakers, and policymakers with rather uncommon approaches that have worked well elsewhere. Doing so can provide a meaningful starting point, or perhaps an 'emulation point', for deeper rethinking and for local recontextualization.

Albert Einstein is often quoted as having said that 'we cannot solve our problems with the same thinking we used when we created them'. Indeed, solving the grand challenges of the UN Sustainable Development Goals demands radical thinking to generate revolutionary ideas, rather than evolutionary thinking which would only yield incremental ideas. Innovators are often challenged to think outside-the-box in order to arrive at a completely novel idea, and this often difficult for the uninitiated. Naysayers insisting that 'there's nothing new under the sun' discourages one from thinking harder. Looking elsewhere, especially by learning from the imaginativeness of cultures different from our own, can be very stimulating, helping reboot our thinking and stirring us to reframe our problem using a new set of lenses.

Behavioural and cultural change are often required to implement radical breakthrough solutions in the community, and innovators can often avoid resistance and facilitate acceptance by codesigning the solutions with stakeholders and involving them intensively from the very start. But there are always exceptions to rules. Jaime Lerner wasn't consultative when he first pedestrianized Curitiba's main street almost overnight. Instead he just did it.

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DESIGN AND SUSTAINABILITY: SYSTEMATIC REVIEW OF LITERATURE IN BRAZILIAN PHD THESES

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ABSTRACT

Several processes were developed to design products, services and, more recently, more sustainable systems in the last decades, as well as studies for a transition to less aggressive lifestyles to the planet. Although there is already a certain amount of research in this field, specifically in PhD programs, there are few ones. Thus, the aim of this study was to investigate sustainability approaches in design's PhD theses in Brazil. For that, a systematic review of literature of Design and Sustainability's theses in the Industrial Design field was performed at Coordination of Improvement of Higher Level Personnel [CAPES]' data basis. As results, to understand the state of the art of PhD theses regarding Design and Sustainability in Brazil, contributing to the identification of knowledge gaps, mapping their main types and applicability, besides fomenting new PhD studies.

Key Words: Sustainability; Design; Systematic Bibliographic Review; PhD

1. INTRODUCTION

The population's augmentation coupled with the fast growth of economies and the withdrawal of resources from the planet has brought the sustainability discuss to the center of the researches. Design, historically linked to industrial production, has addressed sustainability with a variety of methods, from the redesign of existing products to the proposal of new lifestyles (Manzini & Vezzoli, 2002).

Several processes were developed to design products, services and, more recently, more sustainable systems in the last decades, as well as studies for a transition to less aggressive lifestyles to the planet. Although there is already a certain amount of research in this field, specifically in PhD programs, there are few ones.

PhD researches are developed in the long term, being able to obtain more accurate results. Based on this finding, the aim of this study was to investigate sustainability approaches in design's PhD theses in Brazil. For that, a systematic review of literature of Design and Sustainability's theses in the Industrial Design field was performed at Coordination of Improvement of Higher Level Personnel [CAPES]' data basis, since it is the foundation that plays a key role in the expansion and consolidation of stricto sensu postgraduate courses in the country, subordinated to the Ministry of Education. Twenty-one theses were found between 2009 and 2018. Qualification criteria were those that focus on new approaches, strategies, methods and tools to enable the development, implementation, diffusion and dissemination of sustainability for all. As a result, it is intended to understand the state of art of these theses in the country, contributing to the identification of knowledge gaps, mapping its main types and applicability, besides fomenting new PhD studies.

1.1. Research question

How do design's PhD theses in Brazil address the theme of sustainability?

1.2. Goals

- To investigate sustainability approaches in design's PhD theses in Brazil;
- To understand the state of art in Design and Sustainability's PhD theses in the country;
- To extract applications and new methods for the development of sustainability in the country;
- To foment further research on gaps in the area.

2. THEORETICAL FOUNDATION

2.1. Design and development of products and/ or services

The way the design is seen and practiced has changed over the years, the contemporary designer is no longer seen just as a draftsman, or who develops artifacts as he was seen some decades ago. The profession has covered, in addition to product development, the development of systems and methodologies. In this context, it is necessary a more complex notion of development, as expressed by Morin (2000, p.70) "is not only material, but also intellectual, affective and moral."

Rodrigues, Bellio & Alencar (2012) state that designers should practice their craft in a way that improves the world, as they are seen as transformers of society, considering that when designing, directly affect people's way of life, having the opportunity to create new social proposals influencing attitudes.

In the process of developing products and/or services it is not always necessary to use or develop new materials, what is seen is a trend of renewal, reuse and replacement of products by systems of products and services, which may generate novelties through the combination of materials, new processing media creating composites, hybrid materials and creation of new types of service.

2.2. Design and sustainability

Design is characterized by its holistic and dynamic look, in this way it has the fundamental role of being an area that articulates in the decoding of contemporaneity, in a universal character to reach a more coherent society, it is indispensable and of extreme importance that the designers think about sustainability and apply their concepts to product and/or service project requirements (Rodrigues *et al.*, 2012).

According to Manzini (2008, p.19) "sustainability requires a systemic discontinuity" of changing thinking and behaviour at the most diverse levels of production, use and consumption. There is more and more speeches of reduction of these levels, but we do not know for sure how this will happen, yet, several initiatives have arisen. In any case, the designer has a key role in reducing levels of production and therefore, the importance of incentives for academic research in the area.

In the same way, Vezzoli (2018) affirms that the approach of "systemic innovation" should be adopted as a way of seriously treating the transition to sustainability. Such innovation is defined by the development of Product + Service Systems (PSS). Through the design of these systems, the emphasis would be on the user's ultimate satisfaction, where the limits of environmental resilience and the social demands of the environment should be respected, rather than the mere offer of products/services.

2.3. Design and research

Sustainability research has been advancing quickly, ranging from changing conservation ethics, the emergence of the concept of sustainable development, through technological innovations and the search for more integrated solutions (Visser, 2012). Besides the environmental demands, the social and economic ones are incorporated. The literature

on design for sustainability has followed these transformations and has shown to be an important guideline for action and planning of the designers, being extremely relevant their continuity and expansion in the academic area.

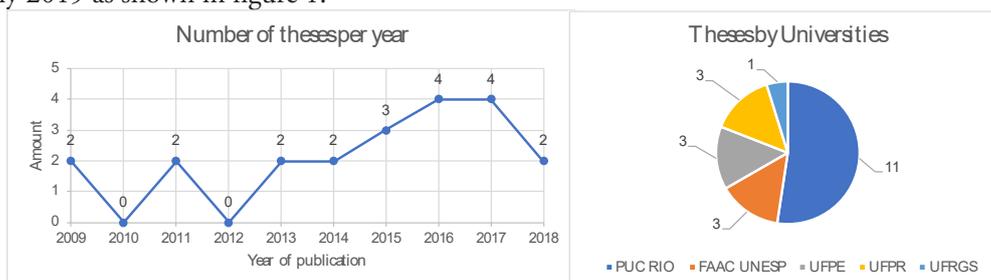
3. METHODOLOGY

This research has a theoretical and exploratory nature, has an inductive method and a basic nature. A systematic review of the literature on the Design and Sustainability's theses in the Industrial Design area in CAPES' data basis was performed. This is a systematic and rigorous bibliographic research that assists in the development of a solid foundation that contributes to the identification of gaps and new opportunities (Conforto, Amaral, & Silva, 2011). For its accomplishment, a script called methodological procedures was elaborated, described below:

- 1). Search for sustainability string at CAPES' catalog of theses and dissertations;
- 2). Refinement of PhD theses in the Industrial Design knowledge area;
- 3). Reading theses' abstracts, introduction and conclusions;
- 4). Refinement of those that approach the theme: "new approaches, strategies, methods and tools to enable the development, implementation, diffusion and dissemination of Sustainability for all";
- 5). Discussion of results.

4. RESULTS

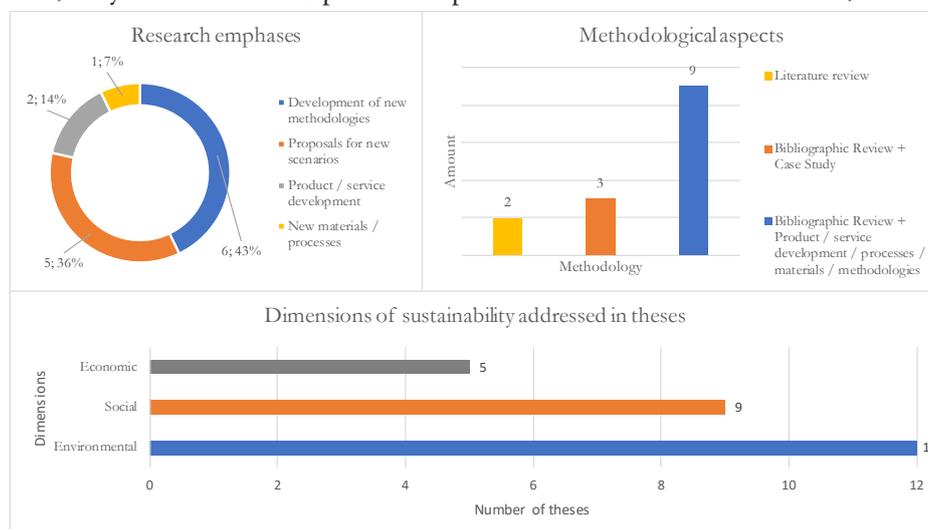
Through the search at CAPES' catalogue of theses and dissertations, 21 theses on sustainability were found belonging to Industrial Design category. Among them, the following universities were distinguished: Pontifícia Universidade Católica do Rio de Janeiro [PUC Rio] has 11 theses, Faculty of Architecture, Arts and Communication of the State University of São Paulo [FAAC Unesp], Federal University of Pernambuco [UFPE] and Federal University of Paraná [UFPR] has three theses each and Federal University of Rio Grande do Sul [UFRGS] has one. Regarding to the publication years, there was a considerable increase in 2016 (4) and 2017 (4). In 2018 there were only two publications, however, this number may change due to later updates at CAPES' catalogue, since the search was performed in early 2019 as shown in figure 1.



[Figure 1] Search results at CAPES data basis (Font: the authors, 2019)

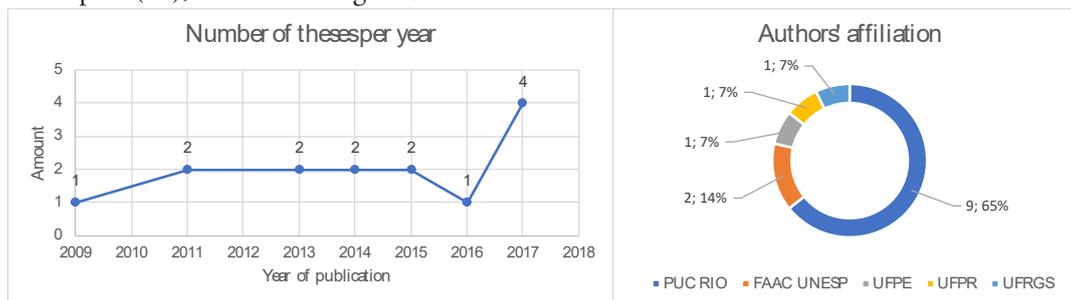
After the research, the results were refined by reading the theses' abstracts, introduction and conclusions with the intention of selecting those that fit the theme: "new approaches, strategies, methods and tools to enable development, implementation, dissemination and dissemination of sustainability for all". At this stage, 14 theses were selected, however it is highlighted here that one of the 2018' theses could not be analysed (Dickie, 2018), since only its summary was available at the time of conclusion of this study.

Regarding the authors' affiliation PUC Rio has 9 publications, FAAC Unesp has 2, UFPE, UFPR and UFRGS has one thesis each, stands out again. In relation to publication years, 2017 was the year that had the highest number (4), 2016 had only 1 publication, the years 2011 to 2015 presented 2 publications each and 2009 with one, as shown in figure 2.



[Figure 2] Selected theses information (Font: the authors, 2019)

Considering the methodological aspects, the great majority (9) of the researchers opted to develop new products, services, methodologies or materials and processes that would be more sustainable. The adoption of the methodologies can be seen in figure 3 below. In relation to the approaches used related to sustainability, the theses were classified according to the emphasis given in the surveys and in relation to the dimensions of sustainability (environmental, social and economic), with most addressing more than one, however, the largest number still refers to the environmental aspect (12), as shown in figure 3.



[Figure 3] Emphasis, methodological aspects and dimensions of sustainability addressed in theses (Font: the authors, 2019)

5. DISCUSSIONS

Although the sustainability theme has been recurrent for some decades, especially after the report of the World Commission on Environment and Development entitled *Our Common Future* (United Nations, 1987), the first thesis on sustainability in the Industrial Design area was published only in 2009 (Xavier, 2009), indicating a very recent research field. Most of the theses on the subject were defended at PUC Rio, which is the pioneering institution, both in the master's degree (1994) and PhD (2003) at design in Brazil (Pontifícia Universidade Católica do Rio de Janeiro - Teaching and Research - Graduate Studies, 2019). This predominance indicates the maturity of the institution in relation to the theme, which may indicate that in the future other institutions will follow the same path, increasingly covering the theme of sustainability.

Also, publications of only 5 educational institutions were found, showing that there is a need for a greater diversification of research in the area and a greater adherence by HEIs in research in this area, considering that Brazil currently has 25 post-graduation programs in the Design area, among them 12 with PhD course (Coordination of Improvement of Higher Level Personnel, 2019).

In relation to the methodologies adopted, the majority of the researches is of a qualitative nature applied (Xavier, 2009; Santos, 2015; Santos, 2011; Oliveira, 2013; Castro, 2014; Silva, 2014; Sóter, 2016; Albach, 2017; Ashton, 2017), seeking to develop proposals for solutions that allow a step towards greater sustainability, by its products, services, systems or processes.

According to the classification of design interference fundamental levels in relation to sustainability (Manzini & Vezzoli, 2002), most of the theses are found in the environmental redesign levels of the existing one or the design of new products or services that replace the current ones. Of the 14 theses, only five apply to the level of proposals for new scenarios (Schulte, 2011, Ripper, 2015, Junior, 2017, Pantaleão, 2017, Bezerra, 2013), which correspond to the sustainable lifestyle, which indicates the need for more researches on this level.

It can also be verified that the most contemplated dimension of sustainability is environmental, however, several theses approach more than one dimension, which is favorable and desirable to the research, as it is known to a project be truly sustainable, it must address all dimensions (Vezzoli, 2018).

6. FINAL CONSIDERATIONS

Through the Systematic Review of Literature, it was possible to identify 14 theses that discuss sustainability with focus on "new approaches, strategies, methods and tools to enable the development, implementation, diffusion and dissemination of sustainability for all" in the CAPES thesis catalogue. The analysis of these publications demonstrated that although sustainability has been a recurring theme in academic research for some decades, in Design field, researches are still very recent and requires further studies.

After analysing the data of these publications, it was possible to identify emphases and gaps in the surveys. There are gaps for research in the levels of interference of the design in projects of new products-services intrinsically sustainable and proposals of new scenarios that correspond to the sustainable lifestyle.

The emphasis occurred on environmental and social aspects, predominantly, with few theses addressing the economic aspect. The ideal, as explained above, would be the comprehensiveness of all dimensions of sustainability.

In this context, the research was basically divided into four categories: a) Development of new methodologies; b) Proposals for new scenarios; c) Development of products / services and; d) New materials / processes.

Most of the theses propose specific solutions for sustainability, which, however, can be generalized and transferred to other localities, indicating that their disclosure is extremely important.

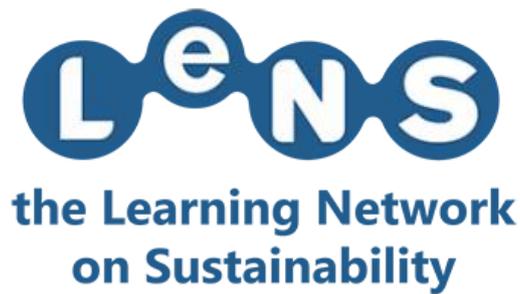
Finally, it is emphasized that this research was limited to the Brazilian context and the theses published in the

CAPES catalogue, without considering researches in other databases and journals for the state of art presented here. However, the theses analysed allowed us to understand the state of art of sustainability in Industrial Design PhD research in the country, indicating that a greater diversification is necessary in relation to approaches, methodologies and also in quantity.

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COMPARATIVE STUDY OF PRODUCT SERVICE SYSTEM BASED ON LIFE CYCLE ANALYSIS— INNOVATIVE LUNCH TAKEAWAY SERVICE SYSTEM DESIGN

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ABSTRACT

As a design strategy with great sustainable potential, product-service systems are widely used to discuss issues related to sustainable development. However, systems that are not properly designed will generate further serious irreversible consequences on the environment. It is therefore necessary to accurately assess and analyze the environmental impact of product-service system solutions. This paper expands the method of environmental life cycle analysis from the analysis of products to the analysis and evaluation of product-service systems, discusses life cycle differences between product-service systems and traditional product models, and demonstrates the application of life cycle analysis methods to systems. The process unit establishment method was applied in sustainable design curriculum, in which a sustainable takeaway lunch service system solution that was proposed in the course was tested. The process unit was described to provide a theoretical basis and support for future in-depth measurement and analysis.

1. THE SUSTAINABILITY OF PRODUCT-SERVICE SYSTEMS

The impact of design activities on the environment is enormous and far-reaching. Design and designers have been and remain a necessary component of modern business systems, and design has promoted consumption as well as a large amount of waste and garbage. Design seems to be both within and outside of the life cycle of products. Design is only an intermediate link in the industrial chain, but it is also the origin that determines whether products can be born. From a life cycle perspective, the product of design never leaves the environment, whether in the form of raw materials, finished products, or waste; it is instead transformed into different forms of matter.

Mont (2004) defines product-service systems (PSS) as products and services that support networks and infrastructure systems designed to compete to meet customers’ needs and have less impact on the environment than traditional business models. The PSS field has continued to evolve, and environmental considerations are no longer the most influential aspect of the PSS research process.

From a macro perspective, product-service systems can promote the acceleration of economic development in emerging economies and low-income countries, skipping the stage of the personal consumption of products and leaping into the service economy stage based on consumer satisfaction and low resource consumption (UNEP, 2002). An idealized product-service system can also help companies improve their economic impact and competitiveness while reducing their environmental impacts.

Overall, the development of product-service systems has great potential; they can improve environmental impact while improving profits and achieve a win-win situation. Such systems have the potential to provide some of the necessary conditions to promote a shift in social and economic systems to resource-saving (lower resource consumption). However, it is important to emphasize that even with good design, some changes in product-service systems may have a negative impact (e.g., a rebound effect).

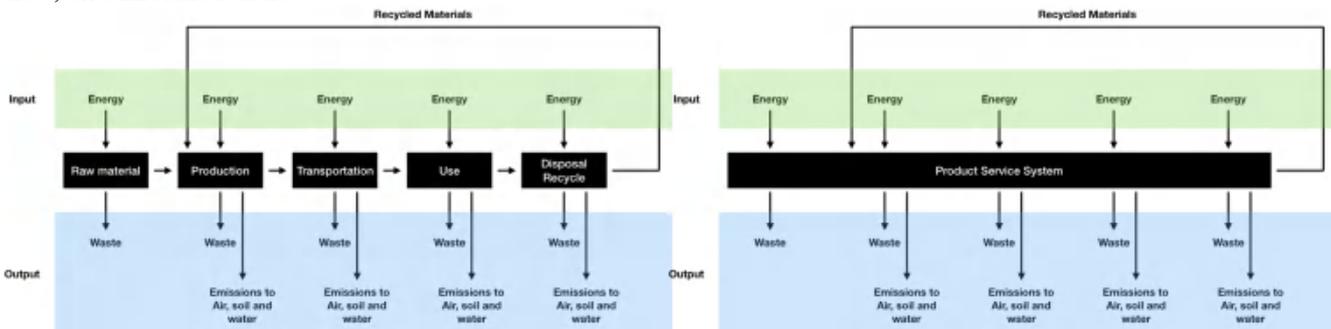
2. PRODUCT SERVICE SYSTEM LIFE CYCLE AND ASSESSMENT

The PSS strategy involves the transformation of business models from selling specific products to providing functional services through a mix of products and services in order to motivate resource efficiency and user satisfaction. Although PSS has the potential to reduce environmental impact, it is not at an absolute advantage over the traditional system.

At the same time, because the problems that PSS faces and aims to solve are often wicked problems, their solutions cannot typically be optimized and improved. Once implemented, such solutions will have irreversible effects, so a sufficient number of decision makers and designers must be involved in the development process. At the beginning of the design, this will allow the development of a more comprehensive understanding of the advantages and disadvantages of PSS solutions and the quantification of their impacts on the environment. On the other hand, since the types of PSS are complex and varied, the systems they face and try to optimize are equally complex. Therefore, the environmental impact of PSS must be assessed and the circumstances under which PSS leads to environmental improvements must be determined to support PSS design and related decision-making during implementation or when optimizing existing PSS.

Life Cycle Assessment (LCA) is one of the most effective methods for the environmental assessment of systems that include goods, services, or a combination of both. However, the current LCA guidelines focus on evaluating tangible products and lack special attention to more complex systems, such as product-service systems.

As shown in Figure 1, life cycle analysis can measure the energy input and output of each link and process in the life cycle of the target product to evaluate the environmental impact of the entire process. This process helps decision-makers adjust and optimize the target system. However, when faced with a product-service system, the entire process becomes a “black box” system that is difficult to define due to its complex boundaries, intricate material flow, and information flow.



[Figure 1] Product life cycle and PSS life cycle comparison

Life Cycle Assessment (LCA) is a mature, standardized approach to product environmental assessment. However, using LCA in a PSS environment is challenging. Current LCA guidelines are product-centric in nature and do not clearly state the characteristics of PSS. According to the LCA standard of ISO 14040:2006, a “product” can be defined as any good or service (ISO, 2006a). Therefore, the steps involved in LCA are considered to be the same

regardless of whether the function is implemented by delivering a physical product or an intangible service. This definition implicitly makes the method applicable to PSS.

Kjaer et al. found that the main challenges of applying LCA in three PSS (2016) were:

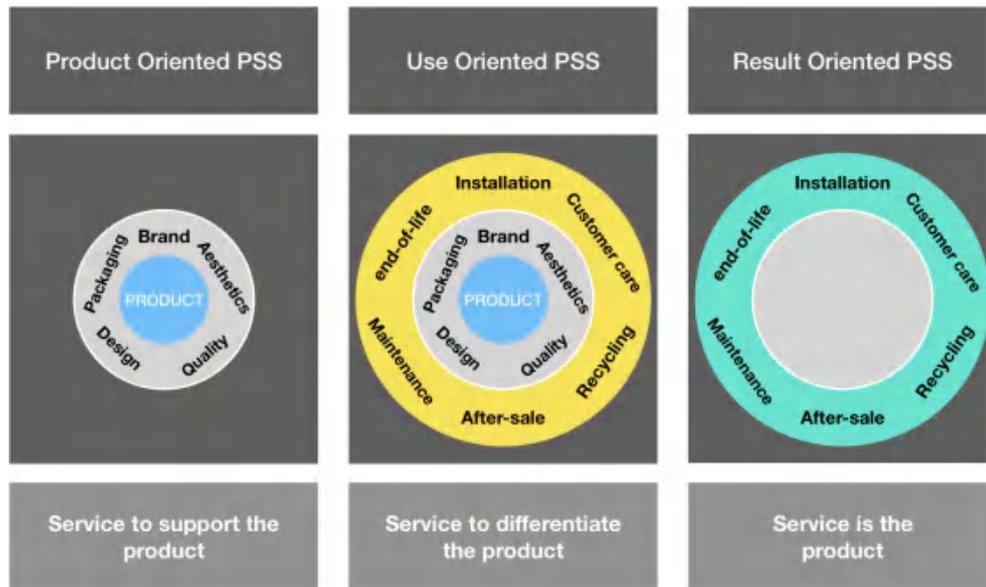
1) Identifying and defining the reference system: How does one identify and describe the relevant reference system of the PSS for comparison? Three ranges of PSS evaluation are defined: (1) PSS optimization (in which the reference system is an existing PSS); (2) PSS comparison (in which the reference system is one or more predefined comparable alternatives, usually traditional business models); and (3) PSS consequences (in which the reference system is defined as the baseline case without PSS).

2) Defining the unit process: How does one determine functional equivalence when defining the unit process (UP)? If the relevant sub-functions are not included, an imbalance in functional results and quality will occur. In addition, differences in the perceived value of users may result in a rebound effect.

3) Setting system boundaries: How does one ensure sufficient integrity of system boundaries (including products and services in the back-end system) to avoid truncation errors and thus ignore potential important contribution processes?

Kjaer also pointed out that using LCA to evaluate the environmental performance of PSS can be challenging. While the method framework in LCA is considered to be the same for products and services, the PSS concept is more concerned with differences between tangible products (such as machines) and intangible services and activities (such as maintenance) because their integration is value-added and creates a “system” (Baines et al., 2007). In this sense, PSS is not just a set of product and service inputs; it is also the result of design strategies based on new value systems and innovative market opportunities (Manzini and Vezzoli, 2003). In their multi-level design model, Joore and Brezet (2014) used PSS as a link between product technology systems and social technology systems, demonstrating PSS’s position to transform social needs into novel solutions.

To clarify the relationship between products and services in this model, we combine the three core design strategies proposed by Tukker (2004) – pure product design, product-service system design, and service design – in conjunction with Thoben’s (2001) and C. Favi’s (2012) concept of extended products and two service-oriented scenarios: the product+service and product2service models. Product-oriented PSS is a service that supports a product, while use-oriented PSS is a service that differentiates a product, and in result-oriented PSS, the service is the product.



[Figure 2] Product-service system model

We can consider that in the product-oriented phase, the service is only used to support the product. In the LCA, the rules of cut-off can be used because in a conventional product-oriented system, the service usually appears as infrastructure or manpower consumption. This is negligible in LCA. In the other two types of systems, however, intangible services and tangible products have undergone fundamental changes in their relationship.

In a product-oriented PSS consisting of traditional washing machine sales and the related after-sales services, the corresponding life cycle generally refers to the life cycle of the washing machine itself, and the related incidental services are not considered therein. However, life cycle analysis in a usage-oriented PSS such as a shared laundry room considers the energy consumption of the washing machine itself and the energy consumption (electric energy and water consumption) generated by the single-use service, as well as the number of times the service occurs and the maintenance of the machine. In a results-oriented PSS such as the provision of cleaning services, the service itself can be regarded as a “product,” and its life cycle includes the energy consumption of the related material products as well as the “intangible service” that can comprehensively consume energy (such as the traffic, electricity, and water consumption involved in the service itself) and the number of services. This is shown in Table 1 below.

[Table 1] Life cycle consideration for three PSSs

Type	Life cycle consideration			
Product-oriented PSS	Product life cycle			
Use-oriented PSS	Product life cycle	Energy consumption per use	Service frequency	Maintenance
Result-oriented PSS	Product life cycle	Comprehensive energy consumption (transportation, water, electric, etc.)		Service frequency

According to the three main challenges proposed by Kjaer, PSS may be considered a “black box” system in LCA due to the uncertainty of its process unit, which is necessary for the establishment of an effective basis for a complete life cycle model. All data collection and analysis for LCA is based on such process units. We will use the sustainable product-service system developed by students at Tsinghua University as a case study to establish a process unit for description.

3. CASE STUDY

3.1. Background

This project relies on the sustainable design curriculum of the Academy of Fine Arts of Tsinghua University, in which research and practice are conducted on the theme of “sales-based sustainable service systems” from the perspectives of lunch box garbage, healthy eating, and sustainable lifestyles. The life cycle analysis checklist method is applied in the design of product-service systems for sustainability assessment.

3.2. Needs analysis

Consumers in many cities in China use digital takeaway platforms to order food daily. In addition to a delicious meal, takeaway delivery leaves consumers with plastic bags, plastic lunch boxes, and tableware. This practice has obvious environmental implications. In the first half of 2018, China’s two major takeaway platforms (Meituan and Hungry) distributed an average of 33.9 million takeaway meals a day, and takeaway composition usually included at least one set of tableware and two meals. This means that on average, 60 million plastic lunch boxes are born in China every day.

The waste created by plastic lunch boxes is usually mixed with other types of domestic garbage and sent to landfills or incineration plants. Without proper professional treatment, this waste will undoubtedly cause severe pollution to the soil, water, and air near municipal waste treatment plants.

Through interviews and investigations, we found that although most white-collar workers are willing to bring meals to work, the companies they work for often do not have food-heating equipment, and when they return home from work, they often have no time to prepare ingredients and cook. This leads them to order food. In addition, white-collar workers tend to pay more attention to their own health, and although takeaway platforms provide choices such as health- and fitness-focused meals, they are expensive and the ingredients and processing methods they use are not satisfactory.

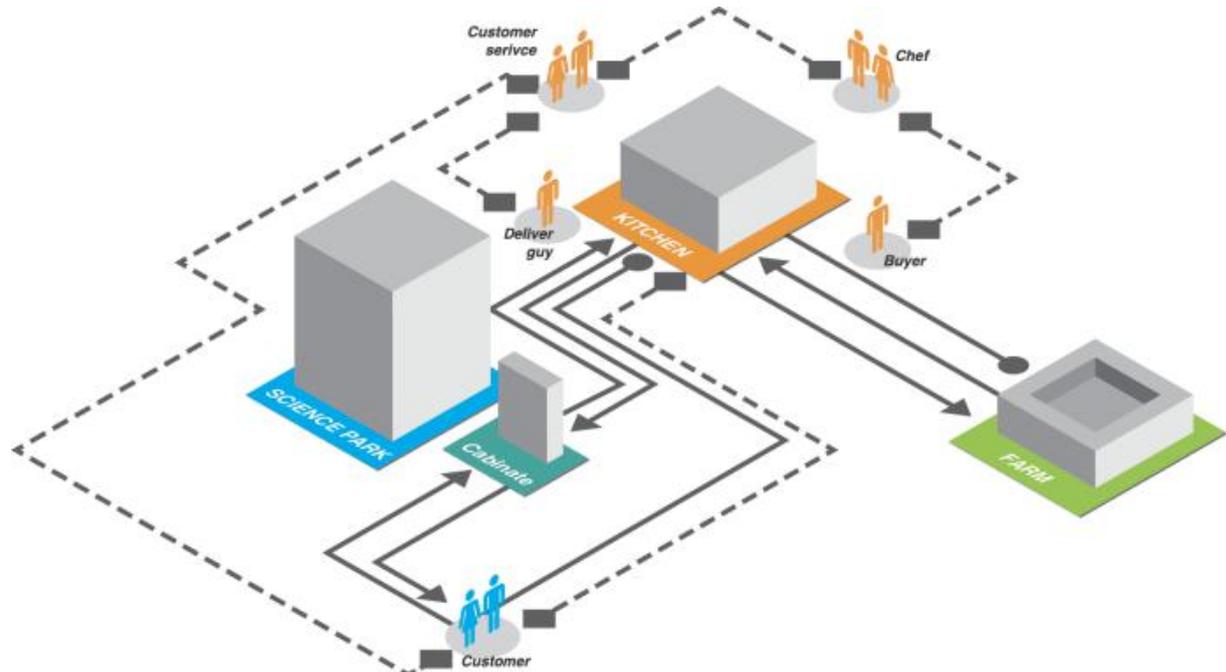


[Figure 3] Field study on typical takeaway meals

3.3. System Design

The design scheme in this project adds a new dining option for lunch, which encourages users to use reusable lunch boxes and customize their lunches through a localized dining platform. Multiple stakeholders such as catering companies, health and medical institutions (such as gyms), consumers, and farmers are included in the consideration.

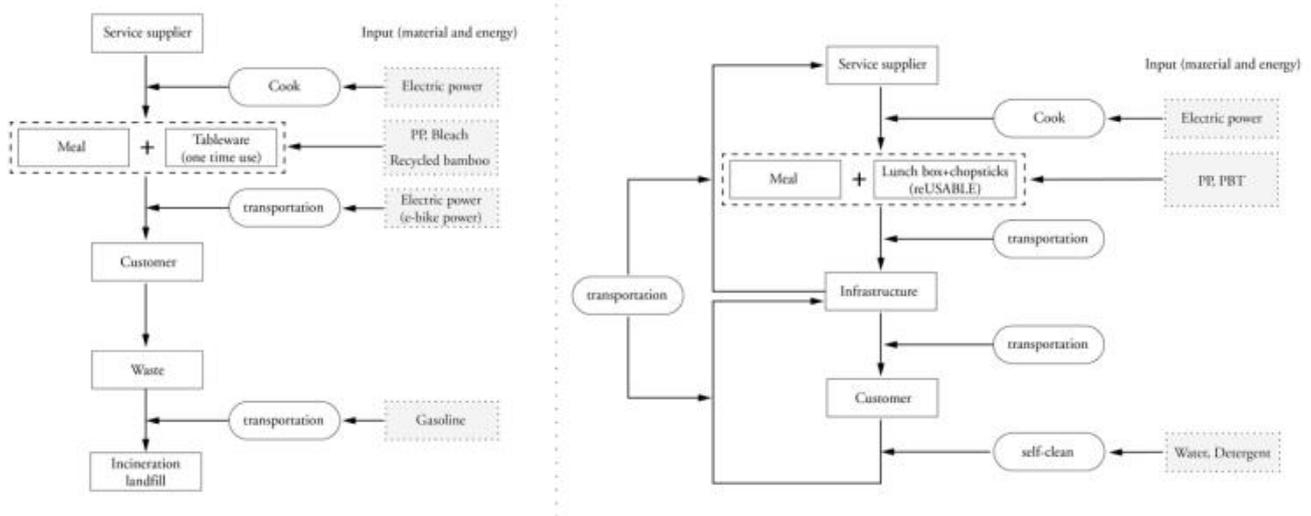
The customized, reusable lunch box allows users to feel a sense of belonging during meals and reduces the use of disposable lunch boxes. Second, the user and the service provider interact through the use of customized lunch boxes in the process of ordering meals and feedback, which will increase trust in the service as well as transparency. Cooperation with local farms may also be increased with this system. The future kitchen in the science park will become a community interface, and the large degree of freedom and flexible service model can easily be copied and provide interaction with different nodes of the system.



[Figure 4] Service system map of new takeaway food system

3.4. Unit Process

In LCA, any production or consumption activity can be described as a unit process. A unit process consists of the underlying stream (input, output), the intermediate stream (input, output), and the product/by-product or service. Combining the current takeaway system and the product-service system design in the conceptual solution, we defined the unit processes of the two services, as shown in Figure 5.



[Figure 5] functional unit of current takeaway food system (left) and concept design (right)

In our research, we found that in the existing takeaway service, electric heating is primarily used for cooking. Tableware is usually made of PP-based lunch boxes and recycled bamboo chopsticks. Food transportation is based on lithium-ion battery electric vehicles, and garbage-transfer vehicles are mainly gasoline-driven. In the new solution, the input of the unit process mainly includes power consumption from cooking, reusable lunch boxes, and the water and detergent required for users to clean their lunch boxes.

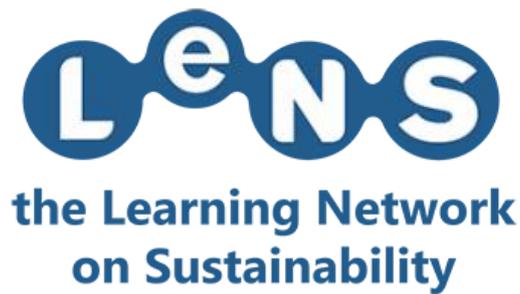
4. CONCLUSION

In this paper, environmental life cycle analysis is extended from the analysis of products to the analysis and evaluation of product-service systems, demonstrating its evaluation power. The process unit was developed in a sustainable design curriculum, in which students’ solutions were tested.

In the future, tools such as Gabi and Sima Pro will be used to further help students establish a comprehensive “system thinking” perspective. This may guide students to understand life cycles, apply life-cycle thinking to solve practical problems, and consider the impact of decisions at each stage of the life cycle in a quantitative and qualitative manner.

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SERVICE DESIGN FOR INNOVATION: THE STRATEGIC ROLE OF SERVICE DESIGN IN INNOVATION FOR MANUFACTURING COMPANIES

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ABSTRACT

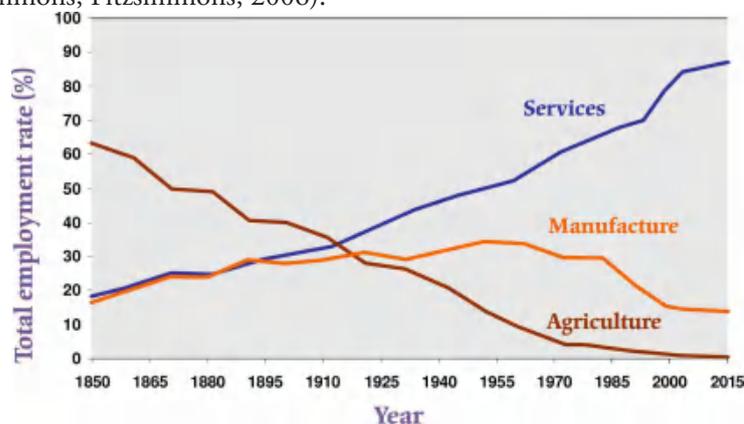
The service sector has been identified as an increasingly important area of the economy and has been generating new possibilities for design activity. Among them there is the identification of innovation opportunities in services for manufacturing companies. In this context, the present article presents part of the development of services for a light manufacturer in the stage of establishing the scope and requirements of the project, where solutions that reflect the company strategy were sought. In order to report this, a case study in which the tool Customer Journey Map was used to develop a Product + Services System for LED lighting, for the low-income population is presented here. In this study we can infer the potential of collaboration of the design in the initial phase of the identification of innovation opportunities and how this can help at the strategic level of the company.

Key Words: Service design, Innovation, Levels of design performance.

1. INTRODUCTION

Design can play an important role in the today's industry around the world. (Stickdorn, Schneider, 2011). This article aims to present the Service Design role in the phase of translation of strategies to provide guidelines and scope for a new service. This article presents a report on the theme of Service Design for Innovations in order to assist strategic thought. This research presents the case study of a manufacturing company that seeks the improve its portfolio through offering of a new service.

The service sector can represent approximately 70% of the economy in developed countries and the world is increasingly characterized by services. (Ostrom et al, 2010). Among the evidences, the evolution of the participation of the service sector in the course of recent history can be considered, as shown in Figure 1 below, presenting the growth of the sector (Fitzsimmons; Fitzsimmons, 2006).



[Figure 1] Total US employment trends. Source: Adaptado de Fitzsimmons e Fitzsimmons, 2006

In this context, some manufacturing companies have been directing their strategies to incorporate the offer of services in their portfolio. Fang et al. (2008) refer to this strategic redirection as Service Transition Strategies, with the premise of associated benefits in the provision of services, such as: potential increase in customer loyalty, improvement in pricing and greater resistance to outsourcing, where services associated with their products are carried out by other companies.

Although the potential of service offerings adds value to customers, the strategy for this transition is not simple to implement, to do that companies must transform many aspects of how they do their business, from their strategies and positions in the supply chain. values, capacities, structural organizations, cultures and mentalities. Not all attempts at transition to service bring positive results despite evidence of the company's contribution to competitiveness. (Salonen 2011).

2. INNOVATION THROUGH SERVICES

2.1 Definitions

Skaalsvik & Johannessen (2014) understand that there is a consensus that innovation is both the information process and the creation of knowledge. This way, the nucleus of definition of innovation is the adoption of a new idea. And at the same time innovation is something to be seen in a holistic way, needing a market expecting for this innovation, indicating that there is a marketing component involved (Skaalsvik & Johannessen, 2014).

One of the important elements in the diffusion and understanding of innovation has been the Oslo-OECD Manual, which was first published in 1990. The Oslo Manual establishes four categories of innovation: Product innovation, Process innovation, Organizational Innovation and Marketing innovation. It is important to point out that Benz and Magalhães (2010) understand that design can be present in all categories of innovation process.



[Figure 2] Types of innovation and their relationship to Service Design Source: Authors, 2018

The Oslo Manual, in its third edition, changes its focus by recognizing the importance of the role of services, and emphasizes that less formal innovation is one that has “a more incremental nature with less technology (than technological innovation)” (P.17 Oecd, 2005). One of the reasons for defending innovation in services lies in the potential contribution to sustainability, particularly through the dematerialization of consumption. The offer of benefits without necessarily having to purchase an artefact. (Vezzoli et al., 2015). It is understood that, in order to provide solutions in services, associated with sustainability, a strategic innovation is necessary, offering a system that can include: product maintenance, recycling, and finally the entire product life cycle. involve and rely on the local workforce, thus including improvements in social factors, among others.

2.2 Peculiarities of Services in the Innovation Process

The peculiarities of the services demand different approaches for the innovation process when compared to the approach oriented to physical artefacts. According to Manzini (2011) services are complex activities due to their hybrid characteristics. The offer of a service is made by things, places, system of communication, interaction and, also, by human beings and organizations. In this way, it belongs to the physical world and, at the same time, to the world of sociology and culture. For Trott (2012) there may be tangible aspects in a service, but for him, the results of experience involving services are in the sphere of performance and is intangible. While the manufacturing company delivers tangible products to perform a function, services are paid to perform a function (Trott, 2012).

2.3 Innovations Integrating Products and Services

The Product + Service Systems (PSS) design can be considered as one of the relevant interventions in the search for more sustainable solutions, which covers the most strategic levels of the project. According to Tischner and Verkuijl (2006), the greater differentiation of a PSS-based innovation model is an effective transformation of sociocultural behaviour and usage patterns, since it combines several heterogeneous elements such as cultural aspects, people, technological artefacts, organizational transformations and new technologies.

The benefits can go beyond the economic ones, attending widely the socio-ethical benefits, extending the access to goods and services (Vezzoli et al., 2015). In this sense, the PSS offers are focused on access to the place of the property and, thus, reduce or avoid the initial investment and, likewise, the operating expenses. It is important to note that not all the resulting PSS changes provide environmental benefits and to be highly eco-efficient it must be specially designed. (Vezzoli et al., 2015). Thus, Vezzoli et al. (2015) argues that in terms of barriers to companies and service providers, the main obstacle still remains internal factors.

3. METHODS AND TOOLS FOR SERVICE INNOVATION

There is currently a range of methods and tools that enhance the Service Design process (Costa Júnior, 2013). Among them there is the Customer Journey Map or Customer Journey Mapping, which is used as an essential tool for the development of services.

The Customer Journey Map enables to present a graph that describes the user's interaction with the service in a clear and structured way (Stickdorn, Schneider, 2011). It is characterized by the emphasis on the user's perspective, particularly in analysing the factors that influence their experience. (Service Design Tools, 2014). By applying this tool, it is possible to identify the problematic areas of the relationship of the service with its user and to point out the opportunities of innovation. The tool demonstrates the interaction in its various forms, which can occur, for example, in the personal contact between the attendant and the user, as well as, intermediated by virtual interactions through a website or system. The tool enables the synthetic presentation of the complex relationship of the user with points of contact along his path in obtaining a given unit of satisfaction.

The Customer Journey Map in this research was elaborated through data collected in interview, technical visits and the low fidelity prototyping performed with the tool homologous to Lego Serious Play. This theatricalization way of elaboration enabled empathic and collaborative co-creation between the team and others involved in the research. In this stage, several assumptions of service were compiled and included in several User Days for analysis.



[Figure 3] Scenarios of schematized prototyping.
This way of working facilitates the exploration of different ideas, quickly and inexpensively. Source: Authors, 2018

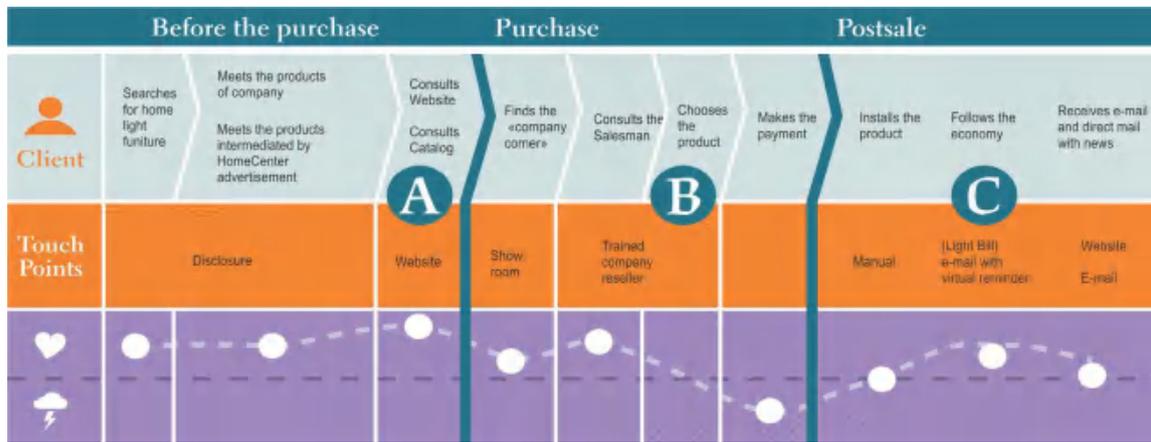
4. RESULTS AND ANALYSIS

4.1 Context

The case study deals with a luminaire manufacturer who wanted to meet a new market and evaluated the consequences of this decision. Thus, it evaluated the impact of this decision through reflections among them using the tool Customer Journey. The study then included a greater prospective action in the sale by the new channel and its contribution in the strategic scope of the organization, which sought to evaluate the profile of relevant services to be integrated into its portfolio.

4.2 Customer Journey (Prospective)

In order to carry out the research, a scenario was created for the analysis where the company had already established partnerships, in this way this study was prospective. The journey was elaborated in 3 (three) stages, the first one referring to the customer's knowledge of the products offered. The second step is buying. Finally, there is the after-sale that can cover actions that help maintain the interest in continuing to buy with the company.



[Figure 4] Customer Journey Map. Source: Authors 2018

5. IMPLICATIONS FOR SERVICE INNOVATION

Here is some opportunities and implications from evaluation of the proposal to use the new sales channel:

5.1 Implications at point A

The company could offer a service through a virtual environment where the customer could simulate the effect of the use of the luminaires. The new service must intensify the amount of interaction between the company and the clients, so it must press the attendance function. Activities such as cataloguing should be included in the company. An idealized service for this portion of service can be adapted from Benchmarking among online commerce companies, thus offering order management facilitating and optimizing the service process.

5.2 Implications at point B

The offer of LED technology can provide the opportunity to offer information about the economic potential of the new technology. This item, besides being a competitive differential, can help in brand loyalty.

5.3 Implications at point C

At this stage, usual installation and service services can be offered, which aim to provide greater energy savings, such as consumer diagnostics or even decoration consulting as new service.

5.4 Other implications

In terms of the immediate consequence of the proximity to the end customer we can point out the possibility of obtaining a greater range of information about preferences, how to use that would otherwise be difficult to acquire with accuracy. This information together can serve to improve and develop new products to be offered by the company (BAINES, LIGHTFOOT, 2013). This proximity opens up an opportunity for user interaction throughout the Customer Journey, as shown in Figure 4, where the client can have contact with the company from the pre-purchase through the means of websites and social networks, through the experience of purchase, and after-sales contacts, such as: technical assistance, replacement, upgrade and disposal, among other contacts.

[Figure 5] The main notes of the analysis allow

OPERATIONAL	STRATEGIC
Fix service details	Compare models
Detail the touchpoints (physical evidence, direct visual customer contacts)	Make or Buy decision
Identify training gaps	Align company strategy
Find the low satisfaction points to improve	Set improvement priorities
Identify new resource needs	Evaluate the financial implications of items to be changed
Analysis of consumer actions	Evaluate impacts of eventual hiring
Customer emotional experience	Evaluate the costs of hiring training

6. DISCUSSION

The article presents the analysis of the use one of the tools of the Customer Journey the possibilities and potential of design at the strategic level. When applying the tool, it allows to understand the potential of dialogue with the development and decisions within the framework of the strategy of the design. With this it was possible to infer that the design is able to aid in the innovation through the thought of the design and, more particularly, in developing services for a manufacturing company. The use of the tool facilitates the measurement of impacts of development actions of a service.

In a deductive way one can use the tools that are usually used to create new services or improvements of existing services, to analyse the possible consequences of decisions, it can be used both to identify opportunities, to assess

the impacts and to generate data for decision making, such as this small case study that can validate the decision whether or not to adopt a new sales channel, by evaluating the unfolding of ideas and future scenarios.

The tool also serves to compare versions of service propositions with the same visual language and makes it easier to compare between competitors. In this way it can help in the strategic thinking of the company. The tool facilitates communication among developmental members as Curedale (2013) advocates and has made it possible to identify points to be developed.

Mozota (2011) understands that management with design participation occur at the following levels: strategic, tactical and operational. In the strategic management of the design we think about interventions in the organizational structure of the company, while in the operational one works in the development of new products / services. Since the strategic procedures are related to the establishment of the objectives, the tactical procedures stipulate the paths and the operational one accomplishes the tasks effectively. The tactical level is located in between these level. Briefly, in design management, when it comes to strategy, it deals with questions related to company objectives and values (mission), among others, that define the future of the company. At the operational level one should think about how to execute this strategy and coordinate control actions and what will be done at the operational level (Mozota, 2011).

Every company action must be consistent with its objectives, so both production and communication must be aligned with the company's strategy. Therefore, the design at this strategic level should contribute to the organization and act as an agent that catalyses, synthesizes and assists in the materialization of the company's overall strategy. It is at this stage that the identification of innovation opportunities occurs. (Mozota, 2011). The Customer Journey tool assists both in understanding and communicating this need to those involved in the new service development project.

Most of explanation for tools is related to the operational level, therefore an emphasis on the purposes in terms of aid in the detail of the design of the service and little characterization in the potential for use in the strategic level in the performance of the design. Contrasting these presentations of the literature, the case study carried out in this research evidences the potential of using the Customer Journey tool, both at the operational level, to design the service, as well as in the strategic of the offer. In this study it was possible to involve more strategic topics such as: business models; stakeholder arrangements and; decision-making subsidies.

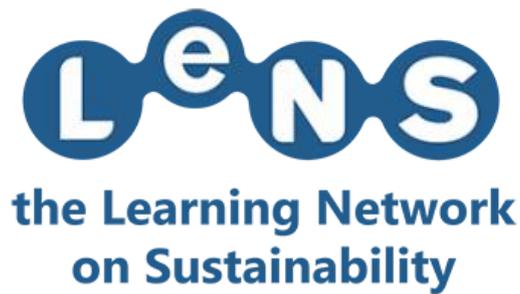
It can be inferred that the use of several tools increases the robustness of information contributing to the process of identifying opportunities. In this sense, the research carried out can add the arguments and instrumentalization of the designer within the scope of the participations in the strategic decisions of a company, through familiar tools of the own design. This contribution can occur in order to facilitate in the visualizations of the consequences that, at the same time, can identify more opportunities of innovations. This way of identifying and analysing the opportunities can be configured as a triangulation of the conceptions raised and improving the capture of ideas, communication among those involved and ultimately potentializing the identified opportunities.

And finally, this cross-analysis of the performance levels of design versus tools could, by analogy, be extended to other Service Design tools in order to contribute to the diffusion and more incisive performance of design at the management level.

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WICKED PROBLEMS AND DESIGN IN EMERGING ECONOMIES: REFLECTIONS ABOUT THE DESIGN OF SYSTEMIC APPROACHES FOCUSED ON FOOD AND TERRITORY

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ABSTRACT

The aim of this paper is to bring a reflection about the design of systemic approaches focused on food and territory. This broad and complex field of study can be categorized as a wicked problem (WP): a problem that is difficult or impossible to solve because its deep and broad roots result in interdependent, inter-related and emergent socio-economic and environmental impacts, for which there is no single set of objective response or approaches from a Design point of view (Rittel & Webber, 1973; Buchanan, 1992). The reflection is based on the discussion of WP theory and its relation with sustainability, followed by a brief review of the concepts of Systemic Design (SD), and its convergence towards a fresh understanding of wicked problems in the context of sustainability. With this aim, three Brazilian initiatives related to food and territory were selected to reflect on possible design contributions.

Key Words: Design, Wicked Problems, Emerging Economies, Food, Territory

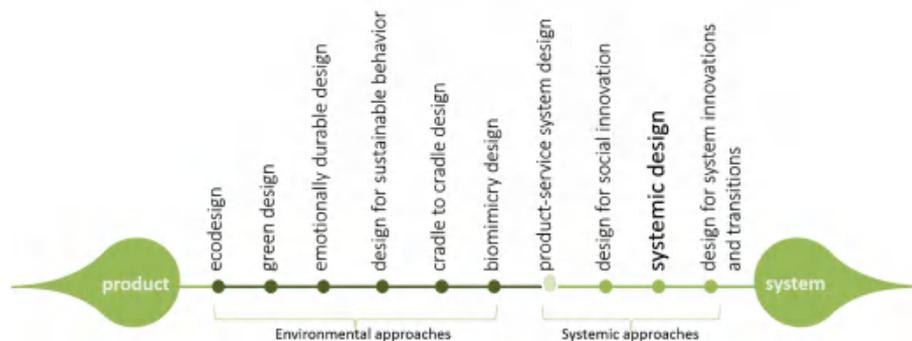
1. INTRODUCTION

The crises experienced today, especially those related to the agro-food chain, go beyond geographic boundaries and make our time of greater complexity of human existence. Hunger, food waste, food security associated to socio-economic, environmental and cultural impacts demand an imperative resolution in order to attain sustainable development. Solutions require drastic changes in perceptions, thoughts and human values, so that actions, local and global, are guided by environmental, social, cultural and economic Ethics (Capra, 1997, p. 15), so that they contemplate effective, long lasting solutions, both at the local and global levels.

This paper brings a reflection about the design of systemic approaches focused on food and territory. This broad and complex field of study can be categorized as a wicked problem (WP): a problem that is difficult or impossible to solve because its deep and broad roots result in interdependent, inter-related and emergent socioeconomic and environmental impacts, for which there is no single set of objective response or approaches from a Design point of view. The reflection is based on the discussion of Systemic Design (SD) and Distributed Economics (DE) and its convergence towards a better understanding of Wicked Problems in the context of sustainability. In order to reflect on possible design contributions to the WP scenario, three Brazilian initiatives related to food and territory were selected as case study. The main contribution is to reflect on the application of theoretical and practical approaches in emerging, complex and biodiverse contexts, currently found in emerging economies such as Brazil, identifying possible positive impacts of design intervention related to environmental, social, economic and cultural sustainability. This paper is based on the ideas developed for the on-going research thesis Design and Gastronomy: the systemic approach of Design in the context of local sustainable development of small Brazilian communities, developed in the Postgraduate Program in Design of the Federal University of Pernambuco, Brazil.

2. SYSTEMIC DESIGN AND THE WICKED PROBLEMS OF SUSTAINABLE DEVELOPMENT

Faced with complexity and assuming its strategic role in the transition to sustainable ways of life, the design discipline has developed systemic approaches with new theoretical and multidisciplinary contributions in the last 3 decades. Ceschin and Gaziulusoy (2016) elicit some of these design approaches to sustainability, (Figure 1):



[Figure 1]: Evolution of systemic approaches on design for sustainability scopus. Based on Ceschin; Gaziulusoy, 2016.

Figure 1 shows a transition to sustainability where, instead of focussing on environmental approaches for product development, there is a shift towards complex systemic approaches in which the use of environmentally friendly materials and processes, clean technologies and sustainable methodologies only make sense for sustainability if designers “pay full attention to the essential relationships and critical connections between systems” (Nelson and Stolerman, (2012, p. 57). According to the authors, designers should be able identify and protect the essential connections found in life, so that systemic thinking can be applied to design projects and the macro systems in which such projects are incorporated.

Systemic Design (SD) emerged in the first decade of the 21st century, to give support to the development and understanding of complex and systemic issues, such as those involving the discontinuity of the anthropic lifestyles. This methodological approach has the ability to operate beyond the boundaries imposed by other Design initiatives, promoting systemic change in thought patterns, organizational cultures and societies (Ryan, 2016). Systemic design, different from graphic or product design, is not a ‘discipline’ but a guideline that emerged from the need to elaborate and evolve design practices to work with complex problems, with the ultimate goal of creating best policies, programs and service systems, involving all stakeholders in the process (Jones, 2013, p.3). According to Ryan, (2014, p. 4), there are several approaches or ‘schools’ to Systemic Design operating in various contexts, promoting a broad discussion about the construction of this theory and its methods, as well as encouraging its Practice (Ryan, 2014, p. 4). Such approaches have in common, at different levels of appropriation, the theoretical framework of Systems Science (Hieronimy, 2013) and complex Thinking (Morin, 2005). They also share interest in the so-called Wicked Problems, problems that are difficult or impossible to solve because its deep and broad roots resulting in interdependent, inter-related and emergent socioeconomic and environmental impacts, for which there is no single set of objective response or approaches from a Design perspective (Rittel & Webber, 1973). Given its transversal and transdisciplinary nature, wicked problems are resistant to traditional problem-solving approaches (Mota, 2014 p. 53). In-

stead of adopting a right-wrong approach, which is highly susceptible to the rebound effects and tend to create new problems (Ackoff, 1974; Ritchey, 2011; Rittel & Webber, 1973), the understanding wicked problems need to adopt a better or worse logic, in the search for solutions to face a given situation at a given time (Conklin, 2008).

According to Ryan (2014, p. 4), Systemic Design “is designed for situations characterized by complexity, uniqueness, conflict of values and ambiguity about objectives”, i.e., a category in which many of the contemporary problems fit in, such as the ones associated with sustainability. Sustainability related challenges have deep roots that result in tangles of social, economic and environmental impacts interdependent and interrelated, for which there is not a single set of solutions and not even a set of definite rules so that design can tackle them (Buchanan, 1992).

As a transformation strategy towards sustainable development, SD presents the following characteristics: [1] The organization of systems is centred on the activation and/or development of harmonic relationships between stakeholders, structured in an organized network, aiming at high efficacy and efficiency in all dimensions of sustainability (Bistagnino, 2009). [2] The appreciation of situations by multiple scales and perspectives and through deep empathy with stakeholders in a collective learning process (Ryan, 2014, p. 3). [3] Support for groups to construct shared reference structures, visualize alternatives to current paradigms, and align actions to improve confusing situations. Systemic Design is, therefore, an approach to work, act, reflect and learn during the process, in an intrinsically collaborative way.

For Ryan (2016) Systemic Design “is not a process, but a new space to take advantage of the complexity of reality as generator of innovation and creator of new [sustainable] values “. According to Bistagnino (2009, p. 68) and Ryan (2016), the systemic Design favors the complexity of relationships as an inexhaustible source of solutions to current problems and events, inviting stakeholders to form a shared reference framework for collective action. Peruccio (2017, p. 72) agrees and adds that “designing complexity is achieving a precise goal, through concrete structuring in a way capable of organizing a multiplicity of factors, processes and interactions at multiple levels originated from a context generated by three strictly connected spheres: Biosphere, Sociosphere and Tecnosfera “. This interdependent connectivity is easily verified in the agro-food value chain, in which the impacts of human practices on the environment and on society itself are taken to the extreme (Borja et al., 2010). Its complexity, as well as its potency, exceeds the nutrition, in the basic sense proposed by Maslow (2016), to achieve the status of cultural language shared by societies, which reflects profound relations between human beings and territories by them inhabited.

3. DESIGN, GASTRONOMY AND LOCAL SUSTAINABLE DEVELOPMENT

Papers The connection between design, gastronomy and sustainable development has not only reflected in the food industry, but also promoted new forms of interaction with communities and localities. The valorization of both agricultural products and their origins has contributed to the development of many small, local communities, especially in countries that recognize and honor their gastronomic heritage, such as France and Italy.

The Design activity also understands that food is a language that forms the interactions between the environment, the territory, the culture and society. Food manifests itself in a physical and abstract way, in products, habits and traditions, thus being able to communicate the identities of the site and the community that produced it (Montanari, 2013, P. 165). The metaphor of language is very prolific when applied to gastronomy, because it assists in the visualization that, even being part of a larger system, each site produces its own dialect, its corruptions, its expressions, which are determined from those same interactions.

Thus, for the design of systems related to gastronomy, the design discipline creates a bridge between the many actors and the various realities, through which this language can flow. However, for this communication to occur within the parameters and values considered sustainable, it is necessary to adequate the system considering its environmental, economic, social and cultural impacts. As Bistagnino highlights, “Only designing food systems as a product, without coordinating and integrating all the functional, symbolic, cultural, technical and manufacturing factors related to it, is an approach to be overcome (...)” (Bistagnino, 2011).

A differential that highlights Systemic Design from other approaches of design for sustainability, consists of promoting and/or activating internal processes of self-organization, which directly influence the resilience and autonomy of the community. To do so, systemic design uses social and biological theories that work within complex systems and assist in the flexibility of the structure facing the excitations of the environment, allowing to maintain the organization and its identity, even in the face of constant structural changes. This quality is essential for the survival and evolution of small communities as it results in the balance between development, innovation and tradition, co-creating a highly adaptable and robust social fabric.

Three case studies related to food and territory are presented to discuss design contributions, focusing wicked problems. The cases are based on the production and commercialization of food within the context of culturally responsible, sustainable local development. The evaluation of these initiatives points out possible strategies for the design field and reinforces the role of food as a promoter of local sustainable development.

4. CASE STUDIES - ALAGOAS - BRAZIL

In the state of Alagoas, the third poorest in the Northeast of Brazil (Agência Brasil, 2017), solutions that help in the development of communities that live in extreme poverty, are levered by mixed initiatives that include a network of stakeholders that include political entities, third sector organizations, private companies, education and research

institutions, funding agencies and the residents themselves (Lepre, 2018). Among a wide array of projects and initiatives, three cases using gastronomy as a platform to design sustainable local development call attention due to their positive results in the search for solutions of wicked problems.

4.1 Tapera's Chilli Project

Since 2006, the community of São José da Tapera, municipality of Brazilian Semi-arid with 32,000 inhabitants and 60% of the population with monthly income of up to half minimum wage (IBGE, 2017c), has been producing, benefiting and commercializing varieties of peppers, an ingredient much appreciated throughout the Brazilian Northeast (Figure 2). The practice has changed the lives of the previously marginalised population, through the involvement of the members of the community, helping to reduce poverty, generating equal opportunities to its members, and promoting gender equality. According to representatives of an NGO involved in the development of this initiative, it is women who command and maintain the operation of the project. One of the main points related to the productions of the peppers is the use of photovoltaic technology and hydroponics. (IEE, 2018).



[Figure 2]: Pimentas da Tapera Project: planting, processing, packaging, marketing. (Source: <https://imagenshumanas.photoshelter.com>)

4.2 Pink Peppercorn Project

In the same region, along the banks of the São Francisco River, other small communities of high sub-development index, such as Piaçabuçu (19,000 inhabitants), has benefited from the introduction of the Aroeira Project (Figure 3), developed and Managed by the NGO called Instituto Eco-Engenho and its partners. The project seeks to promote local sustainable development from the collection, beneficiation and commercialization of pink peppercorn. (from the the Aroeira tree) This ingredient is highly valued and appreciated in haute cuisine, both by flavor and aesthetic presentation. The local production has projected [even if timidly] this community from Alagoas in the international scenario and point to the feasible opportunities for sustainable growth of this population from the exploitation of the culinary base.



[Figure 3]: Aroeira Project - logo, collector, packaging and Eco-Engenho, use. (Source: <http://www.ecoengenho.org.br/projetos>)

4.3 Purified Oysters Project

Still in Alagoas, gastronomy has been used as a basis for the development of social technologies for local sustainable development that have positively transformed several small municipalities along Alagoas coastal line. These municipalities are part of a systemic and distributed project that aims to generate income and social development as well as promoting community-based tourism in this region (Pimenta & Sette, 2016) from the production, purification and commercialization of oysters. The Purified Oysters Project (Figure 4), aims to establish a differentiated marketing strategy, adding value to the traditional production process of oysters, strengthening the local gastronomic culture and the concepts of fair trade, consumption and sustainable tourism. Since its launch, the project has received the effective support of local trade, through the elaboration of menus having the oyster as its main ingredient and promotion of gastronomic competitions for the dissemination of the product and the region. At the end of 2017, the project was certified among the 21 best social technologies developed in Latin America, by the TS-2017 award, offered by the Banco do Brasil Foundation in partnership with UNESCO.



[Figure 4]: Systemic Project Ostras Depuradas from Alagoas - logo, plate, sale on the beach, walk to farms of creation, meeting between tourists and breeders. (Source: <https://www.facebook.com/OstrasDepuradasDeAlagoas/photos>)

In all cases mentioned above, the gastronomy has been connected to the local and sustainable social development and addressed as part of the solution to complex problems, such as those listed at the beginning of this text. To this end, the projects have benefited from the vocations of the territory and involved the communities in mixed actions (bottom-up and top-down), through the mobilization and involvement of various sectors and stakeholders,

guaranteeing the success of the initiatives. It is also important to say that these initiatives are part of the redevelopment of the identity of these communities that give birth to new traditions (Hobsbawn & Ranger, 2008), whose impact on the quality of life and the belonging of its components, should result in its subsequent recognition as a local cultural heritage.

DISCUSSION

In the three initiatives presented, we can identify design strategies in a systemic perspective at three levels: tactical, operational and strategic. From the planning of the productive circuit to the final presentation of products, we can observe the protagonism of the local community and the appreciation of the culture and history of the territory.

Considering the various aspects raised, we highlight some challenges for the designer's performance in projects that focus on sustainable use of territorial resources: a) learning about the context and the local imaginary, in a collective way; b) develop participatory processes and integrate stakeholders; c) implement tools to support environmental sustainability and give visibility to initiatives and their achievements; d) promote the training of designers in a systemic perspective of design; among others.

Projects that focus on local communities-based products need ranging from mental and imaginary constructions to the development of "concrete" solutions related to existing or latent demands. One of the most interesting and important aspects of these projects is the idea of belonging, especially in relation to the symbolic dimension, which is so necessary for people to feel part of a society and to develop democratic actions / projects (and also take part of places and recognize rights and duties in relation to the collective space). As part of the methodological approach to the design process, the initial stage "research and contextualization" (which involves understanding the situation) deserves to be highlighted, since it is from that moment that the project begins. In this sense, it is essential to develop strategies that allow the understanding of values and meanings related to the culture of the people involved in the process and the place where designers work. But it is necessary to go beyond, and understand, in fact, the possible forms of interaction with the community and, building the process together, from the demands presented.

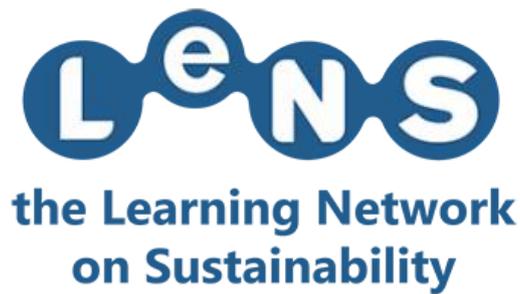
FINAL CONSIDERATIONS

The main contribution of this paper is to reflect on the application of theoretical and practical approaches of Systemic Design in emerging, complex and biodiverse scenarios, such as the ones currently found in emerging economies like Brazil, identifying possible impacts of the design intervention related to environmental, social, economic and cultural sustainability. Learning from development initiatives in specific contexts is an important step for us to reflect on strategies that can support other communities that face similar challenges. Therefore, the importance of developing and adapting tools that support the design process, coupled with the peculiarities of the socioeconomic, environmental and cultural conditions of emerging economies, is reinforced.

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HORTALIÇÁRIO: GARDEN FOR ANY SPACE

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ABSTRACT

This article, through a systematic review of the bibliography and case study, discusses new perspectives for sustainability in the environmental, socioeconomic and economic spheres, highlighting the importance of sustainable product-service systems (S. PSS) and design tools to build business models that are more innovative, competitive and sustainable in the face of opportunities and challenges and in pursuit of lifestyles more coherent with the current panorama. The design tools and the Sustainability Design Systems Method (MSDS) were applied to the start-up Hortaliçário in order to show the possibility of thinking about a business model that, from its origin, includes socio-environmental actions. The result was a systemic understanding of the business within the analyzed aspects, understanding the product in such a way that it is service oriented and ecoefficiency, in order to contribute to the development of solutions for more sustainable products and services.

Key Words: S. PSS; Business model; design tools; social innovation; society

1. INTRODUCTION

This paper deals with important concepts and tools that seek to balance the relationship between society, production, consumption and the environment. In the contemporary world, it is noticed that business models and labor relations are changing. Companies can no longer position themselves and compete only with prices, term and quality as a differential. Customers (users) are increasingly demanding, eager for news that makes their lives easier and environmentally conscious. Thus, the need for a new way of offering products, processes and services aimed at the well-being of the population and significantly reducing environmental impacts is understandable (Hashimoto and Santos, 2006). According to Maldonado (2009), Design has the task of mediating consumption and production, challenging the defiance of proposing innovative and sustainable solutions for the current systems of production / consumption, from the efficient integration between products and services, as he states in his study.

It is necessary to innovate and in a sustainable way. According to Engler (2009), innovation only makes sense if it is carried out in a sustainable way, regardless of whether it is a product, process or service. The more the company has, in its organizational culture, of commitment to environmental practices and understanding of these new users, the greater its sales. In this sense, the concept of a sustainable product-service system is presented as an innovative strategy that associates product supply (tangible part) with services (intangible part), promoting new sustainable business models. For Manzini and Vezzoli (2003), the shift of focus from physical products to an integrated system of goods and services aims to offer solutions to the consumer, satisfying a specific customer demand.

The design tools and the Sustainable Design Systems Method (SDSM) that will be detailed throughout the research are a support to create a project / business / business thinking for more sustainable purposes from the outset. In this way, we place the central objective of this research, which is to show the importance of thinking about the essence behind the business from the foreground. In addition, valuing the construction of businesses and entrepreneurs who look beyond the limits of the company itself and cultivate socio-environmental actions for a more harmonious world.

In order to reach these objectives, the concept of product-service systems will be worked out, demonstrating how it is expressed, its objectives, its categories and some tools and design method for its construction and application in business models. In a second moment, these concepts will be exemplified by means of the business model proposed for the startup Hortaliçário, "Gardens for any space".

2. METHODOLOGY

The methodology for the development of this work consists of qualitative research of applied nature. The research is exploratory and will be developed by combining bibliographical studies and exploration of a case study, in a descriptive approach through the qualitative analysis of the data.

The first stage was based on a theoretical study addressing the following themes: Design Method for Sustainability (DMS), design tools, Product-Service System (PSS) and Sustainable Product-Service System (SPSS).

The second stage concerns the case study that was conducted applying and reflecting on the concepts and tools of the theoretical reference that led to the formulation of the business model of the startup Hortaliçário, because according to Ganem, 2016 when we write and put into practice and when we bring the practice for our texts, writing is impregnated with a different energy. The startup, acting on a local scale, was chosen among the others as a case study, since it has its business model based on sector 2.5, in a way that seeks to undertake and at the same time generate social impact. Hortaliçário is not only about profit, proposing the association of financial sustainability with the positive impact it can generate in society, by offering solutions that integrate products, processes and services aimed at the well-being of the population. The startup has structured the niche market, the supply system (products, services and production), communication channels, distribution and sales, relationship with customers and suppliers, human resources and local partnership.

3. METHOD AND DESIGN TOOLS

The method selected in this study to analyze the business model during the case study was the Sustainable Design Systems Method (SDSM) proposed by Vezzoli (2010), with the objective of providing support and guiding the process of development of innovations of a sustainability system. According to Vezzoli (2010), the method allows the joining of several design tools, in the same way that allows the remodeling and / or addition of new activities, according to the needs of the project.

According to Dias (2016), the basis of the SDSM is structured in five main stages: strategic analysis, stage where the data necessary for the subsequent generation of ideas with sustainable potential is gathered and processed; exploration of opportunities, where the promising opportunities for strategies are recognized, identifying contexts for the orientation of sustainable projects; development of system / project concepts, the ideas with the greatest potential for success are chosen, through the involvement of all the actors; detailing the system, the specific requirements of the developed idea are identified, without which, it is not possible to execute them; and communication, the aspects of the projected solutions, especially those concerning sustainability, are communicated.

These tools were selected for application and analysis: the Sustainability Design-Orienting (SDO-Toolkit) and

the System Map. The first tool guides the process of generating ideas for product-service systems through a priority checklist for each sustainability pillar / radar, as well as making it possible to check for potential improvements over the existing system. The second describes graphically the actors involved in the process and the interactions between them regarding the flows of materials and products, information, money and work performance, contributing to the representation of the existing system and its organization (Vezzoli, 2010).

In addition to these tools, the following tools were used: Personas that are archetypes created through the understanding of the behavioral, cultural and geographical characteristics recognized in extreme profiles of consumers; Analogous scenarios where parallel situations are analyzed that tend to facilitate the view of the business by new perspectives; Competitive differentials in relation to singularity that makes a company unique and better than its main competitors; and Tomorrow headlines where fictitious calls from journals and magazines are projected where one wants to be in the future, trying to generate understanding as to what kind of impact the service or product will bring to society.

4. DEVELOPMENT

4.1 Concept of the product-service system (PSS) and sustainable product-service system (S.PSS)

The concept of the Product-Service System expresses more than simply adding services to the products. There is still no consensus on its meaning, but the present study suggests the following definition: system of products, services, actors / support network and support infrastructure aiming at competitiveness, meeting customer needs and a lower environmental impact compared to traditional business models (Goedkoop et al., 1999; Mont, 2002). The business goes from a simple transaction selling a product to a more complex relationship with the customer (Oliva; Kallenberg, 2003).

With respect to the elements that constitute a PSS, the product consists of the tangible part of the value, and the service consists of its intangible part (Tukker, 2004). With regard to the infrastructure and network of PSS actors, Neto, et.al. (2014) score:

Infrastructure fulfills its role in the PSS through the supply of area, energy, materials, technology and various consumables, as well as the provision of the necessary organizational context. This element of PSS enables the creation and extension of value, which may consist of the pre-existing infrastructure of the manufacturers or service providers, or an own infrastructure for the planned enterprise. The network of actors involved in the extension of value creation in the PSS is understood by the service network and the production network. The service network comprises the branches and location of the services, as well as their distribution, whether or not they may involve partnerships. This network is responsible for the regular delivery of services in the product life cycle. The production network, in turn, includes the PSS provider, the suppliers of parts, components, modules or subsystems. This network is responsible for producing the main physical product of the PSS at a limited number of production sites (Neto et.al., 2014, p.921).

Pawar et al. (2009) argue that the design of a PSS begins with defining the value unit that will satisfy consumers; then the cost estimate as well as the risks involved. Subsequently, one starts to think and design the PSS that will create the defined value. Finally, it is necessary to identify and manage the network of partners that, together with the organization, will build the value proposition, using the PSS. The advantages of a PSS are synthesized by Tukker (2004) as: providing customers with integrated and personalized solutions; build a long-term relationship with customers, favoring loyalty; providing more speed in innovation, since the focus is to meet the needs of customers through solutions; and reducing the environmental impact of products and the costs involved throughout their life cycle.

Some authors (Goedkoop et al., 1999; Manzini; Vezzoli, 2003) point the importance of association of PSS with sustainability. For these authors, the PSS can lead to the sustainable consumption of resources and transform patterns of consumption. But, according to Manzini and Vezzoli (2002), this should be checked on a case-by-case basis. It is only when the PSS contributes to the reorientation of unsustainable consumption practices that it can be called a Sustainable Product-Service System. The work in question starts from the understanding of the importance of integrating the PSS with the pillars of sustainability - socioeconomic, economic and environmental - to promote new business models that are more necessary and in coping with the current scenario.

Carlo Vezzoli (2006) presents some key moments in terms of extending the scope of the sustainability pillars associated with design. At first, concerns in the production process were linked to the selection of low-impact materials and energy, such as safe, recyclable, biodegradable and renewable materials. Then the planning of the product with low environmental impact was taken into consideration taking into account its entire life cycle. Subsequently, we began to think of more radical changes in production and consumption models, and the focus turned to a design of eco-efficient product-service systems, with a larger dimension than the individual product. The author points out some criteria to determine the eco-efficiency of this type of system: optimization of the system life; reduced transportation and distribution; resource minimization; minimization and recovery of waste; increased biocompatibility and conservation; minimization of toxicity.

More recently, scholars have opened the discussion about the role of design in relation to social and ethical sustainability, in which the principle of equity is directly associated, not indirect, with a potential result of a radical reduction of resources in industrial contexts (promoting responsible and sustainable consumption), as well as pay-

ing attention to the distribution and availability of these resources in an egalitarian way (promoting fairness among partners). Other aspects of the association of design with the socio-pillar are raised, such as: improving working conditions, prioritizing local resources, promoting social cohesion and integrating marginalized people.

In this context, Vezzoli (2006) places the promise of the emerging distributed economy model, whose main goal is to make products and services available locally, in a flexible and connected network system. For the author, distributed economics can reduce environmental impact and facilitate democratic access to resources. In this way, in terms of sustainable consumption and innovation system, a key role could be played by local companies, based on structured networks, initiatives and activities.

4.2 S.PSS Categories

S. PSS can be classified into three groups according to the type of orientation: product-oriented service, use-oriented service and result-oriented service. In a product-oriented S. PSS, the business model refers to the traditional way of selling, so that it is still essentially product-oriented, but some extra services are added, such as after-sales services - maintenance, repair, reuse, recycling, training and consulting (Williams, 2007; Baines et al., 2007). According to Williams (2007), in a S. PSS oriented to use, the product continues to play a central role in the business, but it consists of sale of use or availability of a product, not its property. This strategy is adopted by companies in order to maximize product use, however Sakao et al. (2009) argue that this can lead to an accelerated replacement of products, since many users will not provide them with the same care if they are owned by them. Already in the results-oriented S. PSS, there is agreement on granting of the result or competence / capacity to be delivered without the necessary involvement of one or another product (Tukker, 2004). In this context, companies sell personalized services in which the producer retains possession of the product and the customer pays only for the delivery of the results - laboratory tests, reports, among others (Baines et al., 2007).

5. CASE STUDY: HORTALIÇÁRIO

The startup team Hortaliçário is formed by the partners-founders Thalita Barbalho, Graphic Designer; Ana Carolina Lacerda, Architect and Urbanist; and Letícia Hilário, Designer of Environments - all three having a Master in Design, Innovation and Sustainability in common. Horticultural, "Gardens for any space", "provides not only a physical garden, but also quality of life." The startup satisfaction unit is access to quality food. It offers the solution to those customers who: (a) want a vegetable garden and do not know how to start, (b) have tried to have a vegetable garden, but the seedlings have not avenged, (c) would like something that would facilitate the acquisition of seedlings and maintenance of the garden, (d) have no incentive to start or continue production. The solution that Hortaliçário delivers to its customers is the product - the vegetable garden (module¹ with a three-seedling kit) - associated to the service (experience and practicality), which is offered through a subscription plan with integrated and customized solutions according to customer needs. The garden module, besides being adaptable and flexible, suits different spaces, is a biodegradable product, which contributes to the reduction of environmental impact.

The benefits delivered through the plans consist of products that are needed to maintain the garden (kit of seedlings, fertilizers and organic manure), exclusive courses, tips, recipes, online consulting opportunities and gifts to enable customization of the product. There are three types of plans: monthly (R \$ 42.00), semiannual (R \$ 38.00 / month) and annual (R \$ 30.00 / month). Through these plans and values, Hortaliçário seeks to build a long-term relationship with customers, favoring their loyalty.

The social impact generated by Hortaliçário is linked to the fact that, with each vegetable sold, the startup undertakes to enable, support and empower (through courses and training) community gardens, for production of agro-ecological foods to be consumed by the producers themselves or destined for sale, generating income for the impacted community. Some of the seedlings produced by the community vegetable garden will still be acquired by the startup, which contributes to the growth of the local enterprise and feeds Hortaliçário. When the assisted community garden is self-sufficient, another garden is chosen to start the same support process.

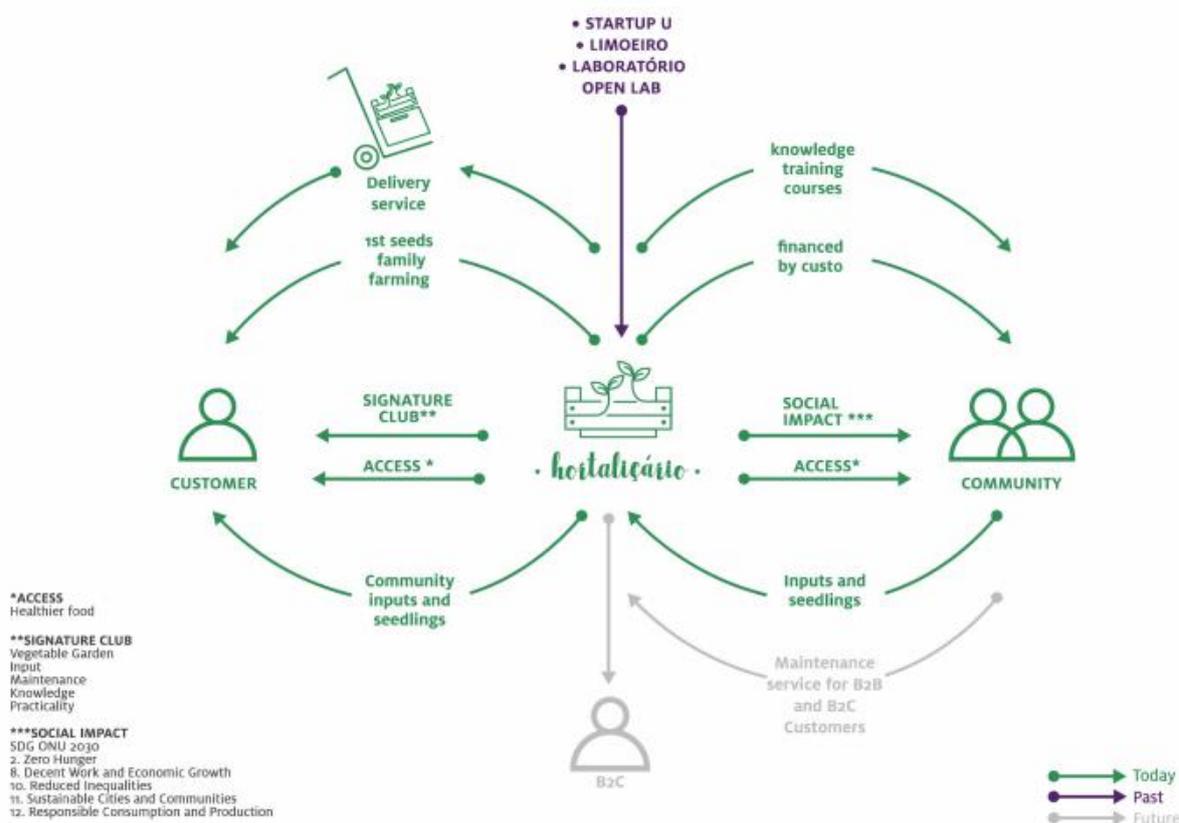
The current market niche of Hortaliçário is in the B2C (Business to Commerce) model, that is, the commercial transaction is between the company (distributor) and the final consumer, through an electronic platform (e-commerce). In the near future, the startup expects to act in a B2B (Business to Business) niche, conducting business-to-business transactions, meeting the demand of condos and restaurants through a new business model. Hortaliçário does not have a physical unit, therefore, its sales are made, as mentioned, online, and its revenue is the result of the association of sale of products and services signatures.

Hortaliçário today has partners/suppliers who collaborate to build a successful venture, such as the Senai Open Laboratory, which supports the creation and execution of the biodegradable module for vegetable gardens; CEDTec (Design and Technology studies centre - Design School/UEMG), which, through research and extension projects, collaborates in the choice of gardens to be impacted and in the effectiveness of partnerships; and Agroecology in the Periphery, a potential partner for the purchase of seedlings, whose objective is to promote socio-environmental development in peripheral communities and the strengthening of urban agriculture network of the Metropolitan Region of Belo Horizonte through training workshops, joint efforts and exchanges with focus on agroecology to guarantee the right to sustainable cities.

¹ Modular biodegradable container: Today, the startup offers two options, one to be placed on the floor and another to be placed in the window or wall.

In order to build this system model, a strategic analysis and the recognition of opportunities achieved through a pre-acceleration conducted by Startup U (initiative of the UFMG's Junior Business Center) were carried out with a practical methodology and meetings with mentors who work in the entrepreneurial field. These analyzes, recognition of opportunities, and the subsequent development of system concepts involved all actors in the process - partners / employees, clients and potential partners - through interviews and questionnaires that led the team to recognize the promising opportunities for sustainable strategies and determine/detailing the business system. Hortaliçário's business model is product-oriented S. PSS, so the sale is still essentially product-oriented, but some extra services are added, such as after-sales services - maintenance, training and consulting. The communication of the aspects of projected solutions was carried out throughout the whole process, mainly with respect to sustainability

Figure 1 below shows the startup system map. The image shows the main fluxes, observed in green, referring to the present; the secondary ones, in gray, referring to the future; and the others, in purple, referring to past actions. The main flows are characterized by direct relationship with the customer (paying), community supported (social impact) through the sales and distribution sectors for the first and financing and training for the second (and possibly later, sales of seedlings by the community for the Horticultural and maintenance of the client gardens in response to the given training). Secondary flows refer to possible and future actions in the B2B market niche (business to business) by making transactions between companies (condominiums and restaurants). The purple flow is characterized by pre-acceleration and fruit awards from this, which started the construction of the business system.



[Figure 1] System map — Hortaliçário (Font: Thalita Barbalho, 2017)

Complementing the system map, Figures 2, 3 and 4, next, present the tool SDO (Sustainability Design Orienting) according to the environmental, socioeconomic and economic radars, respectively. For the analysis of the graphs below, it is considered the priority level of the projects as important actions for the enterprise in A (high), M (medium), low (L) and neutral (N), besides comparing the proposal of the startup with the services and products offered by competitors, between: radical improvement (++), incremental improvement (+), changes (=) and depreciation (-).

[In the environmental radar, the analysis showed that, in relation to the existing systems, Hortaliçário has high priority in relation to: optimization of the lifestystem, placing emphasis on the use of the biodegradable module; transport and distribution, emphasizing the partnerships with local producers for maintenance and distribution of seedlings; minimization and recovery of waste, with a view to reuse of food waste (in the future, through the people involved in community gardens). On the other hand, the medium priority occurs in relation to the increased conservation and biocompatibility; the low priority, in relation to the minimization of resources; and the neutral priority in relation to the minimization of toxicity, since there are no toxic substances involved at any stage of the process.

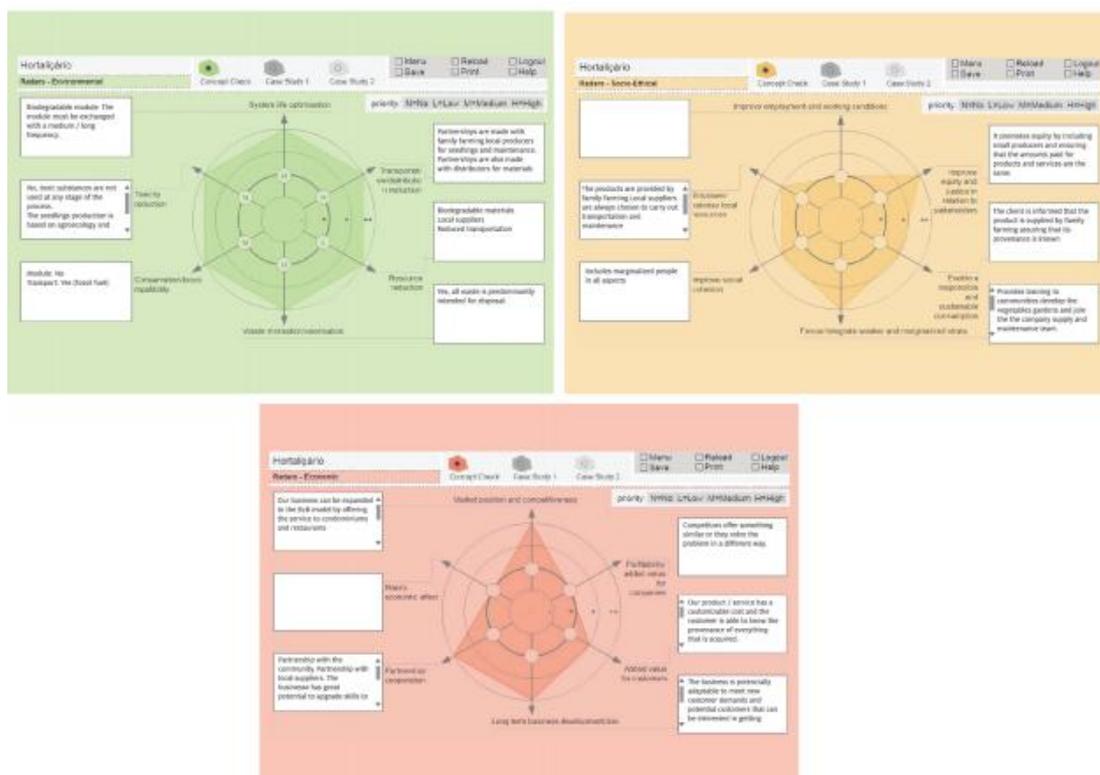


Figure 2] SDO — Environmental, socio ethical and economic dimensions (Fonte: lens.polimi.it - Sustainability Design Orienting Toolkit, 2017)

On socio-ethical radar, analysis demonstrated that the system has a high priority for Design in all criteria: promoting fairness between partners by including local producers in the process and ensuring a fair payment for products and services; integrating marginalized people by providing community training for the development of community gardens and, in the future, enabling trained people to join the company’s supply and maintenance team; promote social cohesion; prioritize local resources; promote responsible and sustainable consumption; and improve working conditions.

In the economic radar, analysis showed that the system has a high priority of Design with respect to actions in the following criteria: partnerships and cooperation, emphasizing the important partnership with local communities and producers; market position and competitiveness, due to the fact that startup is the first home gardening club, in addition to being able, in the future, to expand the market niche for B2B, carrying out transactions with condominiums and restaurants; long-term business development as the business is potentially adaptable to meet the new demands of customers and potential customers who may be interested in getting courses, information and even seedlings whether or not they have a home garden; and added value for customers, for offering customizable cost and for the customer to know the source of all products being purchased. As a criterion of medium importance, we identified: macroeconomic effects and added value for companies, with no actions with low or neutral priority.

5. FINAL CONSIDERATIONS

The creation of a S. PSS business model allows us to think and believe in more environmentally correct, socially just and economically viable production and consumption models. In addition, the implementation of this system in companies presents a series of strategic benefits, “[...] as opportunities for innovation and market development; increased efficiency of operations; more stable and long-term relationships with consumers / suppliers; enhancement of corporate identity; and better return on consumer needs” (SANTOS, 2009).

It was understood that the use of design tools in this process of building a S. PSS business model is extremely valuable with respect to aspects of: identifying and guiding the products and services to better meet specific demands of customers; define priorities for sustainability radars; create the map of enterprise system, making it clear what are the partners and flows, among other elements; view competitors and recognize competitive differentials; projecting at what point you want to be in the future and what impacts on society this business model can lead.

It is also understood the importance of this study beyond the understanding and analysis of tools and method. Through the case study, the valuation of entrepreneurs and businesses that transform a good idea from the beginning into something concrete and good not only for company, but for society, thinking about the pillars of sustainability, is put in the agenda.

The startup Hortaliçário did what most companies, as a rule, do not: think the product associated with the service so that it is service-oriented and eco-efficient. Thus, the startup seeks to develop more sustainable production and consumption solutions and contribute, even at a local scale, to behavioral /cultural change of communities.

As a proposal for future work, it is possible to point out the possibility of reflecting on new case studies that

approach companies that have as a guideline sustainable purposes, making a consistent survey about the number of companies that have emerged, and which have the desire to generate positive impact in the world building initiatives that change reality for the better, thus expanding the knowledge of these activities and inspiring similar actions.

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A DESIGN TOOLKIT TO INTEGRATE DISTRIBUTED MANUFACTURING INTO PRODUCT-SERVICE SYSTEMS DEVELOPMENT

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ABSTRACT

Implementation of Product-Service Systems (PSS) has a great sustainability potential. However, PSS are not widely put into practice because of a number of barriers. The authors of this paper propose that Distributed Manufacturing (DM) can be applied to improve PSS development. Existing, yet very fragmented attempts made by other scholars illustrate potential applications of DM features to PSS. However, the absence of practical support of DM and PSS combination encouraged authors to develop a DM applied to PSS design toolkit. This paper describes the research process which has been carried out to develop the design toolkit and define the proposed design process. Empirical toolkit's applications with companies, design practitioners and students show the potential of the toolkit to support sustainability-oriented idea generation for each PSS life cycle stage.

Key Words: Product-Service Systems; Distributed Manufacturing; Design Toolkit

1. INTRODUCTION

Product-Service Systems (PSS) is an offering model made of “a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs” (Tukker and Tischner, 2006). Integration of products and services has the potential to improve environmental, social and economic sustainability, at the same time providing competitive advantage for companies delivering PSS (Cooper and Evans, 2000; Mont, 2002; Vasantha et al., 2012). However, PSS implementation is not a straightforward process. It requires companies to adopt different competences compared to those needed to implement traditional productbased business offerings (Besch, 2005). Key implementation barriers are related to organisational mind-set, customer consumption habits and lack of supportive regulations (Ceschin, 2013; 2014; Vezzoli et al., 2015). The hypothesis of this paper is that Distributed Manufacturing (DM), described as a shift from conventional mass production to small-scale manufacturing carried out at the point of need (Kohtala, 2015) can help to address some of PSS implementation barriers. Literature describes existing attempts made by other scholars to improve PSS development through the application of DM features, such as mass customisation (Suominen et al., 2009; Mourtzis et al., 2018), digitisation and cloud manufacturing (Lerch and Gotsch, 2015; Charo and Schaefer, 2018), additive manufacturing (Despeisse and Ford, 2015) and direct consumer engagement (Sinclair et al., 2018). However, these attempts are still very fragmented: none of the scholars aim at addressing PSS implementation barriers and focus only on individual DM features without providing a complete overview of the potential of DM as a whole. Existing contributions by other scholars illustrate the potential of DM to support PSS development, however, scholars agree that systematic knowledge about potential DM application to improved PSS development is needed, as well as practical validation of this knowledge. (Ford et al., 2015). In addition, there is a need to translate this knowledge into practically applicable tools to support PSS development. The research presented in this paper aims to fill this knowledge gap by answering the following research question:

How to practically support PSS development through the application of DM?

This paper presents the process and outcomes of three-year research framed within the LeNSin project (EU-funded, 2015-2019) and carried out to develop DM applied to PSS design toolkit. The aim of the design toolkit is to facilitate companies, design practitioners and students in considering potential DM applications in each PSS life cycle stage, in order to improve PSS development. The toolkit has been empirically tested with experts, companies, design practitioners and students in order to evaluate and improve its completeness, effectiveness and usability. This paper presents only the final version of the toolkit, describes its elements, a proposed design process and toolkit's compatibility with other tools and methods. Initial research findings, evaluation studies and the initial version of the toolkit are described in Petruilaityte et al. (2017), Petruilaityte et al. (2018) and Petruilaityte et al. (2019).

The paper is structured in four sections. Section 2 describes the methodology adopted in this research and outlines each element of the DM applied to PSS design toolkit. Section 3 discusses application of the design toolkit and its sustainability implications. Section 4 concludes the research.

2. DEVELOPMENT OF THE DESIGN TOOLKIT

2.1. Methodological framework

The research activities have been framed within the Design Research Methodology (DRM) framework (Blessing & Chakrabarti, 2009). The DRM provides a plan of action for the formulation and assessment of theoretical knowledge and the development and validation of a practical support (in this case a design toolkit) built on these theoretical findings. DRM approach is particularly relevant for this research, since it frames the collection and analysis of theoretical findings about PSS and DM, the development of the design toolkit (design support) and the iterative process of its testing, refinement and validation.

The research process was split in nine stages [Table 2.1]. The research started with the literature review aiming to collect PSS implementation barriers and DM opportunities (RC). Later, semi-structured expert interviews and DM research seminar were carried out to gather most recent knowledge about DM (DS-I). All collected theoretical knowledge was later used to develop a set of DM applied to PSS near-future scenarios which were later integrated into a DM applied to PSS design toolkit (PS-I). The design toolkit has been tested in three rounds of empirical applications (DS-II, DS-III and DS-IV) with improvements being made after each round (PS-II, PS-III and PSIV). First four research stages - RC, DS-I, PS-I and DS-II – are introduced and discussed in Petruilaityte et al. (2018). In particular, PS-I stage framing DM applied to PSS near-future scenario development is presented in Petruilaityte et al. (2019).

Table 2.1 Research stages according to DRM with corresponding data collection methods and outcomes

DRM stages	Research methods	Outcomes
Research Clarification (RC)	• Literature review	• Collection of existing PSS implementation barriers and promising DM opportunities
Descriptive Study I (DS-I)	• Semi-structured expert interviews • DM research seminar	• Validation of literature review findings regarding DM; • Collection of the most recent knowledge and nearfuture trends of DM

DRM stages	Research methods	Outcomes
Prescriptive Study (PS-I)	<ul style="list-style-type: none"> Literature review Scenario development Scenario integration into the design toolkit V1.0 	<ul style="list-style-type: none"> Analysis of scenario planning techniques Development of DM applied to PSS near-future scenarios; Development of the first version of the DM applied to PSS design toolkit
Descriptive Study II (DS-II)	<ul style="list-style-type: none"> Workshop with design students 	<ul style="list-style-type: none"> Evaluation of usability and effectiveness of the first version of the toolkit
Prescriptive Study II (PS-II)	<ul style="list-style-type: none"> Development of the design toolkit V2.0 	<ul style="list-style-type: none"> Development of the second version of the toolkit based on DS-II findings
Descriptive Study III (DS-III)	<ul style="list-style-type: none"> Structured expert interviews Workshops with manufacturing companies and design agencies Workshop with PSS design students 	<ul style="list-style-type: none"> Evaluation of completeness, usability and effectiveness of the second version of the toolkit
Prescriptive Study III (PS-III)	<ul style="list-style-type: none"> Development of the design toolkit V2.0 	<ul style="list-style-type: none"> Development of the third version of the toolkit based on DS-III findings
Descriptive Study IV (DS-IV)	<ul style="list-style-type: none"> Workshop with design students 	<ul style="list-style-type: none"> Evaluation of usability and communication elements of the third version of the toolkit
Prescriptive Study IV (PS-IV)	<ul style="list-style-type: none"> Development of the final version of the design toolkit 	<ul style="list-style-type: none"> Development of the final version of the DM applied to PSS design toolkit based on DS-IV findings

In total, 9 PSS and/or DM experts, 81 professionals from companies, 13 design practitioners and 74 students took part in toolkit's testing activities [Figure 1]. Participants evaluated different aspects of the toolkit and defined recommendation for improvements. Furthermore, three rounds of practical design toolkit's applications helped to define a proposed and alternative design processes briefly discussed in Section 3.



[Figure 1] Empirical toolkit's applications with DM and/or PSS experts (1), companies (2), design agencies (3) and students (4)

2.2. DM applied to PSS design toolkit

The final version of the toolkit presented in this paper is designed to achieve the following goals: 1] to provide knowledge about potential DM opportunities; 2] to encourage its users to generate ideas for each PSS life cycle stage; and 3] to stimulate creative future-oriented thinking. The central component of the design toolkit [Figure 2] is 40 near-future scenario cards illustrating application of DM features to PSS development. Each card is doublesided. The front side (1) describes and illustrates the scenario, summarises PSS life cycle stages and implementation barriers scenario addresses. The back side of the card (2) provides a DM example, benefits and challenges of the scenario and idea triggering questions. In order to classify scenario cards and facilitate their selection process three scenario cards selection diagram are provided alongside the cards. Each diagram is related to a specific purpose. The stage-by-stage DM and PSS connection scenario cards selection diagram (3) intends to help to create a new Product-Service System. The Distributed Manufacturing features scenario cards selection diagram (4) aims to help innovate an existing Product-Service System. The Product-Service System implementation barriers scenario cards selection diagram (5) helps its users to address issues of an existing Product-Service System. Each diagram has been supported with idea-triggering questions and numbers referring to near-future scenario cards. The decision sheet has been developed to help toolkit's users to identify their intention (6). The final component of the toolkit is the idea generation diagram created for generated idea categorisation according to PSS life cycle stages and DM features (7).

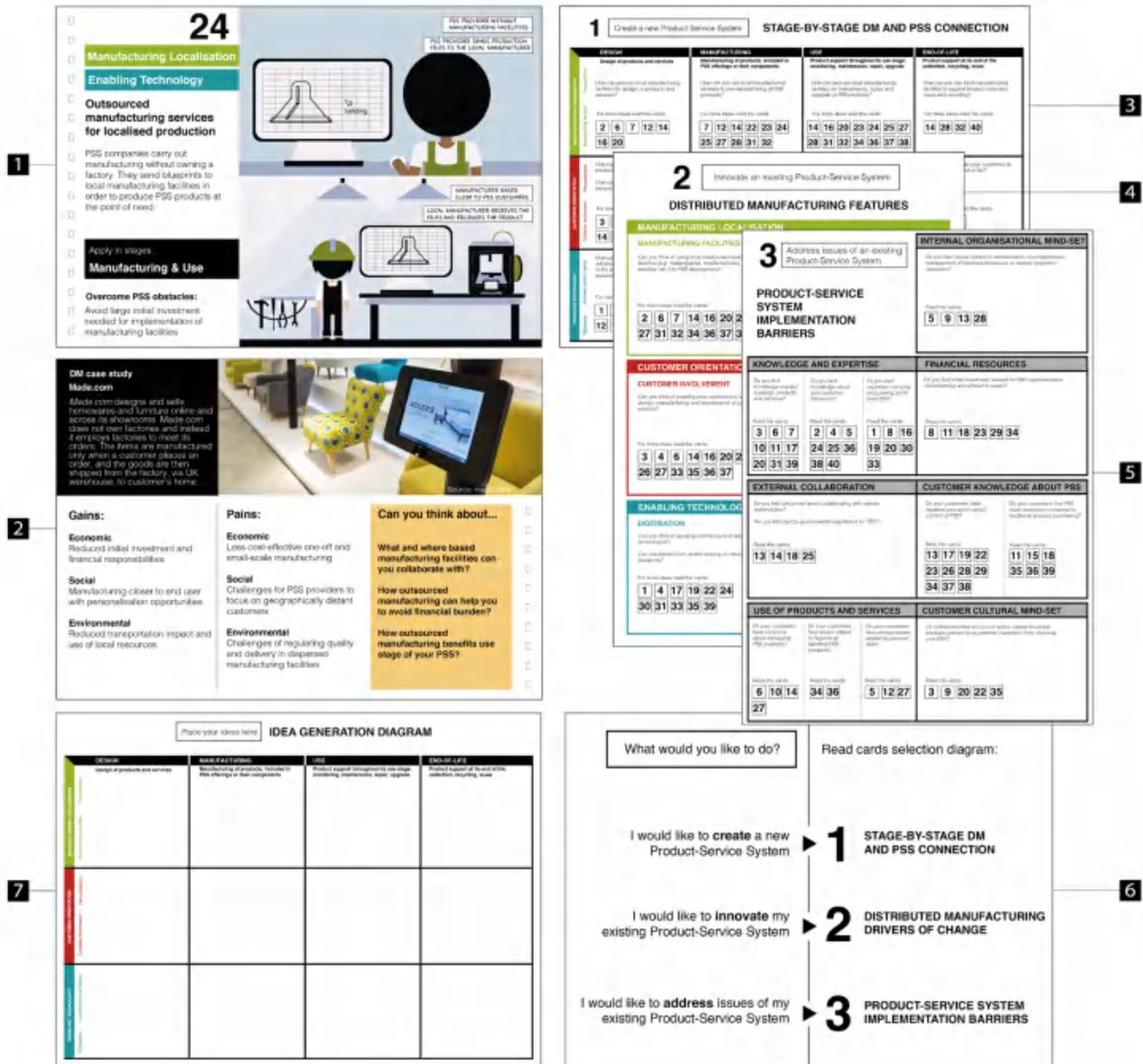


Figure 2 DM applied to PSS design toolkit

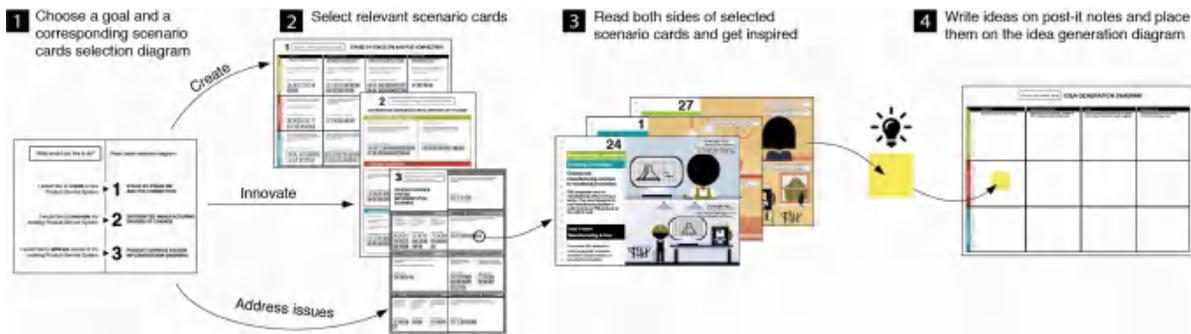
3. DISCUSSION

A number of PSS tools and methodologies have been developed and are widely described in the literature. However, none of them include Distributed Manufacturing aspects in any stage of PSS development. The literature review conducted at the early stage of this research showed the growing interest on DM applications to PSS. Empirical toolkit's testing activities with manufacturing companies, design agencies, academics and students proved that additional support to PSS development through the application of DM is needed. The studies showed that the DM features described in the toolkit facilitated participants engagement in idea generation process. Certainly, such user interest was caused by DM dependence on topics particularly relevant nowadays: innovative manufacturing technologies (e.g. 3D/4D printing), unconventional manufacturing facilities (e.g. public spaces, home, etc.), opensource data, improved personalisation, etc. Furthermore, the studies with companies allowed to observe, that most of the manufacturers were already planning of innovating their PSS business offerings with DM solution, thus did not know how to strategically frame such innovations. Design students who participated in toolkit's testing shared that the toolkit provided valuable knowledge about DM and PSS and they were planning of integrating gained knowledge in other ongoing university projects.

3.1. Design process

Each element of the DM applied to PSS design toolkit is created to be used in the purposeful order [Figure 3]: first, identification of the goal using the decision sheet (1); second, selection of relevant scenario cards using the scenario cards selection diagrams (2); third, DM applied to PSS idea generation using near-future scenario cards (3) and,

finally, positioning of developed ideas on the idea generation diagram (4). The design process evolved from its em-



pirical applications with various user groups. It has been observed that the design process using the toolkit can vary depending on the users' background and the amount of time appointed for the idea generation process. Firstly, initial DM applied to PSS ideas can be generated using only scenario cards selection diagrams by answering questions provided on them. Secondly, idea generation process can be carried out by reading all near-future scenario cards. This method is useful for educators and students, because reading all scenario cards help to build an in-depth understanding about DM opportunities and their role in PSS development. Finally, generated ideas written on post-it notes can be clustered in a way chosen by toolkit's users without using the idea generation toolkit. On the other hand, the idea generation diagram can be used to sketch and visualise ideas. It can be summarised that the toolkit enables its users to adopt flexible ways of applying it depending on their background, abilities and time constrains.

Figure 3 A design process using DM applied to PSS design toolkit

The DM applied to PSS design toolkit is made to provide knowledge about DM and support idea generation process of DM applied to PSS development. However, for building an all-inclusive PSS solution, the toolkit must be applied alongside other tools and methods. Evaluation studies showed that user profiles, field observations, customer journeys, system maps, storyboards and sustainability blueprints can be applied prior and after using the design toolkit. It can be summarised that the DM applied to PSS design toolkit can be integrated into a complete PSS design process: benefit from the information collected using initial design methods and contribute to further project development stages.

3.2. Sustainability implications

The research on DM and PSS combination focused on two sustainability-oriented models. The rise of DM is caused by increasing sustainability awareness and its potential to become an alternative to wasteful centralised manufacturing (Stai et al., 2016; Angeles-Martinez et al., 2018). Furthermore, it is well known that properly implemented PSS shows the potential to improve environmental, social and economic sustainability (Cooper and Evans, 2000). According to Vasantha et al. (2012), innovative value adding PSS can only be created combining products and services throughout the life cycle stages. Mont (2002) argues that the majority of existing PSS are fragmented because of the lack of complete life cycle stages perspective. For this reason, DM applied to PSS design toolkit enables its users to focus on a complete PSS life cycle. The key sustainability implication of DM is decreased environmental impact caused by transportation linked reduced distances between manufacturing facilities, customers and resources and ability to send digital files globally and produce products or spare parts close to or at the actual point of need. Localisation of manufacturing facilities enables PSS companies to collaborate with local start-ups and SMEs, support local producers and potentially benefit local communities. On-demand production and direct customer involvement enables development of relevant and potentially long-lasting PSS solutions. Additive manufacturing machinery used in DM networks allows to reduce number and amount of materials, simplify components for easy disassembly, re-manufacturing and upgrade, as well as reduce waste production during the manufacturing stage. It can also optimise (and localise) maintenance services potentially reducing time and resources needed to support PSS offerings. Application of DM features in each PSS life cycle stage shows the potential to improve sustainable PSS development.

4. CONCLUSIONS

If properly implemented Product-Service Systems business models show the potential to improve environmental, social and economic sustainability. However, PSS implementation is still limited by organisational, cultural and regulatory barriers. There are existing, yet very fragmented attempts to improve PSS development through the application of Distributed Manufacturing features. This paper has described the research process which was carried out to develop a design toolkit, aiming to support idea generation process for PSS. The research partially answered the initial research question: How to practically support PSS development through the application of DM features?

The DM applied to PSS design toolkit contains 40 double-sided near-future scenario cards describing applications of DM features in different PSS life cycle stages and addressing specific PSS implementation barriers. These cards are classified on three scenario cards selection diagrams supporting relevant cards selection. Finally, the idea generation diagram is provided for positioning generated ideas. The design toolkit aims at supporting companies,

design practitioners and educators in gaining knowledge about DM and generating future-oriented ideas to create new or improve existing PSS solutions. The toolkit can be used following a proposed design process or in a flexible way depending on users experience and time constrains. The toolkit can be also applied before and after other PSS design tools and methods. It enables its users to focus on a complete PSS life cycle thus increasing the potential to create truly sustainable PSS.

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DESIGN FOR SUSTAINABILITY APPLIED TO WORKSPACES

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ABSTRACT

Due to the behavioral changes of society in a dynamic and interconnected world, workspaces have gotten a new meaning. Designers must understand the needs and desires of the final users in order to create something that fulfills them and creates a whole experience out of it. By adopting living systems “ecological” worldview, design will require a higher level of interrelationships between natural, human and built systems, and the disciplines within them (Boecher et al, 2009, p xii) describe the achievement of a broader integration of systems within the sustainability movement as an “Integrative Design Process (IPD)”.

The aim of this paper is to comprehend how Product-Service System Design methodologies can be applied in Interior Design with the means of designing a workspace that by being co-created by the users, can become more sustainable and that can satisfy better the end user. Besides, the relation of Interior Design and Sustainability, that comes after the comprehension of it in two levels. The first one is a social level, associated to the well-being of the end user in a workspace (lighting, insulation and many other specs of the spaces), while the second level is the study of the environmental design of the spaces (materials & products) supported by Life Cycle Assessments (LCA) studies, to cognize about the carbon footprint left in the world through all the life cycle phases. These different studies become crucial on the decision making, since they can change the perception we have about materials or furniture chosen within a project.

Finally, with means of supporting the ideas exposed and to have a better understanding of it, we expose some case studies. The aforementioned research is part of the outcome of an ongoing thesis held for a Master of PSSD at the Design Department of Politecnico di Milano and part of the Farb Research (ISBN: 9788891777201).

Keywords: Product-ServiceSystems, Interior Design, Sustainability, Co-Design

1. EVOLUTION OF WORKSPACES & NEW TRENDS

The growth of the world population and the increase of inhabitants in urban settlements, together with the constant technological developments, impose a continuous rethinking of ways and places in which we live (Heidegger, 1954). It is estimated that by 2050 the earth will reach 10 billion inhabitants, from which 66% of the world population will live in megapolis and large cities¹.

Over time, living has increasingly become a more composite and multifaceted, both in relation to the numerous declinations of individuality and with respect to technological developments and socio-economic changes, because “the environment that surrounds us is a dynamic intersection of fast and complex social, cultural and environmental entities” (Sayegh, 2018, p.9). In addition, the fast development of many typologies of spaces as a result of the transformation of the activities performed inside them, the experience of motion, and the technological advances in transports, has led to the possibility of traveling to an increasing number of individuals. (Scullica, 2018).

The sociologists John Urry and Mimi Sheller, who have long studied the mobility of individuals, stated that:

“all the world seems to be on the move. Asylum seekers, international students, terrorists, members of diasporas, holidaymakers, business people, sports stars, refugees, backpackers, commuters, the early retired, young mobile professionals, prostitutes, armed forces -these and many others fill the world’s airports, buses, ships, and trains. The scale of this travelling is immense. Internationally there are over 700 million legal passenger arrivals each year” (Urry and Sheller, 2006, p.207).

According to the sociologist Urry and Elliott (Elliott, Urry, 2010) mobile life, is changing the behavior of societies, from the way in which people think and interact to the physical space and connections in which they live. These factors are now an essential condition -in particular interiors -and they must be considered.

During the ‘90s the home office phenomenon started due to the possibility of working home by the new computer technologies. Since then, communication technologies have increased and evolved in a way that nowadays work can be easily carried out everywhere, and it is above all connected with the new spaces for “living, working and travelling”, leading to the new working model, smart working². (Scullica, Elgani, 2018)

“Nowadays, offices are no longer just a system of workstations -they are slowly transformed to match with new lifestyles”³ (Berberi, 2017). Mobility has become an existential dimension based on eradication, related to one’s personal identity, relations in between a community in which it is not linked a physical space nor a given time.

In a global dimension where individuality and isolation prevail, many people share the need to be part of a “light community”, based on lifestyles, tastes and similar interests (Manzini, 2018), in which distinct solitudes can be connected to each other by sharing a sensory experience.

Workspaces have evolved in a dramatic way on the past decades due to many changes of the behavior of society and in the whole working system. Likewise, internet has brought people closer by being virtually connected. Nowadays, there is no need to have physical contact to share information or knowledge, this leads to the rise of “working nomads” or “knowledge workers”, who can be defined as people that work independently in different locations and that thanks to the internet access, smartphones and voice over internet protocol (VoIP) are able to keep contact with clients and employers all over the world, no matter the location.

The rise of rent prices and real estate is making rethink and reorganize the distribution and working areas inside companies. Due to this fact, and thanks to the IoTs that allow people to continue to be connected even from far away, corporations are applying different working systems to have less people inside the working space. Some of these methodologies are to reduce the number of square meters by outsourcing services, using teleworking systems for fixed workers or even using a hot-desking concept inside the workplace.

In addition, the high costs for companies in terms of salaries, taxation systems and workspaces has brought to the demand of outsourcing system services instead of hiring people for fixed-job positions. Thus, the market of freelancers or knowledge workers is increasing in the population -and in response, the rising demand of coworking spaces.

Furthermore, most of knowledge workers who used to have their own space are not able to pay the high rents of private offices anymore. This has led to the demand of spaces capable to suit multi-functions that can easily adapt to different situations and to shared spaces by workers of different fields who are able to share knowledge and build new networks.

Communication through the network has become a central and fundamental element in the work field: in first place, as cause of the IoTs the exchange of information between individuals has increased in a level that it has brought new varieties of collaborations and relationship in informal and formal ways. The comprehension between people, spaces and objects is possible because environments has become progressively smart and able to interact with individuals (Elgani, 2018).

¹ retrieved from www.esa.un.org/unpd/wpp/

² The Italian law n. 81 of 22 May 2017 defines by rule Smart Working -a management model that allows people to work from a distance and increases worker’s freedom and autonomy. In Italy this phenomenon is monitored by the Smart Working Observatory of the School of Management of the Politecnico di Milan

³ Berberi L. “Benvenuti nella casa-ufficio di Milano, gli studi del Politecnico per ripensare il posto di lavoro: diventera uno spazio ibrido tra dovere, riposo e piacere”, in *Corriere della Sera*, 3rd April 2017.

The way in which work is conceived and organized has been radically transformed, even before the physical workspaces. In order to achieve a shared goal, there is the wish to create “community” -a word that the Italian entrepreneur Adriano Olivetti had strongly connected to the work field (Olivetti, 2013) -because of the current need to share complex processes among professionals with different skills. Meanwhile, the users need individual workspaces where they can have privacy and silence to achieve more productivity or concentration.

Flexibility, creativity, speed and adaptation become essential requirements for the nowadays workers. They must learn to relate with increasingly sophisticated tools and machines.

As written by Michele De Lucchi in *Domus*⁴, from an architectural point of view we witness a dematerialization of the workspaces because at present many professionals can easily work from home or from public spaces, like a bar and a restaurant, or while travelling from a place to another by simply having access to a device with internet connection.

Technological and design evolution have allowed the creation of complex devices that are small and easily transportable, and integrated systems for spaces and furnishings that are increasingly capable of relate with the users. Presently, it is possible to organize meetings in real time with people located in different parts of the globe, without the need to meet physically; Pajevic and Shearmur define this phenomenon as “workplace mobility «with reference to “the ability of workers to carry out work-related activities at any time and at any place as a result of the computerization of work-related activities, workplace technology miniaturization, and IoTs” (Pajevic, Shearmur, 2017).

For the previous exposed, we can conclude that social behaviors and the evolution in technologies -between other facts -have led to an extreme change in the working environment. Companies have less fixed workers but focus more on supporting them with an environment that looks after their human needs, taking in count not just the physical space but supporting their health in a holistic way. On the other side, knowledge workers are in continuous search for places where to develop their activities and build new networks, thus, the appearance of coworking spaces and hubs focus on bringing to their users ‘spaces and commodities user-based.

Workspaces -both for smart workers or fixed workers -are mainly places that are currently following sustainable trends in two senses. The first one, is to choose the right materials, furniture and to add the technical solutions to achieve a sustainable environment. The second one, is to achieve sustainability by understanding the ongoing social behaviors to support the wellbeing of the users, achieving a nature minded mindset.

In order to achieve sustainable spaces, designers need to understand the meaning of environmental spaces, for creating afterwards hybrid spaces where smart and modular furniture can adapt to changing situations within some quick changes while maintaining the existence of private spaces, intermediate spaces and public spaces -in which sometimes can be included “hot-desking areas”-. Another topic is to understand the needs and desires of the users to create user-based service-systems that supports the wellbeing of them while allowing the progress of their professional activities.

2. PRODUCT SERVICE SYSTEM DESIGN & CO-CREATION

Due to the societal lifestyle shifts, priorities of the users have changed from owning to experiencing, this means that people are not looking after the sense of belonging goods anymore but the sense of being fulfilled by having the best experience out of something. Therefore, Product-Service System Design (PSSD) is increasingly getting more importance in the design world.

PSSD consists on a mix of tangible products and services designed and combined so that they jointly are capable of fulfilling final customer needs (A. Tukker, U. Tischner, 2006). Product-Service Systems are a specific type of value proposition that a business (network) offers to (or co-produces) with its clients which end up being the final users (Tukker, Tischner, 2006). Having as an outcome user-based PSS.

The evolution in design research from a user-centered approach to co-designing is changing the roles of the designer, the researcher and the person formerly known as the ‘user’. The implications of this, shift for the education of designers and researchers are enormous. The evolution in design research from a user-centered approach to co-designing is changing the landscape of design practice as well, creating new domains of collective creativity. i.e. creativity that is shared by two or more people. (Sanders, Stappers, 2008), thus, co-design is a specific instance of co-creation, referring to experienced designers and inexperienced people working together through the development of the design process to achieve a holistic system where tangibles and intangibles -together -fulfil of the needs and desires of the users.

Before the decade of ‘70s designers took practice of human centered design (fig.1), using people as the center of the study and exploring their needs and desires. On the other hand, with the evolution and further studies of the design practices, it has been proved that it is more efficient to involve the final users as stakeholders into the design process in order to have a better outcome. Therefore, co-design gets the roles mixed up (fig.2), positioning the person who will use the product or service as an expert through the design process, playing a main role in the design process and idea generation. Instead, the designer plays the role of researcher, collaborating and using different tools through the process of idea generation.

⁴“On my travels around the world, coffee chains are my favorite offices: Pret a Manger, Starbucks... I can have breakfast, lunch and dinner, sitting all the day with Wi-Fi and aroma of bread and croissants in the air. I can look around and be surprised by people’s different habits, and I can invite people and easily organize my meetings. Sure, personality is lacking, but no one interrupts me and the efficiency is first class.” De Lucchi M., “With the artificial intelligence, offices are becoming places of ideas” in *Domus* n.1022 March 2018, p. 34.

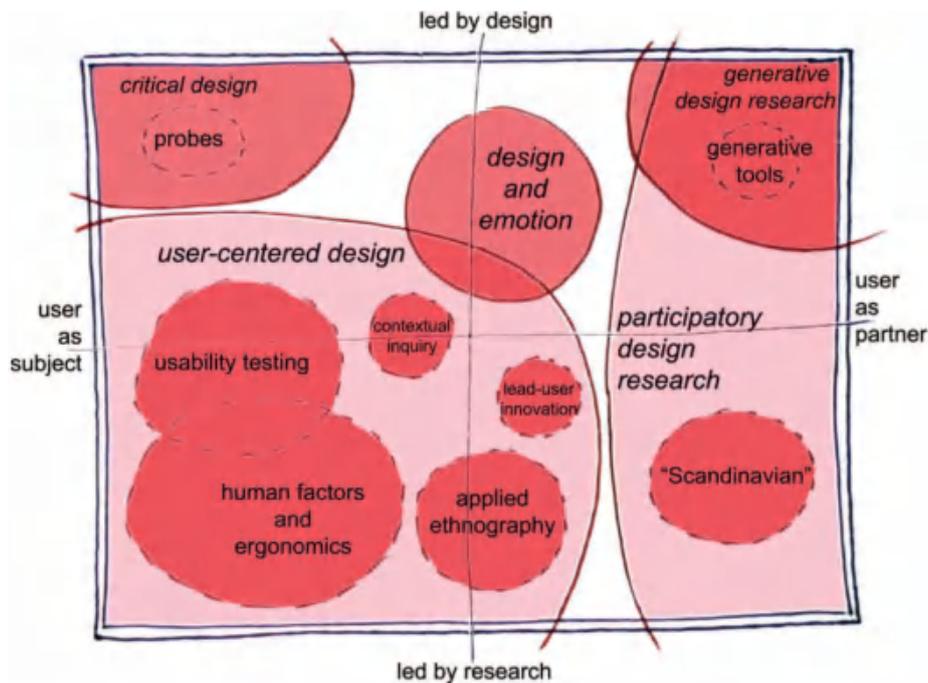


Fig 1.-The current landscape of human-centered design research as practiced in the design and development of products and services. E.B. -N Sanders and P.J. Stappers, 2008

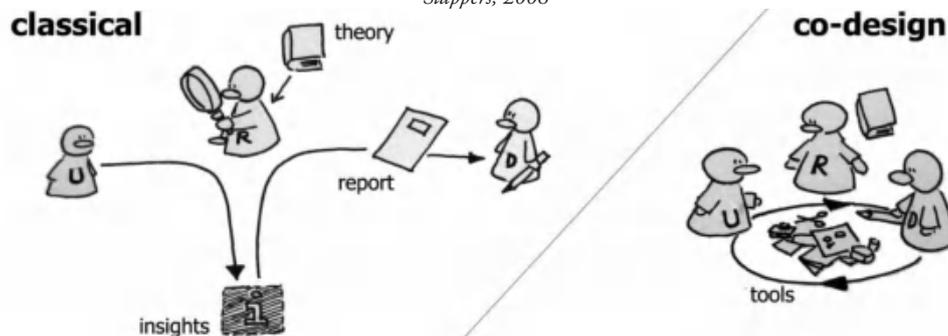


Fig 2.-Classical roles of users, researchers and designers in the design process (on the left) and how they are merging in co-designing process (on the right) -Graphic by Sanders and Stappers, 2008

According to Sanders and Stappers, even though co-design and co-creation are terms that are being used just during the past years, the practice of collective creativity has been used for around 40 years under the term “participatory design”. This was used mainly in Nordic countries and used to increase the value of industrial production by engaging the users in the development of the systems for the workplaces. The approach, thus, built on the workers’ own experiences and provided them with the resources to be able to act in their current situation (Bodker, 1996).

Co-creation practiced on an early stage of the design process tends to have a positive impact with long-range consequences, however, participatory design is getting importance in the interior design of workspaces. The decisions and outcomes created in this stage may vary, but they are helping to reconfigure the way of interior design in a more holistic way by understanding humans in the most basic level. (Institute of Noetic Sciences, 2007)

Techniques used for the concept development such as co-creation and co-design, explain how they work and how this helps designers to have a most accurate -and efficient -design, merging tangibles and intangibles, which ideally become more sustainable.

Co-designing require creative initiative on the part of the entire team: researchers, designers, clients and the people who will ultimately benefit from the co-designing experience (Sanders and Stappers, 2008). We are not only designing interiors, but furthermore, experiences for interconnected societies. We are moving from the design of categories of “Products” to designing people’s purposes -from space design to emotion design, from architecture to serving, from planning to transforming -where the designer gains the skills needed to expertly conceive and give shape to products such as brand identities, interior spaces, buildings, etc. (Sanders, Stappers, 2008).

2.1 Case Study – Gusto by Gensler – San Francisco, CA ⁵

Apple Park employees were said to be ‘in revolt’ over Norman Foster’s valley of a plan in their new headquarters. Gensler saw in this as an opportunity to draw a flexible line: in order to make working styles as democratic as possible, instead of equalizing they decided to respect the preferred layout of each team member. During the design process, workshops and questionnaires were filled by each of the 500 employees where they could choose from a variety of spaces, both open and enclosed, public or private, to accommodate their focus styles. Therefore, co-creating the spaces as the end users desired them and following the linings and forms of the company.

⁵(data retrieved from:https://www.frameweb.com/news/gensler-gusto-headquarters; www.gensler.com).

They involved in a HR services company to -by the development of several workshops -understand the main transformation to be integrated into its human resources and to create a menu of furniture and finishes (FF&E) to define the look and feel of the new space. They created an opening day tour using VR tech allowing their employees understand how would spaces look like. This process not only helped Gusto workers and Gensler designers to have a complete user-based outcome but gave the employees a sense of ownership and compromise them with the brand, bringing positive results not only in the wellbeing of the workers but also in their working development.



Picture retrieved from: www.gensler.com



Picture retrieved from: www.gensler.com

3. WORKSPACES & SUSTAINABILITY

The way of designing workspaces needs to have a drastic change from the way it was practiced in the beginning of time. Aforetime, the purpose of working places was entirely functional, subsequently people wanted places with an aesthetical value, reason why interior designers had to work harder to please their clients. Later, ergonomics and hi-tech came into the scene, challenging designers in another level at the time of designing them.

“The environmental issue, understood as the impact of the production-consumption system on ecological equilibrium, began to be raised on the second half of the 1960’s, as a consequence of the accelerating and spreading industrialization” (Vezzoli, Kothala, Srinivasan, 2014)

Due to the consumerism and abuse of resources in which the world has been living in the past decades, there is now a lack of resources. This evidence has brought new generations to the demand of new practices, where sustainability and “echo-building” prevail in the scene. Thus, interior designers have a big role since they can create a big impact on the environment by designing in a sustainable way and by choosing the right finishings, products and furniture used in a workspace understood within all the life stages of the product.

According to the book of Product Service-System Design for Sustainability (Vezzoli, Kothala, Srinivasan, 2014), there are different practices in design to reduce or eliminate the negative impact in the environment by the comprehension of the life cycles applied to interiors. Sustainable design needs to be practiced on many dimensions

(fig. 3), such as environmental, economic and socio-ethical, looking after the wellbeing of the users and the equity of resources on society. (Vezzoli, Kothala, Srinivasa, 2014).

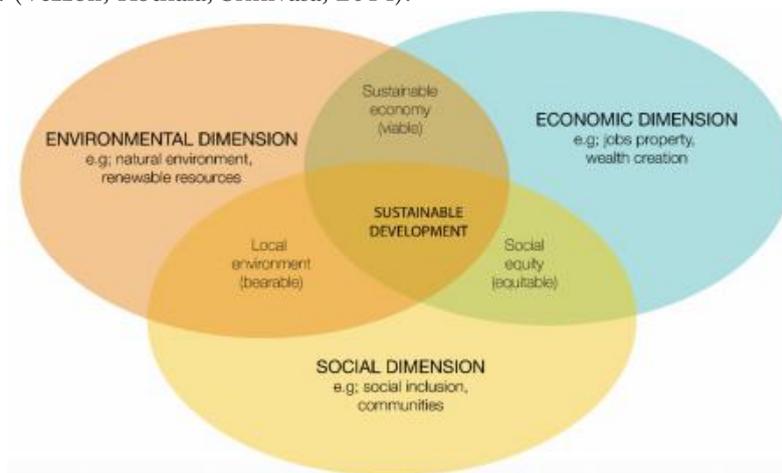


Fig 3.-Dimensions of sustainability

There are many theories and researches about the selection of materials and energy resources with low environmental impact through the different life cycle stages of a product. Topics as selection of toxic and harmful materials, recyclability and incineration, taking in account that design for recycling and reuse must cover all the life stages (Fig. 4) (collection, transportation, disassembly, cleaning, identification and production of secondary raw materials and identifying the opportunities for the re-application).

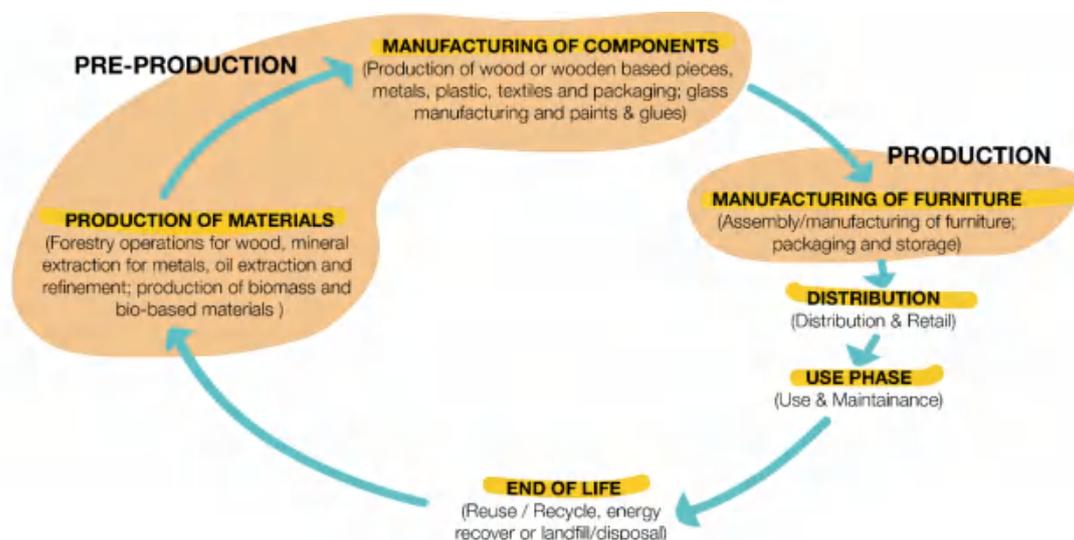


Fig.-4 -Life Cycle Stages of a Product

One ongoing debate intersubjective of biodegradability: an environmental quality that has raised many misinterpretations. It is important for materials to be re-integrable with ecosystems. Many biodegradable materials may pose a problem in the sense of a premature expiration date; this in turn creates new production and distribution processes for both substituting and discarding reasons. (Vezzoli, Kothala, Srinivasan, 2014)

In order to create an eco-efficient system, there exist different design criteria 'and guidelines to be practiced where the optimization of resources, the efficiency of distribution, the waste minimization and the toxicity reduction can bring the whole system to have a lower impact and in the same time to be more efficient comprehending the different environmental dimensions

Thus, when designing a workspace, it is necessary to understand the impact that a product or a whole workspace carries by the comprehension of the LCA through all its phases. To take the right and conscious decisions at the time of selecting the pieces, being aware of the impact created through all the life of the products while understanding how these can be optimized, especially during the use phase and end of life phase -since are the ones that concern more to the workspace, and therefore to the end users -.

Some efficient practices are by using service-systems to prolong the life phase, where repairing, adapting and relocating furniture helps to decrease the impact by boosting the life of a product or efficiently re-inserting it by using pieces to create a new one.

3.1 Case Study – The Edge by Deloitte – Amsterdam, NL

The Edge is a Deloitte Building located in Amsterdam that that opened its doors on 2015. It is promoted as "the greenest & most intelligent building in the world" (the British rating agency BREEAM, gave it the highest sustainability score ever awarded: 98.4 p%). They use service-system with the help of IoTs to shape the way the

user works, personalizing the needs and preferences of lighting, temperature control and space management. Smartphones rule this place, everything works through an app that lets the workers find colleagues, adjust the heating of their workstation and manage their daily routines.

Approaching the environmental perspective, the energy building resources come from solar panels which create more electricity than the actual consumption of the building. About 2500 workers share 1000 desks, using the “hot desking” concept with the goal of encouraging human interaction between the workers. Besides it hosts cafes, exhibition area and conference rooms. Work, space is more focused on the tasks that need to be done and the community that can be created in between the workers.

Ron Bakker, architect of the Edge at London-based PLP Architecture. “We’re starting to notice that office space is not so much about the workspace itself; it’s really about making a working community, and for people to have a place that they want to come to, where ideas are nurtured, and the future is determined.”

Deloitte’s proposal, is a good practice worth to follow since from all the dimensions of environmental consciousness. It does not only approach sustainability on the environmental dimension, but also on the socio-ethical dimension, since they look after the wellbeing of the users by personalizing the preferences and needs of each of the user with the service system run by an internal app where everyone can personalize the space to be used according to their needs. Besides, thanks to the solar panel system used, the savings in energy are worth the investment that the company did.



[Figure 5,6] Photo by Raimond Wouda

4. ENVIRONMENTAL IMPACT APPLIED TO WORKSPACES

Due to the environmental effects caused by consumerism and the excess of industry production, use and disposal, during the ‘90s the attention moved to the environmental impact through a products life cycle (Keoleian and Menerrey 1993; Brezet and Hemel 1997; Manzini and Vezzoli 1998; Tischner et al. 2000; Hemel 2001; Heiskanen 2002; Ryan 2003; Sun et al. 2003; ISO 14062 2002; Nes and Cramer, 2006).

In order to understand sustainability and its implications, it is needed to understand three interlinked dimensions, the first one is the environmental dimension, where the main task is to produce without degrading the world and its resources. The second one is a socio-ethical dimension, referred to the equal redistribution of the natural resources -based on the ideology that everyone has the same access to global natural resources -. Finally, the economic dimension, understood as economical practicable solutions in a more or less norm-oriented market.

New methodologies of assessing the environmental impact of products were developed, from them, the most accepted is the Life Cycle Assessment (LCA). The most important approaches worth to mention were:

- The concept of the life cycle approach -to design and understand all the life cycle stages -activities needed to produce the materials, parts, etc.-of a product, ways of distribution until the disposal of it.
- The functional approach -the evaluation of product environmental sustainability, beginning from its function rather than the physical embodiment of the product itself.

As exposed before, due to the radical changes held in the behaviors and the consumption of societies, the attention moved to design for eco efficient Product-Service Systems where “the result of an innovative strategy that shifts the center of business from the design and sale of(physical) products alone, to the offer of product and service systems that are together able to satisfy a particular demand” (UNEP, 2002). Therefore, the design conceptualization process needs to be expanded from a purely functional approach to a satisfaction approach, to have as an outcome a wider service-system that fulfills the demands, needs and desires of the final user-.(Vezzoli, 2003a)

5. HOW CAN WORKSPACES BE MERGED WITH PSSD METHODOLOGIES?

As exposed before, PSSD looks after sustainable products or services based in a deep research user-based through different methodologies used in the research phase. But what if the product became the place where people walks in, interacts, lives and work? That is the case with interior design and therefore, to workspaces. All the spaces we enter and interact, work and spend our daily life affect our piques, feelings and more, therefore, it is very important to consider the interaction that the user will have with the workspace at the time of designing it.

Within this framework, the discipline of Design for Sustainability has emerged, which in its broadest and most inclusive meaning could be defined as: “a design practice, education and research that, in one way or another contributes to sustainable development”⁵

Some authors adopt a more stringent definition of Design for Sustainability: e.g. Tischner (2010) argues that Design for Sustainability requires generating solutions that are equally beneficial to the society and communities around us (especially unprivileged and disadvantaged populations), to the natural environment, and to economic systems (globally but especially locally).

Product-service systems can be applied into workspaces by being approached through different aspects of sustainability. The first one, approaching the socio-ethical dimension, designers can work as moderators and leaders of workshops in the early stages of the design process to understand the users in a higher level by co-designing with them, letting them to be the co-creators of the space and services that they will use afterwards, therefore the workspace outcome will adapt better to the needs and desires of the workers and in parallel the links to the traditional or non-traditional working space will be stronger .

On a later stage, approaching the environmental dimension, the comprehension and the efficient designation of materials, finishings and furniture that are included inside the workspace are fundamental to make the place have a lower impact into the environment. In these stages it is fundamental to cognize the life cycle assessments of the whole workspace through the different life stages, being conscious not just of the production or pre-production of a material but also of the end of life of the product and how this can be reused or recycled.

Finally, on the economical dimension, the creation of product-service systems can lead to a more conscious design by creating systems that may not only include interiors but entire PSS that let workspaces be more efficient and cover the needs of the users by approaching different perspectives. In the same time, by simplifying the systems and making them more efficient, the economical savings can rise to considerable amounts thanks to the reduce of energy consumption, products maintenance, between others.

At a system innovation level not only products, services and production systems are optimized, and new ways of satisfying consumption needs are found within existing institutional frameworks and infrastructures, but new infrastructures, spatial planning and incentive systems are developed and implemented that promote more sustainable lifestyles (Tukker, Tischner 2006).

6. CONCLUSIONS

The evolution in economy and lifestyles between other factors, have led to the creation of new working models in society. Due to these changes of behaviors, the priorities have mutated from owning to experiencing, therefore, designers now need not only to design products but furthermore intangibles that satisfy the needs of the end user.

Traditional offices are prevailing in the system while non-traditional models such as co-working spaces and hubs are appearing in the scene, bringing innovative spaces and services to different users with the main goal of creating community. Meanwhile, companies that work on the traditional model, are paying more attention to the user by creating spaces and services supporting the wellbeing of the workers.

Both, traditional and non-traditional models look on behalf to the sustainable workspace where three main aspects are taken in account: environmental, economic and socio-ethical (Vezzoli, Kohtala, Srinivasan, 2014). When applying these aspects to workspaces it becomes challenge for designers to create a system in which sustainability works in a holistic way.

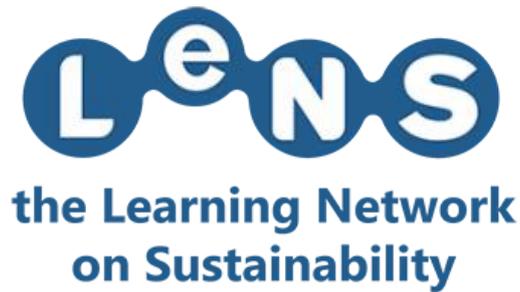
From the socio-ethical point of view, workspaces need to be user based. This means they should be created with and for the user by co-designing with them. This product-service system design methodologies are developed in the early stages of design and are meant to understand the needs and desires of the users to achieve better results in the final workspace system. It is proved that in spaces where the user is more comfortable, and the environment is pleasant, the psychological and physical health of the users is better. In addition, by compromising and involving the workers in the design stages, the loyalty with the company, effectiveness and performance in work is higher.

Finally, to decrease the environmental impact it is necessary to research and comprehend the carbon footprint

that we leave with each material, finishing or lighting equipment that is included in a space. Therefore, as interior designers it is highly important to pay attention to the life cycle assessments to understand the impact that each of these pieces create through all the life cycle stages. These good practices help to take better decisions at the time of designing and will have a tremendous impact on the environment through time by having an efficient system with a low impact on the environment.

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DEVELOPMENT OF SUSTAINABLE PSS FROM INDUSTRIAL WASTE OF THE FOOTWEAR SECTOR

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ABSTRACT

The footwear sector is known for the high volumes of solid waste such as plastic and rubber derived from the cutting of the raw material used in the production of shoes and accessories. Such wastes are generally not used, which generates environmental damage. In order to provide contribution to minimize this problem, this article is based on following the research question: what sustainable solutions can be developed for the correct destination of solid waste generated in the footwear sector? Based on this practical problem, this article has an emphasis on requirement engineering and the use of innovation methods and tools, commonly found in the literature in a disaggregated form. The objective is to present the application of a method for the development of a sustainable PSS offer, based on a case study of a startup from Southern Brazil. The startup's business model is based on the use of industrial waste management for the footwear sector. Through this study, we identified and prioritized the requirements demanded by the main stakeholders. Additionally, we designed the processes necessary for the development and delivery of the PSS and the concept of the prioritized offer. This was done based on the integration of tools used in product and service innovation, requirements management, and PSS design. The concept of the PSS offer prioritized by the stakeholders resulted in a product-oriented PSS for waste management in the footwear industry.

Keywords: Product Service System; PSS; Sustainable; packaging.

1. INTRODUCTION

The Product-Service System is a strategy adopted by managers who seek to develop integrated solutions that meet the needs of consumers, which potentially reduce environmental impacts in relation to traditional offers. Mont (2002) defines sustainable PSS as the PSS that supports networks and infrastructure, designed to be competitive and meet the needs of customers with less environmental impact over traditional business models. According to Tukker (2004) PSS have three classifications to characterize the integrated offer of products and services, namely: product; use; and result-oriented PSS. The product-oriented PSS is characterized by the commercialization of products, with some aggregated services, increasing customer value. Use-oriented PSS is the commercialization of products without transferring the property of the object to the client. The object is granted to the client for use. The result-oriented PSS consists in the marketing of a result, whereby the customer and supplier consent to an end result. Thus, the supplier is paid for the solution of the problem presented.

The correct use of a PSS classification would provide meeting the needs of customers in an integrated way, establishing competitive differentials and adding value to the product; creating a relationship of loyalty with customers; reducing costs through product lifecycle expansion, and more autonomy to create sustainable product-service systems (Tukker, 2004).

In the product development field, the sustainable innovation theme for Product-Service System (PSS) is a global trend in the search for more sustainable solutions. One of the main agents of this transformation are industries, the established companies, and also the Startups. The development of sustainable PSS is an emerging issue, as it deals with a new way of managing the integrated development of a solution, changing the paradigm of traditional product and service development models that consider independent processes. The theme is discussed in several studies, but the integrated development of the PSS is still a challenge, as its competencies are usually polarized, that is, focused only on products or services (e.g., Amaya, 2014, Maussang, 2003, and Van Halen, 2003). These studies address how to establish value for customer in products and services, while treating value separately for products (Tan et al, 2009); and for services (Thoben et al., 2001). In the same way, broadening the vision for more sustainable solutions, methods and tools have been developed to meet the demands of development phases for product and service life cycle (eg., Souza-Zomer and Miguel, 2017, Li et al., 2016).

In this scenario, the present study aims to integrate knowledge from requirement engineering, innovation tools and PSS design, in a holistic way, from the application of a structured method, focused on the initial stages of development process, for the innovation of a PSS in the context of waste management in the footwear sector.

In Brazil, the footwear industry is made up of approximately 7,700 companies that directly generate more than 300,000 jobs and produces around 944 million pairs of shoes per year (Abicalçados, 2017). Therefore, the footwear production generates a large volume of solid waste (plastic/rubber) that originates from the cutting of the raw material. The management of such waste must comply with operating licenses and must also comply with relevant legislation. For this purpose, the National Solid Waste Policy (PNRS) was created (Law No. 12,305/10) to provide mechanisms for waste generation prevention and reduction, based on the proposition of sustainable consumption habits to reduce the main environmental, social and economic consequences of inadequate solid waste management (Ministry of the Environment, 2017).

In this context, this article aims to explore sustainable solutions that can be developed for the correct destination of solid waste generated in the footwear sector through a PSS offer. The conception of this new business model starts from the concept of a sustainable PSS offer for the industrial waste management of the footwear sector.

2. RESEARCH METHOD

This study was carried out based on a case study of a waste reuse startup. The startup reuses waste from factories located in the State of Rio Grande do Sul (Brazil). The work method was structured in the following phases: (i) Requirement engineering - which includes the steps of elicitation, categorization, prioritization, identification of technical requirements; requirement publication, and identification of requirement trade-offs; (ii) Product-Service System Integration - which addresses the deployment and design of the processes for the development and delivery of the sustainable PSS offer; and (iii) Product-Service solution design - which presents the concept and the design of the PSS solution prototype.

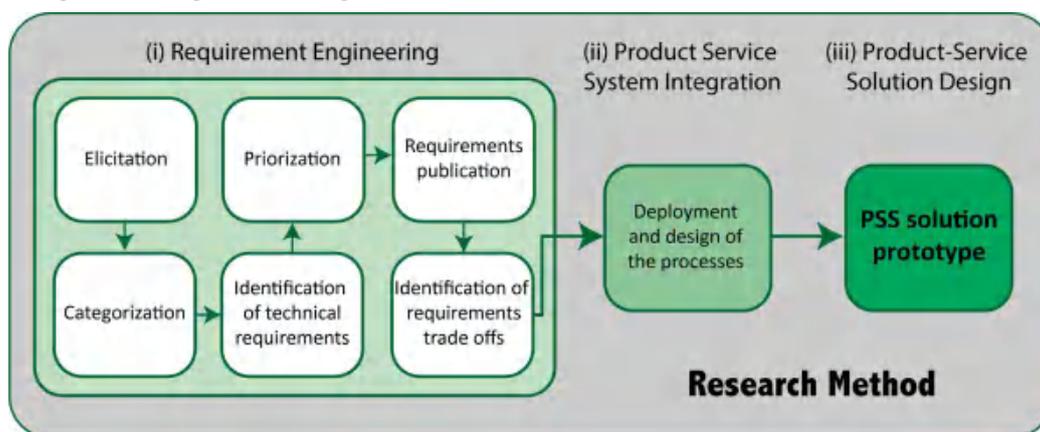
The first phase was developed based on the steps proposed by Sommerville (2005) and Kontonyae and Sommerville (1992) and on the application of the Quality Function Deployment (QFD) (Kim; Yoon, 2012; Ribeiro et al., 2001) for the prioritization of requirements. In the second stage, the design of the processes of the PSS offer was done following the Product Service Blueprint proposed by Geum and Park (2011). In the last phase, the concept design and description was carried out using System Map tool (Tischner and Vezzoli, 2017), which synthesizes the main stakeholders and their relations in the new offer. The stages and activities contemplated in each phase of the applied method are detailed in the Results section.

3. RESULTS AND ANALYSIS

3.1. Requirement Engineering

In this phase, step 1 was started. The elicitation process collected requirements to identify the needs of critical stakeholders. To that end, a qualitative research was carried out with the startup (case study) managers and companies of

the footwear industry. The research with the main stakeholders ratified the importance of incorporating sustainable aspects into the business model. In addition, other needs identified in the qualitative research addressed: the possibility of transforming waste into packaging for footwear as a product of the new solution, pickup services, environmental consulting, reverse logistics, among other PSS offer services.



[Figure 1] Research Method

In Step 2, requirements categorization was done through a Hierarchy Tree (Akao, 1990), which presented the primary requirements for Product and Service. Requirements were deployed at secondary (categorization of needs) and tertiary levels (important requirement) from the perspective of the customer. In Product category, process requirements (maximization of the use of the waste generated) and usability (impermeability, maintenance, resistance, and assembly) were pointed out. In Service category, the deployed requirements were Management (management and negotiation), Logistics (activities of separation, transportation and correct destination of waste) and Regulatory (legislation and regulations).

Step 3 comprised the prioritization of customer requirements, identification of technical requirements and specifications. To do this, a quantitative survey was conducted with 28 respondents from the footwear industry, which are potential users of the new offer. The quantitative survey aimed to assess the degree of importance of the requirements demanded. Prioritized items correspond to the Management and Usability aspects of the offer. The most important ones were: (i) Optimal packaging size for transportation and storage; (ii) Maintenance of the physical integrity of the product through packaging; (iii) Ease of packaging assembly; (iv) The packaging must be resistant to piling; (v) Easy placement of the shoe in the package; (vi) The packaging must be impermeable or absorb the least moisture; (vii) Contracting a company to collect and dispose of the waste generated; (viii) Training to ensure the correct separation of the waste collected; (ix) Improvement in the use of the raw material to packaging manufacture, and x) Reliability in transportation and final disposal of external waste.

In step 4, we presented and asked the development team and requirement managers to approve the customer-prioritized requirements with metrics/indicators (measurable technical requirements associated with stakeholder requirements), and specifications (which assess if technical requirements are being met).

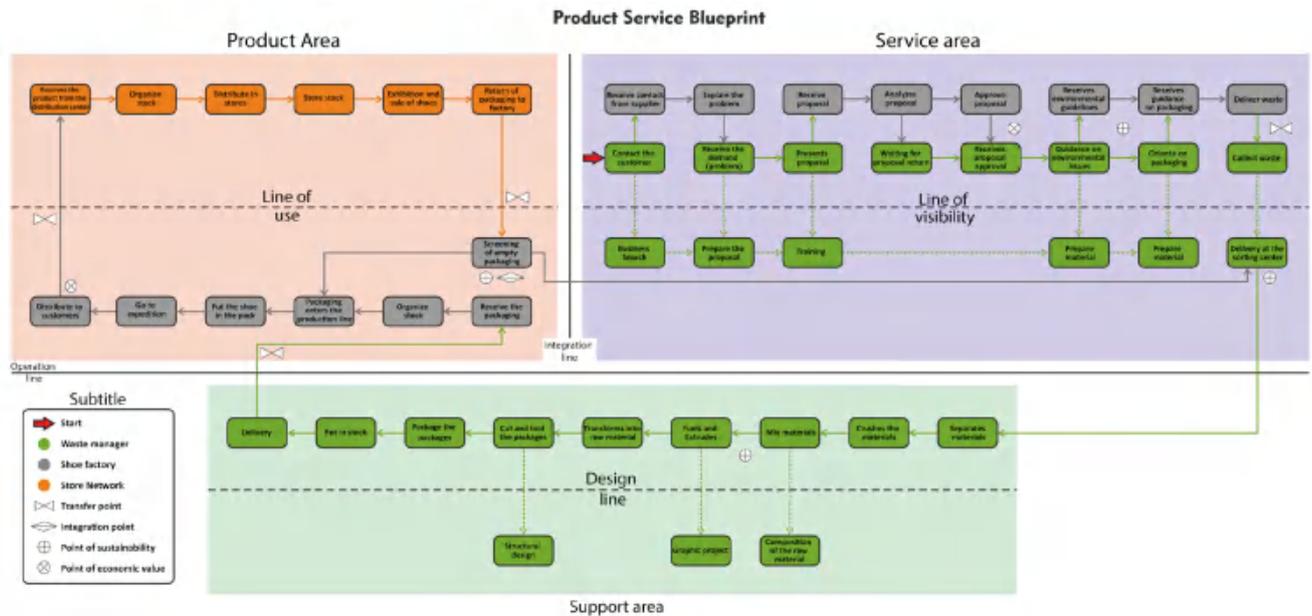
Next, in step 5, trade-off relationships between technical requirements were identified from the QFD quality matrix roof (see Akao, 1990). The 10 technical requirements that presented a greater influence on customer satisfaction were prioritized: (i) Percentage of free area in the horizontal opening of the packaging; (ii) Resistance to compression (weight/thickness); (iii) Percentage of liquid absorption; (iv) Resistance to column compression (kgf/cm); (v) Space optimization (m³); (vi) Time necessary to build creases in the package; (vii) Easy placement of the shoe in the package; (viii) Amount of material sent to landfills/recycled material; (ix) Percentage of personnel trained for the separation and collection of waste; and (x) Percentage of models of waste use based on software simulation.

3.2. Product-Service System Integration

In this phase, the necessary processes to meet the quality characteristics were deployed using the Product-Service Blueprint tool for PSS (GEUM, PARK, 2011), presented in Figure 1.

The processes in Figure 1 are divided into product use area, service area, and support. Several stakeholders were found in the PSS offer (Startup, footwear industry, and footwear commercial establishments). The following points of sustainability were highlighted in the offer: recycling of waste to produce packaging, packaging reverse logistics, and life cycle extension due to packaging sorting. The economic value point is reached when Startup services are contracted. The startup is responsible for managing customers' waste (from the footwear industry) throughout the entire product life cycle.

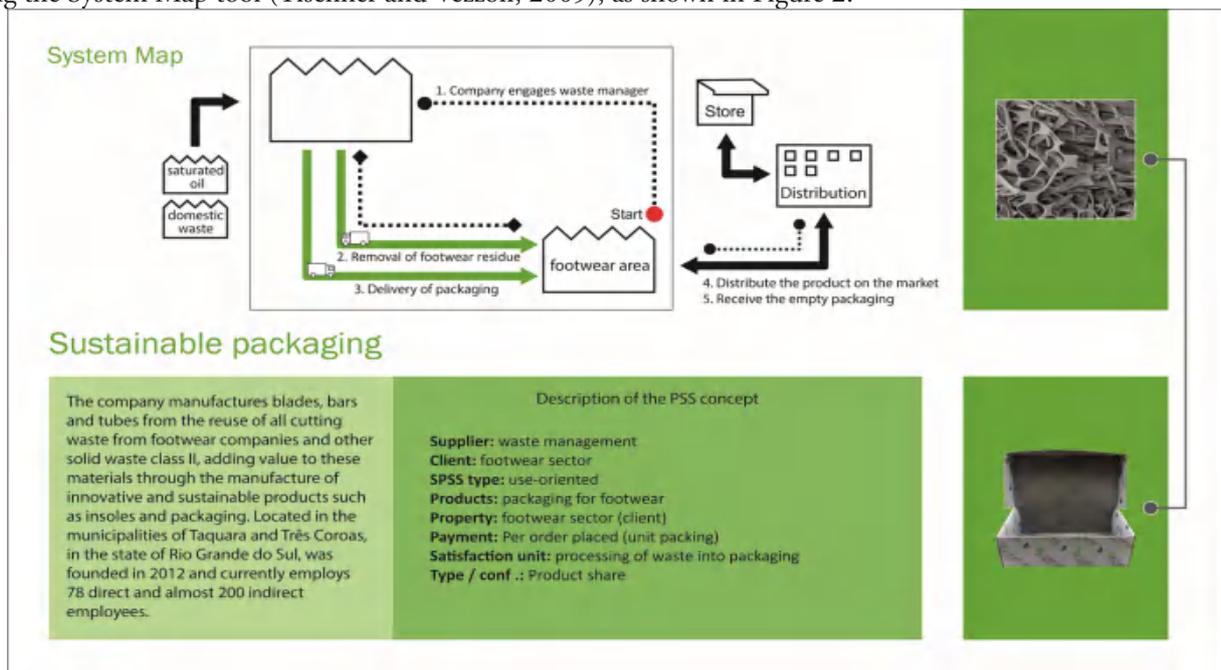
Next, in step 2, 10 critical process steps were selected that meet critical requirements following the QFD process matrix logic (Akao, 1990; Ribeiro et al., 2001). This step was done based on processes' relevance, difficulty and time to implement improvements. Prioritized processes were packaging manufacturing; packaging consultancy; commercial proposal; return of packaging to the factory; extrusion; product distribution to stores; shoe placement in the package; environmental consultancy; material sorting, and waste collection.



[Figure 2] PSS process deployment

3.3. Description of the Product-Service Solution

This phase includes the creation of a prototype of the integrated solution and the final design stage of the PSS offer, using the System Map tool (Tischner and Vezzoli; 2009), as shown in Figure 2.



[Figure 3] PSS Concept

The process begins when the footwear company contracts the company providing services to remove the waste. Thus, the company collects the waste directly in the footwear industry. Next, the company manufactures the sustainable packages, and delivers them to the footwear company to store the shoes. The footwear sector, through its distributors, delivers the products in the stores that will market the footwear without delivering the packages to the final consumer. After selling the shoes, the stores deliver the empty sustainable packages to the distributors. Then the footwear sector receives the empty packages so that the cycle can begin again.

4. IMPACTS ON SUSTAINABILITY

The PSS developed in this study addresses a solution for waste management in the footwear industry through a sustainable packaging used to store, protect and transport a material good (shoes), in addition to waste collection services, packaging management, logistics services, among others.

The impacts on sustainability for developing a package using solid waste from the footwear industry are related to the correct and sustainable destination of waste, avoiding negative impacts to the environment, in addition to contributing to the improvement of processes in products and services.

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MECHANISM ANALYSIS AND APPLICATION STUDY OF SUSTAINABILITY EVALUATION TOOL FOR FURNITURE E-COMMERCE(ICSFE) ¹

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ABSTRACT

Since the 1990s, all trades has been connected with Internet. Many furniture companies are transforming from traditional pattern to e-commerce. Linshimuye is the most representative furniture e-commerce company in China. The article will take Linshimuye as a case.

ICS for Furniture E-commerce(ICSFE)is a localization tool evolved from ICS toolkit, which is developed and adopted by DIS- Polimi. It considers Analytic Hierarchy Process(AHP)as main analytical method and the data comes from Expert Grading Method. The tool will calculate data through its program automatically. Then the users can get a result, and the tool will give recommendations accordingly. The tool can provide some advice on the improvement of furniture e-commerce in China. And it will be improved based on the feedback.

Key Words: e-commerce; furniture; Linshimuye; toolkit

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1. DEVELOPMENT STATUS OF E-COMMERCE FURNITURE INDUSTRY A CASE STUDY OF LNSHIMUYE

With the development of e-commerce, many furniture companies are in transition to e-business. However, many furniture companies failed, because they have neglected the improvement of the product service system. The article uses ICSFE to analyse Linshimuye as a case to evaluate and improve the development of China's furniture e-commerce.

Linshimuye has developed with Taobao and has been the No. 1 seller in the furniture category for five years. In recent years, Linshimuye is developing its offline experience mall and improving its offline services. Linshimuye is the most representative young furniture e-commerce company in China, and it influences many other companies.

2. ICS_ TOOLKIT FOR FURNITURE E-COMMERCE (ICSFE)

ICSFE is based on the research of Chinese online furniture product-service system. It's improved by the research team of Dr . Han Shaohua of Wuhan University of Technology. It is a localization tool improved from ICS_ Toolkit, which is developed and adopted by the Research Unit Design and Innovation for Sustainability (DIS).

2.1 Theoretical basis of ICSFE

ICSFE separates and extracts different development elements of the product service system in the three dimensions of economy, society, and environment. And then extract the criterion factors and index factors. Then import the data into the analysis tool after selectivity. When selecting sustainable development indicators, the tool uses Experts Grading Method to determine a more authoritative set of indicators. In the calculation of index weights, the tool uses the Analytic Hierarchy Process (AHP) and comparison method to ensure the scientificity of the weights. Finally, the final data is obtained by arithmetical average method. The feedback utilizes the data to evaluate the behaviour of the nodes in the system, and finally draws conclusions on the degree of sustainable development and gives recommendations accordingly.

2.2 Structure of ICSFE

ICSFE consists of four steps. First, determine the list of products and services of the system. Secondly, evaluate the product system and service system in the three dimensions of economy, society and environment. Third, the built-in program automatically completes the calculation and statistics to obtains the results of the system. The results show the degree of sustainable development of the whole system, the degree of sustainable development of the system in each dimension, the degree of development of the enterprise compared with other enterprises in the same industry. And it shows the indicators that are not consistent and partially consistent. Forth, improve them. With the help of corresponding improvement measures , the product service system can be improved and the new system can be re-evaluated.

2.3 Using steps of ICSFE

ICSFE has five steps as follows: "Homepage", "List", "Product Evaluation", "Service Evaluation", and "Improvement Measures".

STEP1 In the "Homepage"[Figure 1] section, four questions are asked and answered to help the user identify the object of the tool. The four questions are: What is furniture commerce? What is ICSFE? What is the object of ICSFE? What stage is ICSFE applied to?

STEP2 The tool lists some items to consider in the "List" [Figure 2] section, including the main and subsidiary products and services. It helps users to make certain of evaluation content. The users need to fill in the specific column of each product and service content.

ICSFE	Sustainability Evaluation Tool for Furniture E-commerce	Design Toolkit
HOMEPAGE	<ul style="list-style-type: none"> What is online furniture business? 电子商务家具是指基于电子商务平台进行营销活动的家具。 	
LIST	<ul style="list-style-type: none"> What is ICSFE? 该可持续性评价模型是对电子商务家具中产品系统设计和和服务系统设计的可持续发展状况进行评估的工具。可以用来检测电子商务家具企业某个产品服务系统设计发展问题的工具，能帮助电子商务家具企业根据发展的问题制定相应的设计策略。 	
PRODUCT EVALUATION	<ul style="list-style-type: none"> What is the object of ICSOF? 该可持续性评价模型的适用对象限定于电商家具产品服务系统设计，电子商务家具产品服务系统设计是指某个电子商务家具所包含的产品系统设计和和服务系统设计。 	
SERVICE EVALUATION	<ul style="list-style-type: none"> What stage is ICSOF applied to? 一是，概念形成的阶段。可以用来检测概念会存在的问题，从而制定相应的改进措施，规避概念推到市场后的风险； 二是，已将产品推入到市场后的阶段。可以用来检测现阶段产品服务系统设计的不足，从而指引相应改进措施的制定，以达到实现可持续发展的目标。 	
IMPROVEMENT MEASURES		

[Figure 1] Homepage



[Figure 2] List



[Figure 3] select evaluation indicators

STEP3&STEP4 It contains multiple dimensions and multi-level indicators in the “Product Evaluation” and “System Evaluation” sections. It mainly includes selecting evaluation indicators [Figure 3] and viewing the evaluation results. When selecting evaluation indicators, select “economic dimension”, “social dimension” and “environmental dimension” respectively. Each dimension contains several primary indicators. And each primary indicator contains several secondary indicators. Users evaluate different dimensions and different indicators by switching pages. After all the secondary indicators have been evaluated, users can switch to the evaluation results page to view the evaluation results. The evaluation results include two parts: “summary of indicator evaluation results” [Figure 4] and “comparison on industry level” [Figure 4]. The summary page of indicator evaluation results includes the development degree of all indicators in the economic, social and environmental dimensions. It shows the total number of all evaluation indicators, the number of responses, the number of fully qualified indicators, the number of partially qualified indicators, the number of non-conforming indicators, and the sustainable development degree of the system. The industry level comparison page compares the degree of sustainability of the system in the economic, social, and environmental dimensions with other systems or industry average to help users understand the advantages and disadvantages in the industry.



[Figure 4] the summary of indicators



[Figure 5] the comparison on industry level



[Figure 6] prioritization of improvement measures

STEP5 In the “Improvement Measures” section, there are two parts. One is “Prioritization of Improvement Measures” [Figure 6] and another one is “View Specific Improvement Measures”. In the prioritization interface of improvement measures, all the primary indicators are ranked according to the level of sustainable development in the three dimensions of economy, society and environment. In the specific improvement measures page, the secondary indicators that are evaluated as partially or non-conforming are listed under the primary indicators, and the system

can be improved in these aspects.

3. EVALUATION OF LINSHIMUYE' S SUSTAINABILITY

This article invites four experts who are engaged in e-commerce, furniture, environmental art design and product service system design. They both have a deep knowledge of Linshimuye. When dealing with every secondary indicator, experts can only choose one of the four choices including complete compliance, partial compliance, non-compliance and lack of understanding.

3.1 Product system evaluation of sustainability

Economic dimension: According to the data in the table, the sustainable development degree of Linshimuye' s product system in the economic dimension is 59.75%. Among them, the degree of sustainable development is 67.19% in terms of reducing materials and energy costs, 40.63% in reducing labour cost, 60% in reducing the cost of equipment, 60.49% in terms of improving customers' satisfaction, and 70% in driving development in the surrounding areas.

Social dimension: The sustainable development degree of Linshimuye' s product system in the social dimension is 56.09%. Among them, the degree of sustainable development is 57.50% in promoting the utilization of local social resources, and 54.64% in promoting the interests of marginal and vulnerable groups.

Environmental Dimensions: The sustainable development degree of Linshimuye' s product system in the environmental dimension is 41.44%. Among them, the sustainable development degree is 46.88% in reducing materials and energy consumption, 46.88% in optimizing materials and energy, 40% in saving materials and energy, 48.44% in extending the system life cycle and promoting the utilization of product, and 25% in reducing emissions of toxic substances and pollutant.

3.2 Service system evaluation of sustainability

Economic dimension: The sustainable development degree of Linshimuye' s service system in the economic dimension is 34.62%. Among them, the degree of sustainable development is 40.63% in terms of reducing the costs of materials and energy, 31.25% in reducing labour costs, 30% in reducing equipment costs, 31.25% in terms of improving customers' satisfaction, and 40% in driving the development of peripheral systems.

Social dimension: The sustainable development degree of Linshimuye' s service system in the social dimension is 27.69%. Among them, the degree of sustainable development is 20.31% in improving the work of employees, 25% in promoting the development of stakeholders, 34.38% in promoting the utilization of local social resources, 18.75 in terms of promoting the interests of the marginalized groups, and 40% in strengthening the cohesiveness of the overall society.

Environmental dimensions: The sustainable development degree of Linshimuye' s service system in the environmental dimension is 33%. Among them, the degree of sustainable development is 40% in reducing materials and energy consumption, 37.5% in optimizing materials and energy, 30% in saving materials and energy, 50% in extending the life cycle of the system and promoting the use of products, and 7.5% in reducing emissions of toxic substances and pollutants.

4. PRIORITIZATION AND IMPROVEMENT MEASURES.

4.1 Economic dimension

Priority 1: Control labour costs. It' s sustainability degree is 23.44%.

Priority 2: Reduce equipment costs. It' s sustainability degree is 45%.

Priority 3: Improve the satisfaction of the system. It' s sustainability degree is 46.9%.

Priority 4: Reduce materials and energy costs. It' s sustainability degree is 53.91%.

Priority 5: Drive the development of peripheral systems. It' s sustainability degree is 55%.

4.2 Social dimension

Priority 1: Improve the work of employees. It' s sustainability degree is 20.31%.

Priority 2: Promote the sustainable development of stakeholders. It' s sustainability degree is 25%.

Priority 3: Enhance social cohesion. It' s sustainability degree is 27.08%.

Priority 4: Promote the interests of marginalized groups. It' s sustainability degree is 36.72%.

Priority 5: Promote the use of local social resources. It' s sustainability degree is 45.94%.

4.3 Environmental dimension

Priority 1: Reduce emissions of toxic and pollutants. It' s sustainability degree is 16.25%.

Priority 2: Make use of materials and energy. It' s sustainability degree is 35%.

Priority 3: Add options of materials and energy. It' s sustainability degree is 42.19%.

Priority 4: Reduce materials and energy consumption. It' s sustainability degree is 43.44%.

Priority 5: Extend the system life cycle and improve the usage of products. It' s sustainability degree is 49.22%.

5.FEEDBACK

According to the feedback of Linshimuye staff, all the secondary indicators in the tool are guiding the enterprise to comprehensively examine its own development from every detail. The evaluation results help them visually evaluate the development of the enterprise. Among the suggestions for improvement, some of the suggestions will play a role in the future development of the company. But other points may not be considered because of the company's own development plan. However, during the communication with the staff and industry experts, it was found that there are some problems in ICSFE that need to be improved. First, the tool structure is complex. Users need to spend a lot of time understanding the tools before using it. Second, there are some descriptions in the tool that are vague, so users need to guess and trial to know how to understand and operate it. In the later stage, a sub-bar would be added to explain the operation items.

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SUSTAINABLE PRODUCT SERVICE SYSTEMS: A NEW APPROACH TO SUSTAINABLE FASHION

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ABSTRACT

Consumption patterns in the fashion industry which aim at decoupling economic success from resource consumption lack a system-based approach in relation to sustainability. While negative environmental impacts of products of fashion continue to be reported in the literature, these have not been radically addressed with respect to system-based sustainable business models such as S.PSS. The purpose of this study was to explore how companies in the fashion industry in Botswana and Kenya could benefit from adopting sustainable Product Service System as their business strategy, leveraging on their existing practices. The study adopted a single exploratory case study with multiple units of analysis and data was analysed using thematic analysis to allow inductive development of themes. From the main results, common benefits include strategic positioning, cost savings, income generation and employment creation. The authors conclude by recommending modelling of S.PSS offerings that leverage on the identified benefits.

Key Words: consumption, environmental impacts, fashion products, environmental impacts, S.PSS

1. INTRODUCTION

Fashion consumption is a highly resource-intensive and wasteful practice. Sustainability on the other hand discourages wasteful consumption (Dissanayake and Sinha, 2012). The quest for newness by fashion consumers which often leads to fashion change (Horn and Gurel, 1981), makes sustainability an interesting challenge. Fast changing fashion trends, affordable prices and mass production systems have led to unsustainable consumption behaviour and disposal of waste products (Niinimäki, 2012), requiring a reversal and proactive approach through sustainable innovation. The concept of sustainable innovation has been discussed under various terminologies varying from, for example, environmental innovation, eco-innovation, cradle-to-cradle, service innovation, eco-design, design for environment, sustainable design, design for sustainability, service design, whole system design and system design for sustainability (Hellström, 2007; Charnley et al, 2010; McDonough and Brangart, 2002; Cox and O'Connor, 2005; Vezzoli et al, 2014; Bhamra et al, 2013; Bhamra and Lofthouse, 2007; Curedale, 2013; Baines and Lightfoot, 2013). Sustainability in the fashion business is still an emerging agenda and authors such as Armstrong and Lang (2013) and Pears and Fletcher (2012) have recognised the importance of investigating on how sustainability could be achieved (Dissanayake and Sinha, 2012).

The current rate of material extraction for industrial activities poses a threat for our future generations to meet basic needs. Dependency on finite resources rapidly being exploited to meet increasing needs of an increasing population, satisfied by individual product ownership is a true picture of unsustainable consumption (Evans et al., 2009). Revolutionary new technologies are not necessarily the answer to all problems caused by our industrial systems but new revolutionary ways of thinking which embody effective use of resources, optimised use of available technology and collaborative ways of creating value in a systemic manner (UNEP, 2011). The concept of sustainable innovation aims at aiding manufacturers make significant savings from eco-efficient practices to eco-effective strategies involving closed-loop processes that consider the entire product life cycle (Sustainability Learning Centre, 2013). Sustainable innovation concepts and strategies are essential in addressing environmental and social concerns with financial targets when looked at as a whole, making it a fit into the triple bottom line philosophy of environment, people and profits (Evans et al., 2009). In the fashion industry, one such sustainable innovation strategy being explored is Sustainable Product Service System (Armstrong et al., 2015; Armstrong et al., 2016)

A Product Service System business strategy that is based on continuous life cycle improvement taking into account the product and service life cycles (Tan and McAloone, 2006) is called Sustainable Product Service System. The concept is representative of a holistic approach to sustainable innovation. Through this strategy fashion design companies and fashion houses can undergo servitization to redefine value creation in non-product terms (Baines et al., 2007; Tomiyama, 2001). According to Tomiyama (2001) the benefit of this process of servitization is in intensifying service contents of offers to arrive at environmentally conscious design and manufacturing and create more added values in future advanced societies. Tomiyama (2001) describes service as an activity that requires mainly service channels to deliver and amplify services and service contents to be delivered. This description portrays service as an intangible value that requires an environment, provider, consumer and a product to facilitate its provision (Tomiyama, 2001).

PSS is categorised as product-oriented, use oriented and results oriented (Mont, 2000; Manzini and Vezzoli, 2003; Tukker, 2004). PSS have been looked at mostly in large companies (Kang and Wimmer, 2009; Morelli, 2003; 2006; Manzini and Vezzoli, 2003) with recent attention growing in SMEs (Kowalkowski, Christian and Gustafsson, 2013; Hernandez-Pardo, 2012), as an extension of contribution towards developing service oriented value and sustainability practices in manufacturing SMEs. PSS depends on different entities connected together to serve a particular purpose (Charnley et al, 2011). Interactions between different stakeholders with different needs at different stages of the value chain require that the PSS provider possess certain capabilities to facilitate design and delivery of value.

2. THEORETICAL BACKGROUND

Sustainable innovation business models support the argument on growth which is not based on high volumes of production, but on business sophistication led by design innovation in redefining what value means. Product Service Systems (PSS) innovation business models can be viewed as an integration of new product development and new service development (De Lille et al, 2012). By simultaneously addressing product and service components of value creation, PSS aims to shift the business focus "from designing (and selling) physical products only, to designing (and selling) a system of products and services which are jointly capable of fulfilling specific client demands, while re-orienting current unsustainable trends in production and consumption practices" (Manzini and Vezzoli, 2003, p851).

Moreover, Vargo, Maglio and Akaka (2008) introduced two types of value creation: value-in-exchange and value-in-use. Value-in-exchange underscores the entity's output and price, thus creating an advantage for the firm and its users through the exchange of goods and money. Value-in-use is attained when customers use the firm's products and services. Value-in-exchange suggests that product sales are the major income channels for firms whereas services are subsidiaries that add value to those products. Add-on services such as free home delivery, guarantee extension, and repair can create feedback and extra value on products (Chen, 2018). Contrary, value-in-use turns product sales into functional sales or operational services, where customers only pay for the use/operation of products rather than buying the products and this decouples economic success from material consumption (Baines, 2007) for instance hire wedding gowns or mink coats.

A business application of S.PSS in developing countries may act as a catalyst to facilitate the growth of the solution-based economy, by-passing the stage characterised by individual ownership of mass produced goods towards the more advanced service-economy (Manzini & Vezzoli, 2000). The success of S.PSS hinges on its capability to provide human satisfaction through eco-efficient solutions (Vezzoli, Kohtala and Srinivasan, 2014). S.PSS in the fashion industry includes services such as maintenance, renting, upgrading, redesigning, swapping or lending.

S.PSS in fashion may provide the industry with a mechanism to increase factors such as product quality and longevity and at the same time providing alternative consumption models that decrease unnecessary consumption and facilitate material recycling. This study explores sustainable Product service system benefits for fashion practitioners in Botswana and Kenya. Armstrong and Land (2013) report that some companies for instance, Del Forte, Patagonia, Avelle's Bag, among others have implemented the S.PSS business model in apparel design and this include: re-design and take-back recycling services as well as renting designer handbags, jewellery, sunglasses and other fashion accessories. Another important feature of S.PSS design and delivery is the intensive involvement of users in the process. This relationship has the prospect to raise users' awareness about environmental issues of products and services and their socio-economic and ecological impacts. The engagement of users can motivate users to practice S.PSS processes to attain the sustainability agenda.

In order to define S.PSS benefits for fashion companies in Botswana and Kenya, it is necessary to first understand the industry players studied and how current sustainability practices in the industry are being implemented. The following sub-section describe how this process was achieved.

3. METHODOLOGY

A focus on understanding industrial practice was vital, since defining, characterising and designing a S.PSS for an industry is a complex undertaking. A single exploratory case study with multiple units of analysis was deemed appropriate for this research enquiry to allow proximity to the phenomena being researched (Dyer and Wilkins, 1991), because of the informal nature of some businesses being researched. The units of analysis were businesses in the fashion industry in developing economies of Botswana and Kenya. Ten purposeful sampled companies in Botswana and eight in Kenya participated in the study. Semi-structured interviews were used to collect data. The focus of the semi-structured interviews were to find out what sustainability initiatives fashion practitioners undertook, determine how fashion practitioners translated sustainability initiatives into income generating initiatives and identify drivers and barriers for adopting such initiatives and identify opportunities in possible sustainability initiatives that could contribute to the development a S.PSS business model.

3.1 Participants

Botswana's fashion design companies interviewed were mainly new start-ups which had 3 to 5 years in operation and they has less than 6 employees. However, in Kenya, the majority of companies were mature businesses which had more than 10 years in business and employed less than 25 employees. Out of ten companies who participated in the Botswana study, only four had relevant professional qualifications in fashion design and the rest came from other fields such as accounting, engineering, political science, etc. Of the eight companies interviewed in Kenya, four had relevant professional qualifications in fashion design and the rest in other fields. Of all the eighteen interviews conducted in both countries, only two companies in Botswana had their vision and mission, which recognised sustainable fashion design.

3.2. Data analysis

Qualitative interview data was analysed using thematic analysis (Braun and Clarke, 2006). The analysis was divided into the following: (a) defining the samples for analysis, and (b) developing a coding system which involved naming and grouping data into themes. That is, similar properties were grouped together to form a theme. "The crucial requirement is that the themes are sufficiently precise to enable different coders to arrive at the same results when the same body of material is examined" (Silverman 2001, p123). Quantitative data were analysed using descriptive statistics which include measures of central tendency.

4. RESULTS

From the results, common benefits in the two contexts of Botswana and Kenya which can result from current practices should S.PSS be adopted as a business strategy include strategic positioning, cost savings, income generation from waste material and employment creation. In Botswana, companies can also increase their market size while in Kenya they can have consistent supply of affordable resources.

4.1. Strategic positioning

There was a generally interest in mind-set change towards developing sustainable fashion practices around S.PSS as a business strategy that can serve as a differentiator. A S.PSS strategic approach to business development was seen as a possible route to contributing to diversifying markets and producing customised offerings. This is further substantiated by the SMEs professional qualifications, opening up opportunities for strategic competitiveness. The small company sizes also make knowledge exchange programmes manageable since there are not many internal structures

and processes to vet decisions. Company visions in both Botswana and Kenya also had a lot of similarities supporting strategic positioning through collaborative knowledge exchange. For example, participants expressed that:

“To have a leading design outlet and agency, establishing a reputation for innovative fashion solutions that alter people’s perceptions, transforms behaviour and builds lasting relationships with brands” – BW2

“To transform Africa’s fashion and empower young designers to great heights” – K1

The position of SMEs on strategy development is clear even though there is no mention of it. A deliberate intention towards sustainable fashion strategy development is possible as a result of these commitments. Almost all companies’ visions in both contexts had clauses in their visions speaking to a leader in innovative and high quality fashion products as evidence of their desire to explore innovative business strategies.

4.2. Costsavings

The cost savings benefit was viewed by almost all fashion houses as a possibility to achieve sustainable fashion. The alignment of this view to their understanding of sustainable product service system demonstrated that if implemented, S.PSS could save the fashion houses costs. Most fashion houses understood S.PSS as a way of proving essential end use functions, creating environmentally friendly products at affordable prices and aligning to international practice as stated below:

“Combination of strategies to minimise total environmental impacts over the whole life cycle of a product or ability to use something without either buying it or owning it” – BW6

“Sustainable fashion is the in thing; our clients would be happy to be part of an internationally recognised system. Therefore, it would result in more clients and more sales” – K5

Cost saving opportunities for S.PSS strategies became eminent in light of raw material costs and use of waste material for down cycling of used apparel for both up-cycling and down cycling in exploring new markets and expanding existing markets. The reported possibilities were in terms of giving products a second life through remanufacturing, material recycling for creative use in new products and minimising waste through systematic way of cutting materials and amount used in products. Operationalization of these initiatives appeared to be tied to professional training in fashion design, which most companies do not have.

4.3. Incomegeneration

Sustainable PSS business models emerged around the concept of extended producer responsibility in very few fashion houses in both Botswana and Kenya. The care labels attachment to clothing concept proposed by among others BW3 and K2 is meant to extend the life cycle of the product and the provider-customer relationship in providing care services. Taking care of the apparel this way gives the providers control and income generation activities throughout the life cycle of the product so that additionally, they are also able to recover the material for recycling activities. However, most fashion houses in both Botswana and Kenya suggested low end product-oriented PSS models based on repair, product maintenance and consultancy as services attached to the sold product. Income generation activities are still skewed towards selling the product.

4.4. Employmentcreation

Even though companies’ commitment to employment creation was also evident in their visions, there seem to be disparities in definition of futuristic market segments. This definition is important as a strategic alignment to S.PSS means expansion of related markets, hence more jobs in the same direction. Market segments interested in purchasing sustainable products were not well subscribed for in Botswana fashion houses when compared to the situation in Kenya. Most Kenyan fashion houses accommodated this type of market segment as a result of a better awareness of what sustainability meant. Notwithstanding a similar understanding of sustainability in Botswana, the fashion houses defined all other market segments except greenconsumers.

5. DISCUSSION

The fashion industry in Botswana and Kenya viewed S.PSS in terms of employment creation, income generation, cost savings and strategic positioning of their companies. Though, there were highlights of understanding S.PSS within their industry, there was little evidence which showed that there were implementing the principles of this concept. The underlining theme of the findings is that companies were still interested in selling products instead of services or a combination of the two. This shows that a lot of education still needs to be done in raising awareness and assisting the fashion industry with appropriate methods that can help them to implement S.PSS. For example, researchers can co-create S.PSS business model in apparel design include: re-design and take-back recycling services. Using the co-creation method will enable the fashion industry to have ownership of business model created. This is a new concept which will take time to have a lot of buy-in. However, it is encouraging that the fashion industry in the two countries were receptive to embrace new changes to the industry.

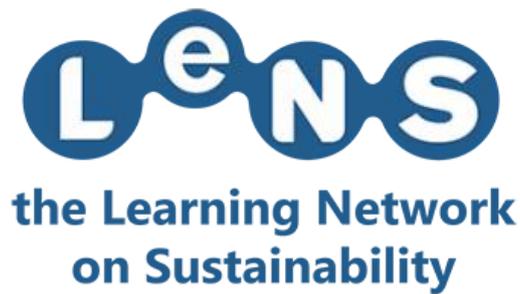
6. CONCLUSION

This study has demonstrable implications on benefits of sustainable PSS. The adoption of S.PSS as a business strategy creates huge benefits for the fashion houses studied as well as the end-users especially the increasing population

of green consumers. However, there is a huge untapped market of green consumers in Africa which fashion practitioners operating SMEs should fully exploit with innovative S.PSS. The concept of fair trade needs to be promoted rigorously to enlighten both producers and consumers on fairly traded products and services in order for them to promote and support the same. This should contribute to better treatment and dignity of workers, impacting on social sustainability, which is directly related to the reported employment creation benefit. Environmentally, such initiatives as repair, maintenance and reuse will ensure product longevity and keep products in use for a longer period of time. These are initial and easy to relate with, opportunity for modelling S.PSS offerings for product-oriented PSS. The success of these models will heavily depend on design of the apparel to be adaptable to various contract conditions under a particular model. Indigenous knowledge and materials combined with common African values of sharing and collaborative consumption in the two contexts will create attachment and sense of pride, thus reducing the extraction rate of non-renewable resources. Economically, it is clear from the benefits that fashion businesses want to reduce costs and maximise profits through S.PSS models. A case of contribution to GDP for fashion houses will have to be put forward to policy makers for them to incentivise fashion businesses willing to be proactive S.PSS providers.

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PRODUCT-SERVICE SYSTEM DESIGN OF HOUSEHOLD MEDICAL WASTE MANAGEMENT FOR DIABETICS

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ABSTRACT

According to the data from China Center for Disease Control and Prevention shows that the prevalence of diabetes aged 18 and over is 9.7 percent, or nearly 100 million people in china. While the number of diabetic patients in China shows “explosive growth”, hundreds of millions of household medical waste are at risk of being discarded. At present, the whole society including patients, hospitals, medical products manufacturers and chinese government has not attached great importance to this matter.

The purpose of this paper is to clarify the study of medical waste management for diabetic patients in family and community environment, and the practice of product-service system design based on a community in China, united families and related professional institutions. It is an exploration that scientific research working intendem with design practice. We carried out the study in a systematic way by using the method of product-service system design. During the course of study, different stakeholders fully showed their requirements and creativity in the form of co-creation.

Keywords: Chronic disease management, household medical waste, Product-service system design, Co-creation

1. INTRODUCTION

Medical waste is defined as the number one hazardous waste worldwide, and there are strict regulations on the treatment of medical waste generated in medical institutions.[1] But, the law is not binding when the hazardous medical waste generated environment is the family and the executors are the patients. In China, the number of chronic diseases is continuing to grow due to the aging of urban populations and the changing of lifestyle. [2] However, the management of chronic diseases often occurs in the community or family environment. The hidden dangers lurk in household medical waste have become a problem that cannot be ignored. Among them, Diabetes is a lifelong condition that needs long-term care. The number of diabetic patients in China shows “explosive growth” has ranked first in the world. This means that every year, hundreds of millions of lancets, syringes, blood glucose test paper, alcohol cottons, etc., are at risk of being discarded. If this problem is neglected, it may lead to epidemics of blood-borne infections such as HIV/AIDS, hepatitis B and hepatitis C caused by needle-stick injuries (NSIs) among scavengers, sanitation workers and children in the community [3], and cause a marked economic loss.

All over the world, the management of household medical waste is still in the neglected field of society, except for a few research literature in medical field, other research fields are still in the blank. At present, the medical field is not to explore the management of family medical waste from the theoretical level, but to the community (medical) center or family bed specific household medical waste management methods.

2. CASE STUDY

Although now it is very poor management of household medical waste for patients with diabetes, but there are still some effective cases in this regard. By learning from these relevant cases, we may be able to find a direction to solve the problem.

The first case is a public welfare video. World AIDS Day, December 1, 2016, the first public service video jointly supported by Jingan avenue, Shanghai government and BD (China) released to public “Stopping needle stick injury, proper disposal of medical sharp”. BD (China) is one of the largest global medical technology companies in the world. The main character of the video is sanitation workers who handle a variety of household waste every day. The aim of the video is to make urban inhabitants aware of the dangers of dropping medical needles and to call on diabetics to dispose of medical sharp waste properly. [4]

The second case is a public service. Wuxi “i-love-future” Public Welfare Organization was founded by Dr. Hu, Endocrine of Wuxi traditional Chinese Medicine Hospital. Since 2014, Love Future has launched a “small box and big love” environmental welfare project to deal with hazardous waste in families of diabetic patients. They are providing free sharps containers for diabetic patients for more than 10 public hospitals in Wuxi, Suzhou, Nanjing and Shanghai. The project raises money in the form of fund-raising to buy medical sharps containers and needles, and attracts patients to bring the sharps container with medical waste back to the hospital to disposal by giving away needles for free. At first, This paper was launched on the basis of “small box and big love” project, and obtained much support from the cooperative hospital and community of Wuxi “i-love-future” Public Welfare Organization.

The third case is an Internet service. “Safe sharps” is an initiative organized by the Riverina Eastern Regional Council, supported by the New South Wales Branch of the Australian Diabetes Council. The purpose is to help sharp users find the most convenient location to safely handle their sharps. The project has developed a smartphone-based application that allows users to easily search online for a single sharps disposal point, sharps containers centralized disposal point or sharp box vendor. [5]



[Figure 1] Case1-public welfare video, Case2-"small box and big love" project, Case3-"Safe sharps" app

The three typical cases are developed in different stages and ways, respectively. Case1 is the first step to trigger patient behavior motivation-Education. Case2 is a service which providing the patient with the condition or environment to trigger a behavioral. Case3 provides a convenient Internet service for triggering the disposal of waste by patients. Although the three cases serve different clients, the ultimate goal is the same, effective management of household medical waste. But they also have different deficiencies.

	Case1	Case2	Case3
Service Provider	Government & Commercial companies	Public Welfare Organization	Government
Service Object	Sanitation workers	Diabetics who produce household medical waste	Sharps users
The way to trigger behavior	Education	Products, Environment, Services	Internet service for disposal
Disadvantage	Narrow scope of service	For Medical Institutions: - Fund shortage - Fear of taking risks For Diabetics: - Lack of consciousness - The background of deterioration of doctors and patients For 'i-love-future': - Fund shortage - Difficulty of popularization	Different areas have different legal controls. Narrow scope of service

[Figure 2] Three cases analysis

3. RESEARCH AND ANALYSIS

Due to the characteristic of the research project, we need to investigate multi-stakeholders such as patients, medical institutions, communities and government departments. A lot of research process is going on with co-creation activities. Different stakeholders fully showed their requirements and creativity.

3.1 User interview

We interviewed 15 diabetics at Wuxi traditional Chinese Medicine Hospital, who continued to produce household medical waste and have never been educated about the concept of it. According to the patients' different consciousness and behavior, four kinds of user portraits were obtained and sorted by the number of people from more to less:

(i) No concept, No cognition, No disposal

The patients have never learned about household medical waste and its hazards and disposal methods from any channel, and they will naturally throw household medical waste into domestic waste.

(ii) With concept, No cognition, No disposal

The patient is aware of the harm, but does not know the specific harm and the degree of the hazard.

(iii) With concept, With cognition, Not enough disposal

The patient is aware of the hazards, but lack of understanding of disposal. He/She chooses simple disposal and then throws waste into domestic waste. Such as wrapping them in paper, or putting them in soft drink bottles or hard cans, which are not actually correct and sustainable.

(iv) With concept, With cognition, Correct disposal

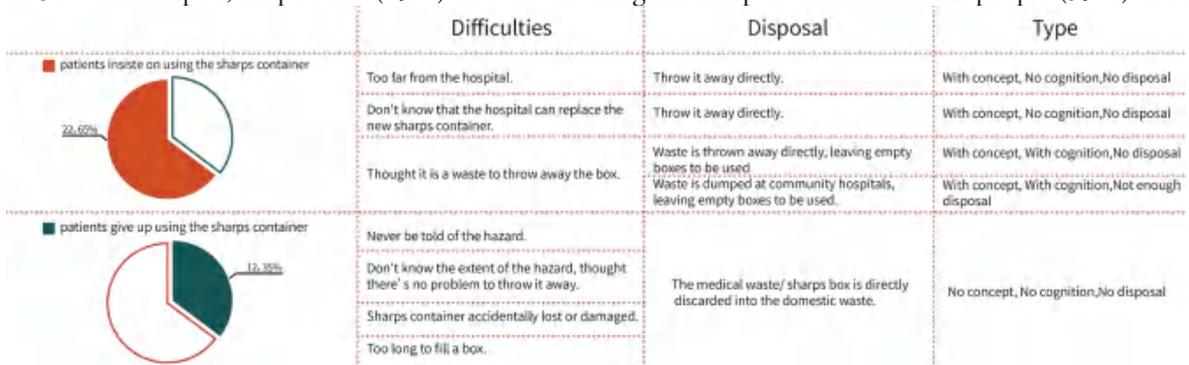
The Patient who is well aware of the hazards and disposal will take household medical waste back to hospital after a simple treatment.

3.2 User telephone interview

This project conducted telephone interviews with 78 diabetics who had participated in the "small box and big love" project and had been distributed free sharps container. We got 34 valid samples from them. The largest number of invalid samples is due not only to the lack of valid information, but also to the provision of an error number. It means that when receiving the free sharps container, this part of the patient is not approved of the activity.

It is important to note that, due to the limited funding, the sharps container purchased by "i-love-future" Public Welfare Organization, is the smallest size for medical environment. Since household medical waste is not subject to the control of the law, it is not necessary to strictly require the patient to disposal the waste every 24 hours, but to fill it up and then throw it back to hospital. So it takes 6-12 months for each diabetic to fill a box. Product defects are objective limitations and will affect the results of the survey.

In 34 valid samples, 22 patients (65%) insisted on using the sharps container and 12 people (35%) did not.



[Figure 3] Two valid sample analysis

3.3 Field research

We surveyed 5 middle-class Communities, 3 hospitals that distribute charge sharps container, and the Wuxi Environmental Protection Government. And we got the current situation of household medical waste management in

Wuxi and Shanghai ,developed cities in China.

A total of 5 middle-class communities were surveyed in Wuxi and Shanghai, of which only 2 provided garbage bins for hazardous waste.Garbage bins for household medical waste are only for expired medicines, and community managers reported poor recovery.

Nurses and doctors at the three hospitals that hand out free sharps containers said the activity adds to their stressful workload.They do not have enough energy to teach patients repeatedly, register and check information, recycle and dispose household medical sharps containers.

Solid Waste Department of Wuxi Environmental Protection Government said:‘There is currently no clear policy to manage household medical waste.However, if the project is to centralize the collection and disposal of household medical waste, it will be considered as medical waste management and will need to be controlled by government departments.In the community, for example, the household medical waste disposal site must be set away from the 300 meters of the population.In addition, they need to be disposed of within 48 hours in accordance with the law of medical waste management.’There is no doubt that the difficulty of the project is increased.

4. DESIGN OPPORTUNITY

This paper starts from the whole process of household medical waste management, looking for stakeholders and service touch point and insight needs.To get the design opportunity from four aspects:pre-education, hardware facilities, community collection and post-processing.

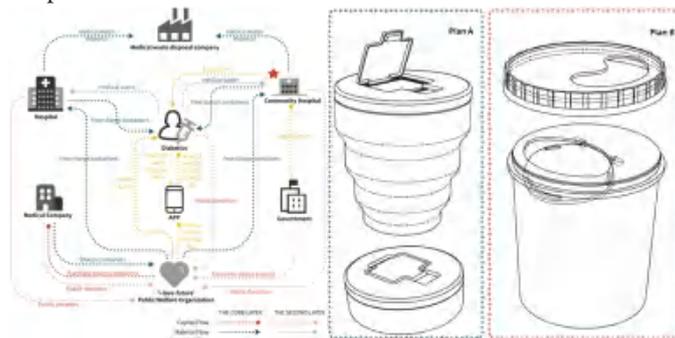
Stage	Receiving treatment in hospital	Purchasing medical product	Using medical product	Disposing of medical product	Regular inspection
Stakeholder	Medical staff	Diabetics&Medical companies	Diabetics	Diabetics	Diabetics
Touch point	Teach the way of injection, blood collection and using sharps container	Hospital&Community Hospital&Drug Store&Online shopping	Process of treatment	Hazardous waste disposal sites near the community.	Regular inspection&Taking back sharps container
Requirement	Teach quickly and efficiently and reduce the workload.	Free sharps container&Correctly using sharps container	Sharps container is easy to be used, Waste doesn't dump easily.	The disposal point is not far from the residence.	The sharps container is convenient to carry. The process of recycling old boxes and getting new ones is smooth.
Design opportunity	*Brochure design *Public video	*Medical product packaging design with a warning for proper dispose of medical waste *Sharps container:be suitable for home use	*Sharps container: be convenient for the elderly to use;suitable size for home use;be convenient to carry.	*Recovery treatment point service design in community hospital	*The service design of managing and disposing of different boxes.

[Figure 4] Design opportunities in different stages

5. DESIGN PROPOSAL

The study analyzed the factors that triggered awareness change and behavioral motivation of diabetics to dispose of household medical waste properly under the supervision of no laws and regulations in China at present.The methods and contents of innovative interaction among stakeholders in different service processes are also analyzed.Meanwhile,we analyzed the background of the study from the angle of environment, society and economy, and through the methods of product-service system design and co-creation, to determine the design intervention scope,the design priority order and the design practice content with community as the service center.

This Product-service system is based on the “i-love-future” public welfare organization and Centered on community hospital.“i-love-future” purchases sharps containers from the Medical Company and distributes them to diabetics in the community hospitals and hospitals for Free.With the APP, patients could quickly find nearby community hospitals or hospitals that can dispose of medical waste, and track information about the sharps containers ever collected.Meanwhile,“i-love-future”will give health talks on diabetes in community hospitals from time to time to guide patients to understand the harm and disposal of medical waste.And,the household medical waste collected from community hospitals and hospital would be disposed of in medical waste disposal company.There two kinds of sharps containers in this product-service system,the one is retractable and portable,the other one is convenient for the elderly and not easy to dump waste.



[Figure 5] Service system map [Figure 6] Sharps containers design

6. DISCUSSION

Stakeholders such as manufacturers, medical institutions, and diabetics are willing to take financial responsibility for their behavior. It is a sustainable consumption and can support the management of household medical waste. Design practice attaches importance to the interests of vulnerable and marginal groups by reducing the risk of NSIs from diabetics household medical waste for scavengers, sanitation workers and children. At the same time, this practice also benefits the management of household medical waste from other diseases. The success of a typical community practice case could raise the awareness of diabetics and the public about the management of household medical waste, and increase the recovery rate of household medical waste. Therefore, it is possible to provide legislative reference for the Chinese government and for the classification of garbage in China.

In the future, the specific ways and content of education for patients with diabetes need to continue to be studied. Compared with the current product and service system, there are many uncertainties about how to educate and which stakeholders should guide diabetics to participate voluntarily and correctly in the service system.

7. ACKNOWLEDGEMENT

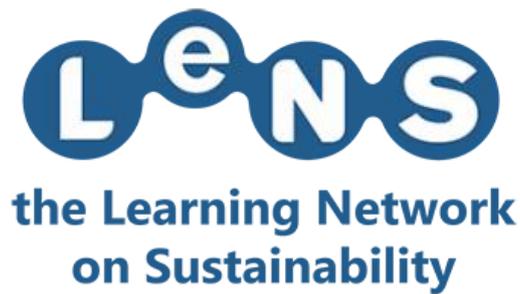
Thanks to my mentors, Dr. Miaosen Gong and Dr. Xiao Dongjuan, for their guidance and help in academic research, so that I can find defects and deficiencies in my continuous exploration and continue to seek breakthroughs.

At the same time, thanks to the research resources provided by “i-love-future” public welfare organization, Wuxi Traditional Chinese Medicine Hospital, Wuxi Chengnan community, Wuxi Wanke community, Wuxi Shangxian community, Shanghai Panyu Road Community and Solid Waste Department of Wuxi Environmental Protection Government.

And finally, Thank you to the 15 patients and 34 telephone patients who agreed to be interviewed

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BUSINESS MODEL DESIGN BASED ON THE CONCEPT OF SUSTAINABLE DEVELOPMENT—A SERVICE DESIGN OF THE PHYSICAL IDLE MALL AS AN EXAMPLE

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ABSTRACT

In the first half of 2018, the total retail sales of consumer goods in China reached 18 trillion yuan, a year-on-year increase of 9.4%. In addition to what we often call the concept of consumption upgrades, the trading of idle goods is also highly anticipated. Reasonable reuse or sharing of old things reflects the concept of sustainable development. The article aims to study how to use commercial services to make old and more rational and effective use of sustainable development. Realizing the rapid circulation of information and funds in the secondary market, but the market is still inactive. The article studies consumer psychology and summarizes the problems of the network idle trading platform, compares and studies the advantages and disadvantages of the domestic and international flea market business models. Finally, a business model and service system for the sale of new used old goods with integrated physical stores was proposed.

Key Words: Sustainable Development, Service Design, business model canvas, second-hand goods

1. INTRODUCTION

The total retail sales of China social consumer goods reached 18 trillion yuan in the first half of 2018, with a year-on-year growth rate of 9.4% which is higher than the growth rate of GDP in the same period. Basically, the effect of domestic consumption on the national economy is obvious. In addition to the general concept of consumption escalation, the transaction of idle commodities is also expected. In recent years, with the help of large-scale operation networks, a large number of idle trading platforms have linked buyers and sellers in different regions, thus realizing the rapid circulation of information and funds in the secondary market. However, the current market is still in an inactive state. Through the investigation of the development of related second-hand businesses at home and abroad, the paper has defined the second-hand business that China needs to develop in line with the concept of sustainable development. In addition, through the network and literature as well as consumer research, this paper also explores the problems in China's secondary market, puts forward a new business model of second-hand idle commodities based on foreign excellent cases, that is, a business model that integrates offline sales of physical stores and online service cooperation. Moreover, combined with the design thinking of service design, this paper has also created a sustainable business model with customer demand as the centre, and the recycling, sorting and selling as the standard procedures, as well as advocating the concept of sustainable development and sharing as the value proposition.

2. THEORETICAL BASIS

2.1. Development of Second - hand Business

People are familiar with the concept of “flea market”, which originated in France. As there are many conveniences for buyers and sellers, the flea market has gradually spread to world. Through transactions in flea markets, sellers can sell goods that have been eliminated from the market, and buyers can also purchase excellent and cheap goods, while reducing waste of resources. At present, network become the most important sales channel that is second only to the traditional physical channels. Due to the limitations of online shopping, the hoarding of idle and unwelcome items is increasingly serious. On the contrary, the rational reuse or sharing of old items embodies the concept of sustainable development. Therefore, the online “flea market” has also become a member of the online shopping market. However, China's second-hand turnover still lack authoritative and accurate data. The network market in developed countries has a more complete intellectual property protection system, credit system and logistics distribution system than the domestic network market, with most mature mechanism for purchasing and selling second-hand products and the more advanced sense of sharing consumption.

2.2. Problems Existing in China's Second-hand Trading Market

Asymmetric market information: It is not mean that the seller intentionally deceives the buyer and provides false information (although such cases occur from time to time as well). This is because that both buyers and sellers' evaluation and preference for the quality of goods come from personal subjective judgment. Firstly, in the process of transaction, one side of the hidden information damages the interests of the other side of the transaction; Secondly, the market distorts the mechanism of survival of the fittest.

Uneven quality of commodities The uneven quality of commodities in the secondary market is a major loophole in the secondary market. The seller is the random individual with a large base. Compared with new products, the platform is more difficult to control the quality of second-hand products.

It is difficult for consumers to safeguard their rights: Every day, a large number of transaction information and the subsequent processing of each case require masses of technical support and background processing. Consequently, when consumers are faced with the problem of safeguarding their rights and interests, they often cannot choose due to the complicated application and slow processing speed of complaints, which in turn tolerates the fraudulent behaviour of illegal sellers and fraudulent groups.

Incomplete credit system Due to that it is difficult to establish contact between strangers, it is more difficult for users to establish trust and association in the network. Generally, the threshold for registering users in the electronic secondary market is low, and the credit rating system is not perfect as well.

2.3. Practical Cases and Service Design Concept of Second-hand Business

The concept of product service system is to transform tangible products into intangible services, so as to reduce the environmental impact brought by the waste of resources and product consumption. This concept is consistent with the concept of sustainable development and is gradually being applied in the second-hand consumer market. For example, “Apple Giveback”, it offers discount prices for Apple's own old products and competitors' old equipment, as well as waste recycling options for antique mobile phones that do not meet the conditions of trading in the old for the new; “Plum”, which is a domestic second-hand women's fashion trading platform, also provides diversified services to obtain more users, and converts the traditional second-hand trading demand into a consumption scene of “fashion consumption upgrading and rapid cycle iteration” through strong product category, technology and data drive; “DuoZhuaYu” set up a temporary offline bookstore in Beijing with a traffic volume of about 3,500 in 6 days and more than 20,000 books being sold which is much higher than that of traditional bookstores. The venue of the bookstore plays beautiful jazz music, and books are divided according to difficulty, thus attracting the attention of

many readers. This online platform learned from Japan’s second-hand bookstore “Bookoff”.

Service design aims to help create new or improve existing services to make them more useful to customers. Basically, this kind of design thinking has long been applied in the business model. Most traditional business model innovations are based on marketing and management, while design-driven business models have become a new trend, which more emphasis on users and sustainable development and more in line with the people-oriented and sustainable development ideas advocated by our country.

3. SERVICE DESIGN AND BUSINESS MODEL OF PHYSICAL IDLE SHOPPING MALL

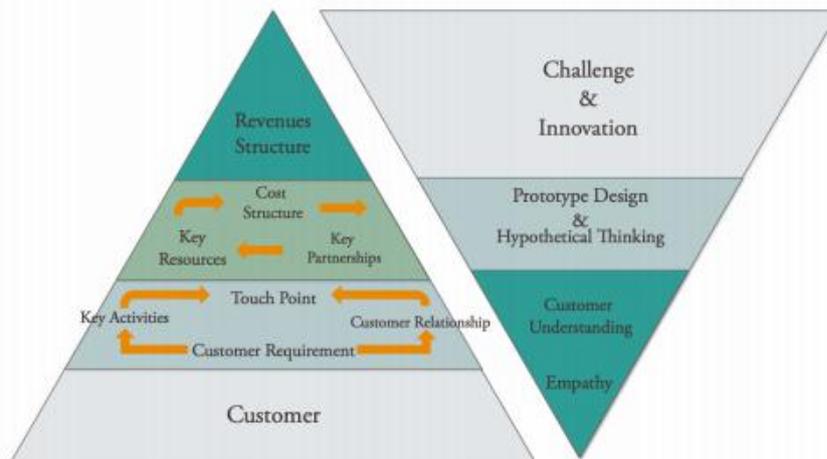
3.1. Value Discovery

It can be seen that the circulation of second-hand idle commodities through the single network is very limited. According to “Quest mobile data”, as of the end of 2017, the number of second-hand transaction users in China was close to 40 million, while the penetration rate of mobile Internet was only 3.6%, the number of second-hand trading users in China is 80% lower than that in the second tier, while the users under the age of 24 is 50%. Consequently, young Chinese users are pursuing the improvement of material life, instead of fully realizing the sustainable development and sharing. Therefore, the current second-hand business service design has a deeper objective, that is, to convey the awareness of sustainable development and sharing to the whole society.

“Bookoff” and the temporary offline bookstore of “DuozhuaYu” offer a new idea—— how to circulate more kinds of second-hand goods through the combination of online and offline transactions? Through a questionnaire study of 100 college students’ views on e-commerce, physical shopping malls and second-hand trading Apps, the paper found that the young people think that it is better to donate or exchange or trade idle items than to throw them away. Surely, they also hope to buy good and cheap second-hand goods at low prices. Based on the needs of users, this paper uses the mode of converting second-hand businesses from a single online transaction to a combination of online transactions and offline physical stores for service design.

3.2. Business Model Analysis and Product Service System Design

Firstly, based on the butterfly framework of business model, this paper designs the business model structure (Figure 1) in line with the sequence based on the sequence formed by the idea of taking users as the starting point and then analyse the business model content of the entity idle mall with this structure as the method.



[Figure 1] Pyramid of Business Model Structure

The target users of the service design of the physical idle shopping mall should be all customers with online and offline shopping capability and awareness of handling idle items. According to the sorting of users’ needs and the concept of sustainable development in the survey, the paper roughly divides the business designed by this business model into a flow chart (Figure 2). The most important business is the physical idle shopping mall, which needs to be divided into venues and shops according to different types and the recency degree of commodities, and the business that covers a wider range is the users’ online transactions.



[Figure 2] Business Model Flow Chart

According to the concept of business model canvas (Figure 3), this paper divides users into 6 categories, including young people, housewives, women who love beauty, people who are conscious of sustainable development, people who have sharing ideas, as well as people who are extremely fond of luxury goods or other certain types of goods. Shopping malls sell unused items through purchasing, sorting, repricing and sorting, while users trade through physical stores through self-selection and online reservation. Alternatively, shopping malls can also donate or auction products according to the value of products provided by users and users' wishes. The physical stores attract customers through the special classification of goods and the design of shopping environment.



[Figure3] Business Model Canvas

3.3. Service System Design

In the service design of the mall, the paper uses the method of user's journey design to focus the design on the needs and experiences of users of both parties. The user's journey is divided into 9 contact points:

- 1). Searching. Users of seller can preview similar goods by scanning or uploading idle goods through App, while the users of buyer could know the products that they need through the App.
- 2). Arrival. Users of seller can choose the methods of service personnel to receive the goods at home or going to the recycling office of the mall for sale, while users of buyer can purchase on their own when they arrive at the mall according to the online scores.
- 3). Consultation. The self-service information platform indicates the main category, recency degree of the main commodity of each floor to facilitate users to search;
- 4). Environment. The environment of idle stores should be different from that of ordinary stores. In particular, the furnishings and background music of it should reflect the retro feelings. Each store should have different characteristics so as to increase the residence time of customers.
- 5). Wandering. The floor layout of the shopping mall is classified according to commodity category; each floor is classified according to the brands of similar commodities; the commodities in the store are classified into shelves according to their recency degree, to facilitate customers to quickly select the products they are satisfied with.
- 6). Information. The information of commodities such as recency degree and price and so on are comprehensive, and these commodities have been classified and priced in a unified standard, so as to eliminate customer doubts.
- 7). Self-service. Reduce the human resources of waiters and set up 1 - 2 consultants in each store to create free and comfortable shopping space for customers.
- 8). Purchasing. Each floor set up a check-out channel and relatively cheap second-hand goods which are arranged on both sides of the check-out channel, so that customers can browse more practical and cheap goods while waiting in line, so as to stimulate consumption.
- 9). After-sales service. Each user has his or her own App account number, and the goods purchased and sold are recorded, so that the customer can enjoy convenient after-sales service. At the same time, the users can receive information such as commodity recommendation and processing activities through big data, thus increasing the stickiness of users.

According to the business model canvas and the shopping mall service design, the paper divides this idle goods transaction business plan into three parts, including the recycling, sorting and selling. In order to meet all the needs of the target users, the system pays attention to the inner needs of each user through interaction.

4. CONCLUSION

To sum up, it is the requirement of the development of the times to integrate design thinking such as service design into the establishment of business models, and the people-oriented ideas should be applied in all walks of life, of which the idea of sustainable development is the long-term way. Reasonable use of second-hand goods in life can not only reduce unnecessary waste, but also give full play to the greater value of products and make significant contributions to the shortage of resources and sustainable development. Based on this concept, this paper proposes a new second-hand trading business model and introduces the main contact points in its service system. On the other hand, this paper also describes the key interaction scenarios or service forms in each contact point, and theoretically summarizes and interprets the design practice. Actually, the new second-hand business model based on the concept of sustainable development is an important component of future development. As people's awareness of sharing gradually increases, people's demand for second-hand transactions will also increase correspondingly. Therefore, the establishment of a reasonable and comfortable trading environment for users and the establishment of the life cycle of the second-hand commodity of "recycling - sorting - selling" are the primary concerns of designers. Basically, this article only introduces the service design of the physical idle mall in theory without covering all its contents. Consequently, how to establish and plan the complete life cycle of "recycling - sorting - selling" of second-hand goods is still the direction that needs further research in the future.

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3. DISTRIBUTED ECONOMIES DESIGN FOR SUSTAINABILITY



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DISTRIBUTED MANUFACTURING APPLIED TO PRODUCT-SERVICE SYSTEMS: A SET OF NEAR-FUTURE SCENARIOS

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ABSTRACT

Product-Service Systems (PSS), if properly designed and implemented, represent a promising approach to sustainability. However, there is a number of organisational, cultural and regulatory barriers that hinder the widespread PSS implementation. In this paper, we address this problem by applying Distributed Manufacturing (DM) to tackle some of PSS implementation barriers. We systematically analyse favourable DM features and their potential application for PSS and put forward a set of near-future scenarios. 40 scenarios created to initiate strategic discussion about DM and PSS combination are presented along PSS life cycle stages illustrating the potential of DM features to address PSS implementation. These scenarios can be used by educators, designers and businesses to identify future opportunities to design sustainable PSS solutions.

Key Words: Product-Service Systems; Distributed Manufacturing; Scenarios; PSS lifecycle

1. INTRODUCTION

Modern societies face a number of global environmental challenges, such as resource depletion, excessive waste production, climate change, etc. caused by the patterns of production and consumption of goods (UN, 1992). Attempts to solve these challenges by improving design of products can only partly address existing issues, since these improvements are more than offset by increasing consumption levels (Binswanger, 2001). There is a need to redesign not only products but also services to influence people behaviour towards choosing more environmentally-aware consumption patterns (Cherry and Pidgeon, 2018).

A promising way to address environmental challenges is through the implementation of Product-Service Systems (PSS), defined as “a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs” (Tukker and Tischner, 2006). An appropriately designed PSS has the potential to improve production processes and consumption patterns towards environmental sustainability, provide companies with competitive advantage and build strong relationship with their customers (Cooper & Evans, 2000; Mont, 2002). However, PSS implementation requires companies to redesign their business processes as well as acquire different competences, thus creating a number of obstacles for companies to overcome (Besch, 2005). In this paper, authors investigate Distributed Manufacturing (DM) as a promising production model which can be applied to PSS to address some of its implementation barriers. DM is defined as “a network of small-scale production units equipped with advanced manufacturing technologies, which facilitate localised and individualised production” (Petrolaityte et al., 2017). Initial attempts to apply DM principles to PSS development can be found in the existing literature (Suominen et al. 2009; Arup, 2015; Moreno & Charnley, 2016; Ford & Despeisse, 2016). However, these attempts are still fragmented and illustrate a need for a systematic in-depth analysis of DM application for improved PSS development.

Aiming to explore and illustrate DM and PSS combination, authors put forward a set of DM applied to PSS near-future scenarios developed within the LeNSin research project (EU-funded, 2015-2019). Scenarios can be described as “narratives of alternative environments in which today’s decisions may be played out.” (Ogilvy and Schwartz, 2004). Scenarios are used to stimulate strategic conversation (Ogilvy, 2006) and facilitate decision-making process in the present (Lelah et al., 2014). Near-future scenarios introduced in this paper were developed to illustrate the potential of DM to address existing PSS implementation barriers. Furthermore, the aim of the developed scenarios was to encourage educators, designers and businesses to discuss DM and PSS combination and consider DM application to PSS development.

This paper is structured in three sections. Section 2 presents scenario development process, including adopted methodology, examples and a complete list of developed scenarios. It also discusses classification of near-future scenarios and their sustainability implications. Section 3 concludes the paper briefly outlining future development opportunities.

2. DEVELOPMENT OF DM APPLIED TO PSS NEAR-FUTURE SCENARIOS

This section introduces scenario development process, provides one example of DM applied to PSS near-future scenarios and summarises a list of scenario titles. Furthermore, it outlines scenario classification to illustrate areas in which scenarios can be applied.

2.1. Methodology

DM applied to PSS near-future scenarios aim at illustrating how DM can be applied to foster and support PSS implementation. For this reason, the research started with in-depth literature review aiming to collect existing PSS implementation barriers. Later, DM benefits, challenges and near-future trends were gathered through the literature review, semi-structured expert interviews and research seminar. All collected DM benefits and near-future trends were listed as DM opportunities with their corresponding challenges. In total, 50 PSS implementation barriers and 68 DM opportunities with 39 challenges were gathered to develop DM applied to PSS near-future scenarios. Initial data collection and analysis are described in Petrolaityte et al. (2017), Petrolaityte et al. (2018).

In order to arrange a large amount of the collected data in a meaningful way, a theory building approach has been applied (Meredith, 1993). The aim of the theory building is to define relationships between events and studies, reasons for which these relationships exist and their potential influences (Meredith, 1993; Wacker, 2008). Therefore, relationships between collected PSS implementation barriers and DM opportunities and challenges have been defined to develop new insights. This has been done by matching all PSS implementation barriers with DM opportunities and challenges in all possible combinations: each identified PSS barrier was systematically coupled with each individual DM opportunity to understand if the latter could tackle the former. Logical pairings were described in short scenarios narrating specific DM features and their application for PSS implementation, with multiple scenarios addressing individual barriers as well as multiple barriers being addressed in individual scenarios.

In order to control the scenario building process (in total 3,876 DM and PSS pairings can be made from the collected data) a cognitive mapping method was applied (Goodier and Soetanto, 2013). According to this method, opportunities, trends, challenges and other collected data have to be mapped in an empty space between present issues and desirable futures. PSS implementation barriers were identified as undesirable situation that needs to be addressed. Desirable futures – actual DM applied PSS near-future scenarios – represented improved PSS implementation. Collected DM opportunities (and challenges) were named as a link between present issues and desirable fu-

However, adoption of sensor technologies and their integration in existing company's business processes requires high initial investment from PSS providers. Moreover, data available from sensors can cause issues related to company's and customer's data.

In total, 40 DM applied to PSS near-future scenarios have been developed. A complete list of scenario titles is presented in Table 2.1.

[Table 2.1] A complete set of DM applied to PSS near-future scenarios

No	Scenario title
1	Facilitated implementation of PSS businesses
2	Comparison between PSS and traditional product-based solutions
3	PSS solutions created by customers in makerspaces owned by PSS providers
4	Collaboration between PSS providers and customers in makerspaces
5	Customisation of existing PSS solutions carried out by customers
6	Personalised PSS solutions designed by customers themselves
7	Entirely bespoke PSS solutions created for each customer
8	PSS solutions available on a high street
9	Complex geometries of PSS products and reduced material usage
10	Reduced number of materials needed to produce PSS products
11	Design of self-(dis)assembling PSS products
12	Design of self-repairing PSS products
13	Design of lightweight PSS products
14	Simplified components for remanufacturing of PSS products
15	Improved development of future PSS solutions through user monitoring
16	Maintenance of PSS products predicted through product specifications and historical trends
17	Reduced waste production
18	Home manufacturing of personalised parts of PSS products
19	Outsourced manufacturing services for localised production of PSS solutions
20	Remote control of manufacturing equipment
21	Manufacturing kit for local production of PSS solutions
22	Blueprints of PSS products available in makerspaces
23	Simplified upgrade of PSS products
24	Production and support of PSS solutions carried out by local artisans
25	Reduced number of supply chain actors
26	Simplified transportation through local manufacturing
27	Manufacturing ran by customers, service provision carried out by PSS providers
28	Reverse engineering for remanufacturing of components of PSS products
29	Educated customers with knowledge about PSS benefits and maintenance
30	Monitoring of PSS products carried out by PSS providers and/or customers
31	Monitoring of hygiene level of PSS products carried out by customers
32	Identification of manufacturing facility located closest to the customer
33	Upgrade of PSS products with personalised parts
34	Home assemble and maintenance of PSS products using DIY kits
35	Maintenance of PSS products carried out by customers at home
36	Maintenance of PSS products carried out by PSS providers in makerspaces
37	Production of spare parts of PSS products carried out in a mobile factory
38	Monitoring of PSS products for their End-of-Life
39	Simplified collection of PSS products at their End-of-Life
40	Transformation of obsolete PSS products into personalised solutions

2.2. Classification of DM applied to PSS near-future scenarios and their sustainability implications

In order to illustrate areas in which scenarios can be applied, all DM applied to PSS near-future scenarios have been classified according to PSS and DM attributes. For this reason, scenarios were categorised according to four PSS life cycle stages: Design, Material Production and Manufacturing, Use and End-of-Life with some scenarios addressing more than one life cycle stage. Later, scenarios were classified according to three DM features scenarios contain: Manufacturing localisation, Customer-orientation and Enabling technologies. These DM features based on Srari et al. (2016) defines key components of distribution of manufacturing. PSS and DM attributes with mapped numbers representing near-future scenarios (from Table 2.1) are presented in Figure 2.

Distributed Manufacturing features	Manufacturing localisation	1 3 4 8	8 18 19 20 21 22 24 25 26	19 20 21 22 24 25 26 29 32 35 36 37	25 26
	Customer-orientation	3 4 5 6 7 8	8 18 22 25 27	22 25 27 29 30 31 33 34 35	25 27 40
	Enabling technology	2 5 9 10 11 12 13 14 15 16	9 10 11 12 13 14 17 20 23 28	11 12 13 14 15 16 20 23 28 30 31 32	28 38 39
		PSS Design	Material Production and Manufacturing for PSS	PSS Use	PSS End-of-Life
Product-Service Systems life cycle stages					

[Figure 2] Classification of DM applied to PSS near-future scenarios

According to Vasantha et al. (2012), sustainable value adding PSS can only be created taking into account every life cycle stage of products and services. Figure 2 illustrates that DM applied to PSS near-future scenarios address each PSS life cycle stage. PSS Design stage predominantly benefits from collaboration between PSS provider and customer, enabled by connectivity through digital channels and physical interaction in local manufacturing facilities. Application of Additive Manufacturing technology helps to optimise design of PSS products to simplify their production and extend their lifespan. Material Production and Manufacturing for PSS stage benefits from distribution of manufacturing facilities, equipped with digitally connected manufacturing technology. An ability to send digital production files to remote locations allows PSS companies to produce products at the close proximity to customers and/or resources. Use of PSS stage is supported with the largest number of near-future scenarios tackling on-site and on-time provision of maintenance services. PSS End-of-Life phase is facilitated by the application of sensor technology, which helps to indicate products' end-of-life by alerting PSS providers and customers. Even though recycling is considered as the last chance to retrieve materials and energy embedded in PSS products, a distributed network of localised recycling facilities eases product collection, recycling and re-manufacturing.

3. CONCLUSION

Implementation of Product-Service Systems shows the potential to improve business processes and consumption patterns towards environmental sustainability at the same time providing companies with competitive advantage and an ability to better satisfy customer demands. However, PSS implementation is still limited by a number of barriers, linked to organisational mind-set, lack of customer acceptance and absence of appropriate regulations. This paper has introduced a set of near-future scenarios developed to illustrate the potential of Distributed Manufacturing to address some of PSS implementation obstacles.

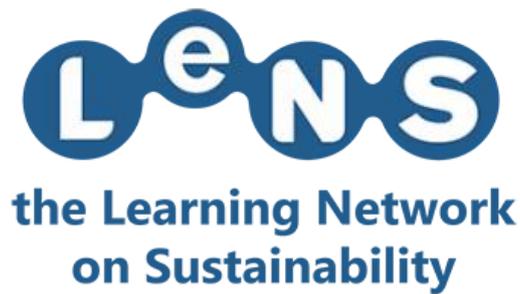
50 PSS implementation barriers and 68 DM opportunities with corresponding challenges were used to describe 40 DM applied to PSS near-future scenarios. Later these scenarios were classified according to PSS and DM attributes to illustrate potential application areas. These 40 near-future scenarios provide an overview of the sustainability potentials and practical implications of applying DM throughout the whole PSS life cycle. These scenarios can be used by educators, designers and businesses to identify future opportunities to support sustainable PSS implementation.

The developed near-future scenarios have been integrated into a design toolkit aiming to support various user groups in PSS solution development (Petrulaityte et al., 2019).

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METHODS AND TOOLS FOR COMMUNITY BASED RESEARCH PROJECTS: DISTRIBUTED DESIGN AND DISTRIBUTED INFORMATION FOR VOLUNTEER ORGANISATIONS IN SOUTH AFRICA: UNLOCKING VALUE IN TEACHING AND LEARNING PROGRAMMES

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ABSTRACT

The growing global challenges such as rising global population and youth unemployment have devastating impacts on developing countries. Many not-for profit organisations strive to reduce unemployment by running volunteer programmes for the youths while socially and economically improving communities. The aim of this research is to provide sustainable information and communication technology (ICT) solutions within the Sustainable Product Service System (S.PSS) framework to facilitate social innovation of volunteer organisations in order to scale social impact of developmental programmes in South Africa. The paper adopts the theoretical principles of S.PSS to design the proposed solutions. A qualitative case study approach is followed. Multiple methods of data collection were used to gather rich data from the volunteers and their mentors, allowing to better understand the extent to which an ICT based intervention could sustain developmental programmes for social impact. The findings show that the developmental programmes proposed by volunteer organisation presents challenges at different levels.

Key Words: S.PSS, Social Innovation, ICT4D.

1. INTRODUCTION

The growing global challenges such as rising global population and youth unemployment have devastating impacts on developing countries. It is to this effect that the United Nations General Assembly (2015) established the global agenda 2030 to address such challenges. The sustainable development goals (SDGs) are set to guide efforts towards addressing global challenges. In particular, Goal four of the SDGs speaks of quality education with a specific target ensuring that all learners acquire knowledge and skills promoting sustainable development practices (United Nations General Assembly, 2015). With less than 5% of the global population and less than 4.5% in South Africa going to higher education there is a need to establish alternative and innovative ways to ensure continuous skills development for the majority of the youth and more specially for the youth in marginalized communities in order to stimulate sustainable development and lifestyles (South Africa, Department of Higher Education and Training, 2018:6). Harnessing ICT in service of the world most severe problems require a clear understanding of these challenges (Dada, 2006; Heeks, 2008). Thus, existing institutions or organisations within South African communities can have a positive influence on ICT interventions. Development organisations and Non-Governmental Organisations (NGOs) such as volunteer organisations are well positioned to prioritise ICT-based interventions to achieve developmental goals (Marais, 2011; Dada, 2006:8; Ashraf et al., 2008). Hence, the South African National Integrated ICT Policy articulate that all South African must benefit from the ability of ICT to support social development and improve the quality of life of individuals and communities (National Integrated ICT Policy White Paper, 2016:3). Moving toward using available technologies to address existing socio-economic challenges is the main objective of these organisations (Marais 2011:120; Sithole et al, 2013).

This paper, being part of an ongoing study, investigates the challenges faced by an NGO which provides teaching and learning support to primary schools in under-resourced communities in Cape Town, South Africa. It has been observed that a number of NGOs and Non-for Profit Organisations such as volunteer organisations are working towards providing skills development to the youth within marginalised communities. Yet, the impact of their actions are not scaling and lack sustainability. Under this background, the question which the paper seeks to answer is: How can ICT strategies be designed to support a sustainable teaching and learning experience by volunteers in developmental programmes?

The next section describes the empirical case in the study, which is Action Volunteers Africa (AVA). The section that follows one on the empirical setting describes and explains the concept of sustainable product service system (S.PSS), followed by the section on the social pillars of sustainable development. The theoretical lens guiding the study is explained in the next section, followed by data collection before the paper ends with finding and recommendations.

2. EMPIRICAL SETTING

In 2012 Action Volunteers Africa (AVA) was set up as the CSI initiative of Action Appointments, a well-established NGO recruitment agency. AVA became an independent not for profit organisation (NPO). AVA has had a great impact on the 300+ young people who have volunteered on our programmes. Over 90% of the youth who have passed through AVA programmes have managed to secure further opportunities for work or full time study and are firmly on the path towards sustainable careers. The AVA project has also had a positive impact on the capacity of the partner organisations and schools, allowing them to expand or extend their impact at no extra cost. AVA has played an active role in advocating for the large scale use of volunteering as a means to address our growing youth unemployment.

3. SUSTAINABLE PRODUCT SERVICE SYSTEM (S.PSS)

According to Vezzoli et al. (2015), S.SPP is an offer model providing the integrated mix of products and services that are together able to fulfil a particular demand of (customer) satisfaction, based on innovative interactions between the stakeholders of the value production system, where the economic and competitive interest of the providers continuously seek after environmentally beneficial new solutions. S.PSS is a dynamic system with a multidimensional impact (Lee, et al., 2012; Annarelli, et al., 2016:1024). S.PSS has the potential to bring change in consumption and production patterns which could accelerate the shift towards sustainable practices and societies (Mont, 2002:239; Manzini & Vezzoli, 2003; Tukker & Tischner, 2006:1554; Baines et al., 2007:5; Vezzoli et al., 2015). Hence, S.PSS allows the identification of opportunities, trends and developments in societies and provide an innovative space for social systems. Thus, S.PSS enable close relationships between all stakeholders, effective and efficient communication, decentralisation in decision making, establishment of new performance indicators and the creation of new networks focusing in the identification of societal needs and changes such as shifts in social sustainability elements, information sharing networks and best practices. By following the S.PSS approach, volunteers organisations could deliver high value ICT-based solutions to communities and society at large (Baines et al., 2007:6). Such innovative solutions lie on the premise that existing technologies within organisations could be systematised (Manzini et al., 2003). This systematisation rely on innovative partnerships of all stakeholders (Chou et al., 2015).

S.PSS needs to be designed at the systemic level and must be user-oriented and users' involvement at the early stages of the solutions design process (Morelli, 2006); Baines, et al., 2007:7; Lee, et al., 2012:174; Gaziuloso, 2015:104; Chou, et al., 2015). There is a need for interrelated innovation systems to support new models provid-

ing insight into societal developments and changes (Joore & Brezet, 2015). The scope of PSS solutions must meet broader sustainability issues. Systems combining and connecting users, organisations and sustainability must be established (Figure: 2) (Chou et al., 2015). Organisations need to focus on contextual conditions which may favour or bloc societal embedding of S.PSS approaches (Ceschin, 2013:5).

S.PSS can potentially deliver social welfare with limited negative environmental and societal impact (Lee, et al., 2012:174; Joore et al., 2015; Vezzoli, et al., 2015; Xin et al., 2017:399). Understanding social aspects of S.PSS within specific contexts is important to achieve sustainable development (Ceschin, 2013; Reim et al., 2015). The contribution of S.PSS on social sustainability depend on the acceptance level of S.PSS solutions and change of existing unsustainable practices (Mylan, 2015:13). Social transformation need to occur at the institutional, social, cultural, organisational and technological levels to achieve sustainability (Gaziulusoy, 2015:104; Mylan, 2015:13). Therefore, societies need to co-evolve and align with sustainability goals.

4. SOCIAL PILLARS OF SUSTAINABLE DEVELOPMENT

There is a need to focus on the social pillar of the sustainable development concept rather than just the economic and environmental dimensions (Vallance et al., 2011). Murphy (2012) recall the need to clearly understand the social pillar of sustainable development. McKenzie (2004:21) calls for new models of understanding and collaboration in social sustainability. There are currently limited integrated social sustainability frameworks due to the fact the social sustainability dimension has been neglected compare to the environmental and economical dimensions (Missimer et al., 2017b). To overcome this challenge, there is a need to develop frameworks which focus on the social dimension within specific contexts. Andrade et al., (2008) suggest that an integrated framework need to incorporate aspects of human capital, social capital and institution theories. Cuthill (2010) also mention the need to focus on aspects of social justice and equity (equity, rights, access, participation), social capital (social networks, social norms, trust, civic engagement, institutions, relationships, attitudes, values), engaged governance (inclusion of all stakeholders in the decision-making process) and social infrastructure (health, education, activity centres, transportations). Colantonio (2009) discuss social sustainability concepts (Table: 1) by contrasting between hard and soft concepts. The former includes employment and poverty while the later speaks of happiness, social mixing and sense of place. Murphy (2012) also identify awareness, equity, participation and social cohesion as essential elements for social sustainability.

Cuthill (2010) note the importance of shifting toward soft infrastructure elements which aim at identifying community needs and build capacity to meet those needs. The capacity building exercise need to bring clear outcomes to impact social sustainability. While there are many well established indicators such as social impact assessment (SIA) which focus more on assessing hard social sustainability concepts, little focus has been on understanding the impact of new emerging themes on social sustainability. There is a shift toward developing new set of indicators which will focus emerging themes (Table: 2) such as well-being, social capital, happiness and fairness rather than just looking at looking more traditional themes of equity, poverty and employment. For example, Rogers et al, (2012) argue that the well-being is a multidimensional concept and all components need to be measured objectively and subjectively to monitor progress.

5. THEORETICAL LENS

S.PSS principles propose three main approaches which organisations can follow to achieve successful analysis, design and implementation of solutions within the S.PSS framework. The three approaches as shown in Figure 2, involve service or product design, user oriented and result oriented. The three have been adopted to provide ICT solution for sustainable development within the learning and development programme of the volunteer organisation in the study. Several researchers, including Mont (2002), Manzin et al. (2002), Tukker et al. (2006), Baines et al. (2007) and Vezzoli et al. (2015), have identified key principles of successful development of ICT solutions within the S.PSS framework as: PSS solutions involves close relationships of all stakeholders throughout the process, Effective and efficient communication between organisations and users, Decentralised decision making process, Establish new performance indicators in dealing with stakeholders and Creation of new networks focusing on identifying societal needs and changes.

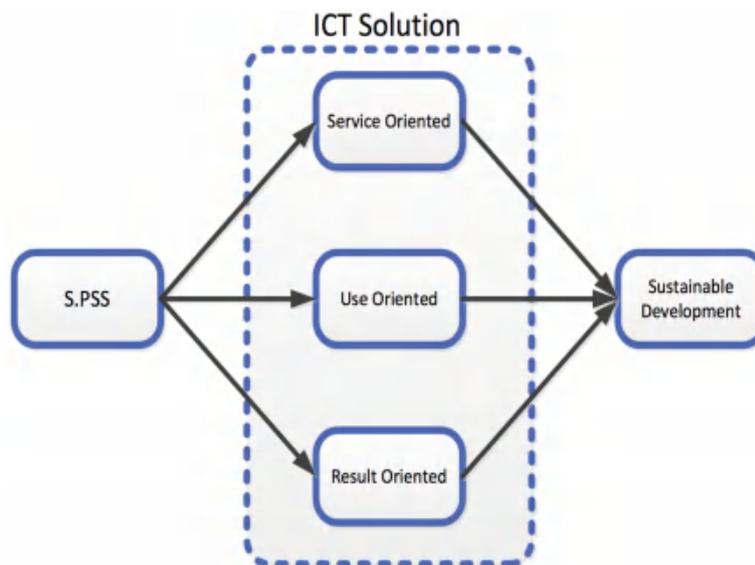
6. DATA COLLECTION

Multiple methods of data collection were used to gather rich data from the volunteers and their mentors, allowing Tukker, A., Tischner, U.(2006). Product-Services as a Research Field: Past, Present and Future. Reflections from a Decade of Research. *Journal of Cleaner Production*, 14(17), 1552–1556.

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Xin, Y., Ojanen, V., Huisken, J.(2017). Empirical Studies on Product-Service Systems - A Systematic Literature Review. In *Procedia CIRP*. 399–404. to better understand the extent to which an ICT based intervention could sustain developmental programmes for social impact. The following approaches and tools were used simultaneously

and sequentially in some cases: Stakeholder mapping and analysis, Focus group discussion, Patterns quest (explore deeper interviews outcome to identify deeper reasons behind issues), Creating storyworld (develop an understanding of structure of entities), Problem definition (to narrow down from a rich picture about complex interconnected

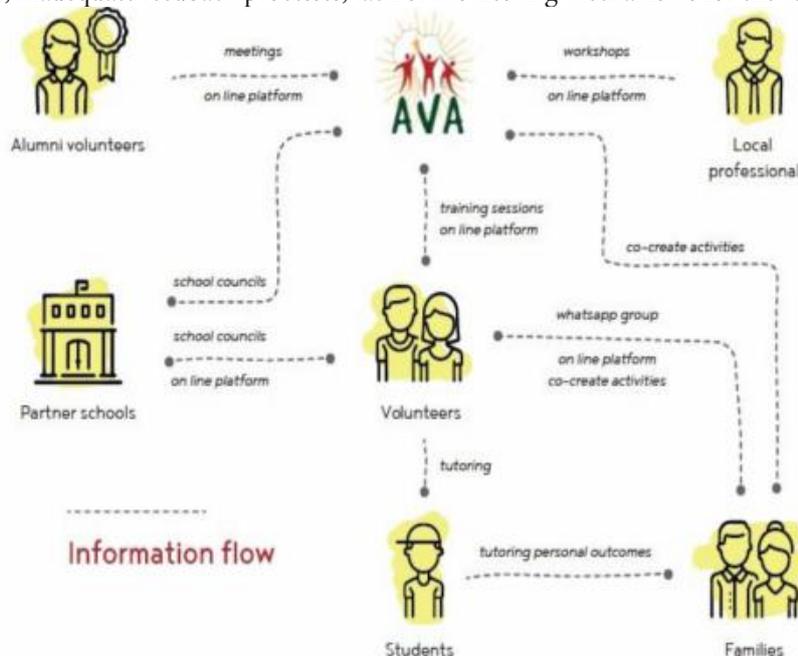


[Figure 1] S.PSS theoretical principles

issues, towards a key issue which could be improved upon and helps participants reveal their unspoken assumptions about how they interpret what is going on and why it matters), Jam sessions (aim to create ideas with group of participants), Observation (observing social phenomenon in their natural context) and Participatory research or co-design (users are part of the creative process and tools are provided to participants to discuss their experiences and express solutions).

7. FINDINGS AND RECOMMENDATION

The findings show that the developmental programmes proposed by volunteer organisation presents challenges at different levels. At the of Data administration, there is limited data sharing; at Management level, challenges of data integration, poor conflict resolution, inadequate feedback processes, lack of monitoring mechanisms for the reading activities.



[Figure 2] Recommended ICT Solution

The recommended ICT solution which considers all three S.PSS approaches is shown in Figure 4. With this solution, data seamlessly flow in a realtime environment among all stakeholders. The solution brings together volunteers, the mentors, school teachers and parents. Identified challenges like poor data integration and lack of proper feedback systems can be addressed. The flow of data throughout the stakeholder network may eventually leads to easy of volunteer integration into schools, evaluation of volunteers' performance, conflict resolution as well as a shared understanding of expectations.

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RECOVERY AND RECYCLING OF A BIOPOLYMER AS AN ALTERNATIVE OF SUSTAINABILITY FOR 3D PRINTING

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ABSTRACT

The aim of this work is to present an initiative to take advantage of the PLA waste discarded and to carry out experiments through the process of mechanical recycling of the material. PLA is a biopolymer from renewable sources that is extensively used in 3D printing in form of filament. The PLA waste is recovered on an additive manufacturing services bureau and goes through a mechanical recycling process in Materials and Design Laboratory at University of State of Pará. Some researches are conducted with the purpose of evaluating the material performance when added natural fibers such as jute and açai. As impact on sustainability it increases awareness of sustainability in additive technologies and encourages research about the PLA recycling and developing of new materials and products with this recycled material.

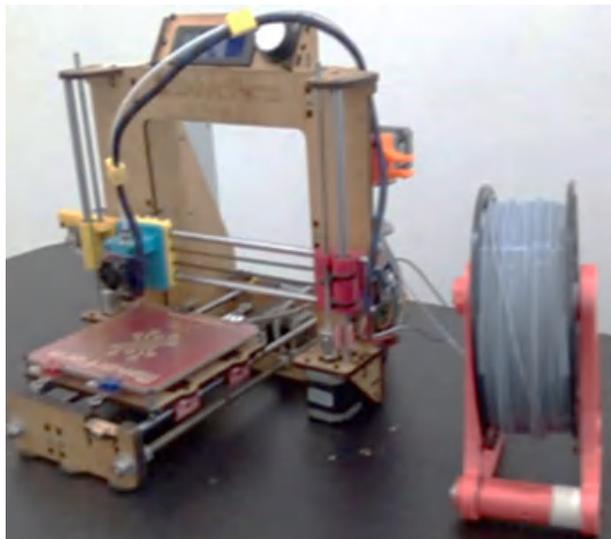
Key Words: Waste, Additive Manufacturing, Polimeric Composites.

1. INTRODUCTION

Human activities generate changes in the planet such as scarcity of natural resources, climate change, alteration of the cycles of nature and alteration of the soil. In this context, the concept of sustainable development arises, which, among others, must respect the limits of environmental resilience (Vezzoli, Kohtala, & Srinivasa, 2018). However, plastic waste with inadequate disposal spread in the environment has been a major problem, especially its presence in the oceans has been much discussed (GESAMP, 2015; Gregory, 2009; Jambeck et al., 2015; Lebreton et al., 2017; Velis, 2014).

Therefore, to meet the requirements of sustainable development it is necessary to look for alternatives of polymers that can better respect the limits of environmental resilience, such as thermoplastic polymers and biopolymers. Thermoplastic polymers are plastics that do not change their chemical structure during heating, and can be cast and remolded several times, for example, polypropylene (PP), polyethylene terephthalate (PET) and polyvinyl chloride (PVC) (Okimoto & Lima, 2009). Biopolymers are those made from renewable sources, alternatives to petroleum. However, biopolymers are not always biodegradable, and not all biodegradable plastics are biopolymers. Biodegradable resins are those that can be fully reabsorbed by the environment (Mottin, Câmara, Miranda, & Pagnan, 2011).

The poly (lactic acid) PLA is a thermoplastic, biopolymer and biodegradable. It has its origin in the fermentation of vegetables rich in starch or sugar as corn, wheat, sugar cane, beet and potato. It is possible to produce several products, such as packaging, paper coating, fibers, films, and a host of molded articles (Rudnik, 2008). This material has been much researched by the scientific community (Bartolomei, Correa, & Valera, 2015; Brito, Agrawal, Araújo, & Mélo, 2011; Guo, Bao, & Wang, 2013; Mesquita et al., 2015; Oliveira, dos Santos, Pacheco, Grisa, & Zeni, 2013; Pereira & Morales, 2014; Rudnik, 2008). Being an easy-to-work material, it is used as the main filament in rapid prototyping (figure 1), which allows a variety of possibilities in the manufacture of parts and products. It is the most sustainable material for 3D printing, because it is a non-toxic and biodegradable thermoplastic (Besko, Bilyk, & Sieben, 2017), where it is used in the form of filaments generally in the thickness of 1.75 mm in diameter but also in 3 mm.



[Figure 1] 3D printer on the left and PLA filament coil ready to be printed.

The impression is 3D printing is a process where a three-dimensional model is made in a CAD (Computer Aided Drawing) system, where a file is generated, then, sent to a Computer Aided Manufacturing (CAM) system to be “sliced” in layers, so a thermoplastic filament is unwound from a coil to the extruder of the 3D printer (Besko et al., 2017).

This process is seen as an essential component of the fourth industrial revolution, in which users will be able to produce objects according to their need, and with the potential to lead to the decentralization of manufacturing (Santana et al., 2018). However, the realization of what is predicted will also lead to an increase in the volume of discard of materials such as PLA, since the generation of waste is an inherent occurrence in any manufacturing process, whether in the manufacture of tests or defective parts.

In this context, there are few works talking about PLA recycling, even less with 3D printing waste. Therefore, the aim of this work is to present an initiative to take advantage of the PLA waste discarded and to carry out experiments through the mechanical recycling process of the material.

2. METHOD

PLA wastes (fig. 2) were collected from the 3D printing services bureau to be recycled at the UEPA Materials and Design Laboratory. The residues were selected by color, washed and dried for the beginning of the mechanical recycling process. During the recycling process the PLA is placed in an enameled pan and subjected to the melting temperature and the molten material is poured into silicone molds. To verify the performance of PLA to consolidate composites, the polymer was mixed with wood granules (PLA/wood granules composite plate), and with jute (*Corchorus capsularis*) fiber (PLA/jute fiber composite plate).



[Figure 2] PLA wastes used in this work (left), enameled pan and silicone mold (right).

The mixtures can be subjected to pressure or not. After cooled the pieces are removed from the molds and analyzed in their macroscopic aspects. All the experiments were carried out by the students of the Materials and Production Processes discipline of the Design course.

3. RESULTS AND DISCUSSION

Figure 3 presents the samples of PLA recycled used waste of dark colors shows that PLA waste can be easily recycled due the low melting temperature of this polymer. The tablets can be saved to use in other researches, or mixed with cellulosic fibers to consolidate composite plates such showed in figure 4 and 5.



[Figure 3] Recycled PLA pellets obtained (right), pellet detail (right)

In fig. 4 we have plates of PLA recycled with addition of wood granules consolidate with no pressure, showing mold contact surface and the opposite surface, where we can observe that the fast cooling after leaked promote an irregular surface texture mainly on free surface of the sample.



[Figure 4] Samples of recycled PLA with addition of wood granules, contact surface with mold (left), free surface (right)

In figure 5, below, it is possible to observe the aspects of the plates produced with the recycled PLA with addition of jute fiber of 1.5 to 2,00 centimeter, consolidated under pressure, showing the regularity on the surface on both sides. For this samples light color waste were selected.



[Figure 5] Samples of recycled PLA with addition of jute fiber both sides.

The addition of lignocellulosic reinforcements to thermoplastic polymers it's environmentally interesting. The wood waste can return to the production chain and can generate new products when added to thermoplastic resins. The jute fiber mainly used in packaging can now be able to generate other products with PLA biopolymer.

4. CONCLUSION

Considering the problem of the increase of materials waste generated from 3D printing, a process that tends to become popular, and few researches were found in the literature focusing on the recycling of these materials, this work contributed to the identification the residue of PLA discarded in the digital manufacturing activities as a possible raw material for new products through the recycling process;

The waste recycling of 3D printing is a sustainability alternative for this activity;

As future research it is proposed to carry out physical and mechanical characterization of the samples made from the recycled PLA.

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EXPLORING SCENARIOS TO FACILITATE THE ACCESS TO 3D PRINTING TECHNOLOGY IN EGYPT THROUGH SUSTAINABLE PRODUCT-SERVICE SYSTEMS APPLIED TO DISTRIBUTED MANUFACTURING

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ABSTRACT

In low and middle-income economies where resources are often limited, innovative business models are developed to utilize them efficiently. Past research attempts proved the strength of combining Sustainable Product-Service Systems (S.PSS) with Distributed Manufacturing Systems (DMS) in achieving the environmental, social and economic sustainability in the designated contexts. However, scenarios for the implementation of S.PSS applied to DM are still a gap in literature. Hence, this study is investigating near-future scenarios for the coupled models to allow access to resources and emerging technologies in low and middle-income contexts. The study implemented a qualitative research with a focus on Additive Manufacturing (AM) in the Arabic Republic of Egypt to investigate the business models of local 3D printing enterprises. Possible scenarios were formulated, and later discussed with local stakeholders through in-depth interviews to highlight the opportunities and the barriers, along with recommendations to overcome the barriers and benefit from their positive impact.

Keywords: Sustainable Product-Service System, Distributed Manufacturing, Additive Manufacturing, 3D printing

INTRODUCTION

Nowadays designers are shifting from product to service focused approach in design, and this shift is due to the economic change of perspective to focus on systems and services rather than designing products only, changing the whole paradigm in design thinking (Rodriguez & Peralta, 2014; Young, 2008). From the product-service perspective in doing business and building long-term relationships with customer for better value delivery, new systems are developed to redesign business models where the product and the service are combined to satisfy the needs. Product-service systems (PSS) have been proposed by researchers to endorse sustainability and develop strategic business model (Manzini & Vezzoli, 2003; Tukker, 2015). Discussing sustainability in system design, Sustainable Product-Service System (S.PSS) applied to Distributed Manufacturing (DM) is a concept proposed to address environmental, social and economic issues, and offer opportunities for the youth to launch start-ups without the need for an initial capital by allowing access to resources.

This paper is studying the status of Additive Manufacturing (AM), the modern type of DM, in the Egyptian market as a trendy practice among entrepreneurs and how PSSs enable access to such technology. Egypt is chosen for the field research because it is an example of a low and middle-income context according to the report of Doing Business (World Bank, 2017). The Global Entrepreneurship Monitor in 2017 reported that entrepreneurship in Egypt is perceived as a positive activity and good choice for a career to escape poverty and unemployment. However, the entrepreneurial environment in Egypt is considered weak and not as enabling as it should be (Saeed, El-Aasser, & Wasfy, 2015). The key factors that are hindering entrepreneurship and tackled in this study are: access to tangible and intangible resources (funds, skills, knowledge and technology), bureaucracy and regulative policies (GEM, 2017). The adopted methodology was qualitative and included: a literature review about the two models S.PSS and DM, workshops to generate near-future scenarios for the coupled models, and in-depth interviews with local stakeholders in the field of AM.

LITERATURE REVIEW

Sustainable Product Service System (S.PSS) is described as a promising offer model because it provides products and services that can fulfil a customer demand identified as a 'unit of satisfaction'. This unit of satisfaction is delivered through innovative interactions between the stakeholders in the system, where the providers pursue new environmental and social solutions in favour of their economic incentive (Vezzoli, Kohtala, & Srinivasan, Product-Service System Design for Sustainability, 2014). S.PSS benefits involve: following a customer-centred approach, empowering the local stakeholders, increasing local employment and diffusing skills through the intense relationship in the system (Vezzoli, Ceschin, Diehl, & Kohtala, 2015). Since it allows the manufacturer to retain the ownership of the product, then lengthening the product's life cycle becomes an economic incentive; the profit in such model is always dependent on the price of the satisfaction unit delivered to the customer, after subtracting the managerial costs (Vezzoli, Ceschin, Diehl, & Kohtala, 2015), see Figure 1. As for the customer, S.PSS offers the benefit of cutting the cost of the initial investment and running cost by allowing access to goods and services in return of only paying per unit of satisfaction (Vezzoli, Kohtala, & Srinivasan, 2014).

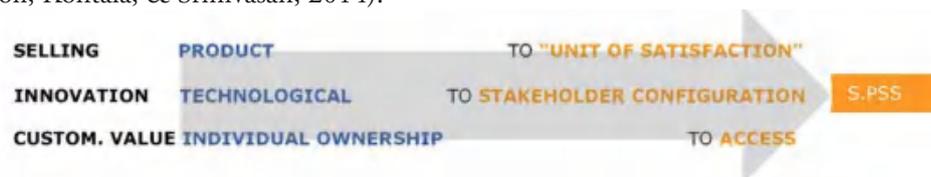


Figure 1 S.PSS: a paradigm shift from traditional product offer (Vezzoli & Basbolat, 2016)

DM is a system of small-scale manufacturing units that have both physical and digital equipment empowering localized facilities and full communication between all players in the supply chain to enable customers' on-demand production (Petruilaityte, Ceschina, Peia, & Harrisona, 2017).

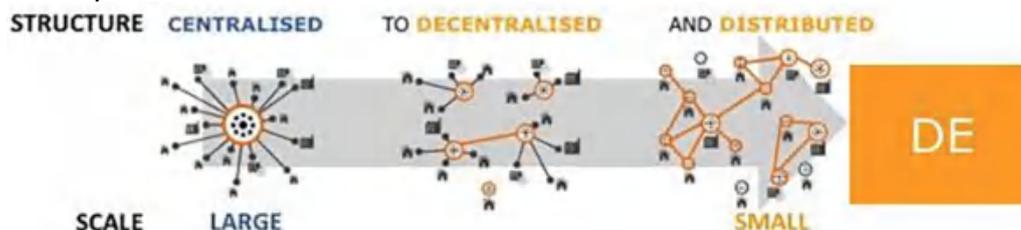


Figure 2 Centralized, Decentralized and Distributed Networks (Vezzoli & Basbolat, 2016)

The classification of centralized, decentralized and distributed manufacturing is related to where the operation is taking place within the network, see Figure 2. A distributed setting forms a network that is relying on several points for operation and processing, and accordingly the decision making is not centralized but distributed over this network (Baran, 1964). Scholars discussed the ability of DM in tackling environmental and social issues caused by mass production through developing sustainable patterns in production and consumption, avoiding the exhaustion of resources, and providing a good standard of life for people and accordingly the decision making is not centralized

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Coupling Product-Service Systems PSS with DM has been investigated in literature and described as promising in meeting customers' requirements by customizing services through the localization of manufacturing and customers' involvement in design process (Despeisse & Ford, 2015), and also lengthening the product's life cycle in PSS (Despeisse, et al., 2017). Both models, PSS and DM, take advantage from the advance Information and Communication Technology (ICT) as a competitive advantage in a market of PSSs in relation to accessibility and improved performance in services with less intermediates (Franca, Bromana, Robert, Basile, & Trygg, 2017).

Lens Hypothesis

This research is conducted under the LeNSin project, European Union supported project, aiming to empower a new generation of designers who undertake the role of providing a sustainable society for all. The project focuses on the integration of Distributed Economies (DE) into the S.PSS in the aim of promoting sustainability in low and middle-income contexts; the LeNSin research hypothesis is (Lensin, 2016; Vezzoli & Basbolat, 2016, p. 296): "A S.PSS applied to DE is a promising approach to diffuse sustainability in low/middle-income (all) contexts, because it reduces/cuts both the initial (capital) cost of DE hardware purchasing (that may be unaffordable) and the running cost for maintenance, repair, upgrade, etc. of such a DE hardware (that may cause the interruption of use), while increasing local employment and related skills, as well as fostering for economic interest the design of low environmentally impacting DE products, resulting in a key leverage for a sustainable development process aiming at democratizing the access to resources, goods and services." Distributed Manufacturing, one form of DE (Vezzoli, Kohtala, & Srinivasan, 2014) has been chosen due to the limited past research covering its integration in S.PSS.

Additive Manufacturing (AM)

Additive Manufacturing (AM) is the newest form of DM: It represents the 3D printing technology that builds objects through layering. It has started as a technology for prototyping, but now it produces final parts also (Spath, et al., 2013). The technology offers sustainable solutions considering efficient management of energy and resources through localized on-demand production (Ford & Despeisse, 2016). However, there is a concern about the operators' safety because epoxy resins, powder materials and most of the polymers used in 3D printing are highly toxic: they endanger embryos and might cause irritation of skin and eyes (Kellens, et al., 2017). Nevertheless, some safety procedures can avoid health problems: choice of place, clear production plan, regular collection of dust, air ventilation, wearing masks, glasses and gloves (Deak, 1999; Kellens, et al., 2017).

METHODOLOGY & FINDINGS

How and why questions are still missing in the literature about S.PSS and DM due to the absence of qualitative research about the paired models. While reviewing the literature, a gap was highlighted: need for developing detailed near-future scenarios of S.PSS applied to DM (Petruilaityte, Ceschina, Peia, & Harrisona, 2017). Qualitative methods allow the researcher to define, analyse, and comprehend facts, activities, players and decisions in the research about entrepreneurship by developing the proper tools and theories (Hindle, 2004). The research aims to answer through facts on the ability of S.PSS applied to DM, both when combined, to allow the access of young entrepreneurs to an emerging technology like 3D printing.

Method-1: Workshops

Since this research is part of the LeNSin project, the network offers a set of tools for the development of business scenarios for the coupled models that are both environmental and socio-ethical. Using Sustainability Design-orienting toolkit (SDO toolkit, <http://www.sdo-lens.polimi.it>) sustainable PSSs were explored through the proposal of concepts that follow criteria in the online modular toolkit. The workshop process started by analysing the best practices, developing sustainable concepts and assessing the improvement in sustainability aspects. A polarity diagram of x and y axis was used to organize and place the clusters of concepts according to the variables of decentralized or distributed, and use-oriented or result-oriented, to exhibit promising concepts according to the setting and function of the proposed network. The workshops took place at the design department in the university of Politecnico di Milano, in January 2018. The participants with background in product-service system design contributed with concepts that could fill the gaps in the existent practices, such as: negative environmental impact, absence of network for aftersales services, lack of safety procedures, and neglectation of socio-economic responsibility toward the communities where PSSs were present.

Method-2: Stakeholders in-depth interviews

After generating near-future scenarios, localizing these scenarios to the Egyptian context required semi-structured in-depth interviews with individuals who had a working experience in the AM field. In order to gather primary data, in-depth interviews are the main method in qualitative research to collect it first hand from the interviewee (Merriam, 2009). Sampling took the approach of convenience: twelve main stakeholders were chosen from different backgrounds covering the private, public and civil society sectors. They were asked in an open manner through face-to-face discussion about the applicability of the scenarios in Egypt, the barriers that might face them and possible opportunities and recommendations of the participants to facilitate their application. The data collection in qualitative research is often done through interactions' recording, therefore the findings are based on the analysis of this recorded data (Flick, 2013). The inductive thinking helped in analysing the data moving from specific observations and understandings to broader theories while detecting themes and patterns in the data (Creswell, 2005). Data was analysed according to the thematic analysis where the collected insights were organized under the main themes discussed in the findings.

Finding-1: The near-future scenarios

Four scenarios were developed to represent how 3D printing could offer new services and great value for young makers, see Figure 3. The scenarios involved use-oriented decentralized, use-oriented distributed, result-oriented decentralized and result-oriented distributed. They were referred to in numerical sequence (1st, 2nd, 3rd and 4th) for an easier discussion with the interviewed stakeholders. Use-oriented scenarios were more towards enabling makers to create products through access to digital fabrication tools and information about it or receive on-site units of manufacturing to produce locally. Result-oriented scenarios were targeting aftersales services of lifetime support for customized 3D printers and initiating joint ventures with local service providers to deliver both services and goods as an infrastructure for the 3D printer operation. The level of servitization in these scenarios increased in order to insure the dematerialization process of the offering. The concepts that were more toward product-oriented approaches were incorporated into the four scenarios by making the 3D printer the main PSS value, to which customers could have access in return of a satisfaction unit.

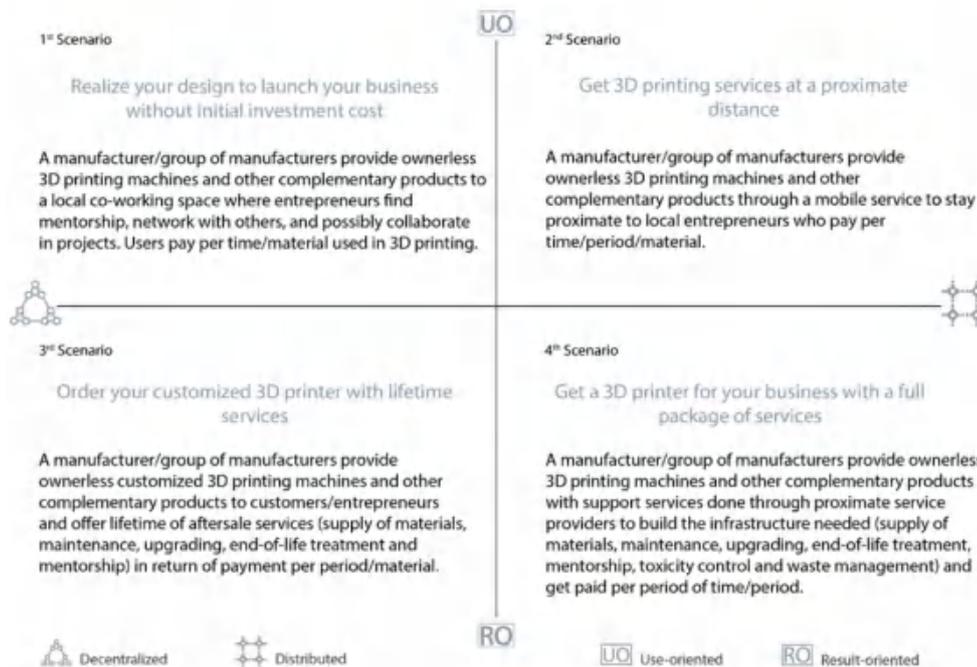


Figure 3 Polarity diagram illustrating the categories of S.PSS and models of DM

Finding-2: Their Applicability in the Ecosystem

During the interviews, the stakeholders declared that the near-future scenarios were feasible in a low and middle-income context like Egypt under the condition of keeping the price affordable for a better access to 3D printing. Comparing UO with RO and decentralized with distributed, see Figure 4, the UO decentralized model was highlighted as the lowest in expenses and the most feasible. UO (the upper part) would provide services of mentorship, along with the temporary access to machines, so that users could manufacture for themselves, unlike RO the price that covered the wages of experienced operators handling the task of fabrication. Also, due to lack of expertise in the ecosystem about AM, the decentralized setting (left side of the polarity) was more feasible in operation than distributed because not everyone would have the expertise to run the machines efficiently. Despite of all these constraints, it was confirmed by all that once the technology spreads, its price will drop in consequence and everyone will have access to it. Since UO models provide access to machines and RO models provided access to ready products/services (Tukker & Tischner, 2006; Reim, Parida, & Ortqvist, 2014), those who look for training will refer to the first and those who look for a result, product or service, will refer to the second.

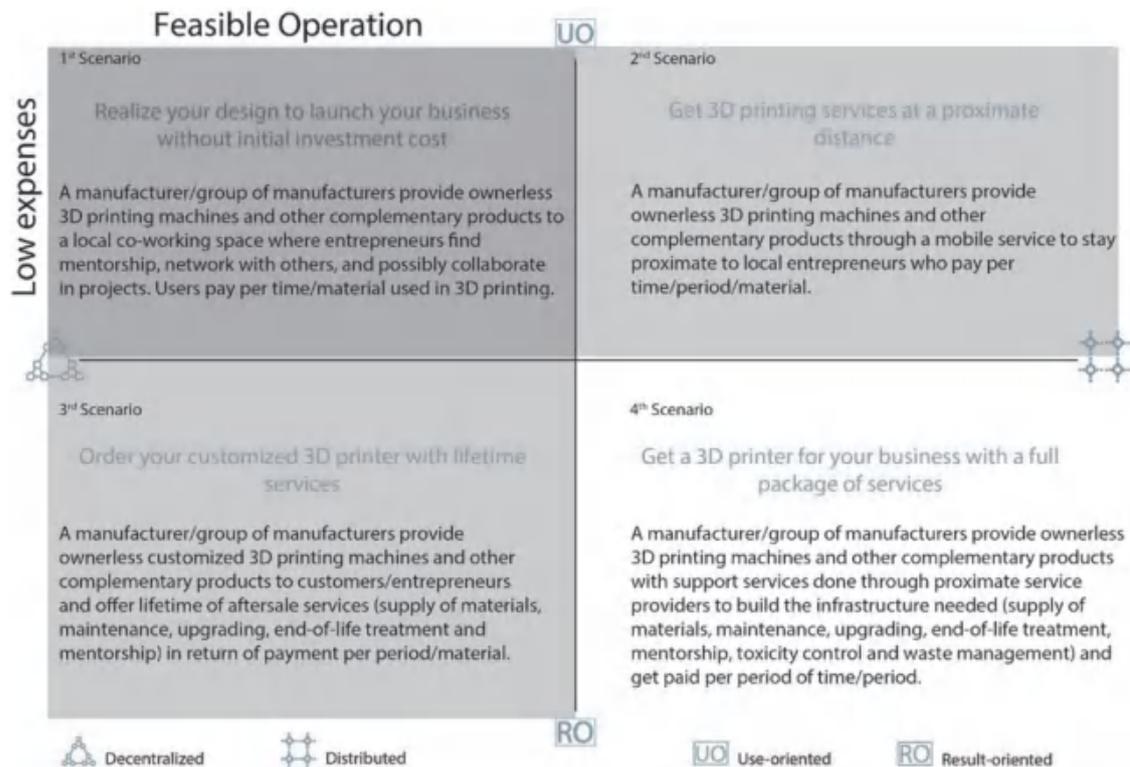


Figure 4 Applicability in the ecosystem from the perspective of feasible operation and expenses

The 1st scenario was perceived as a good opportunity for students, researchers and tech entrepreneurs where they could get mentorship and proper assistance from a team of experts in digital fabrication. The 2nd scenario was identified as promising due to the mobility factor, which gave flexibility in the place of manufacturing, and more power to cloud production allowing decentralized/distributed manufacturing. The 3rd scenario was recognised by participants as aftersales services that needed sustainable financial plans in order to cover their costs. These financial plans could resemble the S.PSS strategy of payment per unit of satisfaction. Such model would be highly applicable not just for customized 3D printers, but also for 3D printed products needed in daily life e.g. prosthetics. The 4th scenario was discussed from the perspective of providing services through proximate providers, which was recommended by the participants. However, to have these providers, it would mean that the technology has become mature in the context and trust was established among the stakeholders.

Finding-3: The opportunities and the barriers in the ecosystem

The findings unveiled the barriers against the scenarios: legislation against 3D printers, lack of awareness about the technology capabilities, difficulties in the registration of fab labs and 3D printing companies, lack of expertise in relation to 3D printing, limited investment in hardware fabrication, and the poor quality in the aftersales' services provision. The stakeholders also emphasized that the usability of machines in many cases was poor, along with the gap of mentorship in UO setting for users to learn how the machines worked. Another gap was the poor marketing of fab labs and co-working spaces that adopted this model and could not raise awareness about their services, hence delay in sales. As for the RO setting, customers would be concerned to get services from a provider other than the main producer they got the machine from, and companies would be also afraid to lose customers to their joint partners; researchers identified these two behaviours as: lack of knowledge and uncertainty about the system (Catulli, 2012; Rexfelt & Ornas, 2009), and fear of consequences of partnership like co-dependence, core competencies decrease, confidential information spreading, complications in the purchase of the customers, and customer's complicated behaviour when it comes to purchasing and accepting the service (Vezzoli, Ceschin, Diehl, & Kohtala, 2015; UNEP, 2002; Mont, 2004).

The findings also endorsed that S.PSS applied to DM could tackle the barriers in the Egyptian entrepreneurial ecosystem. The success of the scenarios was due to the absence of the need for initial capital and covering running costs by providing access to resources instead of individual ownership. Additionally, opportunities like offering a customization option, enhancing products/services for customers, increasing local employment, and creating long-term relationship with the end-users (Vezzoli, Ceschin, Diehl, & Kohtala, 2015) were discussed in the in-depth interviews as advantages for the local ecosystem to grow and prosper. Likewise, for the network and trust barrier, win-win cooperation is one of the main criteria to have a successful operation for S.PSS. Without a network, a PSS will not be able to satisfy all customers' demands; any business should stay focused on the value it delivers not to be distracted by trying to satisfy all demands and offer other services that are over its capacity. Also, trust can be built through the transparent cooperation and the consistency in providing a good quality of products and services among different partners and stakeholders allow the trust to grow.

FINDING-4: RECOMMENDATIONS

Recommendations of the stakeholders involved that the educational and research institutions would cooperate with 3D printers' local manufacturers to develop a user-friendly hardware. Once the hardware is enhanced then the technology will be feasible just like 2D printing. In addition, strengthening a network of service providers in AM field was claimed as a necessity for the technology to spread and offer new opportunities for young makers. This strong network would present the socio-economic advantages of S.PSS: incorporating new markets, increasing competitiveness, adapting efficient operations, and introducing new technologies (Omann, 2007). Marketing was one of the solutions discussed for the cultural and legislative barriers since marketing campaigns could spread awareness about the potentials of this new technology. Also, the collaboration among stakeholders from different sectors in finding solutions and empowering small-scale communities to adopt the technology in their economic activities were suggested as ways in overcoming many barriers. With the increasing level of servitization and dematerialization in the systems, along with proper marketing, individuals in the community will be more conscious and responsible about their production and consumption patterns. It is necessary to control the process of manufacturing within PSS to avoid further negative environmental impacts or health issues caused by AM, especially when the technology disseminate broadly.

DISCUSSION & CONCLUSION

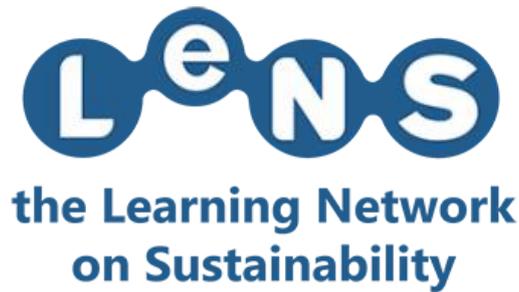
This study highlights the possible opportunities of applying S.PSS and DM combined in developing innovative and sustainable business models in low and middle-income contexts. The findings of this study proved S.PSSs' opportunities in addressing the barriers of access to resources and network in the Egyptian entrepreneurial ecosystem. In fact, S.PSSs in Egypt have already offered access to digital fabrication through networks of service providers in return of payment per unit of satisfaction. The unit of satisfaction controls the production and consumption patterns of the customers because they become aware of the amount of time and material consumed through the unit's price. The other barriers of bureaucracy, regulative policies barriers and environmental awareness were identified as the legislative and cultural barriers that must be addressed by all stakeholders from the different sectors. The barriers will logically disappear through the dissemination of sustainable practices based on win-win cooperation and emerging technologies.

The limitation in the research includes the quantitative data about the performance of S.PSS applied to DM in a low and middle-income context. Future research should fill this gap, in addition to investigating the legislative and social barriers hindering the dissemination of S.PSS models, emerging technologies and sustainable practices in different contexts/countries.

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INVESTIGATION OF THE IMPACT OF SUSTAINABILITY ON 3D PRINTING TECHNOLOGIES

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ABSTRACT

3D Printing technologies are becoming pervasive and used both in industry and in informal contexts like domestic self-production and craftsmanship 2.0. A large part of the current studies concerning 3D Printing aims at increasing the performance of processes, materials and devices; however, only few studies approach sustainable issues (i.e. printable eco-materials, distributed networks, etc.). 3D Printing instead could play a crucial role in the transition processes toward the so-called Sustainable Society, if linked with current Design for Sustainability approaches. The paper analyses current literature regarding 3D Printing and Design for Sustainability in order to identify new open research topics and re-think their impact and design roles for future sustainable applications. Specifically, the paper produces evidences linking 3D Printing technologies and Sustainability from the design point of view; it outlines a number of promising open cross-sectorial research topics that aims to anticipate the impacts and the evolution of future Sustainable 3D Printing technologies and new generation of democratic products and services for All.

Key Words: 3D Printing, Design for Sustainability, Sustainable Design Opportunities, New Research Topics.

1. INTRODUCTION

3D Printing is a term used to describe all processes in which materials are joined or solidified under computer controls to create three-dimensional objects having computational-based silhouettes. It was originally born for industrial and commercial-oriented applications but, in last years, the democratization of services and the low prices of devices generated a large number of non-industrial applications (i.e. Fab Labs). However, uncontrolled industrial, commercial and new 'informal' 3D Printing applications – intended as new distributed socio-technical forms of production – might produce unsustainable impacts on the ecosystems. In the perspective of a Sustainable Development defined as 'a development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (UN WCED, 1987), it is important to control this type of innovations to mitigate the anthropic impacts on ecosystems both at micro-and at macro-scale. For this reason, the future development of 3D Printing sector could play an important role in the transition toward the so-called Sustainable Society, becoming more and more a part of new production processes and ways of thinking able to produce radical, distributed and large-scale innovations.

The main problem is that, in last years, sustainable-oriented research on 3D Printing technologies has been mainly implemented through the development of non-connected solutions, vertical approach and mono-disciplinary studies. For example, researches about: eco-efficient materials (i.e. recycled biomaterials); spontaneous forms of services for production (i.e. print-to-delivery services, cloud manufacturing); economically efficient services (i.e. 3D Printing for education); architectural solutions for housing emergency and low-tech applications (i.e. DIY 3D printers); etc.

A more systemic approach is therefore needed to connect all existing forms of sustainable-oriented advances – horizontal approach, multidisciplinary research. In the field of Design, new theories and methodologies have been recently developed; they allow to create products and services in a systemic way in terms of social, environmental and economic sustainability. Accordingly, this work is based on the hypothesis that current advances in Design for Sustainability theories (i.e. PSS: Product-Service Systems) (Ceschin and Gaziulusoy, 2016) and SLOC Scenarios (Small-Local-Open-Connected) (Manzini, 2003) can improve the quality of existing 3D Printing related services, generating new opportunities and research challenges. An expansion of current technology-centered 3D Printing approach toward multidisciplinary perspectives can expand its intrinsic potential toward new sustainable scenarios.

2. AIMS

According to the research framework before described, this paper aims to:

- Produce evidences linking 3D Printing technologies and Sustainability, from the design point of view.
- List a number of promising open research topics linking 3D Printing and Design for Sustainability.
- Show the positive impacts of Design for Sustainability in the evolution of 3D Printing technologies toward new generation of democratic products and services 'for All', including new 'Design Opportunities'.

3. METHODOLOGY

This research has been developed using traditional Design Research approach and it is organized in three main phases, and their aims are synthetically described below:

- To study and analyze the literature on emerging sustainable-oriented 3D Printing theories, to know research and technological advances in the field.
- To focus attention on cutting edge Design for Sustainability models, for the implementation of theories.
- To develop a cross-fertilization to generate a design-oriented scenario for Sustainable 3D Printing, which is based on the combination of results achieved in the two research phases.

3.1. 3D Printing's Literature Review

Sustainability-oriented 3D Printing advances follow a vertical approach (i.e. mono-disciplinary research), which is the result of a 'traditional' industrial technology-push culture. In fact, current state of the art of researches and industrial developments, regarding sustainable-oriented 3D Printing, are mainly focused on: innovation in engineering and engineering-related domains (Gebler et al., 2014); low-cost and open-sources 3D Printing technologies services (Canessa et al., 2013); Circular Economy's scenarios – i.e. recycling, low energy grids, etc. (Rifkin, 2012); interdisciplinary applications – i.e. Inclusive Design (Rossi and Barcarolo, 2018); technological improvements of production processes (Liu et al., 2016); development of printable (bio)materials (Jammalamadaka, and Tappa, 2018); new technological components – i.e. semi-finished – including for construction industry. As discussed, the aspects that are most considered are those related to environmental protection (i.e. lowcost processes, mitigation of the impacts on ecosystems, compatibility of materials, etc.). On the other hand, the economic and social sustainability aspects are less considered. A holistic view of 3D Printing is therefore needed in order to evolve the simplistic eco-characteristics of productions, toward integrated approaches that consider all products' life cycle elements, including: material supply, design of solutions, processes simplification, etc.

3.2. Design for Sustainability's Literature Review

It is possible to refer to Design for Sustainability approaches that are 'systemic' in order to obtain a holistic view of 3D Printing. As such, the literature review will be mainly focused on the analysis of the three approaches that are today considered as the most promising ones for current Design for Sustainability Research: (1) Design for Small-Local-Open-Connected Scenarios of wellbeing (SLOC); (2) Design of Product-Service Systems (PSS) and (3) System Design for Sustainability (SDS). SLOC Scenario is a sustainable-oriented design model developed by Ezio Manzini (2010; 2015) where emerging global phenomena are intersected with three main innovations: the green revolution, the spread of networks, the diffusion of creativity. SLOC Scenario directs toward sustainable solutions. In particular, Manzini indicates that such solutions have to refer to the local (e.g. local community) and to the 'small' (in terms of relationships, participation, and democracy).

At the same time, it promotes the solutions' implementation using the framework of the global network society in which the local and the small are both open and connected. PSS is defined as 'a marketable set of products and services capable of jointly fulfilling a user's need' (Goedkoop et al., 1999). According to Mont (2002), PSS consists of a combination of products (eco-designed) and services (designed at different stages of a product's life cycle), closely involving final consumers and actors in the chain. Thanks to this design theory, benefits are produced both for customers and for producers (Ceschin, 2014).

For consumers, we include both buying products and buying services and systems of solutions that minimize the environmental impacts of consumers' needs. For producers, PSS imposes a higher control on full life cycle process (i.e. co-design, closed loop systems). Moreover, there are different benefits in developing a PSS for manufacturing companies (Ceschin and Gaziulusoy, 2016) for example: improving relations with consumers; to increase the product's value, to base a growth strategy on innovation in a mature industry, etc. SDS is defined by Carlo Vezzoli (2010): as 'a design approach for eco-efficiency, equity and social cohesion of systems of products and services, which are able to respond to specific customers' needs planning the interaction of stakeholders and the value's production system'. The SDS's aim is to obtain a product-service system that is sustainable from the environmental, social and economic point of view.

This approach adopts different design tools (i.e. System Map, Polarities Diagram, etc.) and a 'Modular Method for System Design Sustainability' (MSDS), which is based on the interaction between designers and stakeholders to satisfy a customer's needs (Vezzoli, 2010).

3.3. Cross-Fertilization

After the analysis of the literature of both sustainable-oriented 3D Printing and methods concerning Design for Sustainability, in the third research phase a number of new Design Opportunities (DO) – see '4. Results' – have been developed using a cross-fertilization process, to produce both vertical and, mostly, meaningful horizontal innovations. Accordingly, cross-fertilization has been used as a 'sustainable-oriented scenarios generator'.

4. RESULTS

The research results carried out so far have led to the definition of new Design Opportunities (DO). As shown in the formula below, we can describe new Design Opportunities (DO) as the result of a qualitative analysis developed combining main elements of 3D Printing technologies (3DP) and Design for Sustainability (DfS).

$$DO = 3DP \text{ DfS}$$

In Table 1 four main Design Opportunities (DO), and related sub-themes, are presented as part of an early research framework concerning the 'Sustainable 3D Printing'.

[Table 1] Design Opportunities for 'Sustainable 3D Printing': early results

3D Printing Technological Advances (3DP)	Design for Sustainability Research Approaches (DfS)	Design Opportunities for 'Sustainable 3D Printing' (DO= 3DP .DfS) (S3DP)
1. New materials. 2. 4D/5D solutions. 3. (Recyclable) biopolymers. 4. Lean productions. 5. Green printing. 6. Low energy 3D Printing services 7. Open source. 8. Software R&D. 9. Rapid (raw) Prototyping. 10. Extreme uses. 11. Nano-and Micro-3D Printing	A. SLOC Design. B. Design for SMBs. C. Design for local resources. D. Design and ICTs. E. Inclusive Design (and HCD). F. Design for social innovation. G. Context-based Design. H. Co-Design. I. PSS Design. J. SDS. K. Eco-Design (i.e. LCA and LCD).	<ul style="list-style-type: none"> • Use of local resources and values for Circular Economies and SMBs, for example: <ul style="list-style-type: none"> o Creation of renewable, zero impact, eco-and/or biomaterials (i.e. 1, B). o Creation of smart GLocal production networks (i.e. 7+9+20 D+I+J). o (Co-)creation and sharing of tangible and intangible resources (i.e. 7 H). o Development of B2B services for SMBs and SMEs (i.e. 4+6 G+S). o New business models for social inclusion and innovation (i.e. 3+5 E+F). • Extension of local values in the new GLocal business scenarios, for example:

<p>12. Macro printing. 13. Smart uses. 14. Sensitive printing. 15. Printers' fabrication. 16. Multi-material 3D printing. 17. Medical advances. 18. AR, VR and 3D modeling. 19. Home printing. 20. Innovations in SMEs and SMBs.</p>	<p>L. Creativity-driven innovations. M. Design for Circular Economies. N. Design for developing countries. O. Design for customers' values. P. Service Design. Q. Bottom-up Design approach. R. Eco-productions. S. Design for sharing economy.</p>	<p>o GLocal-oriented co-development of solutions for the economic emancipation (i.e. 8+15 N+O). o Strategic co-development for the GLocal growth (i.e.19 E). o Development of human capital to empower self financeable forms of GLocal entrepreneurship (i.e. 18 S). o Support the GLocal promotion of autochthonous productions (i.e. 2 N). o Codification and exportation of identitary production techniques and skills in the GLocal markets (i.e. 20 O). o Development of context-based products and services to empower the GLocal businesses (i.e. 18 B+I). • Sustainable innovation of products, services and systems of products, for example: o Creation of context-based innovations to boost local heritage (i.e. 10 M). o Development of HCD business solutions to promote inclusive and sustainable socio-technical-economic self-sufficiency (i.e. 9+20 L+Q). o Promotion of sustainable 4.0 (i.e. 13 O+R). o Identitary development of GLocal forms of business (i.e. 14 G+L). o Sharing of know-how (i.e. 7 N). • Strategic development of economies and large-scale actions to support GLocalisms, for example: o Development of GLocal platforms to meet top-down and bottom-up needs (i.e. 4+5+6+11 F+L). o Democratization of GLocal technologies (i.e. 17+18 M+N). o Development of resilient GLocal infrastructures to support multi-level forms of business and entrepreneurships (i.e. 19+20 D+R). o Development of distributed forms of intellectual capitals (i.e. 1 H+L).</p>
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Design Opportunities here described show promising strategic design-oriented scenarios where the idea of 'Sustainable 3D Printing' can play a significant role in the creation, promotion and participative implementation of eco-friendly production processes, aware ways of consumption and new business-oriented behaviours. In particular, the results here presented are conceived to involve, where possible, all product-service's value chain. Design Opportunities are therefore intended as favorable if related to scenario-based sustainable conditions (i.e. there must be the stakeholders' will to act in a sustainable-oriented way, existing – or will to start – of green business models, etc.). Thus, information shown in Table 1 can be applied both to industrial and to non-industrial sectors.

5. CONCLUSIONS

As discussed in this paper, 3D Printing technologies are radically evolving and improving the all design activities, production processes and supply services. Since the increasing of technological advances and performance of processes are producing a sort of democratization of solutions and services – technology-push approach (Verganti, 2009) – the environmental issues linked to the printing of products and items are still less considered, while the marked demand of sustainable solutions needs and, in some cases, it drives the marked demands. In general, the issue of Sustainable Development only partially is meeting the 3D Printing domain, while in some way it is ready to act in a sustainable-oriented perspective; however, to meet the instances of the 'sustainable culture', a new idea of 'Sustainable 3D Printing' must be developed in order to produce systemic impacts and bottom-up innovations (i.e. SLOC-oriented 3D Printing) both in industry and in informal scenarios (i.e. GLocal small productions of printable items, SMBs for printed masterpieces, etc.), which are perfectly in line with the Design for Sustainability approaches. The new idea of 'Sustainable 3D Printing', if correctly understood and implemented using, for example, proper context-based technologies and aware business models, can play a significant role in the transition process toward the sustainable society. Accordingly, as the need of sustainable solutions is still high, the evolution of 3D Printing's paradigms toward network-based, hybrid PSS-based and SLOC-oriented scenarios, can surely meet the Design Research in the field of Design for Sustainability and the technology-driven research of 3D Printing industry. As shown, this study also analysed both Design for Sustainability and 3D Printing literatures to produce a new framework for the 'Sustainable 3D Printing', which is now composed by a number of promising Design Opportunities, as a part of a

more wide and holistic scenario where, in the near future, promising applications will connect Engineering, Chemistry, Materials Science, Economics, Design, etc. Finally, the Design Opportunities synthetically introduced a number of new topics and scenarios for promising applications concerning 'Sustainable 3D Printing' – if conditions of Sustainable Development are reached using competitive business models – linking current 3D Printing advances with traditional and novel Design for Sustainability's research approaches, with the idea that a holistic approach can be used, and warmly recommended, to tackle the various issues of Sustainable Development, beyond the mono-disciplinary approach.

6. DISCUSSIONS

This work can be considered relevant for both the research domains of 3D Printing and for Design for Sustainability due to it systematizes the relevant advances of both areas, proposing a their convergence toward the development of a common ground for mutual experimentations. Specifically, it is possible to identify some aspects of novelty for products, services, systems and, in general, for the culture of designers. About the products' dimension, the early insights developed in this work can meet, for example, the emerging need of new sustainable solutions made using the minimum amount of material (Rifkin, 2012; Ceschin and Gaziulusoy, 2016), as well as the number of new eco-friendly and sustainable-oriented solutions (i.e. eco-products), which now can be designed and produced – printed – using eco-aware processes and technologies now more in line with the values of contexts, networks and materials. About the services' dimension, the results developed within the Design Opportunities' framework can be further implemented to support any tangible dimension for Sustainable 3D Printing. In other word, the early data achieved in the domain of new printable products can be consolidated using new low-footprint services and intangible solutions, to empower the tangible dimension of solutions (Vezzoli, 2010; Ceschin, 2014). Consequently, the third level of development concerns the systemic dimension, as a result of the combination of both tangible and intangible applications, namely products and services. As demonstrated by SLOC, PSS and SDS, the systemic development of Sustainable 3D Printing can surely improve, as a consequence, the quality of products and services (Manzini, 2010; Gebler, 2014).

Finally, about the culture of designers, the results here achieved can be useful to develop a new design awareness, which can be used by designers, makers, entrepreneurs and stakeholders to address the future development of new proactive printable sustainable solutions for new emerging markets and countries.

CREDITS

This paper shows the early results of a research project on the role of Design for Sustainability in 3D Printing domain. While all authors have contributed in the development of results, the writing of paragraphs can be attributed to: Emilio Rossi for '4. Results', Massimo Di Nicolantonio for '3. Methodology', Paola Barcarolo for '1. Introduction', Jessica Lagatta for "6. Discussions" and Alessio D'Onofrio for 'Abstract' and '2. Aims'. Furthermore, Emilio Rossi and Massimo Di Nicolantonio equally contributed for the writing of "5. Conclusions".

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DESIGN OF ABANDONED VEGETABLE AND FRUIT TRANSPORTATION SYSTEM BASED ON SUSTAINABLE DISTRIBUTED ECONOMY

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ABSTRACT

Designed for the ugly supply of fruit and vegetable products in Changsha, Hunan Province, China, to reduce food waste and increase the economic income of all parties involved. Through the establishment of an online fruit and vegetable distribution and trading platform, we will establish various workshops offline, and cooperate with local NGOs, farmers, restaurants, and wholesalers to carry out online and offline dual-platform models. By improving the design of the overall supply method, the income of local farmers has been increased, the waste of ugly fruits and vegetables has been reduced, the utilization rate of energy has been increased after composting, and the profit of stakeholders has been increased through trade fairness.

Key Words: sustainable distribution economy; Use-Oriented Services; Trade fairness; S.PSS

1. INTRODUCTION

China's cold chain transportation problem is about 12 million tons of fruit and 130 million tons of vegetables per year, with a total economic value of 10 billion US dollars[1]. In the logistics links of fruit and vegetables during picking, transportation and storage, the loss rate is 25% to 30%. The annual depletion of fruits and vegetables can meet the basic nutritional needs of 200 million people, and the loss is the highest in the world.

In China, due to ugliness or damage to the skin of fruits and vegetables, the fruits and vegetables of the defective fruits are seriously wasted. Take the Xinqiao Agricultural Products Logistics Center in the West Third Ring Road of Xi'an as an example. The wastage of fruits and vegetables caused by damaged skin and other causes is approximately 60 tons.

2. METHOD AND SYSTEM

2.1. Method

Based on the basic concepts of sustainable design and distributed economy, by integrating "products and services" to build "sustainable solutions" Sustainable Solution to meet consumer-specific needs, "results" and "benefits" to replace the consumption of material products, while at the same time reducing resource consumption and environmental pollution, and changing people's social life quality[2]. By using the steps of Strategic analysis; Exploring opportunities; System idea development; System design; System implement to design the service system, carry out design practice and evaluation, and then design iteration. Through the basic classification of product service system design, the use of product-oriented service system design means (Use-Oriented Services provides users with a platform, such as products, tools, opportunities and even qualifications to meet people's needs and wishes. In this service system design, the product and the service coexist, and the product is effectively integrated into the service[3]. The user can use but does not need to own the product, but only pays the specific time period or the consumption cost according to the agreement of the two parties. The redesign planning involves the service system of the stakeholders has been optimized to optimize the use of defective fruits and vegetables from the original product orientation to the use orientation. From simple sales to system-like services, the benefits of stakeholders have been improved, thus solving the problem. Distributed sustainable design through the redesign of economic networks and service systems consisting of fruits and vegetables and stakeholders.

This paper takes the fruit farmers and vegetable farmers in rural areas of Changsha City, Hunan Province, China as the research personas, and designs the systematic product service system for the local waste fruit and vegetable waste problem. Through local surveys and expert interviews with local farmers, bazaars, local NGOs, institutions, supermarkets, customers, restaurants and fertilizer plants, combined with local statistics, the main causes of defective fruits and vegetables, namely the appearance of fruits and vegetables, were analysed.

Ugly fruits and vegetables are partially damaged and slightly spoiled due to weather conditions such as hail. The current treatment methods for defective fruits and vegetables are analysed.

The treatment methods are generally divided into two types: the first one is for suppliers to collect from local farmer's parks, and the unselected fruits and vegetables are directly rolled on the road and then passed to the cleaning department; The second is to treat the gradually decaying fruits and vegetables in the farmer's market, discard them and collect them for disposal by the cleaning department. In response to the above-mentioned massive waste problem, a practical-oriented service product system design was carried out.

2.2. System

The design of the new and defective fruit and vegetable delivery system designed in this paper is in the form of a dual platform, namely the online deployment platform and the offline workshop platform.

For the online platform, first, the local farmers can sell the main sales to the local wholesalers. The defective fruits and vegetables are recycled by the local cooperative NGOs through the platform, and the booths are set up in the wholesalers, also by the cooperative NGOs. Recycling of defective fruits and vegetables. After recycling, cooperate with local NGOs to screen the fruits and vegetables and rough them. Among them, the higher quality fruits and vegetables are processed by rough processing, some are delivered to local restaurants, Gyms and other places; the other part is handed over to NGOs for public welfare social activities. Corruption and serious corruption of fruits and vegetables in wholesalers and farmer households are connected through local platforms, collected by local fertilizer plants and packaging plants, and produced in eco-friendly environmentally friendly packaging such as composting and vegetable paper packaging. Farmers receive fertilizers and product packaging reward.

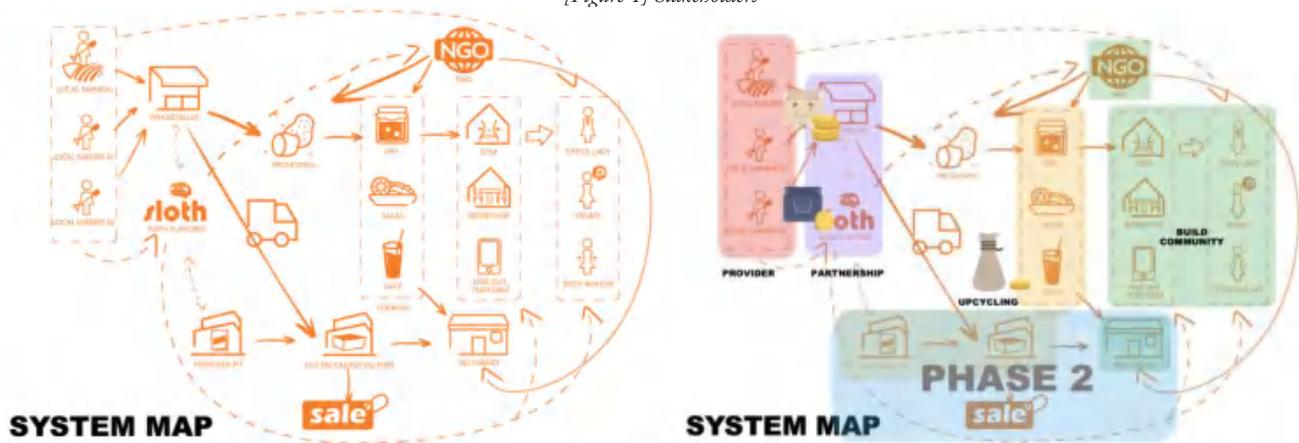
Secondly, consumers can make appointments for workshop activities through the online platform and can communicate with farmers online to achieve trade fairness; for the offline experience platform, the main function is to provide consumers with experience, consumers can pass the offline workshops carry out simple food processing, juice pressing, and popularizing basic sustainable environmental concepts.

There are two types of profitability of the platform, which are profitable by directly selling the products, such as selling rough-processed products to restaurants and gyms; and selling raw materials to fertilizer plants and packaging plants for industrial production; Services purchased by consumers, such as workshops and monthly packages.

The first phase is the establishment of online and offline platforms and the realization of cooperation with fertilizer plants and subsequent packaging plants. Business Category. The second stage is to cooperate with fertilizer and packaging manufacturing plants to promote a win-win situation for farmers and them (Figure 2).



[Figure 1] Stakeholders



[Figure 2] System map

3. RESULT

Through design, the utilization rate of defective fruits and vegetables has been improved, and people’s understanding of sustainable concepts has been raised. The realization of trade equity has increased the income of stakeholders in the project, especially the income of local farmers.

3.1. Impact

For economic:

- 1) Reduction in food waste and greenhouse gases; 2) Fully utilizing local resources minimizing landfill demand; 3) reducing the root cause for growing surplus crops with better communication platform;

For social:

- 1) Increasing employment opportunities for local area; 2) Rising awareness and directly helping Local BOP by cooperating with NGOs; 3) Allowing different local stakeholders to understand the environmental problems and impact; 4) Connecting different stakeholders within the local area, from rural to city and individuals to business; 5) Integrating a new standard on food safety standard hence reduce wastage and improve individual well-being.

For Ecological:

- 1) Up cycling add value to unwanted materials; 2) Fair trade for local farmers, minimizing destructive competitions; 3) Cost saving opportunities for local businesses and NGOs.

At the same time, due to the influence of cost control, manpower deployment and other factors, the completion of the service system design will be divided into two phases.

Sustainability impact: In general, the waste of fruits and vegetables is greatly reduced, the income of stakeholders is increased, trade fairness is promoted, and public awareness of food waste is raised.

3.2. STAKEHOLDERS

The defective fruit and vegetable delivery system design has different benefits for different stakeholders:

- 1) For farmers:

Real trade fairness can be achieved by recycling defective fruits and vegetables, which can increase the household income of local farmers; by cooperating with local fertilizer plants, the cost of agricultural activities can be reduced; through online and offline communication Activities can help them cooperate with large-scale bazaars, restaurants and other industries to expand sales and increase farmers' income.

2) For consumers:

you can eat the fruits and vegetables of the place of origin and communicate with the producers of the place of production, food safety is guaranteed, and the concept of sustainable development is popularized.

3) For local NGOs:

Expand the influence of local NGOs and provide raw materials for their public welfare activities to save operating costs.

4) For fertilizer plants and packaging plants:

providing a large amount of raw materials can help it reduce production costs and increase profits.

4. CONCLUSION

Increase the income of local farmers and related personnel through online and offline dual platforms. Reduced waste of resources, increased fertilizer production, and reduced pollution and waste. Through the change of business model, help multiple parties achieve a win-win situation.

In the actual work, there are some shortcomings: more manpower and material resources are needed for sorting; there are certain difficulties in the promotion of ugly fruits and vegetables; the shortage of professional personnel and other problems cause problems such as shortage of offline platform personnel.

In the actual work that follows, the "participants" will be changed into "implementers". Through a series of trainings, the past production and management mode of farmers will become a new model of production, promotion and consumption.

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DISTRIBUTED PRODUCTION AND SUSTAINABILITY STRATEGIES FOR FASHION

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ABSTRACT

From the possibility to express oneself to functionality, from the creation of new ways to communicate to greater renewability: one of the challenges which the fashion industry, together with most other sectors, is called upon to tackle concerns sustainability.

The aim of the paper is to trace the main solutions adopted by the fashion system in terms of sustainable practices.

Firstly it analyses the contribution of material and technological innovation to promote the adoption of green products, in order to challenge the waste and the pollution.

Secondly the paper focuses in particular on the impact of digital technologies over processes and actors involved, fostering practices based on distributed production.

Key Words: Fashion, Innovation, Sustainability, Distributed Production

1. INTRODUCTION: THE HYBRIDISATION OF FASHION AND THE CHALLENGES OF THE PRESENT TIMES

Fashion as a discipline has always been characterised by the intertwining of complex trajectories based on thematic references, borrowed methodologies and the appropriation of various unrelated fields of expertise, with the clear aim of generating innovation (Conti & Dell'Acqua Bellavitis, 2006).

An example of cross-fertilisation which has traditionally been widely implemented is the formal reference, whether literal or freely reinterpreted. Throughout history there are plenty of examples which bring to the fore fashion's highly referential nature. There are numerous instances of this kind of cross-fertilisation; one of these is notably the influence which different geographical cultures have exerted on the creative production of many a famous fashion designer, an influence which to this day cyclically inspires modern collections.

Another form of traditional cross-fertilisation resorted to materials usually employed in other sectors, as was famously the case with denim. While 15th-century Ligurians originally destined it to the production of sail bags and to be used as merchandise wrapping, in the mid-19th century Levi Strauss adopted it for the manufacturing of work clothes due to its excellent resistance. Another example is Elastam, the study of which began in the 1930s as Bayer began to invest on the exploration of viable alternatives to rubber. Elastam was later marketed by Du Pont under the name Lycra and was initially aimed at the medical sector, until Emilio Pucci managed to exploit its potential to the full by presenting his fitted Lycra bathing suit in the 1960s. In a historical perspective, innovation has been achieved by importing procedures and technologies from a number of sectors, regardless of their degree of affinity. Thus, in her project 'The Mantle and the Skin' which won the Compasso d'Oro design award in 1974 Nanni Strada turned to circular knitting machines normally associated with hosiery production, and designed a line of wholly seamless "on-the-skin" clothing.

The cases reported above are just a few examples that highlight how in the history of fashion the use of contamination and hybridization is a frequent practice for product innovation.

Today the fashion industry is a highly complex pluralistic and diversified organism in which material and immaterial products, cultural capital and human resources merge together. As the outcome of a complex integration process among different methodologies and areas, fashion contributes to a new reading of the cultural changes which shape our present, and by drawing on various codes it is capable of generating a narrative which bestows meaning on the relationship between references, materials, technologies, products and processes. Given the need to rise to modernity's challenges and to be innovative, the forms of cross-fertilisation in the contemporary world are becoming ever more daring, while the number of sectors involved is steadily growing, and the skills required are becoming increasingly specialised. Fashion's boundaries (Conti, 2012), which are open to the boldest forms of research and experimentation, are the result of the interplay and mutual integration of highly diversified and specialised fields, which range from medicine to aeronautics, from engineering to city planning, and from biology to cosmetics. It is these mergers which supply the lifeblood of creativity and innovation. Contemporary fashion designers are forced to operate on more levels in increasingly complex contexts, and to harmonise diverse elements which are in contrast if not in outright diametrical opposition; they therefore show a shared inclination to a high degree of flexibility which conjugates the cross-fertilisation of different kinds of knowledge and know-how, and experience a similar need to experiment materially and to reach a developed vision of the technology they apply. Such *modus operandi* strives to seek and define original scenarios, and presupposes a special ability in audaciously stretching the designers' initiatives beyond the comfort zone, thereby challenging and breaking the limitations derived from traditional paradigms such as matter, codes, and processes.

The examples contained in the following paragraphs are presented in an order that is not intended to highlight the state of diffusion, marketing, or development process of the product, but to picture and highlight a general common trend, the existence of some avant-garde sectors, generated by contamination and integration with areas other than fashion. It is in fact a transversal research towards the approach to innovation in the field of fashion.

2. THE BOUNDARIES OF SUSTAINABILITY. TOWARDS A SUSTAINABLE MATERIALITY FOR FASHION INDUSTRY

One of the most complex challenges posed by modernity concerns the need to use the available resources wisely.

The fashion industry is only second to the oil one in terms of world pollution: not only does it make large use of chemicals, but it also produces a huge quantity of waste. The concept of waste is structurally inbuilt in the consumerist model underlying the fashion industry, which is in turn largely regulated by notion of trend. The textile market has expanded very quickly, and has grown by 50% in the first decade of the 21st century alone (Material District, 2014). According to some estimates, moreover, the quantity of discarded products is extremely high: only 30% of the clothes are paid their full market price, 25% are sold at a reduced price, and 45% remain unsold. Since only 0.1% of the recuperated textiles is recycled, the waste of resources becomes enormous (State of Fashion, 2018).

In view of these data it is imperative that a joint action between designers, materials scientists, biologists, biotechnologists and chemists be undertaken in order to identify and develop new materials and innovative solutions which may solve the issue (Forbes, 2016).

Further proof of the great interest which this topic elicits is supplied by the close partnership between the H&M group and the Swedish re:newcell, which pursues the goal of enabling the former to employ exclusively recyclable materials by 2030; indeed, the technology developed by the Swedish firm is capable of transforming cotton,

viscose and other cellulose fibres into a blend which can be processed more easily, and turned into a new manufactured fibre to be subsequently reintroduced into the production cycle (Fashion United, 2017).

There are a number of enterprises which have developed new fibres and production technologies which could foster a sustainable development.

A few experimental projects have been devoted to the recycling of highly polluting materials, such as plastic waste.

The Spanish brand Ecoalf which was founded in 2010 by Javier Goyeneche, uses for instance the plastic scattered in rivers and in the sea to create body equipment such as its Shao sneaker collection. Clean Waves, for its part, has employed the plastic recuperated in the oceans in its limited-edition line of sunglasses, while Monique Collignon has developed a line of clothing called Waste2Wear whose materials are drawn from PET plastic bottles. Finally, Anna Bullus has opted for the recycling of the plastic material contained in the chewing-gums discarded in the streets to develop her fashion objects and accessories.

Christopher Raeburn's designing activity also centres on upcycling: by repurposing the technical textiles from military gear such as vintage army snow uniforms, thin-cotton RAF flying suits, and Euro Star uniforms, he has inaugurated an ethically conscious production of outerwear.

The fast fashion industry produces 53 million tons of clothing every year, 87% of which ends up as waste in landfills (Copenhagen Fashion Summit, 2018); in this sense, the creation of biodegradable clothing might provide an alternative solution to the closed cycle of production, disposal, and recycling (Seymour, 2010). Indeed, some firms have already started developing alternative and sustainable materials.

Solve's answer to the consumerist dynamics underlying the Fast Fashion industry has been the Omdanne collection: three items of clothing which are 100% biodegradable, are wholly made of an artificial cellulose fibre derived from eucalyptus called Tencel Lyocell, and may be worn in twenty different ways.

Although traditional natural fibres, such as cotton and flax, are considered to be less environmentally damaging than synthetic fibres, they still require an abundant use of resources to be cultivated. Moreover, for example, the industrial production of cotton, the most common natural fiber used to make clothing, representing about 33% of all the fibers present in fabrics, has a strong negative impact on the environment (World Resources Institute, 2017). In fact, cotton is a fibre that requires large quantities of water to be cultivated: to obtain a useful quantity for making a cotton shirt, 2,700 litres of water are required. In areas already subject to water stress, the production of this natural fiber can be particularly harmful. Cotton cultivation is also responsible for 24% of insecticides and 11% of pesticides, even though it uses only about 3% of the world's arable land (World Resources Institute, 2017). Another important problem related to cotton concerns the use of pollutants to dye tissue.

It is for this reason that some firms have started turning organic waste available in large quantities, especially of vegetal origin, into innovative materials which may be useful for the fashion industry. An example in this sense is supplied by those materials which convey the aesthetic impression of the human skin without being of animal origin: Fruit Leather makes use of waste derived from unsold fruit and vegetables, the Piñatex fabric has been developed from pineapple leaves, while Vegea resorts to grape waste from the wine industry. Salvatore Ferragamo, for his part, is pioneering the use in the fashion context of the Orange Fiber, the first fabric made from citrus fruit waste, and Happy Genie has launched a line of handbags made from apples; Suzanne Lee, on the other hand, has created a material akin to human skin thanks to a process of tea fermentation.

Other firms have preferred to exploit the intrinsic potential of mushrooms: examples abound, and include Iris Houthoff's Mylium fabric, Muskin, Stella McCartney's handbag, which was presented at the Fashioned from Nature showcase held in the Victoria and Albert Museum in 2018, the bag jointly designed by Bolt Threads and Ecovative, the line of shoes by Nat-2 and Zvnder, and Aniela Hoitink's MycoTEX, which after having been worn may be buried in the ground and left there to decompose.

The fashion industry may thus turn an environmental threat into an opportunity, as was the case with the project jointly developed by Vivobarefoot and Bloom.

Indeed, a very concrete threat to our planet is currently posed by the exponential proliferation of algae, which is largely due to the phosphorus and nitrates released into the sea by chemical waste; however, these organisms are in fact extremely versatile, and may be transformed into bioplastic material. For instance, Ultra is a footwear collection made from algae-based foam, a valid vegetal alternative to the synthetic and oil-based ones; Tjeerd Veenhoven produces a similar fabric which is also made of the same aquatic organisms, while AlgaLife has focused on biofibres and an eco-friendly dye. Moreover, these fibres release antioxidants, vitamins and other nutrients which are beneficial for the skin of the wearer.

There are also other kinds of innovative and eco-friendly materials which rely on the processing of waste of animal origin.

Spider Silk, despite its apparent fragility and flimsiness, is in fact extremely resistant, a characteristic which has been developed by researchers with quite different backgrounds.

Adidas has presented a footwear prototype made of synthetic, biodegradable spider silk, and the same material has more recently been used by Bolt Threads in their new line of ties.

Osklen has recycled the skin of the Arapaima gigas, one of the world's biggest fish, and has made fashion accessories out of what had hitherto been considered waste material.

BioCouture, on the other hand, develops items of clothing from bacterial cellulose, and endeavours to explore

and follow natural processes which rely on an extremely limited number of raw materials, such as bacteria, moulds and recovered waste.

However, the above examples still constitute isolated cases, avant-garde experiments, whose results are often available in the prototype form and far from industrial incorporation. These researches, pioneering as they are, constitute an avant-garde trend that points to a future direction, as demonstrated by the results of *The State of Fashion 2018* (BoF and McKinsey & Company, 2017). According to the report, fashion companies have begun to grasp the importance of a sustainable and transparent approach to production: 42 out of 100 fashion brands in 2017 disclosed information on their suppliers. Also, according to *The State of Fashion 2018*, millennials are interested in more sustainable solutions: 66% of global millennials are willing to spend more on sustainable brands. Therefore an important lever towards the adoption of eco-friendly strategies is the awareness that in the fashion sector, attention to sustainability can be an important element of differentiation for the consumer.

3. DISTRIBUTED PRODUCTION AND SUSTAINABILITY STRATEGIES

«Personal fabbing, prototyping, interactivity, cutting-edge technological content, all of which are put to good use to create innovation and new kinds of sustainable local economy thanks to the open-source mechanism and Creative Commons licenses.»

Andrea Branzi

From the possibility to express oneself to functionality, from the creation of new ways to communicate (Seymour, 2008) to greater sustainability (Forbes, 2016): one of the challenges which the fashion industry, together with most other sectors, is called upon to tackle concerns sustainability.

The introduction of digital technologies has entailed a radical change which has affected the very notion of fashion. Aesthetics and technical skills have now been joined by the ethical selection of materials, respect for the environment, and the protection and promotion of the joint cultural and traditional heritage associated with the surrounding territory. This approach has had obvious repercussions also on the designers' activity and location choice, who are met with a growing need to reduce the consumption of the resources required by research, product promotion, and product commercialisation.

Biology, chemistry, and materials engineering have greatly contributed to the identification of solutions favouring sustainability, thanks to the development of new materials that are either recycled or made of biocompatible and biodegradable natural fibres; digital technologies, however, can also supply some solutions which may make the fashion industry more sustainable.

Indeed, digital technologies have occasioned great changes in the whole of fashion's production process by assisting the transition from large-scale, centralised design and production systems to ones that are decentralised, or else spread among smaller, networked units.

Modern design arose from industrial chain production with great output, and brought about the aesthetic standardisation of the industrial offer, whose only lingering value resides in its very brand name; design's widespread presence and distributed production, however, (Srai et al., 2016) do not supply only products, but also services which are instrumental in the creation of customised objects, and which actively engage consumers by educating them and stimulating their creativity. The serial production of the finished product is replaced by the design of models, digital platforms and semi-finished products which may be modified, customised and finished by the consumers themselves.

The Post-Couture Collective is an interesting example of production which endeavours to be open and cooperation-based: they actively encourages final users to access their website, and to download, customise, produce and self-assemble their chosen garments.

Consumers' new role from passive users to well-informed 'self-creators' (Recession Design, 2013), together with their involvement in the design process, has made them more discriminating as regards the products available on the market: designer products and brands are now being snubbed in favour of the consumers' own creativity and ability to constantly reinvent products, and consumers no longer acritically accept to have products imposed on them. Consumers therefore contribute to the conceptual definition of goods, and rather than waiting for companies to decide for them, they create the product they require themselves.

Industrial production has become distributed, decentralised, and has even ended up in the users' homes-turned-laboratories, as is the case with self-production; this trend greatly reduces the number of resources needed, the costs of production, packaging and transport, and even diminishes the waste derived from unsold finished goods. Manufactured objects are consequently becoming territorialised, and are being produced closer and closer to their end users, thereby cutting down the pollution occasioned by the excessive consumption of resources and transport. What is more, the consumers' new active role, together with their involvement in the actual manufacturing process, helps them develop greater manual skills, and makes them more aware of waste-related issues. The emotional attachment they develop with the object they have built reduces the tendency to easily dispose of it which is, more often than not, a common side-effect of serial production. Consumers become more sensitive to discarded objects that only exacerbate waste-related problems, and strive to reuse exhausted objects as much as possible, either by creatively modifying them or by finding new uses for them. Within this system, the waste of resources and the

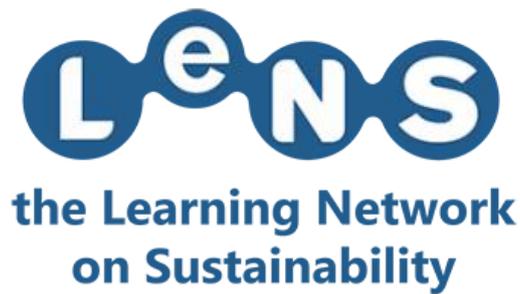
costs of storage and transport are much lower than in the traditional centralised production. Mixed groups of active consumers and professional designers jointly develop projects and freely exchange skills and knowledge, pool together their strengths and abilities, and foster a production system which offers an alternative to the company-based one characterised by the lack of mediation and by costs determined by large-scale retailers. Assuming that this model may altogether replace the traditional serial one is of course unrealistic, but there is no reason why it cannot compound and influence it.

4. CONCLUSION

The introduction of digital technologies has entailed a radical change which has affected the very notion of fashion. Aesthetics and technical skills have now been joined by the ethical selection of materials, respect for the environment, and the protection and promotion of the joint cultural and traditional heritage associated with the surrounding territory. This approach has had obvious repercussions also on the designers' activity and location choice, who are met with a growing need to reduce the consumption of the resources required by research, product promotion, and product commercialisation.

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SUSTAINABLE PRODUCT SERVICE SYSTEMS: CASES FROM OCEANIA

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ABSTRACT

Considered innovative and radical due to the way they disrupt consumerist lifestyles, ‘sustainable product service systems’ (s.PSS) can reduce the negative environmental impacts from wasteful consumption. An inventory of existing s.PSS solutions in Oceania was carried out to help inspire entrepreneurs and innovators to champion alternative ways of needs fulfilment and to offer added value to customers with less ecological damage. The search encompassed cases of collaborative consumption lifestyles, redistribution markets, distributed production, and the circular economy. Over 140 innovative cases were found. Analysis showed that the majority of cases found were use-oriented PSS, such as product sharing, renting, leasing or pooling, and there were hardly any innovative cases of product- and result-oriented PSS. While many of the PSS cases in the study demonstrated environmental improvement through minimized resources and waste, others in fact were more material and energy intensive and therefore negated the sustainability advantage.

Keywords: Collaborative consumption; sustainable product service systems; Australian PSS.

1. INTRODUCTION

For the last couple of decades European researchers have actively investigated ‘sustainable product service systems’ (s.PSS), mainly due to their promise as a radical innovation strategy. They are seen to disrupt consumerist-driven lifestyles and often shift the focus from the design and sales of products for individual ownership to an alternative function fulfilment via shared or cooperatively-owned products and services. In many cases their potential to reduce the adverse environmental impacts from wasteful consumption, as well as their ability to improve person-to-person interaction and cohesion in the community, have been demonstrated (Mont, 2002; Tukker & Tischner, 2006).

While s.PSS seem to be common in Europe, they appear to have relatively lesser presence in Australia and New Zealand, both in academic study and in everyday practice in the community. An inventory of existing s.PSS solutions in Oceania was carried out to firstly determine the reality of s.PSS in this region and secondly provide inspiration for design thinkers and innovators in Oceania on how to champion alternative and sustainable ways of needs fulfilment.

The Learning Network on Sustainability (LeNS) – an international association of Design for Sustainability educators from 125 higher education institutions in 27 countries, working to diffuse sustainability capacity through innovative curriculum development – has actively promoted the design of s.PSS. The website of LeNS International features a collection of cases from Brazil and Italy. The inventory of Australian and New Zealand s.PSS cases that results from this paper will become the contribution of LeNS Oceania to this international case collection.

2. CASE STUDIES

This paper used case studies to examine in greater depth the various s.PSS solutions that have been identified in Oceania. A broad Google search – employing such keywords as ‘product service systems’, ‘product sharing’, ‘sharing economy’, and ‘collaborative consumption’ – found 190 innovative cases, all of which involved a service provider and a product user interacting within a system. These were tabulated in a spreadsheet, then categorized by types of products, services, ownership model, satisfaction units, and PSS orientation. Each case was also summarized into a visual slide with standardized textual descriptors. The text below presents some of the more notable cases.

2.01. Shared use of transportation vehicles

Sharing of vehicles of various types is a highly common PSS in many cities around the world. These come in the form of: *publicly hired cars with drivers*, such as conventional taxi cabs and TNC (transportation network company) vehicles with online ride-hailing services (such as Uber.com, Taxify.eu, and OlaCabs.com); *self-drive cars for shared use* (such as GoGet.com.au, Flexicar.com.au, CityHop.co.nz, and GreenShareCar.com.au); *self-drive bicycles for shared use* (such as Melbourne Bike Share); *self-drive holiday vehicles for shared use* (such as Britz.com, Jucy.co.nz and Camplify.com.au); *self-drive private cars for peer-to-peer shared use* (such as DriveMyCar.com.au, CarNextDoor.com.au, and YourDrive.co.nz); and *ride-sharing or carpooling* (such as CoSeats.com and Shebah.com.au).

2.02. Shared use of tools and equipment

Infrequently-used tools and equipment occupy storage space, could be costly to own and maintain, and could become obsolescent due to new features in the latest models. Tool sharing was found to be present in various formats: *for-profit tool rental companies* (such as Kennards Hire, Bunnings Warehouse Hire Shop, and The Rug Doctor); *not-for-profit tool libraries*, which are membership-based and often volunteer-run (Brunswick Tool Library, Brisbane Tool Library, and Newtown Tool Library in Wellington); and *peer-to-peer tool lending*, which can either be for free or for a fee (such as FriendsWithThings.com and ToolMatesHire.com.au).

2.03. Shared use of children’s products

Fast-growing babies outgrow or get bored of their old toys and equipment, requiring parents to buy new ones and often the old ones turn into ‘housefill’. Sharing of children’s products occurs in *community-based toy libraries*, which are often free or have low-cost membership fees (such as the 280 member libraries of Toy Libraries Australia and the 218 members of Toy Library Federation of New Zealand); *for-profit rental of infant equipment*, including prams, portable cots, car seats, high chairs and breast pumps (such as HireForBaby.com and HospitalBassinetHire.com.au); *peer-to-peer rental of idle baby equipment* (such as KinderShare.com); and *mobile toy vans or ‘Playvans’*, which travel to different suburbs, carrying toys and engaging children in play-based skill-building activities (in Sydney, there are Playvans in Penrith, Blacktown and Burwood).

2.04. Shared use of books

Community libraries enable time-sharing of books and audio-visual materials such as CDs and DVDs by patrons. Australian libraries have some innovative outreach services to allow greater coverage of the communities and to promote literacy beyond the physical space of the library. These include *bookmobiles*, which are specially-designed ‘libraries on wheels’, available in Australia since the 1950s; *home library services*, where library materials are sent free to people who are unable to access their local library due to special circumstances; *bulk loan services*, which sends requested ‘talking books’, large-print books, CDs and DVDs to nursing homes; *beach libraries*, which allow borrowing of books and magazines by beachgoers, with no need for library cards, but with the expectation that the book will be returned after use; and *‘book express’*, which are portable book trolleys or book storerooms in the terminuses

of suburban commuter train services, offering commuters print books, audio books and DVDs to read or watch on the train and return them on another morning (such as the ones in Katoomba NSW, Caboolture Queensland and Frankston Victoria).

2.05. Delivering meals to homes

Home delivery of meals could take the form of: home delivery of ready-to-eat cooked meals by couriers using cars, bikes or on foot (such as Uber Eats); home delivery of chilled pre-cooked meals, usually contained in modified-atmosphere packaging and bundled in expanded-polystyrene cooler boxes (such as YouFoodz, Primal Food, Dinner Twist, and THRIVE); home delivery of deep-frozen pre-cooked meals, typically for clients of the Australian Government's NDIS National Disability Insurance Scheme (such as Meals on Wheels, GourmetMeals, HomeChef, LiteNEasy, and Dietlicious); home delivery of recipe-based ingredients for cooking (such as HelloFresh, MarleySpoon, MyFoodBag, PepperLeaf, ThomasFarmsKitchen, WOOP, and Dinnerly); home delivery of food grocery items by supermarkets, straight to the customer's kitchen counter (such as Woolworths and Coles); delivery of fresh produce only (such as YourGrocer and FoodBox).

2.06. Salvaging and redistributing foods

Food rescue organizations, aka 'food banks', collect unwanted edible food from supermarkets, bakeries, fruit shops and restaurants and supply them to front-line charities for free distribution to the needy. The United States built the world's first food bank in 1967, and this example has been emulated by thousands worldwide since then. Australia's first food rescue organization is Oz Harvest, launched in Sydney in 2004 to combat the excessive amounts of perishable food being thrown away by the hospitality industry. Oz Harvest's fleet of 15 vehicles delivers 441,500 meals per month nationwide to over 1,300 charities who redistribute it to those who are struggling and in need of nourishment in the wider community. In 2017 Sydney welcomed the Oz Harvest Market, a supermarket which sells surplus food by donation; patrons are encouraged to 'take what you need, give if you can' (OzHarvest, 2017). Other charities with the same business model include SecondBite, founded in Melbourne in 2005 and focusing on fresh produce; Kaibosh, founded in Wellington in 2008; Good Neighbour Aotearoa, established in 2011 in Tauranga Bay of Plenty; Fair Food, founded in Auckland in 2012; Kiwi Harvest, founded in Dunedin in 2014; and Satisfy Food Rescue, founded in Canterbury in 2015. FareShare was founded in 2001 in Melbourne, quickly becoming Australia's largest community kitchen, cooks more than 1 million free nutritious meals yearly for the hungry, the homeless and those who have fallen on hard times, using surplus quality food donated by businesses. FareShare was formed from the merger of One Umbrella and Melbourne City Harvest. Another platform that tackles food waste is TooTastyToThrow.com, which, towards the end of the business day, offers unsold food from local cafes and restaurants at discounted prices.

2.07. Providing health and wellbeing services

When Australia's Royal Flying Doctors Service began its operations in 1928, it became the world's first air ambulance. Ninety years later, it has grown to become one of the largest and most comprehensive aeromedical response organisations in the world, providing emergency and primary health care services for people in rural, remote and regional Australia. In 2018, with its 71 aircraft and 124 healthcare vehicles in 23 air bases, RFDS doctors, dentists, nurses and paramedics travelled 26.9 million km to deliver vital health services, transporting 113,375 patients by air and by road, providing 21,828 episodes of dental care, conducting 16,209 clinics and 88,188 telehealth consultations (RFDS, 2018). The Purple Truck is a self-contained dialysis unit on wheels, a project of the Purple House of the Western Desert Aboriginal Corporation based in Alice Springs. Established in 2012, it transports patients with end-stage renal failure to their remote communities to attend to family or cultural matters and funerals.

2.08. Furnishing urban spaces

Australia Post offers free and secure 24/7 parcel lockers, providing customers access to an alternative address for online shopping. When the parcel is ready to be collected, an SMS will be sent and the user can stop by at any time in the next 48 hours to collect it using the access code in the SMS or email to open the locker.

Leda Security Products is Australia's largest manufacturer of bicycle parking and end-of-journey facilities. Their Securabike brand produces enclosed sheds and lockers at selected train stations, ferry wharves and bus interchanges all over Sydney, making it easier for commuters to combine cycling with public transport. Free of charge to registered commuters, Securabike sheds keep the user's bicycle, helmet and other equipment safe and protected from the weather, theft and vandalism. Securabike also installs free bicycle repair stations on bicycle paths or at bicycle parking areas, including an air pump and repair tools that are tethered by steel cables or chains.

Many drinking fountains in Australia are equipped with dispenser spouts for refilling water bottles, such as the ones by Civiq Aquafil and Meet PAT. By dispensing free and fresh drinking water into the community, the consumption of bottled sugary beverages and single-use plastic bottles could be potentially reduced.

Sunscreen Stations Australia has coin-operated dispensers for sun-protection lotion using an easy-use spray gun. It's designed to be installed in public swimming pools, sports clubs, theme parks and construction sites.

Compost-A-Pooch dispenses compostable bags for collecting pet waste in public parks, coastal areas, sporting fields, campgrounds, and caravan parks. Ezycharge and Chargespot rent out charging stations for mobile devices in business, hospitality, services and retail environments.

2.09. Outsourcing domestic chores

Jim's Mowing is the largest mowing and garden care franchise system in the world. Began as a one-man business by Jim Penman in 1982, it evolved into the Jim's Mowing Franchise system in 1989. It has since grown into an extensive network across Australia, New Zealand, Canada and the United Kingdom, with over 3,300 franchises. The Jim's Mowing Franchise branched into Jim's Cleaning division and since then the franchise model has been adapted to almost 50 different service industries.

The mobile dog-washing and grooming service Blue Wheelers was established on the Queensland Gold Coast in 1994. Now there are almost 200 franchisees across Australia. Fully-trained groomers come to the pet's home in their Big Blue Dog mobile salon, where the dogs are washed and groomed from snout to tail.

2.10. Redistributing unwanted possessions

There are local Australian branches of international grassroots movements that enable people to give and receive pre-loved or unwanted possessions. Freecycle.org aims to promote a 'worldwide gift economy' by enabling its members to offer each other free second-hand and unwanted items, therefore encouraging reuse, reducing wastefulness, decreasing consumerism, and connecting people through giving. Founded in Tucson in 2003, Freecycle now has 5,206 local groups in 110 countries with 9.3 million members worldwide, including in Australia and in New Zealand. Similar online sites that offer free giveaway of unwanted items to people who need them are: OzRecycle.com, aka the 'Australian Recyclers Community' established in 2007; and Zilch.com.au, launched in Melbourne in 2011.

Gumtree Australia is a subsidiary of Gumtree.com, the British online community website which was founded in 2000 in London. Gumtree connects buyers and sellers in the local community, and the classified ads are either free or paid for depending on the product category. On average, more than 7 million Australians visit Gumtree each month with more than 2.5 million listings across hundreds of categories. A variant of this online trading is offered by the Australian-developed app 'Swappy.com', where users barter clothes, collectibles and electronics without any bidding and no money exchange; users upload photos and descriptions they are willing to trade and a price range, and if other users can reciprocate with something of similar value, they can strike up a conversation and negotiate a swap.

Launched in 2010, Garage Sale Trail now happens every year across Australia during the third weekend of October. It happens with the support of 146 Council partners and more than 400,000 Australians who shop and sell in more than 15,000 garage sales nationwide. An online sellers' page on GarageSaleTrail.com provides insight into what's on offer so shoppers can search for bargains and items of interest.

The Clothing Exchange hosts monthly fashion 'swap-meets' where people swap clothes they value but no longer wish to wear. Launched in Melbourne in 2010, the Clothing Exchange now has events across Australia. Clothes swappers often find themselves elated at seeing their unwanted clothes being wanted by others and getting a second life instead of contributing to landfill or 'housefill'.

Zookal.com is a peer-to-peer marketplace where students can buy and rent second-hand university textbooks.

2.11. Repairing broken products

Repair cafés and similar fix-it initiatives are starting to reappear in communities around the world. The community-driven Repair Cafés are free gatherings between volunteer fixers and people with broken or faulty household items such as bikes, clothing, appliances or furniture, who work together to prolong the life of the damaged goods and prevent them from ending up in landfill prematurely. The sessions are either held on a regular basis or as pop-up events in cafés and community centres. First established in 2009 in Amsterdam, there are now over 1500 Repair Cafés in more than 30 countries; 30 of them are in Australia and 3 in New Zealand. The International Repair Foundation was set up to support local groups in establishing Repair Cafés in their own communities (Postma, 2013).

Since 1998, the environmental charity known as The Bower Reuse and Repair Centre in Sydney has been intercepting reusable items before they are illegally dumped or landfilled, and then repairing, refurbishing, 'resurrecting' and reselling them to the community at a low cost. It collects furniture, bicycles, kitchenware, books, appliances, and bric-a-brac in 20 council areas for free. Their Rent-a-Bench scheme allows individuals to work independently in the workshop with assistance from a skilled woodworker. The Bower holds 8 Repair Cafés per month, teaching the community how to fix broken bikes, electrical items or wood furniture for free (The Bower, 2017).

2.12. Salvaging discarded materials

In 1975 a group of environment-aware teachers and community workers started Reverse Garbage, with a mission to divert industrial and commercial discards from landfill and creatively reuse and repurpose these materials in their classrooms. Every year, Reverse Garbage accepts around 35,000 cubic metres of factory off-cuts, over-runs, art and craft materials, stage props, knick-knacks, furniture and other odds and ends; they renew the value of these resources by making them available for reuse by families, schools, early learning centres, artists, do-it-yourself enthusiasts, set builders, festivals, charities, and 'upcyclers'. They also hold workshops to give community members the skills and inspiration to creatively transform found objects and to reverse their view of 'garbage' and start seeing them as resources. (Reverse Garbage, 2018). Operating in a very similar fashion is the Reverse Art Truck in Melbourne, formerly known as Reverse Garbage Truck, that has been around for over 30 years (ReverseArtTruck.com).

The grassroots community initiative Boomerang Bags started in 2013 in the Gold Coast and has now grown to

745 chapters globally. Community groups sew bags out of donated or found materials; they provide these reusable fabric bags in shopping centres for shoppers to borrow and use for free and return when they are finished with it.

2.13. Recovering 'waste' resources

In 'resource recovery' wastes are considered as valuable input resources to create high-value outputs, thereby extracting maximum value from the waste. Australia's REDcycle Program, launched in 2010, is a recovery initiative for post-consumer soft plastic. Collection bins are conveniently placed outside Coles and Woolworths supermarkets, making it easy for consumers to deposit unwanted plastic bags. The collection is sent to Replas, which recycles the plastics into outdoor benches. Love NZ also has a soft plastics recovery program whose collections are also sent to Replas for recycling; however, in Dec 2018 collections have been suspended until Apr 2019.

Plastic Forests was formed in 2010 as the world's first company to commercialise a dry-cleaning waterless process for recycling contaminated plastic films from agricultural, food and post-industrial sources. These plastics are recycled into resin for the manufacture of underground cable cover, garden edging, garbage bags and bin liners.

Australia's largest mattress recycler Soft Landing was founded in Wollongong in 2009 and now has sites nationally; so far it has diverted 872,355 mattresses from landfill, recovering 13,241 tonnes of steel springs, 4,340 tonnes of foam, and 6,076 tonnes of timber, and recycling these into roof sheeting, carpet underlay, weed matting, mulch, kindling, and animal bedding.

Tyre Stewardship Australia (TSA) was formed in 2014 by tyre importers to administer the national tyre product stewardship scheme; its Green Tyre Project launched in 2017 recycles old tyres into surfacing for sporting fields and playgrounds, kids' rubber mats, brake pads, conveyor belts, asphalt road construction, and alternative fuels.

Several Australian councils provide their residents with special bins to capture their organic waste from food scraps and garden clippings, which are processed in industrial composting facilities to be made into compost for enriching the soils in community parks and playgrounds.

2.14. Product Stewardship and Extended Producer Responsibility

In 2011 the Product Stewardship Act became law in Australia; this 'provides a framework for reducing the environmental and other impacts of products' (Parliament, 2018). The Act enabled the National Television and Computer Recycling Scheme (NTCRS), which has recycled about 230,000 tonnes of electronic waste. Under the NTCRS, local government councils organize 'E-waste Drop-off Days' to collect them for safe processing. Other EPR initiatives which were enabled by the Product Stewardship Act are: Mobile Muster, voluntarily funded by the Australian Mobile Telecommunications Association to recycle mobile phones, batteries, and chargers using 3,500 public drop-off points across the country (AMTA, 2018); the Australian Battery Recycling Initiative (ABRI), launched in 2008; Paintback, founded in 2016 to recover unwanted paint and packaging; the NSW-EPA Chemical Cleanout, which collects fluorescent lights, gas tanks, fire extinguishers, batteries and solvents during events or at community recycling centres; DrumMuster and ChemClear by AgStewardship, which collects unwanted or expired agricultural and veterinary chemicals and containers from farms, funded by a 4-cent-per-liter levy collected under the Industry Waste Reduction Scheme; and the National Return & Disposal of Unwanted Medicines Project, launched in 2000 to enable community pharmacies to collect any unwanted and out-of-date medicines from consumers for subsequent high-temperature incineration rather than be dumped into toilets.

Container Deposit Legislation (CDL) has been practiced in South Australia since 1977, where the beverage industry pays back 10-cents for every container returned for recycling. The South Australian container deposit scheme is an environmental success story in terms of litter reduction and resource recovery, with an overall return rate of 76.9% and almost 603 million containers (42,913 tonnes) recovered by the 132 staffed collection points throughout the state in 2017. In 2012 Northern Territory adopted CDL, followed by New South Wales in 2017, and Australian Capital Territory and Queensland in 2018. In New South Wales 'Return and Earn' self-service reverse-vending machines scan the eligible drink containers and issue the 10-cent refunds in the form of retail vouchers or charity donations. Queensland's 'Containers for Change' uses the same self-service system.

3. DISCUSSION AND CONCLUSION

The majority of the cases studied in this paper were use-oriented PSS and result-oriented PSS, such as product sharing, renting, leasing, pooling, and service substitution, with a focus on accessing the value of the product and shifting consumers away from conventional ownership-centric business models. The study provided an opportunity to analyse why more and more s.PSS start-ups get launched as innovative business models that try to capture value and offer meaning to people's ultra-modern lives.

What were the enablers of the growth of s.PSS? One enabling factor would be easier access to distributing information via the internet. Looking at the founding dates of these s.PSS, it is apparent that most of them were established after 2000. It is not coincidental that this growth was fuelled by the universal availability and increasing affordability of the internet in the New Millennium, and the extensive integration of digital apps, websites, smartphones, tablets, WiFi access and online-delivery services into the lives of people in the 21st century.

Another factor could be the rising trust in online transactions (Botsman & Rogers, 2010). Online services are increasingly becoming more reliable, and the reputation of both providers and customers have been made transpar-

ent through customer reviews and rating systems. Indeed, some s.PSS demonstrate economic practicality in simply engaging with the utility and services provided by products rather than purchasing and owning those products, especially if those products will only be occasionally used and will lie idle in storage.

4. ACKNOWLEDGMENT

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VISUALISING STAKEHOLDER CONFIGURATIONS IN DESIGNING SUSTAINABLE PRODUCT-SERVICE SYSTEMS (S.PSS) APPLIED TO DISTRIBUTED ECONOMIES (DE): A NEW STAKEHOLDER SYSTEM MAP FOR S.PSS&DE

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ABSTRACT

In the transition towards to a sustainable society for all, an emerging design discipline: System Design for Sustainability for All (SD4SA) has been proposed by the LeNSin project-the International Learning Network of networks on Sustainability (Erasmus+ programme, EU funded-2015-2019), where focusing on developing the new knowledge-base and know-how for designing Sustainable Product-Service System (S.PSS) applied to Distributed Economies (DE). This paper describes a (co)-design and visualisation tool within the SD4SA discipline: “Stakeholder System Map for S.PSS&DE”, deeply modified from the first system map tool (Jégou et al., 2002) and adapted to the specific context of designing S.PSS solutions to DE models, that can enable an effective integration of seven DE types and five DE configurations. It has been evaluated within a set of pilot courses of LeNSin project, but also with experts to lead to the final tool that is freely available and open access on the LeNS website.

Key Words: Sustainable Product-Service Systems (S.PSS), Distributed Economies (DE), system design tool, stakeholder system map

1. INTRODUCTION

The International Learning Network of networks on Sustainability – LeNSin EU-supported (ERASMUS+, 2015-2019) project involving 36 universities from Europe, Asia, Africa, South America and Central America, is a multi-polar network of Higher Education Institutions aiming at curricula development on System Design for Sustainability for All (SD4SA), i.e. the design of systems of products and services combine environmental protection with social equity, cohesion and economic prosperity – applied in different contexts around the world, based on the promising models of Sustainable Product-Service System (S.PSS) and Distributed Economies (DE), addressing the promotion of a new generation of designers (and design educators) capable to effectively contribute to the transition towards a sustainable society for all.

Based on the first stage research results of S.PSS applied to DE, a promising approach to diffuse sustainability in low/middle-income(all) contexts, the SD4SA emerging discipline have been developed as the potential source of new knowledge and know-how for designers, design educators and students dealing with Designing S.PSS applied to DE. In fact, a new and key role for designer in a SD4SA approach, is to design “appropriate stakeholder configuration”, while addressing S.PSS applied to DE. This discipline has been defined as “design of S.PSS applied to DE, i.e. the design of Systems of Products and Services applied to Distributed Economies artefacts that are together able to fulfil a particular customer demand (deliver a “unit of satisfaction”), based on the design of innovative interactions among locally-based stakeholders, where the ownership of the product/s and/or the life cycle services costs remain by the provider/s, so that economic interests of the provider/s continuously seek both environmentally and socio-ethically beneficial new solutions, i.e. solutions accessible to all” (LeNSin project, 2019).

Along the LeNSin project, with in the SD4SA discipline, a series of tools have been designed and experienced. Those are now available for free on the LeNSin project website www.lens-international.org (tool section). In this paper, the new tool “Stakeholder System Map for S.PSS&DE” is described.

2. METHODOLOGY

- 1). Development. Drawing from literature review on S.PSS visualization tools and from previous LeNSin project research activities, the particular elements and a set of rules to visualise S.PSS&DE were developed.
- 2). Evaluation. The new Stakeholder System Map for S.PSS&DE and other tools, have been experienced and integrated within the Method for System Design for Sustainability (MSDS)¹, adopted during the pilot courses (India-February 2018², Mexico-May 2018³, Brazil-March 2018⁴) of the LeNSin project and tested in the curricular course held by Politecnico di Milano from March to June 2018 (professor Carlo Vezzoli), both aiming at inspiring the courses participants, towards new sustainable opportunity for all through the S.PSS applied to DE. Participants developed new design concepts of S.PSS applied to DE focus on different design topics in different courses, once the strategic analysis and opportunities exploring developed, they applied the new Stakeholder System Map to visualise and detail their concepts (Halen, Vezzoli, & Wimmer, 2005; Vezzoli, 2010; Ceschin, et al 2014). Then they were asked to present their solutions to all at the end of the course and feedbacks about the tools were collected through interviewing and questionnaires.
- 3). Considerations for improvements. The evaluating activities led to adjust the tool according to the specific needs of participants and diverse design contexts and conditions to improve the applications.

3. DEVELOPMENT OF THE NEW STAKEHOLDER SYSTEM MAP FOR S.PSS&DE

The stakeholder system map, originally developed by Francois Jégou in the HiCS research project Highly Customised Solutions, Solution-oriented design, production and delivery systems (European Research, GROWTH Programme/European 5th Framework), is a tool to represent graphically the Product-Service System structure and indicate the stakeholders involved and their interactions. (Jégou et al.,2004, Figure 1). This tool can be integrated in the MSDS designing process of strategic analysis, system concept design, and system detailed design phase (Vezzoli 2010, Vezzoli et al., 2014). Due to the codified visualisation, the stakeholder system map can be also used for communicating the designed solution (Vezzoli et al., 2015). Based on the research achievements of LeNSes project⁵, new advancements on the map tool has been developed and evaluated focused on Distributed Renewable Energy(DRE) and S.PSS (Emili et al.,2016; Emili, 2017). Meanwhile the design tools focus on the Distributed

¹ Method for System Design for Sustainability (MSDS): A modular method for system design for sustainability has been elaborated within the MEPSS EU project, integrated with outcomes from the HiCS EU project and refined within the LeNS EU project.

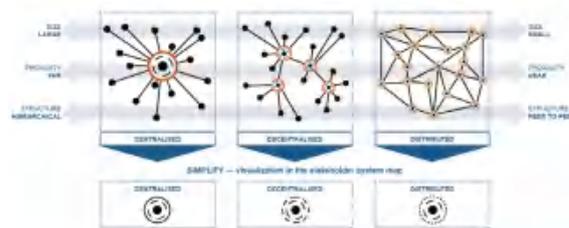
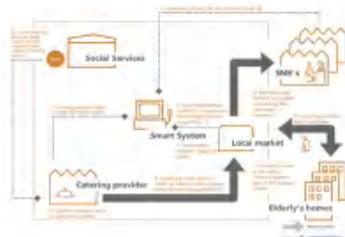
² India-February 2018: The “Sustainable Product Service Systems and Distributed Economy” 2nd pilot course was held by Indian Institute of Technology Guwahati from 11th to 24th of February 2018. Aim of the course was to disseminate concepts and overall knowledge on Design for Sustainability, particularly the method and tools for Sustainable Product Service System Design applied to Distributed Economies.

³ Mexico-May 2018: The “Design for Sustainability” pilot course was held by Universidad del Valle de Mexico from 7th to 18th of May 2018 in campus Lomas Verdes. Designing solutions to the challenges faced by students in paying fees to the university, based on the promising model of Sustainable Product-Service System Design applied to Distributed Economies.

⁴ Brazil-March 2018: The “Sustainable Product Service Systems and Distributed Economy” 2nd Brazilian pilot course was held by Federal University of Parana from 12th to 23th of March 2018 in Curitiba, involving four design teams from Brazil. Participants were asked to develop concepts focused on the rational use of water within low income households, oriented towards a distributed economy, through the method of Sustainable Product-Service System Design.

⁵ LeNSes project: The Learning Network on Sustainable energy systems – LeNSes EU funded Edulink II project 2013- 2016, www.lenses.polimi.it

Manufacturing (DM) and S.PSS have been developed (Petruilaitye et al., 2017, 2018). However, in relation to DE models, S.PSS tools need to extent to the all types of DE that can be used in different scenarios (LeNSin Research Hypothesis II, 2017). As a versatile tool, the system map should be revised and adapted accordingly in order to best describe the complexity of S.PSS applied to all types of DE models, can be used by designers and design students efficiently within the SD4SA discipline, i.e. developing a new Stakeholder System Map for S.PSS&DE.



[Figure 1] Food Delivery Solutions system map of La Fiambrera [Figure 2] Simplify the centralised, decentralised and distributed

3.1. Key elements of SPSS&DE offer models

The first step was to identify and define the key elements to describe the S.PSS&DE models:

- type of distributed economies: it refers to which field of DE involved in the process of designing S.PSS solution, and/or what kind of resources used/shared to deliver the services or products in the system.
- the structure of the system: it refers to the configurations of the DE system, depending on the interaction among the stakeholders of the system as well as from contextual conditions.

3.1.1 Types of Distributed Economies

Distributed Economies can be illustrated a paradigm shift from centralised large production unit and distribution system to small scale locally-based production units empowering end-user control on essential activities (Johansson et al., 2005; Dool et al., 2009) and eventually peer-to-peer network-structured to optimise production and consumption by sharing resources and/or goods and/or information/knowledge (Vezzoli, et al., 2018). To indicate obviously the characteristics of production units in designing S.PSS solutions applied to DE models, we extract the size proximity (to users), structure features from the respective communication and network attribute of Centralised Decentralised and Distributed (Baran, P., 1964), and simplify them into three independent icons (Figure 2) that can be used directly in the new system map.

Moreover, according to the types of resources shared by production units, DE have been classified in two groups: the hardware/natural resources-based including Distributed energy Generation (DG), Distributed production of Food (DF), Distributed Water management (DW), Distributed Manufacturing (DM), and the knowledge/information-based including Distributed Software development (DS), Distributed Knowledge generation (DK), Distributed Design (DD), totally seven types within the LeNSin 2018. As is shown in the Figure 3, we can use the specific DE types icons combine the economic structure to develop and visualise more in-depth and detailed concepts of S.PSS&DE (more in section 3.3).

3.1.2 Configurations of Distributed Economies

Concerning the structure of the system, five main configurations for describing the S.PSS&DE offer model have been proposed and defined within LeNSin project, and visualised as a set of universal configurations in Figure 4.

1. Distributed Stand Alone. It refers (very) small-scale production units of goods (physical and/or knowledge-based ones) located by the end-users (that become the producers, i.e. prosumer) and can be suggested from household use to small business. Strength of such configurations include easy installation, low investment cost, little maintenance, high degree of flexibility and scalability (Rolland, 2011). 2. Distributed Local Network. Sharing various forms of resources and/or goods (physical and/or knowledge-based ones) among distributed production units at local level. 3. Decentralised Stand Alone. It refers to small-scale production units that deliver their goods (physical and/or knowledge-based ones) at or near the point of production, whether individuals, entrepreneurs or other organisations/institutions. Maintenance and operations are still relatively easy to manage (Rolland, 2011). 4. Decentralised Local Network. Sharing various forms of resources and/or goods (physical and/or knowledge-based ones) among distributed and/or decentralised production units at local level. 5. Centralised Connected. It refers to large-scale production units that control all essential activities and deliver their goods (physical and/or knowledge-based) via great distribution networks, to very many (often) far away customers, whether individuals, entrepreneurs or other organisations/institutions.

3.2. Common elements of SPSS&DE offer models

Based on the previous research work that identified elements of the system map (HiCS, LeNSes, LeNSin), the development and adaptation of these common elements to describe S.PSS applied to DE has been described below: Actors contain system solutions providers and target customers, including fifteen provider roles (private enterprise, product manufacturer, et al.) and eight customer roles that have been used in the system map frequently. The category of the products has been enriched and extend to the seven DE types (3D printer, water suction pump, purifier, microwave, laptop, application program, software, et al.). In the whole product life-cycle, services provided to the customers including financing, training, installation, maintenance, use optimization, repair, upgrade, and end-of-

life services. And what is paid by customers for what they gain in the system has been divided into pay-per-period (fixed cost), pay-per-time of access to solutions and pay-per-use/satisfaction unit according to the win-win potential model of S.PSS (Vezzoli et al., 2018), through the various modes of payment (mobile payments, scratch cards & energy credit codes, credit or cash transactions, et al.). These elements of actors, products, services, what is paid and payment modality all have been symbolised with an icon defined by the slogan in the Figure 5.



[Figure 3] DE types diagram [Figure 4] The DE configurations [Figure 5] Icons of S.PSS&DE offers

To clarify the transaction between actors in the system, it has four main types flows: the full, thick arrow indicates material flows (hardware, resource, natura etc.), the fine, square-dotted arrow indicates knowledge/information flows, the full, thick arrow with a diamond at its tip indicates labour performance flows, the fine, round-dotted arrow indicates financial flows. Usually using the dark grey colour to represent the core performance of the main stakeholders, the alternative performance, implementation or back office flows with light grey (Figure 6).



[Figure6] The flows legend [Figure 7] The Example of Grameen Shakti [Figure 8] The way to define the actors

3.3. Visualisation and Communication with the new stakeholder system map for S.PSS&DE

The new stakeholder system map for S.PSS&DE can represent S.PSS solutions in a particular DE satisfaction-system, and simply the understanding of interactions among the socio-economic actors (both primary and secondary stakeholders), in terms of flows of hardware, resource/natura, service, knowledge/information, Labour, and finance. With the standard graphical language, it can be shared and communicated in the whole design team or by different actors involved to support and facilitate the conversation and development of the design concepts.

From the example of Grameen Shakti (Figure 7) the company offers solar home systems with a service package to the low-income households living in rural isolated areas of Bangladesh by the S.PSS&DE offer models, it worth to highlighting the regularised visualisation rules of how to use the tool to represent S.PSS applied to DE:Actors. The system solution provider/s, which can include a single actor or a partnership of actors with a solid blue square around, is represented on the left-hand side of the map and characterised by dark violet colour with descriptive text, while the customer is always placed on the right-hand and illustrated by magenta colour. Ownership described with dashed square by the blue colour. Besides, it is essential to indicate the scale (centralised, decentralised, distributed) of actors and what type resources they provide/gain in the system for visualising S.PSS&DE(Figure.8).

Flows. The interaction flows are made up of arrows and descriptions including the text and corresponding icons, ordered with progression numbers and descriptions to facilitate the reading of the map. By convention, flows of material are placed in the top-middle part of the map to show the transactions between providers and customers, the payments are described in the bottom of the map, showing what the customers pay for and what modalities are used.

DE configuration. The DE configuration is made up of actors involved in the interactions of offer model and the arrows to indicate the transaction and resources type (physical and/or knowledge-based). The way to present the DE configuration has been shown in the Figure 9.

System boundary. From the template of the tool (Figure 10), the system boundary is the constraint of the worksheet, while the offer boundary i.e. “Main Stakeholder Boundary” is defined with a grey box on the central of the map to show the core actors performing the system. Secondary stakeholders which are involved in supporting the S.PSS solution but they are not directly involved in providing the offer to end-users can be placed outside the area.

The new Stakeholder System Map for S.PSS&DE tool (Figure 11) is available for a free download at www.lens-international.org. It can be used in the slideshow software (e.g. Microsoft PowerPoint), which allows users to modify and customise the elements of the systems. The time required to generate a stakeholder system map for S.PSS&DE is approximately 30 min. For more complex systems additional time may be required.

4. TESTING ACTIVITIES



[Figure 9] How to represent a DE specific configuration [Figure 10] The template [Figure 11] The new stakeholder System Map tool

The new Stakeholder System Map for S.PSS&DE has been empirically tested during the course of “System Design for Sustainability” of Politecnico di Milano in May 2018. The 40 international students from the design field were worked in 6 groups and focused on the topic of eating systems for Bovisa (campus of Politecnico di Milano), driven by the design methodology of S.PSS applied to DE. They were asked to visualise their concept models and further detail the stakeholders’ interactions through the new Stakeholder System Map tool. After that, the testing activities involved a discussion regarding potential applications of the tool. Feedbacks were collected through questionnaires and the results are discussed as follows (Table 1). The aim of the testing activities was to assess the comprehension and usability, the usefulness and impact of the new Stakeholder System Map for S.PSS&DE as a strategic design tool.

Tool: S.PSS&DE Stakeholder System Map	No answer	Not at all satisfied	Slightly satisfied	Moderately satisfied	Very satisfied	Completely satisfied
I.Comprehension& Usability of the tool	0%	0%	10%	30%	60%	0%
I.Usefulness& Impact of the tool	0%	0%	0%	10%	50%	40%

[Table 1] The participant’s evaluation on new Stakeholder System Map for S.PSS&DE

The students evaluated on new Stakeholder System Map for S.PSS&DE quite positively. 60% are very satisfied with the usage of the new system map, 90% participants can have a well understanding of the tool. The feedback of the comprehension and usability highlighted that the classification icons, flows and actors can help them design their concepts and clarify the interactions between different roles. As general comment, the specific tools for defining DE types and DE configurations are necessary that they can design and visualise S.PSS&DE models in a simple and effective way. Other feedback referred to the usage of the tool indicate that they have to think more how to use the tool correctly and the power point is not the best program for using this tool. For the satisfaction of the usefulness and impact, showing more positive results (40% completely satisfied and 50% very satisfied), almost all of feedback was related to: the willingness and interests to use the tool to visualise the concept in the future. In addition the comments explain that this tool as a standardised graphic language can reduce the difficulty of communication among team members in the design process. While some interesting points should be considered during the testing activities and field experience of the pilot course (details refer to the footnote 2,3,4): the customization rules of icons and configurations i.e. how to ensure the users of the tool to develop the customised icons and configurations efficiently and simply; improvements on the ways of presenting the roles and interactions e.g. the usage of less slogan text to achieve more higher readability; the development of the dedicated program for the system map tool to reach higher operability; the types involved in the DE will be further expanded and more icons (actors, products, services, et al.) and configurations should be studied and refined.

5. CONCLUSIONS AND FURTHER RESEARCH ACTIVITIES

This research aims at addressing the progression of the stakeholder system map as a representational tool can be adapted and experienced as the S.PSS&DE develop. The new Stakeholder System Map for S.PSS&DE encompasses the seven major DE types that can describe most concepts of DE models with the standardised icons, flows, configurations and specific rules in the S.PSS solution. The testing activities demonstrated that the new Stakeholder System Map for S.PSS&DE can be used to design and detail S.PSS solutions applied to DE effectively and easily. The feedback collected during the curricular and pilot course helped to clarify the needs for improvements of the tool and further testing activities with a wider range of design practitioners.

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LAMPS - 'DESIGNERLY WAYS' FOR SUSTAINABLE DISTRIBUTED ECONOMY

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ABSTRACT

With the growing importance of resonating products with human behaviour, the upcoming field of Design for Sustainability (DfS) is reorienting itself from a 'technical and product-centric focus towards more socio-technical systems' wherein people, their interactions and behaviour play a crucial role. Scholarships in DfS have introduced a multitude of frameworks for sustainability-orienting design such as Methodology for System Design for Sustainability, Circles of Sustainability and LEED. However, during our experience of teaching these methodologies to Design undergraduate students, we observed that the frameworks, often fell short in fostering a "designerly way" of thinking and doing amongst novice designers. They struggled to see open space within these guidelines to explore, experiment and tinker. Hence, we designed a method, LaMPS (Locally available Materials, Practices and Skills), which could be used as a precursor to the more system oriented DfS course and can be introduced to students during their 1st Design Methodology course at the undergraduate level. LaMPS integrates observational studies and material exploration and characterisation using the Material Driven Design method, and translation of the same into products. LaMPS stresses on identification and incorporation of local materials, local skills and local practices, the three keystones of Distributed Economy (DE), in the designed system. Hence it serves as an introduction to the DfS course in the lines of DE.

Key Words: Design for Sustainability, Distributed Economy, Designerly Ways, Design for Sustainability Toolkit

1. INTRODUCTION

Since the emergence of the environmental debate in the 60's, the definitions, role and scope of sustainability, sustainable development (SD) and Design for Sustainability (DfS) have evolved significantly. DfS has strategically moved from approaches such as intervention after process-caused damages and intervention in processes to intervention in products and services and intervention in consumption patterns (C. Vezzoli et al., 2014). The role of a designer in DfS is now to design with holistic life cycle perspectives and with an eye on the socio-cultural dimension. This is in contrast to the earlier focus on mere end-of pipe fixes or product life cycle centred design (Charter & Tischner, 2001; Karlsson & Luttrupp, 2006; Rocchi, 2005; Ryan & Fleming, 2004; C. A. Vezzoli & Manzini, 2008). But, with the DfS approaches largely shifting from a 'technical and product-centric focus towards more socio-technical systems' wherein people, their interactions and behaviour play the crucial role (Ceschin & Gaziulusoy, 2016), its methodologies and frameworks have become increasingly complex, involving multitudes of cross-disciplinary actors, stakeholders with varied interests and sustainability-orienting design parameters. Currently we have a diverse set of frameworks from various disciplines, geographies and economies, each customised to its own unique sustainability challenge. This paper presents our experiments with DfS pedagogy with sophomore Design undergraduate students. The research questions for the paper are: (1) How to teach sophomore Design students a Design Methodology wherein Design is looked as a dimension within the context of sustainability? (2) How to teach product design by embracing 'local materials, practices and skills' as the starting point?; (3) How to teach DfS in a 'designerly way', i.e., to design by dwelling in an immersive mode where engagement, contemplation, aesthetic desires, emotions and inventive thinking take predominance?

1.1. Sustainability and Distributed Economy

As a strategy for sustainable development, Johansson et. al (2005) (Johansson, Kisch, & Mirata, 2005) introduced the concept of Distributed Economies (DE) as an antithetic response to the highly unsustainable large-scale, centralized modes of production. DE proposes that a certain share of production can be conducted locally or regionally in flexible, small-scale production systems which can respond to local market needs better, can reflect the local socio-cultural and environmental milieu better and can be synergistically connected to each other through the flow of non-material assets such as information and know-how, bring in better distribution in socio-economic power and can have higher resilience to uncertainties and unsustainabilities (Johansson et al., 2005; Mirata & Emtairah, 2005; Mirata, Nilsson, & Kuisma, 2005). In the Indian context, we observe that many of our economic activities (handloom industry, craft industry, medium and small scale industries) are closely related to the concept of DE. But, on the Design pedagogy front, we lack in appropriate design methods. (Johansson et al., 2005) With its focus on local modes of production, the DE approach lays out 3 key elements for the design process: local materials, practices and skills. In this paper, we investigate, how designers can design locally rooted product by embracing these 3 elements as the starting point.

1.2. Pedagogy for Design for Sustainability

In implementing sustainability in Design school curricula, there are two approaches (Fletcher & Dewberry, 2002): (1) Sustainability looked upon as one of the criteria in current design activities (sustainability in the design context), and (2) Design looked as a dimension of sustainability framework (design in the sustainability context). In the Design curricula at IIT Guwahati, we have an elective course on System Design for Sustainability (S.DfS) which is offered to both undergraduate and post-graduate students in their final year. The course follows the first approach (Banerjee, Upadhyay, & Punekar, 2019). While conducting this course we identified some drawbacks and need for pedagogic modifications (for in depth analysis, see (Banerjee et al., 2019)). For instance, students looked at sustainability as one of the criteria in their design activities. A better approach would be sustainability as the context for designing. The course was introduced late in their curricula and the students opined that the introduction of the concepts should be in the very first Design Methodology course for better exploration throughout their study period. The existing S.DfS methodologies and frameworks often fell short in elucidating amongst students the "designerly way" to approach sustainability due to the large number of interacting parameters and stakeholders to be considered. The students, being novice designers, used them more 'mechanically' by picking up each parameter, giving them context-appropriate weightage and ideating on them. They missed the opportunity to think in an imaginative and inventive manner. Thus, we saw a need for introducing ways to elucidate amongst students "designerly ways (Cross, 2011)" of thinking, i.e., designing by dwelling in an immersive mode where engagement, contemplation, aesthetic desires, emotions and inventive thinking takes predominance over prescribed guidelines. The students' proposed solutions lacked grounded-ness in the context due to a superficial understanding of the field. This issue has been raised by many other researchers who have suggested more in-depth user research to understand the role of socio-cultural factors in users accepting and adopting a sustainable solution or behaviour (example: (Mylan, 2015; Piscicelli, Cooper, & Fisher, 2015)). The course has a system design approach and students found it conceptually difficult to deal with the complexities. Also, covering in a single course the concepts, doing adequate ground research and coming up with design solutions was very difficult and hence we felt the need to restructure the course.

1.3. About the Sophomore Students

The students participating in the course were sophomores in the Design undergraduate program at IIT Guwahati. This was the first course where-in they learned about Design Methodology. Prior to this course, they had gone through courses in Basic Engineering (Mechanical, Electronics, Electrical, Computer Science) and Basic Design (Representation Techniques, Workshop Techniques, Ergonomics). Hence they were equipped with the knowledge and skills for making a product but were not aware of the creative design process. The course was divided into 3 week modules and LaMPS was introduced in the 2nd week of the course as a week-long workshop.

2. DEVELOPING THE PEDAGOGY

Various researchers have worked on identifying the key competences to be developed for Education for Sustainable Development (ESD) (Lozano, Merrill, Sammalisto, Ceulemans, & Lozano, 2017). ESD for DE will need the following competences: (I) Systems thinking (II) Empathy and Change of Perspective (III) Personal involvement and (IV) Tolerance for Ambiguity. We did not introduce the students to “Sustainability” or “System Design” per se as a concept through theoretical lecturing but rather built in the methodology components which will direct them towards these. To foster a wholesome, empathetic systems view (I & II), we divided the LaMPS method into 4 stages: Understand; Observe; Explore; Conceptualise. Figure 1 summarises the Design Methodology presented to the students and the next sub-sections presents the LaMPS methodology.

2.1. LaMPS - Locally available Materials, Practices and Skills

The 3 key elements of DE which bring in sustainability benefits to it are using local materials and manufacturing, practices and skills to produce for local needs. LaMPS guides the students to identify locally available materials. The study of local practices and skills helps in identification of intervention areas and local consumption patterns. It also helps in understanding what manufacturing skills or prosumption behavior the consumers are used to and hence students are able to learn designing by being grounded in the context.

2.2. Stage 1: Understand

Since the course is meant for sophomore Design students, we found it useful to broadly define the intervention area rather than leaving the project completely open-ended by leaving it to the students to identify areas of intervention. We asked the students to go into the local rural communities and study their context and constraints with water (II). This is a high rainfall region with an average of 1,722 mm of annual rainfall and is located on the banks of river Brahmaputra which is one of the major rivers of Asia. It has abundance of water but potable water is a challenge. Excess water due to long periods of flooding and disposing off wastes into the river are some other challenges.

2.3. Stage 2: Observe

The students here begin by understanding the context: a.) Who is the end user b.) What is the problem area and c.) What are the constraints of the system? This becomes the primal definition of the problem space. Although the DfS process revolves chiefly around the tangible, we contemplated on the intangible (practices and skills) in this phase. In order to meet the three key elements of DE, local materials, practices and skills, we made them as the starting points for students to observe. This phase helped us to secure high degree of personal involvement (III) from the students.

2.4. Stage 3: Explore

Here we used Cross's “designerly ways” (Cross, 2011) of knowing, thinking and acting which ‘lie in the techniques of the artificial’. Modelling, pattern-formation and synthesis form essential components in this ‘culture’ of design in which abstract requirements are translated into tangible design solutions. The students were encouraged to experiment, imagine, draw parallels and synthesize in a creative space. The students understood the materials using the open-ended Material Driven Design (MDD) process (Karana, Barati, Rognoli, Der Laan, & Zeeuw, 2015). Its uniqueness lies in its ability to systematically explore both physical and experiential traits of a material. Materials can be experienced at 4 levels: sensorial, interpretive, affective and performative (Giaccardi & Karana, 2015). This phase helped us to introduce students to the ambiguity which is inherent in any design process and slowly they started developing certain degree of tolerance to ambiguity (IV) and gained experience in steering through it during the next phase. Of the 4 steps of MDD, we used only the first step that provides a synthetic space to experimentally explore a material and its possibilities. We gave the students locally available raw materials and wastes. They tinkered with the materials, trying to understand its technical properties and the technical and experiential properties obtained by creating composites. They also conducted a material benchmarking by studying existing literature on the materials.

2.5. Stage 4: Conceptualise

Here the designer reflects on the context, picks one material (composite) sample, integrates it with local skills and practices and creates an intervention vision and a product solution, prototypes and tests it with the actual users. This goes on as an iterative process. The key questions in this stage are: (1) What should materials do?; (2) What practices to embed?; (3) What skills can be leveraged?. This phase leveraged systems thinking (I) and empathetic thinking (II).



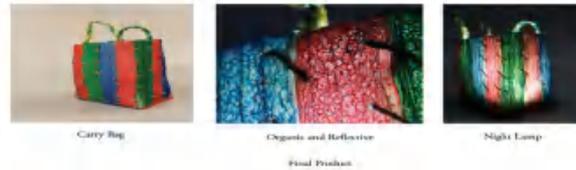
[Figure 1] Overview of the Design Methodology provided to the students



[Figure 2] A local Restaurant Owner using Cleansy



[Figure 3] Frugal thermos made with insulating materials - saw dust and coffee powder



[Figure 4] Bag cum night lamp made of waste styrofoam and PE bags

3. THE JOURNEY DESCRIBED IN THE STUDENTS WORDS

In this section we present the experience of 3 groups of students. The intervention vision was formulated towards the end of stage 3 and we are indexing the students' learning journeys in the sub-sections below with the vision themes.

3.1. Vision - Cleansy (Aaram se Safai) by Purvish and Vidushi

Cleansy (CLEan + Easy), a base of pyramid product, helps in water filtration by making it a fun activity and can promote water hygiene. A quick ethnographic study of the households helped us to understand the problems related to water sanitation and hygiene. The next stage demanded us to not think about the problems and insights gathered previously. A tinkering session was done in the workshop to explore material properties by combining base materials, fiber and binding materials. Initial exploration was random and materials were mixed to see what happens. Then we researched on properties of the materials and ideated to understand what can be mixed. Noting down the insights and keeping it aside helped us not to think about solution and did not hinder the tinkering process. Next we explored the technical and experiential characteristics of the samples to see what peculiar experience can be created out of it. Samples were tested and some of their properties were taken from web. We selected 3 test samples and conducted studies to understand the experience related to those samples. Sample 1 was created by sticking coffee powder on jute to make strands of coffee. Sample 2 was rice grains stuck on jute rope using fevicol. Sample 3 was spiral jute rope burnt using hot gun. 3 sets of interviews for each sample were conducted and participant responses were noted. Participants reported that rubbing rice felt good on palm, coffee had good smell and burnt jute was nostalgic. We also observed how the participants played with the samples given to them. All 3 participants rubbed the rice rope on their palm. This was an interesting observation and helped us create a material experience vision, ie., "Aaram se Safai" (cleanliness with ease). We were curious about how can we map this particular practice into our product which will promote water hygiene in rural areas and encourage its purification by making it a fun activity. We used a framework to map practices into our product. We then utilized the framework provided to us called 'Materials Experience Framework' to create a concept for the product. We mapped the practices, material and people spheres of the collected data to create product vision. We decided to make the process of water purification easy and a relaxing experience through our product Cleansy (from clean+easy). The product designed uses bamboo, rice, glue made with wheat and a cloth bag containing alum, all of which are locally available. We used alum to help in the purification of water. The product can make river water potable. Also anyone interested can make this product at home and use it. Figure 2 shows a local restaurant owner trying our product. To read about our full journey <https://goo.gl/2m63YB>.

3.2. Vision - Connecting Communities by Ankit

An unstructured interview revealed that people used the water from the river for general purpose while clean drinking water was available from a nearby police station for 1 hour daily and an NGO facilitated drinking water supply in a nearby primary school. Among the materials provided, sawdust, bamboo dust, plastic bottles, jute rope were native to the place I visited and coffee is what I drink every day. Tinkering with the available materials, we combined the materials like sawdust and coffee ground with glue, coir ropes covered with coffee grounds etc. and conducted a technical characterizations of the composites developed. A list of adjectives were given, related to emotions it triggered and meanings they infer. I interviewed 5 people for each of the three sample materials. They were asked very specific questions regarding the type of emotions and meanings these materials could drive. From the field visit, I was able to enlist problems, I became aware of their frugal way of life. The final sample material was composed of materials that connected the communities of the carpenter, rag picker and handicraft workers. The idea was to use

the insulating property of the material along with deceiving look. An affordable thermos, with the essence of coffee. I wanted to drive the idea of water hygiene for newborn babies, they need warm water and storing cold water for the farmers who work under sun. The final product is presented in Figure 3 and read the full journey at: <https://goo.gl/r7J5WH>.

3.3. Vision - Sasta (low cost) Sundar (beautiful) Tikau (long lasting) Carry Bag by Simran and Suneet

We went onto field visits during the rainy season in the month of September, 2017 to capture the practices performed by the locals of the nearby village of IIT Guwahati. We found one farmer carrying the grass on his head, few laborers carrying sand in a container for the construction of a house and a woman carrying her child on one shoulder and his school bag on another. We also stopped by a house where we saw the women from the village were gathered to have a traditional ceremony. They were singing in harmony to worship the god for prosperity. This visit to the field gave us a new experience of group activities and also the habit of carrying. We chose 5 materials for the tinkering process: Styrofoam(main material), Plastic Carry Bag, Water Bottle, Jute Thread, Rice, Coffee Waste. The first natural thing we tried was to squeeze it hard using the drilling machine table. We got a very foul smell by burning the Styrofoam and the material obtained looked like an ash. We then put the plastic on top of the Styrofoam and used a hot air gun on it at low heat levels. Both the Styrofoam and the plastic melted and plastic acted as color coated layer. Similarly we tried other materials such as coffee wastes and jute threads along with Fevicol as an adhesive. Further we proceeded for the technical testing of the samples developed. Then we tried to develop different products out of it using the attractive organic and reflective characteristics of the sample as shown in figure 4 below. The final product is a carry bag which can also be used as a night lamp. To read our full journey, visit <https://goo.gl/ur5YGd>.

4. DISCUSSION

The LaMPS method provided a practical guide to the student designers in alternating between divergent observation, experimentation and convergent analysis to design locally-embedded products. The tinkering process placed them considerably outside of their comfort zones where process driven design methods have molded them to think linearly. They sought guidance on ways to initiate the tinkering process and expressed inhibition in experimenting freely with the materials. They were not habituated with the brief suspension from structure and linear thinking and immersive behavior in playfulness and uninhibited imagination. However, on being urged to think in an unrestrained fashion and to anticipate experimental serendipity and incidental revelations, the students gradually started opening up and working in a fluid space. They started experiencing the materials with an eye for new learning and discovery. They creatively thought of new experiments that could be conducted with the material and drawing analogies between objects that they had observed before and the material samples generated. Stepping outside the classroom into the field was especially challenging for the students. But being equipped with the techniques beforehand aided them in smoothly conducting the task. But an in-depth understanding of the practices and their interconnections in the behavioral and social setting, requires a larger time frame and experience. The students expressed that it was a good learning experience for them as they had no prior exposure on how to study 'how users experience something'. However, all the student teams expressed that a 7-day time frame was critically short for them to delve deep into every stage. We also observed that the students tailored the sequence of the steps slightly to suit their needs. The process of ideation, for instance started at different stages for each team. They revisited the field if they felt the need and put varying amount of stress on different stages of the process, indicating that they desired some amount of flexibility in the process. The students came up with innovative and locally grounded solutions and also later extrapolated their learnings to other projects (this batch of students are now in their 4th year of study).

5. FUTURE RESEARCH SCOPE

In Design for DE, local materials, practices and skills are variables that present an array of possibilities for a designer. While LaMPS focuses heavily on material exploration, a structured way in which data on local practices can be analysed and incorporated into different aspects of a product for embedding it in their socio-cultural and behavioural patterns will further enhance it. In future, we will explore how designers can be aided to systematically study different kinds of practices in a community, analyse the data and map them selectively to product idea. Also, LaMPS, as a whole, will be further developed and tested in the context of design for DE for professional designers as well.

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THE THIRD SECTOR AS A VECTOR TO FOSTER DISTRIBUTED DESIGN AND DISTRIBUTED ECONOMY INITIATIVES: A CASE STUDY OF INCLUSIVE, ETHICAL AND SUSTAINABLE SOCIAL DEVELOPMENT IN EMERGING ECONOMIES

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ABSTRACT

Access to water and electricity is far from being a reality in some Brazilian regions. For instance, in the Northeast region, one of the poorest in the country, many communities still live in the dark and distant from sources of drinking water, which impacts negatively in their development and wellbeing. In this scenario, government actions are not always sufficient or efficient to meet the population demands. In order to reverse this situation, many OSCIP - Civil Society Organization of Public Interest, promote social quality life inclusion and improvement of those communities through finding, deploying and implementing water and energy solutions at short, medium and long term, with the aid of national and international funds. This article presents actions developed in the last 20 years by Instituto Eco Engenho, an OSCIP that contributed effectively with simple and effective solutions for electricity and water supply, allowing the advancement of the digital inclusion and income generation for population living in remote areas at Semi-arid region.

Key Words: Distributed Design; Distributed Energy, Third Sector, Emerging Countries

1. INTRODUCTION

One major issue attached to the transition towards a sustainable society is that of improving social equity and cohesion in low and middle-income contexts, while empowering locally-based enterprises and initiatives, for an environmentally sustainable re-globalisation process characterised by a democratisation of access to resources, goods and services (LeNSin, 2016).

Design is a powerful tool to generate alternatives and promote deep social changes. Their various approaches allow you to deal from specific problems to wicked problems, such as those that maintains the unsustainability of human interfaces with their equal and with the environment. The constant process of enlarging the scope of design action, walk with the understanding and search for partnerships with other areas of the theoretical-practical knowledge and the diversity of social actors capable of contributed to the solution of current problems and restrict its future effects. Distributed Economy is one of the design recently investigate fields (Johansson et al, 2005).

The model Distributed Economy promotes small-scale, flexible networks of local socioeconomic actors, using local resources according to local needs, in the spirit of sustainable development (Johansson et al, 2005). According to the author, the centralized model and massive production presents, among other negative effects, the increase of the vulnerability and inflexibility of companies, the greater amount of environmental problems, distancing between manufacturer and consumer and mental and cultural impoverishment resulting from a centralized creation of values. In the Distributed Economy “the global is a ‘network of locations’ that is, a mesh of local systems connected, whose small scale makes it understandable and controllable by individuals and communities” (Manzini, 2010 p.8). The ‘local networks’ model appears in the design literature under synonyms such as: Regional Economy (Johansson et al, 2005), Territory Design (Krucken, 2009; Jègou, 2014) and SLOC - Small, Local, Open and Connected (Manzini, 2010). In all cases benefits of decentralization are assumed, both in relation to environmental issues as the equitable distribution of income. In this sense, Distributed Economy appears as a viable alternative to the centralized economy system (Ceschin, 2015). The following section presents the basic guidelines of the Distributed Economy design and distributed.

2. DISTRIBUTED: ECONOMY AND DESIGN

The format proposed by the Distributed Economy can be a promising path for sustainable development by simultaneously promoting economic growth, respect for the limits of nature and social ethics. According to Manzini (2010 p.8), the mesh of local systems connected in small scale, becomes understandable and controllable by individuals and communities. This is because infrastructure and critical systems are close to resources and demand / utilization points, as well as because the users themselves are producers, whether individuals, small enterprises or local communities (Manzini, 2015; LeNSin, 2016). By its structure and composition, the DE consents in the establishment of new relations between organizational centres and peripheries, allowing more autonomy and the creation of products and customized services, where and when needed (Manzini, 2015; Lepre & Perez, in press).

The DE model, therefore, subverts the status quo of the current production-consumption system, opening space for evolutions and revolutions at societies relations with the environment, economy and in their own social relations. This indicates that the adoption of the Distributed Economy model, through inclusive planning and openness for feedback evaluation, is efficient and effective as a platform for solutions to the complex problems that hamper the required balance of Sustainable Development. The adoption of distributed systems is therefore intimately linked to social issues, and it is necessary to consider the social fabric in which such a system will be implemented, since this implementation requires systemic change in socio-technical and cultural terms (Lepre; Perez, in press). Some examples that can be cited are the need to establish new forms of engagement with users and new work and employment emerging relationships (Manzini, 2015).

The Distributed Economy, therefore, implies the construction of new social relations, allowing the active participation of the people from a determined community in issues that are pertinent to them. According to LeNSin (2016), Distributed Economies (DE) offers communities and users direct access to resources, allowing them to participate in the extraction, production, distribution and use processes as well as increasing the responsibility for the alternatives used at the end of the life. This represents an opportunity for real inclusion and promote the locally-based socio-ethical benefits: empower individuals and local communities; democratize the access to resources, reduce poverty and inequality.

In addition, distributed-type solutions that emerge from local demands, to address local issues, with local resources, within local socio-economic-environmental and cultural perspectives, can be expected to contribute to reduce the imposition and transfer of exogenous solutions, often incompatible with local reality. From this point of view, it is correct to assert that the DE groups at the same model, the provision of sustainable benefits such as: a) social equity - democratizing the access to goods and services, increasing participation and training for local economies and communities; b) economic development - reducing transportation, interposing and crossing, increasing reliability; c) environmental relations - with efficiency gains, reduced transport, reduced emissions and etc (LeNSin, 2016).

Because it is a promising approach in breaking the paradigms of sustainability, design has been investigating the application from existing solutions that allow it to infer its effectiveness and efficiency. The actions found are classified as (Ibidem): Distributed Renewable Energy (DRE), e.g. mini-grid small scale renewable energy generation

plant; Distributed production of (hardware) Products (DP), e.g. 3-D Printing, Arduino; Distributed production of Software (DS), e.g. Linux; Distributed production of Information/knowledge (DI), e.g. Wikipedia, LeNS; Distributed Design (DD), e.g. open innovation/design and crowd-source/design.

According to LeNSin (2016) the definition of Distributed Design can be understood as “an open design project where small-scale design unit (e.g. one person/computer), whether individuals, small businesses and/or local communities, are connected to others. If the small-scale production units are also connected to other DE (for example, to share the energy surplus), they become a Local DE Network, which may in turn relate to nearby similar networks.” By this definition, it is understood that Distributed Design is, intrinsically, a systemic approach and, as such, according to Tamborrini (2017, p.49), it should adopt systemic approaches to innovation, among which: identifying and activating potentialities in a territory for the transformation of existing resources - such as heritage, infrastructure, economic aspects, human, cognitive and cultural characteristics - into a broad system of relationships. Thus, the action triggers a continuous and constructive process of collaboration that can provide a complete view of the investigated phenomena complexity, creating a common language for the different knowledge gathered in the innovative solution of the problem (Ibidem, p.53).

In emerging, broad and plural countries, such as Brazil, which require approaches that can generate solutions for local and highly differentiated demands, the DE model and the DD can bring benefits by generating, promoting and maintaining flexible, inclusive and self-regulatory structures, long-term, within the win-win perspective, considered the ideal for socio-ethical sustainable development. In this scenario, government actions are not always sufficient or efficient enough to meet the population demands.

On contributing to the evolution of this knowledge to be applied in low and middle-income contexts, the next section describes the work of OSCIP Eco-Engenho, which in the last 20 years used distributed and systemic economy model to improve the quality of life for population in areas of extreme poverty at northeastern Brazil. Considering this experience, it is possible to guide distributed design actions applied to high complexity and vulnerability situations and problems.

3. NORTHEAST BRAZIL - A VULNERABLE AND COMPLEX REGION

Brazil is a plural country for its vast territory and its problems. While most southern and southeastern regions benefit from good infrastructure, economic and social development, the northern and northeastern regions suffer from high inequality, income concentration and misery. At Northeast region, many communities still live without light and distant from sources of drinking water, which negatively impacts their development and wellbeing. The state of Alagoas is the second smallest in area in the country and at about 22.5% is considered affected by desertification (IBGE, 2018), meaning reduction or loss of economic and biological productivity of dry ecosystems. Although the state has improved its position in the states ranking of competitiveness (2018), the social sustainability pillar points to the extreme vulnerability of most of its population. Between the most relevant issues, there are the access to water, food and energy, which are basic living conditions. In this scenario, government actions are not always sufficient neither efficient to meet the population demands.

In order to reverse this situation, many OSCIP-Civil Society Organization of Public Interest, promotes social inclusion and quality improvement of life for those communities through finding, deploying and implementing water and energy solutions in short, medium and long terms, with the aid of national and international funds. “OSCIP is a title provided by the Ministry of Justice in Brazil, whose purpose is to facilitate the emergence of partnerships and agreements with all levels of government and public agencies (federal, state and municipal) and allows donations made by companies can be discounted in the income tax. (Xavier, 2008, p.168)

In complex and unequal societies, such as the Brazilian one, where public power actions are essential but insufficient to promote social development and reduce disparities, OSCIP is a vehicle that allows the public power to share with civil society the task of supervising the flow of public resources, through partnerships between civil society organization and public power, dividing and allowing the disposal of public resources and also the administrative burden and accountability.

Not every civil association is framed as OSCIP. To be considered legally an OSCIP, the entity must be linked to: social assistance promotion; culture, defense and conservation of historical and artistic heritage; free education and free health; promotion of food and nutritional security; defense, preservation, conservation of the environment and promotion on sustainable development; volunteering promotion; nonprofit experimentation of new socio-productive models and alternative systems of production, trade, employment and credit; established rights promotion, construction of new rights and free legal advice of additional interest; promotion of ethics, peace, citizenship, human rights, democracy and other universal values; studies and research, development of alternative technologies, production and dissemination of information and technical and scientific knowledge related to the activities mentioned above. Thus, as suggested by De Sampaio et al. (2018), the promotion of these OSCIP's categories generate concrete interfaces between complex problems related, amid others, to the Millennium Development Goals and the human and financial resources to develop, offer and manage possible solutions, complementing the actions of the state, supplying its restrictions and promoting actions in places where it operates. These non-governmental organizations from the third sector accept the challenge and responsibility to act in the name and in the public interest for

complex causes such as social and environmental, which require, among other things, lasting involvement, closeness and constant collaboration.

3.1 Distributed Energy – Case OSCIP Eco-Engenho

Electric energy in Brazil during the last century, has been produced centrally or decentralized in large plants, whose main matrix is water strength. This system, although efficient, is fragile and does not meet the demands of the whole national territory, due to the restrictions, mainly, in the cost of implementing the necessary equipment. Thus, the investment in smaller solutions, with local and distributed generation, respecting the matrix available in each territory and its socio-economic-environmental specificities, are presented as a plausible solution.

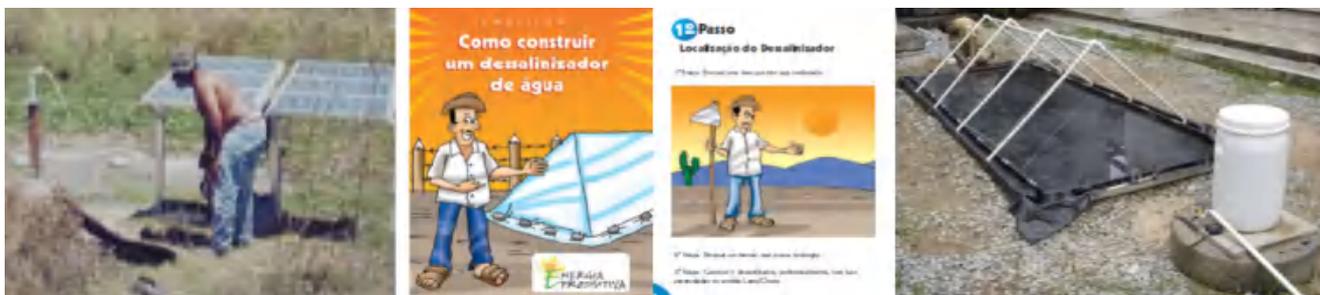
The private generation of electric energy has been adopted by several society sectors as an alternative to reduce, at the same time, the overload of the official system and the costs of this input. In this context, wind generation, biomass and solar energy have been explored. The latter with great capacity for decentralization due to the technology employed. The Sole Matrix has been adopted to promote sustainable and socio-ethical development by serving populations outside conventional energy distribution networks, representing a real social revolution for those who are not served by the conventional system (Nascimento, 2017). A success case to illustrate this transformation can be found in the backlands of Alagoas, which, despite having the hydroelectric power plants of the São Francisco and Xingó Rivers in their territory, can not supply electricity from these semi-arid region communities (Santos, 2002).

The Eco-Engenho Institute, OSCIP based in Maceió, in partnership with Banco do Nordeste, has established the “Luz do Sol” program, which provides a credit line to finance small entrepreneurs who develop solar home systems businesses in small villages. The user must pay service fee to the entrepreneurs. Around 2,700 systems were installed, since 1992, under the program by 90 microentrepreneurs, benefiting 13,500 people (B-REED, 2005). The program works in the form of Sustainable Product-Service System - S.PSS for Distributed Economies, involving the training of local microentrepreneurs offering the product (photovoltaic panels and electrical installation kits) and technical assistance service. It allows them to maintain close contact with consumers, favoring the feedbacks (Figure 1). The Luz do Sol Project exists since 1996 and its success has been deployed in other programs and stimulated local development (B-REED, 2005). The installation of photovoltaic energy kits in 336 schools, with the Project Electrification of Schools was the starting point for the Digital Inclusion Project that serves rural schools (IEE, 2017). The introduction of electric power made possible to approach another serious problem inside Alagoas: the chronic lack of water. In this scenario, Eco Engenho works with the H2Sol Project (IEE, 2017), which uses photovoltaic energy to pump water from the subsoil and desalinizes it, providing potable water to the population.



[Figure 1] H2Sun Project. (Font: BB, 2009)

The desalter device design (Figure 2) was created within the guidelines of the distributed design, using low cost raw material and facilitated access to the site. Its construction, which requires the participation of the user allowing interferences, adaptations and feedbacks to the IEE, is guided by manual in the form of a primer, using language appropriate to the target audience, with drawings and few written sentences, as shown in Figure 6.



[Figure 2] Desalter Project and solution. (Font: IEE, 2018)

Access to water sources, in addition to improving their quality of life, has positively interfered with the structure and has allowed residents to organize themselves into cooperatives within the spirit of the distributed economy for planting, processing and marketing of food products. The projects “Aroeira” and “Pimentas da Tapera” (IEE, 2017), as shown in Figure 3, are the results of these actions, both involving the application of the Distributed Economy concept for local production and taking advantage of local resources, respecting the environment and involving society as producer and manager, promoting the socio-ethical development.



[Figure 3] Pimenta da Tapera Project. (Font: IIE, 2018)

The Pimenta da Tapera project is pointed to women, aimed at social inclusion and the reduction of gender inequality, which is very strong in the location. The choice of pepper (pimenta) as a source of income is, according to IEE, the understanding that the product, within that specific reality, could not be the same as subsistence, because extreme poverty would cause a large volume of domestic consumption making it difficult to sell surplus. With this, the author tried to avoid both the consumption of the production by the community itself and the replication of productions of neighboring communities, generating exclusive products that at the same time meet the demands of the region. Pepper blends were created expanding the variety of products and marketing possibilities. The choice of packaging was made in a participatory manner, as well as the design of the labels, which carry some women images, generating identity, empowerment and symbolic belonging to their place of origin.

The peppers produced by the community of São José da Tapera are made directly in grocery chains, restaurants, hotels and souvenir shops, mainly in the capital, Maceió, and have enabled effective socioeconomic growth, as well as reducing desertification processes inside Alagoas state. The expansion of the distributed cooperation network occurs with the union of merchants and buyers, in complementary activities and a collective construction of sustainable and equitable values. In addition, it has strengthened the local culture and avoided exodus to the larger cities, which tends to lead to marginalization and all kinds of exclusion.

4. CONCLUSION

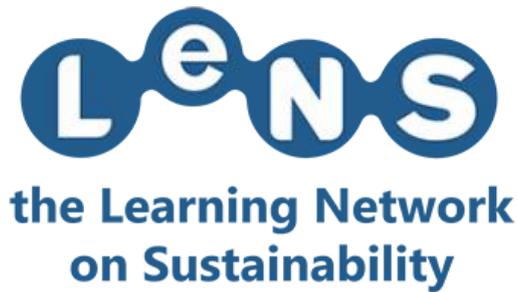
This paper presented the Distributed Economics-DE and Distributed Design-DD models as effective systemic approaches to solving problems caused by the centralized economic model, among which are those that maintain the sustainability paradigm. In order to illustrate its potential, the systemic actions developed over the last 20 years by the Eco Engenho Institute was presented, which, through Distributed Economics and Design, has cascade generated simple and efficient solutions for access to electricity and drinking water in communities of remote and neglected areas of the Brazilian backwoods. In the light of the theory and from the assessment of the case, it is concluded that: distributed models are valid to promote the socioeconomic development of vulnerable regions; the use of clean technologies, based on resources of the territory, are effective in solving local demands when they can not be contemplated by conventional and centralized forms; that OSCIP's participation in the process of social inclusion is fundamental in emerging and plural countries, such as Brazil, in which government actions and traditional models do not address multiple regional realities and singularities; that DE and DD models promote the creation of flexible and dynamic local networks, which make communities more resilient; that in situations of extreme resource constraints (tangible and intangible), actions coordinated systemically in the form of DE and DD and aligned with the local and with territory, have a high probability of fomenting income generation, improving the quality of life and promoting income generation; that the solution of highly complex problems, such as those faced by the Brazilian semi-arid region, requires systemic projects in the short, medium and long term and that OSCIP can represent a bridge between local needs and other spheres interested in solving problems. In this way, it is concluded, finally, that the Third Sector is a relevant vector to foster Distributed Design and Distributed Economy initiatives, addressing ethical and sustainable social development in emerging economies.

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‘SHKEN’ NATURALLY YOURS – SOCIAL DIMENSIONS OF SUSTAINING RURAL DISTRIBUTED BAMBOO CRAFT ENTERPRISES OF NORTH EAST INDIA

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ABSTRACT

The paper presents a model of a sustainable distributed model of a bamboo craft based enterprise through Design intervention. It is based on a human centric approach of wellbeing and economic growth of the local craft community of Syntein village in Meghalaya by a strategic intervention of design and development, production optimization and enterprise modeling of contemporary bamboo products that meet life style aspirations for urban users.

Decentralized and distributed centers of production of home-based enterprises are brought under a unique brand identity that tap into the potential of diverse craft and handloom traditions unique to the region.

The proposed model offers potential of expansion across other handicraft and handloom traditions that are reflected across India.

Key Words: Rural Enterprise, Sustainable Craft Development, Community Wellbeing

INTRODUCTION

As a country committed to sustainable development, the span of these two decades brings the development story of India at cross roads for reflection and reassessment. Vision paper 'India 2020' (1) outlined by Technology Information, Forecasting and Assessment Council – TIFAC, had envisioned policy frameworks that the government of India will aim to achieve the following goals viz. reducing the rural – urban divide; equitable distribution and access to energy and water; working of industry, agriculture and the service sector in symphony; access to education for all; making India an attractive destination for talented scholars, scientist and investors; access to health care for all; eradication of poverty and illiteracy; prosperity, security and good health for all through a path of sustainable growth.

At this stage, India has certainly drawn visible global attention in the steady development of its economy as seen in its Infrastructure development, industrial growth in Manufacturing, Information Technology and the Service sector. Urbanization has also increased and so with it a large middle class. However, these overall developments across geographical regions have been unevenly distributed. Will the development be economically, environmentally and socio-ethically sustainable is still open to debate? Sectors like Agriculture, the Small and Medium industries are in distress and are reflected in increased trend in unemployment and migration of people from rural areas to urban areas.

This paper attempts to focus on sustainable development of the handicraft sector in the northeastern regional (NER) states in India. The North East Region (NER) of India, relatively less industrially developed, covers the eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The region is rich in natural resources. Forest cover in NER constitutes 65% of its geographical area as compared to the nation forest cover of 21% (FSI 2015). The region has a population of 45.5 million with a relatively low density of 174 individuals per km² (NECS 2015). NER has more than 200 tribes and tribal population constitutes about one fourth of the population. Around 82% of the population from the region lives in rural areas. This is higher than the country's average of 69%, which makes rural area a focus of development. NER lags behind the country on various development parameters especially in infrastructure, industrialization and employment opportunities (KPMG and FICCI 2015).

Considering that the entire northeastern region falls in the seismic zone V, earthquakes, floods and other natural disasters are recurring phenomena in the region. To combat climate change, bamboo is a core development resource that provides a wealth of practical solutions to reduce the negative effects that changing climate patterns have on millions of rural communities in the northeast. Overall NER has been free of any social sanctions, stigmas or taboos imposed on women. Women in the NER enjoy better status in the society as compared to the women in the rest of the country. Agriculture and the Small and Cottage Industries sector that include handicrafts drive its economic activities.

In such a scenario, this paper looks at distributed economic model as a possible case for sustainable development of the handicraft sector engaged by a large section of skilled artisan communities in Northeastern region of India.

THEORETICAL BACKGROUND

Sustainable development (SD) is development, which meets the need of the present without compromising the ability of future generations to meet their needs (WCED; 1987). It is based on Economic Efficiency, Use of Local Resources and Local workforce, Conservation of Resources and Social Equity.

Similarly, the broader framework identified as the Millennium Development Goals (MDG) deal with poverty and hunger, universal primary education, gender equality and empowering of women, reduced child mortality and improved maternal health, combating HIV/AIDS, ensuring environmental sustainability, and developing global partnerships for development. It asserts that every individual has the right to dignity, freedom, equality, a basic standard of living that includes freedom from hunger and violence, and encourages tolerance and solidarity.

How can these be translated down the economic value chain in the context of the NER is a challenge.

As a case, this paper presents the intervention through design and enterprise in the bamboo craft sector in Meghalaya as the focus of study and analysis. Meghalaya is one of the NER states that is rich in bamboo as a natural resource. It generates job opportunities in the handicraft and construction sector and is a means for economic well-being in rural development. An earlier project reports on the concerted effort in developing the cane and bamboo (CAB) sector under a major UNDP supported project had failed to bring any significant transformation in the sector. The bamboo handicraft sector in the state continues to remain underdeveloped despite growing opportunities in the international markets for CAB products. The project followed a centralized top down approach with a focus on external expertise to bring about change towards development of the sector. Several government and non-government agencies were engaged on CAB project that aimed at "Promoting Livelihoods in North Eastern India: The Cane and Bamboo Networking Project" ran over two phases for a period of eight years between 2000 -2008. As per the UNDP report (2)

"...the project aimed at addressing a range of problems that plague NE India's bamboo and cane sector: (i) ineffective management of poverty; (ii) unsustainable natural resourced based livelihoods; (iii) the absence of a market driven approach; (iv) inadequate skills and design techniques; (v) inaccessibility to markets and services; (vi) inadequate models of socio-economic organization and entrepreneurship; and (vii) the capacity deficit in implementing bodies. By applying a value-chain approach and organizing beneficiaries into professional associations and groups to enhance industrial efficiency, marketing and trade, the proposed project aims to contribute to securing sustainable livelihood and employment generation for poor rural communities in the bamboo and cane sector."

The project outcome as reported by an external expert review committee, left much to be desired in the out-

come of the deliverables following this top down approach.

Critical reviews of the causes for this failure are very evident - Environment for enterprise face challenges of a very hilly and difficult terrain. Lack of access to market, low literacy levels, lack of awareness and exposure on the part of such remotely located communities being trained in ways and methods alien to their local skill sets; a lack of understanding of the community dynamics involving community beliefs, rituals and taboos; lack of exposure to enterprise, and business made these highly skilled craft communities vulnerable to bureaucratic corruption marked by lack of accountability.

RESEARCH METHOD

This paper outlines the outcome of a project undertaken by a team of designers from IIT Guwahati for the Government of Meghalaya. It outlines an alternative model of intervention - a distributed sustainable model for the cane and bamboo handicraft sector in the northeastern region, that may prove sustainable.

Following a participatory design method, it presents a case study on the development of a sustainable eco-system at the rural grass-root village level involving a 'bottom- up' approach with participation of state representatives, village headman, artisans, designers, private entrepreneur and retailer in developing a sustainable bamboo based rural enterprise.

A circular model involving the following 9 stages of development of the eco-system included



[Figure 1] Sustainable Entrepreneurship Model for Bamboo Craft

The range of product developed are shown below



[Figure 2] Range of bamboo product developed by the IIT Guwahati team and produced by the artisans of Syntein craft cluster, Meghalaya.

Pre-launch market test of these products among leading retail outlets has positive response reflected in inquiries of orders against the different products that the artisans are now trained and capable of producing. Restricted technology interventions have consciously been introduced in the form of molds that can be easily produced using local materials available in the local markets. Consistency and focus on quality of the products are thus achievable by the

local artisans. A data-base of the different artisans is now available for access directly by prospective buyers. Concept of community collectives has been discussed with participation of the village headman, and members of the self-help groups (SHG) formed in the village.

This enterprise model for it to be sustainable can still face challenges for its success due to local considerations. It becomes evident that MSDS has its leanings towards an organized industry oriented 'production centric' framework in its approach and outlook. The present MSDS framework may prove inadequate in applying to the handlooms and handicrafts sector that are distributed across remote locations across different geographical regions in India. These regional and localized units throw up challenges that require consideration of a complex web of socio-cultural; literacy levels; and livelihood factors as the basis for assessment and approach in the success of strategic sustainable interventions.

In the context of the bamboo crafts of Meghalaya, we may have to factor in the following aspects:

The local artisan communities belong to the Khasi tribal community. They follow a rich tradition of living in harmony with nature as reflected in the use of the forest produce in their environment. The forest in which they habitat is classified by the community into sacred forest, community forest and village forest. The forest produce as reflected in the classification can be used by the community in a regulated manner under norms set out by the community – an amazing sustainable concept laid down by the community in living in harmony with nature that needs emulation by modern urban communities.

The community is a very closely-knit community with the village headman playing a very influential role in community and collective decision making on all matters related to the village economy.

Artisan are highly skilled in bamboo-craft and have great potential for upscaling for larger market opportunities. The skills are imbibed as a family tradition and learnt from generations. This is both its strength and weakness. Their products are traditional and limited to local needs that remain unchanged but unique to the regional identity. Any new interventions through design that meet new market opportunities will be accepted only if it has acceptance in the community and can meet economic returns.

Literacy levels are low and restricted to the spoken local Khasi language. For the success of any enterprise, there is need for participation of an educated and committed work force interested in well-being and upliftment of the local community. Playing the role of a social activities can be the only acceptable model that builds upon winning the trust of the local community. This should be through a commitment to honesty, transparency matched with modern day business acumen that match modern day business. A 'bottoms-up', participatory and inclusive approach that is empathetic and trustworthy can ensure acceptance and result in success.

Craft activity is seasonal and is balanced with agricultural activities that the artisans engage in during part of the year. It becomes evident that the success of the enterprise rests on taking this seasonal nature of the activity into consideration. It is unlike an 'industrial business model' of production. Strategizing around seasonal introduction of new range of craft products that match this seasonal phenomenon of production may help the craft enterprise to succeed.

A model of payment against delivery can be the only way for such grass root craft enterprises to succeed, as the livelihood of the artisans is dependent on receiving payment against delivery. A system of introducing a revolving fund needs to be considered to ensure on the spot payment to the artisan against order, if such grass root interventions of enterprise hope to survive in the regular 'production centric' industrial models of business.

Considering these local factors mentioned above, it is suggested that context specific indices such as Inclusiveness index; Literacy index; Wellness index; Happiness index; Socio-political index; Cultural index specific to the region be defined and factored in the assessment of sustainable distributed initiatives. Such region specific sustainability indices may prove helpful in outlining successful strategies for development interventions.

Perhaps it is time that it may be prudent to follow a Gandhian approach to rural revival in which the success of setting up such small-scale distributed production units lies in activation of local 'panchayati raj' governance in the management of such distributed economic enterprises. The scope of developing other handicrafts, handlooms, organic produce, jewellery etc. can be developed based on regional strengths unique to each geographical region in a sustainable manner.

ACKNOWLEDGEMENT:

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DISTRIBUTED SUSTAINABLE MARKET DESIGN BASED ON COMMUNITY

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ABSTRACT

Residents from different regions have developed a set of regional characteristics that suit their own needs according to different environmental characteristics. With the rapid development of the economy and the Internet, people's life pace is accelerating, and more and more people choose restaurants and fast food instead of cooking traditional food. The food culture has been broken down, and individual business of traditional food processing and manufacturing are also facing problems such as unemployment and falling income caused by this problem. This study uses interviews to take Changsha City, Hunan Province, China as an example. Based on the current situation of traditional food culture, from the perspective of consumers and traditional ingredients, the sustainable system under the new situation is proposed. Help the continuation of the food culture, the health of local residents and the economic income of disadvantaged groups.

Key Words: sustainable design, distributed economy, traditional cuisine culture, vulnerable groups, community

1. INTRODUCTION

1.1 The cuisine culture

Chinese cuisine is one of the carriers carrying important Chinese culture. Cuisine culture has a long history and diverse regional characteristics. The cuisine culture is influenced by the climate and geographical conditions of different regions, showing great diversity. Changsha's diet system is based on one of the traditional Chinese cuisine, Hunan cuisine. Hunan cuisine has a long history and a strong cultural value. Changsha is an important central city in the middle reaches of the Yangtze River, and has a superior natural environment. It provides a variety of unique raw materials and seasonings for Hunan cuisine, making the kinds of Hunan cuisine rich and colorful.

There are many cooking techniques in Hunan cuisine, paying attention to the mutual matching of raw materials, mutual infiltration and mutual integration, in order to achieve the purpose of removing odor, increasing delicious taste and enriching taste. [1] After more than two thousand years of baptism and historical and cultural accumulation, Hunan cuisine has accumulated many classic dishes and classic snacks with numerous names, complex varieties, long history and rich allusions. The characteristics of the Hunan cuisine are numerous, and the processing technology is complicated, which leads to the complicated production process.

1.2 Vulnerable groups

The vegetable market can provide fresh and economical fruit, vegetables and meat and other ingredients to nearby residents. For consumers and individual business, it also provides opportunities for socializing and exercising, which is important for the elderly's later life. It also has great value in increasing the emotional bond between people and the vitality of the city [2], which also gives small-scale producers a certain economic income.

Research on the vegetable market has attracted the attention of many scholars. In recent years, the city management department has increased the demolition and remediation of various informal vegetable markets. More and more popular shopping places for the elderly are about to disappear or disappear, and the newly established vegetable market has reduced accessibility. Or the high price will become an objective reason for the poor experience of buying vegetables in the elderly.

On the other hand, due to transportation time and cumbersome production processes, large food production and processing companies are difficult to achieve many kinds of traditional cuisine with many local characteristics. In the fast-paced modern life, the food culture with regional characteristics and historical and cultural traditions is gradually fading out with the lack of communication ties between the elderly and young people. Based on the above questions, this article will focus on small-scale mobile agricultural product producers, elderly groups or self-employed individuals with traditional food cooking skills, and youth groups that lack healthy eating ideas and are living in a fast-paced life. It designs a mutually beneficial trading service model and a heritage of local food culture. This paper proposes a community-based distributed sustainable market design, which integrates the ageing groups in the community, individual sellers from food or ingredients, and community markets to include youth groups, senior groups and self-employed people.

Food sales, food monitoring, site leasing, waste food recycling and sorting services. The economic development is fast, and the life of the elderly is boring. Many elderly people's leisure life is mainly based on chatting and watching TV programs. A small number of them mainly read, visit relatives and friends, and chess and entertainment. The spiritual life of the elderly is extremely monotonous. At the same time, the youth group is in a period of rapid social development, the pace of life is fast, and there is little time to contact the traditional cuisine with more detailed and complicated practices, which leads to the gradual loss of the food culture.

The rapid pace of life has also led to the rapid development of the food and beverage delivery industry. Under such circumstances, people began to realize the attraction of the diversity of food with regional characteristics and the dilution of the food culture. Shared kitchen" application. Shared kitchen

2.METHODS

Based on the basic concepts of sustainable design and distributed economy, by integrating "products and services" to build "sustainable solutions" Sustainable Solution to meet consumer-specific needs, "results" and "benefits" to replace the consumption of material products, while At the same time reducing resource consumption and environmental pollution, and changing people's social life quality[3]

First of all, after discovering the problems, the paper summarizes and summarizes the traditional food culture, small-scale individual food suppliers, the spiritual life of the elderly and commuters. It clarifies their respective important characteristics and characteristics, and formulates interview outlines and contents.

Subsequently, using the literature method and the interview method to conduct interviews and data review for users, establish PERSONAs, and summarize and summarize them. SWOT analysis of key issues, user journey maps, and further analysis of the pain points. After conducting a thorough investigation, the service system was designed from various aspects according to the concept of "sustainability". Through the screening and modification of various programs, it is more able to achieve the goal of "sustainability".

In-depth interviews on the issue of youth groups and traditional food culture show that the youth groups have a certain passion for cooking, and time, complicated cooking techniques and cleaning have become one of the main reasons that influence the youth group to accept the food culture.

3.RESULTS

In this paper, the market organization mainly targets three groups in the community—older groups or self-employed individuals, individual food suppliers, and young residents who want to plan healthy eating, and aggregate resources to provide major services such as trading and food courses.

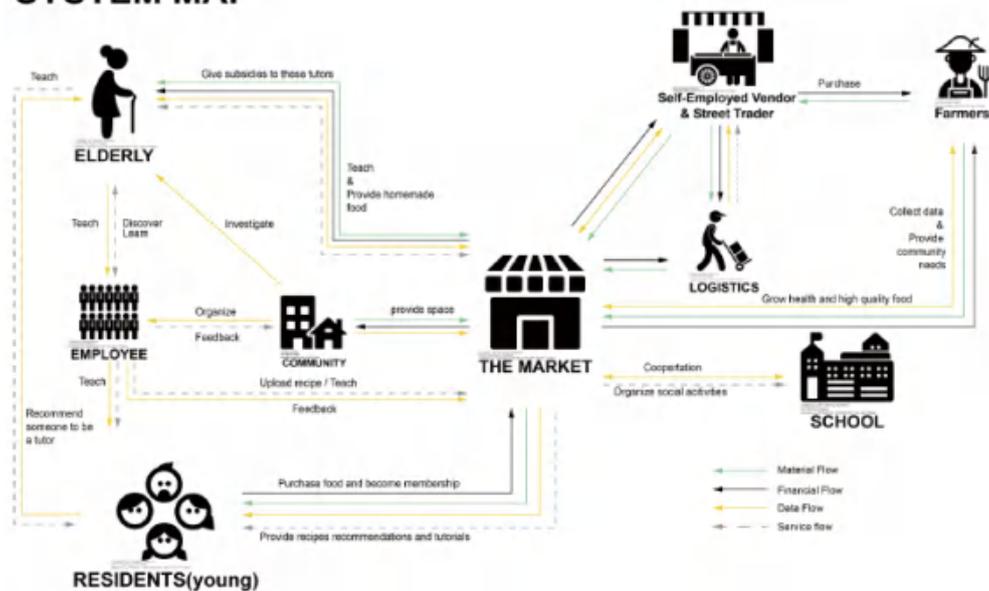
STAKEHOLDERS & RESPONSIBILITIES



[Figure 1] stakeholders

The market provides platforms and venues, collects food processing individual operators and raw material suppliers around the community or villages, and classifies and plans them in the market, and the platform uniformly receives orders from users in the community (users can also conduct online offline) The transaction is transferred to the supplier and the food processor, and the finished products taken by the user to the community market where the customer is located, eliminating the cost of the delivery. Among them, packaging and other aspects use sustainable materials or packages provided by users to reduce pollution and waste.

SYSTEM MAP



[Figure 2] system map

At the same time, the platform also provides users with online and offline course resources on cooking, food selection, and food culture promotion. The course comes from people who have traditional food technology. The platform is responsible for collecting the information and willingness of the members of the community, conducting training and review, and finally publishing the online or offline courses on the platform. Users can conduct free online and online. Paid viewing and learning or through the appointment on the platform, get permission from the course teacher to learn.

The distributed sustainable market design is designed with “sustainability” as the design orientation, taking advantage of seasonal ingredients and food, reducing transportation costs and building trust relationships in a distributed manner. In the collection of small-scale food production. At the same time, the traditional community market is given a distributed business model that integrates food culture exchange, traditional local food processing and trading, youth groups and old age groups.

4.CONCLUSION

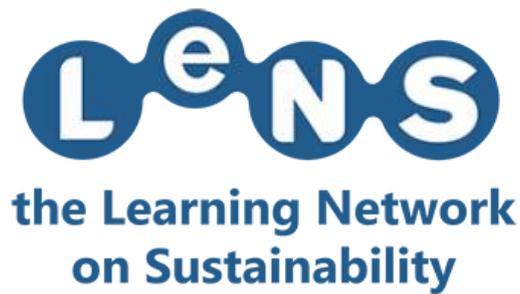
By establishing the market in the community, it can reduce the cost of transportation and distribution of small food production and processing companies and reduce the mental emptiness of the elderly. And increase the additional income to meet the needs of their spiritual and cultural exchanges, and to be able to fully control their workload without overwork. For consumers, it benefits from the traditional dietary concept of healthy eating, and to some extent enhances its cooking technology, the most important thing is to provide environmentally friendly, high-quality, convenient and fast traditional food trading methods.

For the society, the market can effectively reduce the costs and overproduction of small-scale producers, reduce waste, reduce greenhouse gas emissions, and spread the concept of sustainable and healthy diet.

For ecology, greenhouse gas emissions are reduced in the market, and recycled materials are used for packaging, reducing food waste.

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PURA FRAMEWORK - A MODEL FOR DISTRIBUTED ECONOMY FOR INDIA

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ABSTRACT

With majority of Indian population still living in its rural areas, sustainable development of India is undeniably connected to the sustainable growth and empowerment of rural India. Providing Urban amenities to Rural Areas (PURA) framework was conceptualized to meet this end. It aims at spatio-social and socio-technical development of a rural region by creating contextually appropriate livelihood opportunities, wealth generation, self-reliance and skill development through physical, electronic, knowledge and economic connectivity. The concept of Distributed Economy (DE), on the other hand, was presented as a model for sustainable development by creating a network of interconnected and mutually dependent local production system to meet local needs, an antithetical to large-scale centralized production system. In this paper, we analyze Warana and Chittrakoot PURA using literature review and demonstrate how the PURA model is a contextually appropriate way for achieving sustainability benefits of DE in the Indian context. Thus, the PURA model can inspire the conceptualization of Design for Sustainable DE methodologies and pedagogy.

Key Words: Distributed Economies, Provision of Urban Amenities to Rural Areas, Sustainable Development, Sustainable Rural Development

1. INTRODUCTION

On the global front, debates, discussions and scientific studies on environmental issues and disruptions in the ecology as an outcome of production-consumption system started springing up from the second half of the 20th century leading to the development of ecological norms and policies based on Polluter Pays Principle (Vezzoli et al., 2014, p. 11). This eventually led into discussions and defining of Sustainable Development (SD) as the model for development by the Brundtland Commission, defined as “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland et al., 1987)’. From here on the concept of sustainability was no longer limited to the environmental dimension but was looked upon at the junction of social, economic and environmental sustainability. Towards the end of the 20th century, the global community realised that ‘in spite of the progress made by the industrial world and enterprise during the last decade [...] the extent to which consumption exceeds the Earth’s capacity to supply resources & absorb waste & emissions is still dramatically evident’ (Geyer-Allély, 2002). Thus, interventions switched their focus towards designing and promoting sustainable consumption and production (SCP) system. Since then various international accords and agreements have been signed where individual countries depending on their local contexts have set their targets to move towards the SD goals.

Not all nations of the globe have actually followed the above-mentioned trajectory of development. Say, in case of India, the early to mid 20th century saw a series of movements and initiatives to gain freedom from its colonial rulers. Very few industries existed and most people lived in the age-old agrarian society, mostly fulfilling their daily requirements through prosumption. Every village was more or less capable of meeting its own requirements of food, clothing and other material well-beings. The colonial rulers, in order to fuel their factories with raw materials, had to a large extent, destroyed this prosumption behaviour in sectors like textile. The centralised model of mass production and consumption introduced by them posed both economic and political unsustainabilities for India. Gandhi, post his meticulous study of the Indian society, came to the conclusion that India’s freedom lied in reviving this self-reliance based prosumption behaviour and initiated the Khadi Movement in 1918 (Vezzoli et al., 2014). The Khadi Movement is considered as an empowerment-based model of sustainability and also a precursor to the modern day Product-Service System (PSS) concept (Brown, 2010). Post-independence, the Indian economy slowly saw an upward march with high growth trajectories coming from manufacturing and service industry, urban India becoming the hub for jobs and exponential rise in rural to urban migration. The agricultural ecosystem, on the other hand, saw a slow growth trajectory making it loose its lustre. According to Kalam and Singh (2011), Provision of Urban Amenities to Rural Areas (PURA) can help in bridging this rural-urban growth gap and bring-in inclusive and integrated development for India. The authors define sustainability with the following constituents: Economic, Technological, Social, Environmental, Value (Value-based society), Learning and adaptability; and identify these as the key building blocks of the idea of PURA (Kalam & Singh, 2011, pp. 28-29) (Table 1.1) . Thus, we see a close ideological match between the idea of PURA and Distributed Economy (DE). This paper draws a parallel between the two approaches and argues that PURA is a suitable model for propagating sustainable DE for India and hence can be used to conceptualize Design for Sustainable DE (S.DE) methodologies and pedagogy.

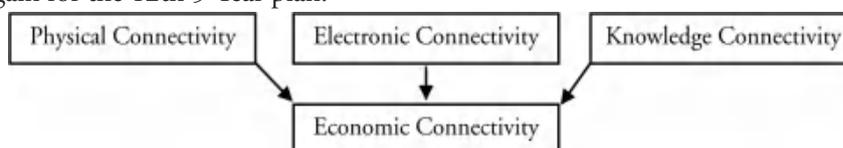
[Table 1.1] *Constituents of sustainability (Kalam & Singh, 2011, pp. 28-29)*

Economic Sustainability	Technological Sustainability	Social Sustainability	Environmental Sustainability	Value Sustainability	Learning and Adaptability
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1.1. The Provision of Urban Amenities to Rural Areas (PURA) Model

PURA is conceptualized as a socio-economic system for achieving sustainable growth, starting from the household level in a village, moving next to the village level and then to the village cluster level (Kalam & Singh, 2011, pp. 31-41). It is a ‘self-sustainable model of knowledge-based development’ (Batra, Singh, & Payal, 2011) and was proposed by the former President of India, Dr. A.P.J. Abdul Kalam. (Kalam & Singh, 2011, pp. 31-41) PURA envisages to achieve contextually appropriate spatio-social innovations by first developing the ‘physical connectivity’ (roads, rails, dams, irrigation facilities, waterways, other spatio-socially appropriate public infrastructure), next the ‘electronic connectivity’ (broadband/ fibre/ satellite/ wireless based networks, etc.) and then the ‘knowledge connectivity’ which will together facilitate the ‘economic connectivity’ (figure 1). The spatio-social customization of PURA will depend on various factors like the agro-climatic conditions, geography, human resource quality, special competencies, connectivity to urban centers/ ports/ villages/ supporting industries etc.

PURA clusters in India refer to two distinct forms: 1. PURA by the Government of India through its Ministry of Rural Development; 2. PURA through private initiatives with loose networking with the office of the former President of India, Dr. A.P.J. Abdul Kalam (Batra et al., 2011). (Working Group on PURA & Ministry of Rural Development, 2011) PURA as a government of India scheme was announced in 2003 and was in-principle approved in 2004. It was piloted in seven clusters from 2004-05 to 2006-07 and restructured post evaluation in the 11th 5-Year plan (2007 -12) and again for the 12th 5-Year plan.



[Figure 1] *Connectivity Model of PURA (Kalam & Singh, 2011, pp. 31-41)*

1.2. The Distributed Economy (DE) Model

Johansson, Kisch, and Mirata (2005) proposed DE as a model for sustainable development, an alternate to large-scale, centralized production systems, for certain share of the production by producing locally/ regionally using flexible and synergistically connected small-scale production units. These small-scale production systems can respond better to local market requirements, can better reflect the local socio-cultural and environmental milieu, bring in balanced regional growth and distribution of socio-economic power while bringing in economies of scale as well as higher resilience to uncertainties and unsustainabilities through synergistic networking (Johansson et al., 2005; Mirata & Emtairah, 2005; Mirata, Nilsson, & Kuisma, 2005). Several authors (Acosta et al., 2010; Johansson et al., 2005; Mirata & Emtairah, 2005; Mirata et al., 2005) have cited examples of DE from various countries of Europe. According to Johansson et al. (2005), SD and DE are connected through the following criteria:

- 1). increase 'wealth creation for a larger number of people'
- 2). reinvent 'quality' in terms of both material and non-material (aesthetics, ethics, experiential) and 'prioritise it before production efficiency'
- 3). encourage 'heterarchies and open innovation', gathering as well as in implementation
- 4). flexible, small-scale production which can satisfy dynamically changing demands
- 5). 'diversification of needs and wants - new consumers, new behaviours'
- 6). 'symbiotic relationship' creation
- 7). co-operation and interdependency created by 'social, economic and ecological diversity' leading to 'efficient production systems'
- 8). 'life quality as an integrated component for development and innovation'
- 9). 'closer attention to real needs and wants' through close 'producer-customer relationship'
- 10). 'integrating design and innovation' in the process so as to create a link to aspects like emotion and imagination
- 11). local 'social and ecological capital' seen as an asset which can deliver unique values and offering mix
- 12). balance and symbiosis between small and large-scale production systems
- 13). building and facilitating a collaborative and collective spirit
- 14). balanced 'intra-regional and inter-regional exchanges of resources'

2. METHODOLOGY

This paper is a literature review-based paper. We studied two cases: Warana and Chitrakoot as PURA using literature and content openly available from various online sources and books. They have been described as model examples of PURA by Kalam and Singh (2011). While, the actual spatio-social innovations at Warana were initiated decades before the coining of the word PURA, the Chitrakoot PURA is younger.

3. DISCUSSION - WARANA PURA AS DE

Warana valley is located in the state of Maharashtra in India and is a fine example of PURA development system wherein an integration of physical, electronic and knowledge connectivity has helped in capacity-building of each household in the valley and brought in socio-economic development. (Kalam & Singh, 2011; Market Missionaries (India) Pvt. Ltd.) Warana mission was conceptualised by a visionary social leader, Tatyasaheb Kore, to transform the poverty and crime stricken region to its current form in the 1940s. He started it with setting up of a school. He realised that the traditional agro-society's main produce was sugarcane converted into jaggery, which has a very small shelf life. He saw an opportunity to convert the sugarcane into sugar by setting up a factory. But there was no funds to achieve the same.

Hence he motivated and convinced the farmers to set up a co-operative and together fund the factory. The co-operative and the factory slowly grew up to reach the status of 'largest cane crushing capacity' in the nation. Next the farmers moved on to together setting up 5 dams to improve the irrigation facility leading to a multi-fold increase in sugarcane production and adding to the prosperity of each house. Next to improve the life of landless labourers of the valley, Warana Co-operative Dairy was started. Also a co-operative bank was founded to help these landless labourers get loans to purchase cattle and so on.

Thus, eventually the dairy became an important source of income for the people of the valley. Further diversification was done in the co-operative to produce value-added products out of milk like shrikhand, ghee, milk powder, etc. The women of the valley also formed their own co-operative to together produce and sell food products like papad, an integral part of every Indian household's meals. Knowledge connectivity, being the backbone of any progress, was also integrated. Schools and colleges (engineering, humanities, art and sciences) were set up. Even an academy for training young boys to become efficient soldiers and citizens was set up and the music group, bal vadya brind, became globally known. Next came many more co-operatives for poultry farming, supermarkets for all the villages by all the villagers, paper using the bagasse (sugarcane pulp left post juice extraction) and distillery for making industrial alcohol using molasses (by-product of sugar production). An agricultural research centre is set up to

device environment-friendly farming techniques and a hospital with state-of-the-art facilities. The government has initiated a project called Warana Wired Village where all the 80 villages of the valley will be interconnected to each other. A fruit processing factory has been set up using American technology and loans.

Warana is an exemplary case of SD through interdependence, self-reliance and interconnectedness. It is evident that all aspects of DE, [1] – [14], listed in section 1.2 are the key characteristics of Warana PURA. It is also evident that Warana has reached its current form due to 8 decades of tireless efforts of visionaries, leaders and each individual of Warana. Meeting all aspect of a DE and reaping the benefits of SD in a developing country context, thus might heavily rely on strong and visionary leadership skills and time to reach its full potential.

4. DISCUSSION - CHITRAKOOT PURA AS DE

Chitrakoot PURA is located in Madhya Pradesh and is operated from two Krishi Vigyan Kendras (KVK): Majhgawan and Ganivan; and was initiated in 2002 by an NGO, Deendayal Research Institute. A KVK is an agricultural extension center in India, are usually linked to local agricultural universities, facilitate application of agricultural research in a practical and localised set up and hence serve as the last-mile link between the farmers and the Indian Council of Agricultural Research. (Kalam & Singh, 2011) The two KVKs at Chitrakoot operates live demonstration farms having similar size as the typical farm sizes of the region and train farmers in farm and non-farm based income generating activities by using sustainable agricultural inputs. The KVKs, on the basis of nutrient requirements of a small family and other expenses, have first calculated how much a farmer needs to earn. Next this amount has been used to chart out a yearly season-based production plan for the farmer.

When the farmers saw practical proof of this demonstrative plan work on the KVK farms, they gained the confidence to adopt the same. Also another scheme by the Deendayal Research Institute, Samaj Shilpi Dampati (mostly a newly-wed young educated couple with a deep commitment towards community service), helped in spreading the word around and encouraging more farmers to visit the KVK and adopt the practices (Manjunatha, Rao, Prabhakar, & Hajong, 2012). Another issue identified in the path of yield was the availability of good quality seeds, suited to the agro-climatic conditions and at affordable rate. A survey with the farmers revealed this as a major need and also the farmers wanted the seeds be available on a barter basis.

Due to limitations of finance available with the PURA and the KVKs, achieving large-scale seed production became a challenge. Also just providing the seeds through PURA or KVKs will not result in self-reliance for the farmers as had been achieved in case of Warana. Thus, Majhgawan KVK introduced something called as a 'seed club' at the village level and a 'seed village' in a cluster of villages. Again through demonstrations in their model farms, the seed club farmers were trained and eventually a sustainable and self-reliant source of quality seeds were available to farmers of their own village as well as nearby villages. Since the farmers preferred a barter based system for getting seeds, a 'seed exchange' was also set up to exchange seeds for grains. (Batra et al., 2011) Other development in the region include aspects like:

- 'Participatory Rural Appraisal' to achieve development through participation of the villagers and better need identification for intervention;
- availability of interest free loan for encouraging entrepreneurship;
- setting up of educational, vocational and entrepreneurship training institutions;
- Samaj Shilpi Dampati reaching out to women to encourage them for pursuing education as well as entrepreneurial ventures;
- provision of solar lamps and setting up of women's self-help group to run solar batter charging stations;
- watershed management initiatives to manage in this drought-prone region;
- e-connectivity and usage of SMS service to reach farming information to villages;
- an educational research center to conduct field-based research in understanding the educational needs of the village cluster in today's times

Chitrakoot PURA, unlike the Warana PURA, is relatively young but has already achieved significant successes in moving towards empowerment, enhanced income and self-reliance through a synergistic network of farmers engaged in co-prosumption of knowledge. The system has empowered the farmers not only to use technology and scientific methods of farming but has also facilitated individuals to innovate and become knowledge creators – 'knowledge society' (Batra et al., 2011). Seeing farming as an entrepreneurial activity and not merely for subsistence has made farming lucrative. In spite of the introduction of the possibility of monetising ones knowledge and/ or farm produce, the model has succeeded in creating an environment of growth through mutual co-operation rather than competition. Hence, again in the context of Chitrakoot PURA we see all the DE aspects, [1] – [14], are being met.

In this PURA we see the leadership role being taken up by the two KVKs who anchor, groom and grow the system. Securing participation of more and more people is achieved also by the grassroot level leaders, the Samaj Shilpi Dampati. According to Manjunatha et al. (2012), if grassroot functionaries of the KVKs belong to and live with the farmers, they are better able to empathise with the farmers, the farmers have greater trust on them and also makes extension services more easily accessible (also 24 X 7). Also being a couple, they have been able to reach out to both the men and the women.

5. CONCLUSION AND FUTURE SCOPE OF RESEARCH

One of the key characteristics of the PURA model is to be able to generate sustainable development (on all three dimensions) in a manner that the Indian rural population can generate for themselves urban level income in rural areas and not just achieve poverty alleviation. The model aims at generating multiple channels of income for each household alongside capability building in all walks of life so as to build resilience. The cluster-based approach brings in special identity to each PURA, in line with their unique local capabilities, and also build in self-reliance as a cluster. The PURA model tries to generate a balanced mix of distributed, decentralised and centralised modes of design, finance, production, knowledge/ information generation and dissemination and distribution. Most importantly, it establishes villages as 'knowledge societies'.

What does this imply for us designers and design-researchers?

DE has been proposed as a way of looking at SD. But design for sustainable DE (S.DE) is still a fuzzy front-end. For designers working in developing country contexts, a study of the PURA model, how it evolves into a success or failure, achieves its localised unique characteristics and SD, can help in designing systemic solutions as well as design methods, guidelines and tools. These design methods can, thereafter be implemented in appropriate curriculum.

Thus, our future research will try to study deeper into the PURA model and existing PURAs through literature as well as ground study. We will then engage into development of design methodologies and tools along with pedagogic content.

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CONTEXTUALIZING SUSTAINABLE PRODUCT-SERVICE SYSTEM DESIGN METHODS FOR DISTRIBUTED ECONOMIES OF INDIA

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ABSTRACT

This paper presents a strategic analysis tools that can help a designer in Sustainable Product-Service System Design with an intervention focus on Socio-Economic Ecosystems (SEE) that seem typical of multi-cultural and diverse communities engaged in distributed economic activities. The research questions for this paper are:

1. To what extent the MSDS (Methodology for System Design for Sustainability) is applicable for design of S.PSS for SEE?

2. What could be a possible sustainability-orienting design approach for S.PSS in the context of SEE, which caters to its unique nature?

Using Design Science Research Methodology, we redesigned the strategic analysis part of MSDS. The redesigned strategic analysis consists of various tools suited for design of S.PSS in the context of SEE. The proposed tools are for identifying the actors and their activities in the ecosystem; understanding the infrastructure and needs of the actors; clarifying the goal, problem statement definition, design brief and unit of satisfaction using participatory method; and, finally for competitor analysis.

Key Words: Socio-Economic Ecosystems, MSDS, Distributed Economy, Sustainable Product-Service System Design.

1. INTRODUCTION

(C. Vezzoli et al., 2014) Design for Sustainability using a Sustainable Product-Service System (S.PSS) approach has a potential role to play in promoting and facilitating system level innovations that can bring environmental benefits while being economically viable and socially equitable. In order to design an S.PSS, a designer should be able to design both products and services, promote and facilitate innovative interactions between stakeholders who can orient the designed system towards eco-efficient and socio-efficient ends, and operate or facilitate a participatory design process involving the project-relevant stakeholders. Since the number of parameters involved in the DfS (Design for Sustainability) considering all three dimensions of sustainability are large and complex, it is important to have tools and methods that can guide and aid the designer during the design process. The Methodology for System Design for Sustainability (MSDS) offers a modular framework to the designer that can aid in conducting a strategic analysis, exploring sustainability orienting opportunities, designing and engineering sustainability oriented system concepts and communicating the same. MSDS has been conceptualised so that it can be used for a scenario where-in the project has project proposers who can be companies, public institutions, NGOs, research centres, or a mix of these. It is a modular method consisting of stages, processes and sub-processes wherein the designer can choose to use the most appropriate stages and tools from MSDS, integrate other tools and activities into it and also give varying degree of contextually appropriate priority to each dimension of sustainability. In this paper, we discuss the applicability of MSDS in designing S.PSS for Socio-economic ecosystems (SEE).

The two research questions for this paper are:

[R1] To what extent MSDS is applicable for design of S.PSS for socio-economic ecosystems (SEE) where “the economic activities of the community is deeply ingrained in the socio-cultural ways of living”, is a multi-stakeholder ecosystem and the economic activities are distributed in nature?

[R2] What could be a possible sustainability-orienting design approach for S.PSS in the context of SEE that cater to its unique nature?

1.1. Defining Socio-Economic Ecosystems (SEE)

According to Banerjee et. al 2019, “A SEE is a context where the economic activities of the community is deeply ingrained in the socio-cultural ways of living.” Authors suggest that there are some major challenges in designing for such contexts. Specifically, one challenge is to orient the systemic solutions to the socio-ethical and environmental dimensions of sustainability such that they are in the “economic interest of the system stakeholders”. Another challenge is the difficulty in identification of “project promoter”. A SEE by nature is a distributed economy; it is a network of actors that function in a distributed manner for design, knowledge generation and manufacturing for economic gain of individual stakeholders. These systems have developed over time to be sustainable on many fronts of their functioning. In such a multi-stakeholder system, it is difficult to identify a single “promoter” who can become a solution provider without buy-ins from other influential actors in the context. Additionally, due to the distributed nature of a SEE, a single ‘promoter’ may not be able to support or implement a unifying solution that is sustainable for the entire SEE. Thus, it becomes very important to understand the existing traditions along with the ecological and social knowledge systems for a designer to be able to provide any sustainable design intervention. Moreover, the designer needs a deeper understanding of the context so that the intervention can be integrated to the existing local cultures. (Banerjee, Upadhyay, & Punekar, 2019)

1.2. Sualkuchi Silk Handloom Industry as a SEE

Sualkuchi is a cluster of 16 villages in the Kamrup District of Assam, India and is located on the banks of the river Brahmaputra about 35 km away from the city of Guwahati. Its population is more than one hundred thousand and it is globally known for its silk handloom industry (called the “Manchester of Assam”). It also has a trademark – Sualkuchi’s. The handloom industry of Sualkuchi has its mention in the works of Kautilya who lived from 371 – 283 BC but mostly took its current shape during the Ahom Dynasty from 1228 – 1828 AD (Phukan, 2012). Typically, each household in Sualkuchi contributes to silk weaving and owns at least one loom for production of silk fabric. Post-independence of India, the industry began to flourish and reached its peak during 1981 – 2001 when looms per household increased from 2 to 6, on an average (Saikia, 2011). This is also the time when many households shifted their operations towards entrepreneurship, owning 50 or more looms, employing weavers rather than using the family members as weavers. There are four major categories of actors in the ecosystem: owners, weavers, reelers and helpers. The owners might be small (< 5 looms) or large (> 50 looms) and own the instrument of production, the Jacquard loom. The small owners mostly weave and reel themselves with their family while others hire weavers, reelers and helpers. The contracted weavers are paid on the basis of length of garment woven and the number of design elements. They learn weaving on the job and come from all over Assam. Some of them stay back in Sualkuchi while others go back to their native place to start their own handloom setup. The reelers are also contractual and perform pre-loom activities like reeling and spinning of yarn while the helpers are paid on a monthly basis for helping the other three actors. There are other standalone actors who support the ecosystem: designers, loom makers and servicers, middle men, distributors, shopkeepers (selling raw materials, selling finished products), government support units for low cost raw material for small owners, silk testing lab, Sualkuchi Tat Silpa Unnayan Samity and so on. The biggest strength of the existing system is its distributed nature in terms of design and manufacturing (it has very few large units). Due to unorganized production systems, enough attention is not being paid to technology, de-

sign and business model upgradation, which has led to stagnation. Also rising cost of raw materials and lack of supportive financial support system, the small owners are slowly disappearing leading to possible centralized economic models kicking in. To get a glimpse of Sualkuchi, visit <https://goo.gl/sLxNtS>.

1.3. Bordowa as a SEE

Bordowa is the birthplace of a 16th century saint, Sankardeva who was an artist, dramatist and the founder of Vaishnavism in Assam, India. It's a village in the Nagaon district and is 140 KM away from Guwhati and 18 km from the nearest town, Nagaon. Vaishnavism, as propagated by the saint, is a religion marked with simplicity and openness, without rules or restraints and requires only love and devotion to the God expressed through chanting and performing Bhaona (theatrical performance) (Goswami). The village attracts thousands of tourists during the weeklong celebrations of Holi and Janmashami and smaller numbers throughout the year. It does not have any restaurants or hotels but during the festival mobile toilets and temporary eating points are built in. Despite the large numbers of tourist visiting the place, the local lake (Akashi Ganga) is never polluted due to the religious beliefs associated with it. The major occupation of the village is agriculture and tourism. People here traditionally follow many sustainable practices. For example, each household has two ponds, one for water and fish while another for throwing compostable wastes. The compost then becomes manure for their household vegetable garden, fish feed and agricultural fields. The offering to deity is made of mostly sprouts and other fresh fruits, which are good for the health of the people receiving it. Unfortunately, due to modern ways of living creeping in, this balance is being disrupted. For example, plastic wrappers are dumped in the composting pond since no municipal collection of these wastes happen. Similarly, the influx of ever-increasing number of tourists also pose a sustainability challenge. To get a glimpse of Bordowa, visit <https://goo.gl/GvjZLT>.

2. METHODOLOGY

In order to answer the research questions, we used Design Science Research Methodology (DSR) as the research approach. DSR is a design-oriented research approach (Peffer et al., 2006). It follows the generic iterative design process: research, analysis, synthesis and evaluation; until we achieve a satisfying balance between the intended outcome and practical realization (Plomp & Nieveen, 2013).

Applying DSR, three separate exercises were conducted where we applied the existing MSDS methodology and updated it based on the learnings in each instance. The exercises were conducted with undergraduate and postgraduate students enrolled in the "System design for sustainability" course at IIT Guwahati, during the months of January-April in 2015, 2017 and 2018.

For answering R1, two design exercises were conducted in Bordowa and Sualkuchi, where MSDS was applied to uncover design opportunities and develop S.PSS concepts. Field visits were undertaken, whenever necessary, to enable a deep understanding of the context. The challenges uncovered in applying MSDS were noted during each exercises. Similar challenges were found in conducting the 'strategic analysis' for both the SEE context due to various reasons (see section 3). Based on this, parts of the 'strategic analysis' was modified and used to suit the context during each exercise.

Based on the outcomes of the first two exercises, the 'Strategic analysis' part of MSDS was modified to accommodate the challenges faced. To answer R2, the modified methodology and tools developed for its application were implemented in the third exercise conducted at Sualkuchi. We discuss the application of the modified methodology and tools in the discussion section (section 5).

3. NEED FOR CONTEXTUALIZATION OF THE STRATEGIC ANALYSIS STAGE OF MSDS

In a SEE context, the design opportunity or need for intervention may originate internally within the stakeholders or externally from other actors. In either of these cases, the ownership of the solution is on a group of actors who have equal influence and stake in the SEE. Unfortunately, this means that there is no single project promoter. Moreover, the group may define the scope of design without considering its implication on other stakeholders or actors. Thus, it becomes important to identify all actors along with their needs and motivations and decide the scope in a way that it is in the economic interest of all SEE stakeholders and suits their current socio-cultural settings.

The MSDS methodology was conceived primarily for designers, companies and additionally for public institutions and NGO's (C. A. Vezzoli, 2010, p. 219). Since there is no single clearly identifiable project proposer, it becomes difficult to conduct the promoter analysis as prescribed in MSDS (Banerjee et al., 2019). Moreover, one implicit assumptions of MSDS is that the promoters appreciate a PSS model and considers it suitable for their context, which may not be the case for an SEE. The actors may not consider PSS as a viable solution or individually may not have the influence to implement an S.PSS for the SEE.

An important consideration for a SEE context is the infrastructure that is available and used within its boundaries. Currently MSDS methodology suggests the analysis of the 'socio-technical regime' (C. A. Vezzoli, 2010, p. 223) as part of analysing the context reference. Although this may entail the study of infrastructure capabilities, it is not explicit nor considered important. In an SEE context, a designer must acknowledge the capabilities of existing infrastructure and suggest the necessary transformation of the infrastructure to support an S.PSS solution.

The nature of competitors in a SEE context may be very different from those of typical organizations. Example, a prominent product of Sualkuchi is Muga silk sarees and Mekhela Sador(a traditional dress) which are used by the bride in marriages. Considering the marriage budget, a competitor for the silk products is gold, because people divide their investment between buying gold jewellery and Muga silk. Thus, a standard competitor analysis based on product innovations and market segmentation may not be applicab and/ or feasible for a SEE. Moreover, besides a direct product competitor, the entire SEE may have a competitor that produces comparable products, or may have competitors from established industries. Therefore, the design team needs to uncover such atypical competitors before a competitor analysis can be done (e.g using Porters 5 forces model).

Another challenge faced in application of the MSDS for SEE, is the difficulty in defining the scope of a design intervention, an S.PSS problem statement, a design brief and a unit of satisfaction. This is amplified if the designers do not know the reference context. Moreover, since the group of promoters do not come forward with a PSS requirement, it becomes more difficult.

Considering such challenges, the design team should use co-design methods and approaches to understand the reference context. Additionally, the analysis of project promoters, their context of operation, the technological and cultural dynamics, carrying structure of the system and the sustainability best practices should be modified suitably to meet these challenges. The next section, thus, presents the refined contextually appropriate strategic analysis tool for a SEE.

4. THE STRATEGIC ANALYSIS TOOL (SAT)

We propose changes in the first two processes of the strategic analysis from MSDS, as detailed out in table 4.1 below. The modifications are explained in the following two sub-sections.

4.1. Process 1: Project Socio-Economic Ecosystem Analysis

Since in case of SEE, there is no one clearly identifiable project proposer but a group of actors who will together own the project, the first step is to identify all the actors and their aspects of activity. Also identifying all the actors is very difficult for a designer since many a times entry into the ecosystem might be challenging due to trust or other socio-economic barriers and also time consuming. Thus, it is best to conduct the process of identification of actors and their activity by interviewing local administrators/ visionaries. Local administrators can be anyone from the Panchayat/ block/ district administration. Local visionaries can be local elders/ thought leaders/ NGOs etc. They are able to quickly provide the designer with the main value proposition of the local ecosystem, its problems and an understanding of all the actors and their activities. We have developed a tool, Awesome Actors Tool (<https://goo.gl/f7ow7f>) to guide the designer in collecting the data. The next challenge and potential barrier/ support for any S.PSS design for SEE is the infrastructure (knowledge, financial, physical or social). Again interviewing the local administrators/ visionaries helps in achieving information on service, product-service and infrastructure transformations planned and required in the local ecosystem. We have developed a tool, KFPS Knowledge Mining Tool (<https://goo.gl/JeZvc6>) to guide the designer in collecting this data. Once this preliminary information and understanding of the SEE is attained, the designer can move into meeting the actual actors and understand their needs. The needs can be captured, mapped and analysed using the Empathy Map (Gray, 2017), AEIOU Map (<https://goo.gl/tskziS>), Value Opportunity Analysis (<https://goo.gl/Xx7vY7>), SWOT, PESTLE and System Map. Table 4.1 details each sub-process, the expected results and links to the tools developed/ suggested.

[Table 4.1] Strategic analysis to study SEE [2] [Process 1 and 2 are the proposed modifications; * Marked are from MSDS]

Process	Sub-process	Result	Tools
1. Project Socio-economic ecosystem analysis	Preparatory questionnaire for socio-economic ecosystems	Identification of actors and aspects of their activity	Awesome Actors Tool - https://goo.gl/f7ow7f
	Infrastructure analysis	Identification of existing infrastructure and required transformations	KFPS Knowledge Mining Tool - https://goo.gl/JeZvc6
	Project Actor Analysis	Need analysis of the actors	Empathy Mapping - (Gray, 2017) AEIOU Mapping - Value Opportunity Analysis - https://goo.gl/Xx7vY7 SWOT; PESTLE; System Mapa
2. Defining intervention context	Clarifying design goals	S.PSS problem statement, design brief, unit of satisfaction	Co-design using “Clarify Your Goal” section of Frog Collective Action Toolkit - (Frog Design, 2016)
	Competitor analysis	Competition space knowledge	Competitor analysis on form, category, generic, budget level - https://goo.gl/iXGyxt Porter 5 forces analysis if applicable

3. System carrying structure analysis ^a	General macro-trends analysis	Report on (social, economic and technological) macro-trends and their influence on the reference context.	
4. Analysis of cases of excellence for sustainability ^a	Identification and analysis of cases of excellence	Summary of cases of excellence analysis describing offer composition and interaction with the user Actors who produce and deliver the offer Sustainability characteristics	Interaction table (storyboard) Animatic System map SDO toolkit – checklist best practices
5. Analysis sustainability and determine priorities for the design intervention in view of sustainability ^a	Existing context analysis from an environmental, socio-ethical and economic point of view	Summary of the existing system analysis	SDO toolkit – checklist existing system
	Defining the design priorities	Definition of design priorities for each dimension of sustainability	

4.2 Process 2: Defining Intervention Context

Post identification and analysis of the SEE’s socio-economic ecosystem, the designer needs to define the intervention context. A participatory approach, involving as many actors of the SEE as possible, needs to be organised by the designer to clarify the design goal. This will provide better chance that the proposed S.PSS is grounded in the context as well as acceptable to all the actors. Also, since a SEE has evolved over a long period of time, the actors have evolved certain degree of harmonious living with the ecosystem which can be captured through a participatory process. At this stage, clarification of the design goal will result in identification of a S.PSS problem statement, design brief and unit of satisfaction. The participatory goal clarification can be done using the “Clarify Your Goal” section of Frog Collective Action Toolkit - (Frog Design, 2016).

In light of the selected problem statement, a competitor analysis forms the second sub-process. The competition analysis is done on two ecosystem parameters: the local ecosystem’s main value proposition and the design intervention goal. The 1st parameter helps to identify the form, category, generic and budget level competitions to the SEE as a whole (in its current form) while the 2nd parameter deals specifically with the proposed S.PSS. We have developed a tool to aid the process and can be accessed at <https://goo.gl/iXGyxt>. Detailed explanation of tool application can be found at: <https://youtu.be/mzzudwyOczs> and <https://youtu.be/MM9IYvWVXho>. Table 4.1 details each sub-process, the expected results and links to the tools developed.

5. DISCUSSION AND FUTURE SCOPE OF RESEARCH

The redesigned strategic analysis for MSDS, SAT, consists of tools which first identify the actors and their activities in the ecosystem; then infrastructure and needs of the actors; clarifies the goal, problem statement definition, design brief and unit of satisfaction using participatory design tools; and, finally a tool for competitor analysis. Currently the tool has been designed and tested on two SEE contexts, both located in Assam, India. Despite the similarities of geographical location, the nature of both the SEE is very different. Sualkuchi SEE has a local to global context of operation while Bordowa SEE has a local to local context. Thus, SAT might be generalisable over a variety of SEE contexts but more research is required to further develop and refine it.

Applying the tools and the MSDS in the classroom context may also have some challenges, which are discussed at length by Banerjee et al. (2019).

Another challenge of SAT as well as MSDS is data, time and resource intensiveness. But also the key characteristics of S.PSS is to create an offering using inventive interactions between actors of the ecosystem. SEE has multitudes of actors and if we try to map its sustainability intervention requirement, it will lie at the spatio-social and socio-technical innovation levels in the “DfS evolutionary framework” mapped by (Ceschin & Gaziulusoy, 2016). Hence, a designer will require to invest heavily on resources. However, we see a scope in improving the visualisation of the data through appropriate tool design and using software aids in future.

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DISTRIBUTED ELECTRIC VEHICLE CHARGING SERVICE SYSTEM DESIGN BASED ON BLOCKCHAIN TECHNOLOGY

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ABSTRACT

Under the background of the rapid development of electric vehicles and the imperfect charging service system, this study investigates the current problems in the existing charging system and the user's usage scenarios. meanwhile, the development and advantages of the blockchain technology are discussed as well. Using the model of shared economy, the study discusses the design of electric vehicle charging system based on blockchain technology combined with system service design and distributed economic thinking in the hope of improving the user's charging experience.

Key Words: Blockchain, Distributed economy, Service design, Vehicle charging system

1. INTRODUCTION

With the increasingly severe global environmental conditions and the ever-increasing total number of automobiles, the environmental problems brought about by automobile exhaust have received extensive attention at home and abroad. Various countries have issued their own fuel vehicle lock-up schedules. Countries such as the Netherlands, Norway, Germany, and India state that they will ban fuel vehicles by 2030 while China endeavours to achieve this goal around 2035¹. The spring of electric vehicles has arrived, and there will be more and more “green card” cars driving on the streets of China. However, with the continuous increase in the number of electric vehicles, the charging problem of electric vehicles has also begun to emerge. Many electric vehicle owners face problems such as the inability to charge in time, the long duration of charging, and the damage of charger. Meanwhile, the problems of charging have also limited the electric car owners to drive in a relatively small scale.

2. RELATED DEVELOPMENT BACKGROUND OF DOMESTIC DEVELOPMENT

2.1. Status of development of electric vehicle

According to the statistics from China Automobile Association, the Chinese private car market experienced its first negative growth in 2018. Nevertheless, different from the decline of overall sales for private cars in China, sales of electric vehicles in China are increasing successively, which mainly benefits from the support of national policy and the subsidy of car purchase.

In the five years of rapid development of electric vehicles, the consumer group has undergone a positive change, and the main body of consumption has changed from the original work unit to the private user. This shows that more and more private users are entering the group of electric car owners. As for the main consumption areas of electric vehicles, the major purchase areas have also expanded rapidly from restricted cities to non-restricted cities. Compared with previous years, the purchase area of electric vehicles nowadays is mainly non-restricted cities. This in turn shows that consumers are increasingly accepting electric vehicles and will think of electric vehicles at once when buying a car. It can be seen from these two points that the development trend of electric vehicles in China is unstoppable.

2.2. Problems with domestic car charging service system

By analysing the use of the existing vehicle charger APP, the author summarizes the scope, density, features and cost of the charger owned by several enterprises with the highest occupancy rate (see Table 1).

[Table 1] Comparison of different charging service companies

Brand	Scope	Density	Features	Cost
State Grid	All around China	Very high	Charging card(without network)	Medium
Star charger	Most city	High	Public & private charger	High
Telaidian	All around China	High	Low
Putian Electric	Most main city	Low	Pay by special card	Low
Judian Technology	Most main city	Low	High
Tesla	All around China	Medium	free	free
.....				

It is found that domestic charger enterprises are better than TESLA in terms of scale and compatibility. However, the survey of most users found that the charging satisfaction of Tesla owners is much higher than that of domestic electric car owners. The main reason is the difference in charging time. Along with the public charger, Tesla also focuses on the private charger. Although domestic car manufacturers provide installation services for private charger as well, compared with Tesla owners, most of the domestic electric car owners do not have their own private parking spaces, and the installation rate of private charger is much lower than that of Tesla. Different from the domestic electric vehicles, looking for charging of public charger during the day, Tesla’s night charging mode saves time and improves the user experience.

2.3. The rise and widespread application of blockchain technology

Since the birth of blockchain technology, its decentralization, anti-falsification of information, openness and transparency, traceability and other characteristics have attracted a great number of investments. The main application mode of the blockchain thus comes to be clearer. The first mode is to build an ecological business synergy on account that the advantages of the blockchain can help the entire business organization to form an ecosystem layer, to dilute the boundaries of the company’s interests, and to form flexible synergies with external resources. The second mode is to build cross-organizational data and process connectivity, the core of which is data sharing, digital-based sharing, commercial automation, and even integration with AI. The third mode is about asset trading in the hope of reducing the cost and the risk of capital flow by virtue of digital currency for it is peer-to-peer and transparent.

¹ Base on the data from BEIJING BUSINESS TODAY.

3. MAIN BODY AND FACILITY PROCESS DESIGN IN EXISTING SYSTEMS

The main mode of the existing system is “equipment manufacturer +facility operator +Internet platform”² and it becomes the core link in the existing electric charging service system design. Besides, the objects that need to be involved in this system include electric vehicle owners, major car charger companies, Internet service platforms, power supply companies, charging equipment manufacturers, government agencies, etc. (see Figure 1).

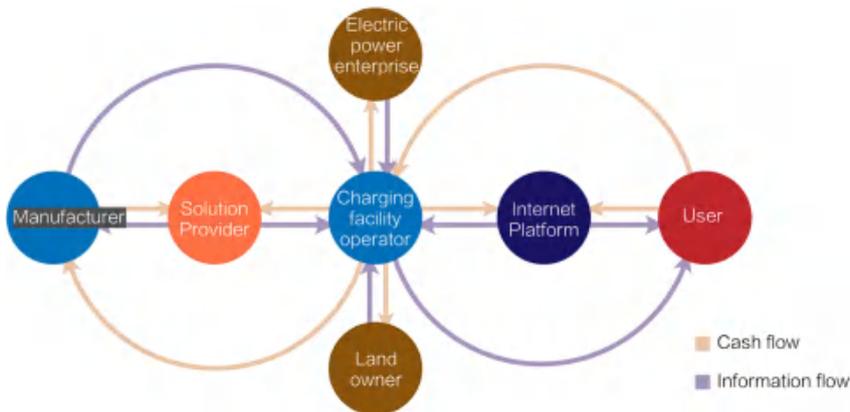


Figure 1 Current electric vehicle charging service system diagram

However, the main problem with this system is that with the establishment of more and more charger Internet platforms, the current electric charging system has presented a model of “small farmer economy”. Electric car owners cannot use cross-platform charger until download a lot of different APPs. This may lead to the burden of use and even financial losses (the disappearing shared bike is an obvious example).

4. DESIGN OF ELECTRIC VEHICLE CHARGING SERVICE SYSTEM BASED ON BLOCKCHAIN

Based on the design of the existing charging system, this paper conceives to use blockchain technology to manage all the devices of the charging service platform, including private charger.

4.1. The business model and user usage scenarios base on this system

In the current concept, the main difficulty of the system design is how to unify the needs of different platforms and ensure the benefits of the major charger platforms. The author believes that through the point-to-point payment function of the blockchain, the user can directly pay the fee to the charger enterprise account after using the charger. And the anti-falsification of information ensures accurate use of records and capital flows. The blockchain service platform can obtain operating expenses and self-interest from the major charger manufacturers by taking commission.

For user, integrating all the charger into the blockchain system network means that he can perform the charging service once he sees the charger and does not need to care about the brand of the charger. It avoids the use load and financial risk caused by multiple APP switching. At the same time, once the private charger is unoccupied, it can provide charging service for users in the same cell as well, which can protect the users from the search for charger during the day and the long charging waiting process.

4.2. Design of charging service system based on blockchain technology

In view of the above ideas, the author designed a charging service system diagram based on this concept (see Figure 2).

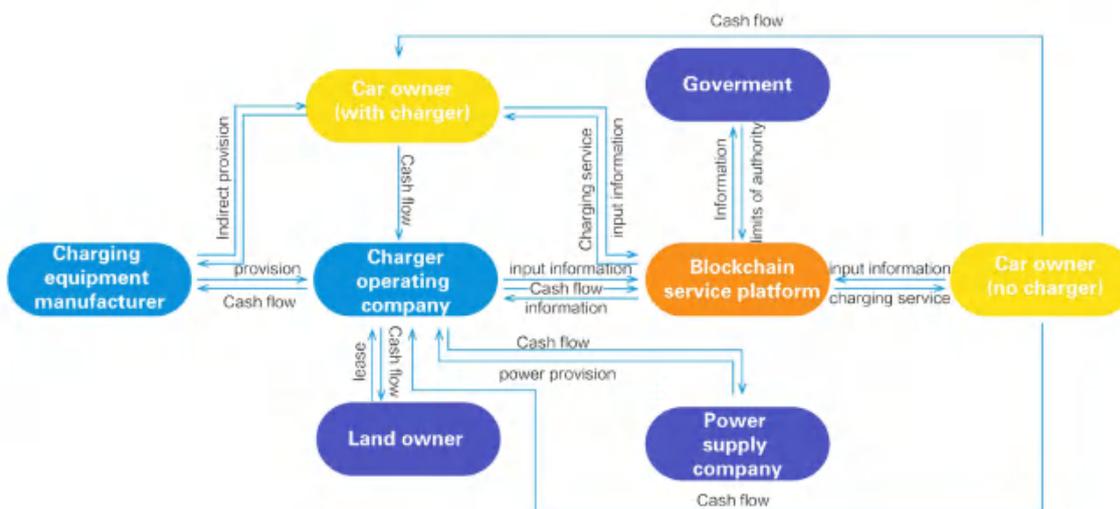


Figure 2 charging service system diagram based on blockchain technology

² Referred to www.analysys.cn

In the system diagram, a charging system connects the electric vehicle owners and the major charger service providers with the blockchain service platform as the core is formed mainly by joining the blockchain service platform and the private charger master. The operation of the system requires the process of charging the pile information - user registration - user information entry - user service. As more and more information being entered on the charger, it will also bring a growing number of fast charging services, thus attracts more users.

4.3. Summary and discovery

The biggest problem with the proposed charging service system may be how to quickly form a wide coverage charging service network. In 2017, the US company eMotorWerks proposed a shared charger project for electric vehicles based on blockchain technology, and advocated sharing the charger to increase the utilization rate of charger. Thus, encouraging people to join the blockchain system is a long process. The author hopes to increase the user traffic by letting the special charger enterprises join the service system, and then attracting more charger owners through publicity and profit.

5. CONCLUSION

The development of electric vehicles is an unstoppable trend. In order to meet the charging needs of the owner and improve the service experience of the owner, it is necessary to make full use of the existing resources and to provide a faster and safer form of transaction. Under the background of the continuous maturity of blockchain technology, there seems to be a solution to such a requirement. Through the design of the charging service system based on blockchain technology, this paper uses the blockchain platform to make full and efficient use of the entire charger system resources, hoping to provide a better user experience.

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MODEL FOR THE DEVELOPMENT OF OPEN SOURCE PRODUCTS MOD+RE+CO+DE

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ABSTRACT

The teaching of sustainable strategies for product design should be structured to propose a fast transition to circular production models, more suitable for the optimal management of resources currently available. These models must be articulated from the academy in each of the stages of product design and allow an open collaborative development of the knowledge generated, so that it be appropriated quickly with tools that facilitate the integration of sustainable methods, concepts and objectives. Mod+Re+Co+De is an exercise that unites diverse concepts, seeking that this transition takes place sooner in the academy and that can transcend to the design of circular products.

Key Words: open source design, circular economy, design method.

INTRODUCTION

In industrial design one of the most important methods for the definition of components and structural detail design is the product architecture, used both in the formal configuration and the function of the components, affecting the manufacturing processes and the useful life of these products. The product architecture defines how the different systems will be integrated and how they will make an equipment to work, how they will be used and the user interface.

Different strategies applied to design and focused on developing the sustainability of products from an “eco-pluralist” philosophy Loy, J (2008) can become fundamental in the teaching of sustainability and therefore in the definition of the proposed architecture, thus, design for X¹ or design by components², can impact on such architecture, affecting from the productive processes to the selected materials and the product-service system connected to all those activities necessary for the maintenance of the useful life of the product.

On the other hand, it should also be borne in mind that many of the strategies that can be applied in product sustainability and focused on the use of materials and subsequent recovery processes, are not being developed in accordance with the product architecture, but there is evidence of a disconnection between both processes. Components that must be replaceable after a period of time established by wear and tear, consumables necessary for correct operation but with a very short time of use, or elements that have a main function of long duration, must be developed in accordance with the product architecture and sustainable strategies for the maintenance of a useful life according to the function provided.

BACKGROUND

In Colombia, product architecture is a subject that is widely used in the different schools or faculties of design and engineering. This “method” is used for the structuring of the components and systems of a product in the detailed design rather than in sustainable management, although it can be a quite useful tool for this management. Different design faculties in the country base their contents on sustainability in environmental issues and almost all of them are structured around product life cycle analysis, or in the selection of materials and processes of lesser impact, evidencing a lack of variety in strategies that connect the design of products with the sustainable management of projects.

With respect to open source³ in Colombia, its application predominates the digital world. In this regard, “the country is timidly approaching the development of open source solutions that are widely visible in the world”⁴. Proof of this situation is that in a country of almost 50 million inhabitants, only 89 software projects and open source applications are registered in the Colombian Public Software platform⁵. Despite this progress, in other productive and knowledge areas, open source is practically relegated and little exploited, with a lack of solutions other than software development, which ensure responding to market trends and the needs of a world that sees collaboration as an alternative to the failures of a productive, economic and social model that every day widens the gap between sustainability and inefficient use of resources.

The Open Source revolution gives the possibility not only to individuals but also to communities to be able to have in their own hands the instruments to improve their own life and also that of others, without having to ask permission or without having to have large amounts of money to achieve it. One of the most outstanding examples is Arduino⁶ which is the world’s leading ecosystem of open source software and hardware. The company offers a range of software tools, hardware platforms and documentation that allow almost anyone to be creative with technology, originally started as a research project at Ivrea’s interactive design institute, Turin in 2000. Other example is Casa Jasmina⁷, a project in the business space of home electric networks or “Internet of things in the home”. Born in 2015 as a two-year pilot project, Casa Jasmina has become a permanent and continuous project. The aim of Casa Jasmina is to integrate traditional Italian skills in furniture and interior design with emerging skills in Italian open source electronics.

In 2016 the OSCED network⁸, which seeks to develop an open source model for the circular economy and has been working on it since 2014, joins the Disruptive Innovation Festival⁹ developed by the Ellen MacArthur Foundation, an event from which the need to make a transition to production processes more in line with the sustainable use of resources and the free distribution of information is raised, for which more than 30 contributions were requested and proposed based on the development of proposals for a future circular city projected to 2050.

HYPOTHESIS

It is considered that a model for product design based on a modular architecture with clearly defined sustainable specifications may allow a much faster transition to a circular economic model, where greater value is given to the

¹ Watson B., Radcliffe D. (1988), Structuring Design for X Tool Use for Improved Utilization, Journal of Engineering Design.

² Bistagnino, L. (2006), The outside shell seen from the inside, Torino, Politecnico di Torino, Document available online.

³ Term popularized by Eric S. Raymond in the nineties to describe a free access software code not necessarily free pay.

⁴ Ana Albir, founder of the Moondropapps company that develop and analyse web and mobile products. Recovered from (<https://www.eltiempo.com/tecnosfera/novedades-tecnologia/proyectos-en-la-cumbre-digital-colombia-4-0-38253>).

⁵ <https://www.softwarepublicocolombia.gov.co/>

⁶ <https://www.arduino.cc/>

⁷ <http://casajasmina.cc/>

⁸ Open Source and Circular Economy Days Network. from : <https://oscedays.org/>

⁹ Global event to shift mindsets and inspire action towards a circular economy. From: <https://www.thinkdif.co/>

components and the recirculation of the resources necessary for the manufacture of products, leaving established from the initial stages of design the useful life time of each component and its final disposition, the functions that the product-service systems must fulfill and project that allow developing an economy of updating, replacement and maintenance of components, focused on the biological and technological cycles¹⁰ of the different components.

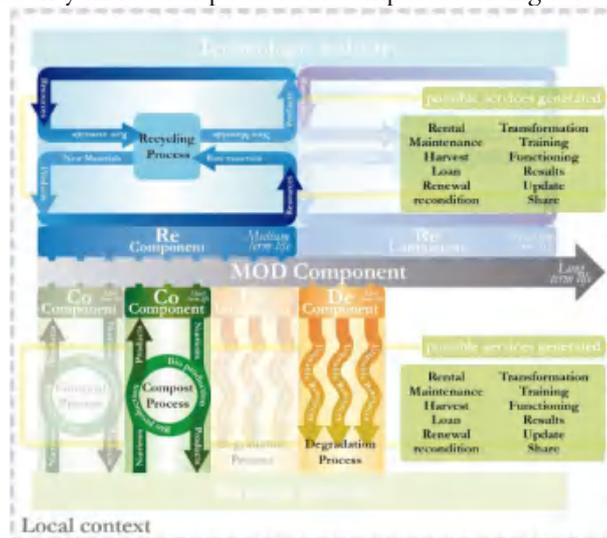
METHOD

For the structuring of this model an inductive method was worked on, proposed as a process of 4 stages (book of methodologies) for the development of products that could be used in the same way in other fields outside the academic. For its development, different work teams of equal number of participants are formed, which must follow specific steps to complete the exercise and be able to evaluate the results of the activity. The exercise is based on a modular product architecture, in which there must be 3 main components (Figure 1):

MOD Component: It is the module that fulfills a primary function in the sectional modular architecture and it is the component to which the others are connected to fulfill the function of the product. Its main characteristic must be to have a long period of useful life, for which its materials must be of high duration and resistance for the function it fulfills.

Re Component: These components fulfill one or several secondary functions, but without which the product cannot meet the performance for which it was intended. These components are designed to have a useful life time that depends on the intensity of use and so that they must be RECYCLED, which implies defining very well materials and processes that manage to close the life cycle of the component. Its exchange can be carried out several times in the total lifetime of the product, allowing the whole product to increase the duration of its use.

Co Component: Are those components that do not fulfill a main function but are facilitators for the proper functioning of the proposed product. These components are periodically replaced and have a very short life of use. Their non-implementation does not imply that the product cannot be used, but they help to maintain it in optimal working conditions. At the end of their use they must be disposed to be composted serving as food for new productive cycles.



[Figure 1] Functioning system of the components MOD+Re+Co+De

CONFIGURATION OF EQUIPMENT AND WORK MODE

The teams begin the work by proposing a product used in a common environment to all participants, seeking to facilitate the understanding of the use and exchange of components between them. For the later configuration of the product they must complete 3 stages that include the generation of functions of the components, the development of detail of each component and the rapid prototyping of these.

[Table 1] Exercise Development Stages

Functions definition	Component detail development	Rapid product prototyping	Group reconfiguration/ testing	Circular productive structuring / Service product system
Originally raised exercise			Exercise Upgrade	
Group definition of the characteristics and base components for all pieces of equipment, individual functions per component.	Detailed development of the components to comply with the established parameters.	Development of conceptual models and volumetric prototypes that allow to understand the configuration of components to carry out verifications.	The teams redefine their components bearing in mind that they must be able to be exchanged and used for other products.	Define the product service systems associated with the development of economic models for the circular production of the necessary resources for the proposed products.

¹⁰ Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braugart & McDonough, Cradle to Cradle(C2C)

DEVELOPMENT AND REVIEWS

The first moment of verification was during 2 weeks of class in 2016, in which worked following the proposed stages and where the teams were able to configure proposals for use in the context of the Colombian rural home. Since then it has been used in 5 academic semesters with 14 courses of 30 students of sustainable design of the Pontificia Universidad Javeriana de Bogotá, and whose evaluation of the results obtained has allowed to make adjustments to the whole model:

Introducing a Component De: that maintains the characteristics of the module Co, but at the end of its useful life it should be possible to degrade it in the environment without generating greater environmental impact. (Figure 1)

Increasing the duration of the exercise to 4 -6 weeks.

Increasing the use of digital tools.

Modifying the number of stages, including prototype testing and group reconfiguration, which implies that teams must work together to allow reconfiguration and exchange of components, and a stage of analysis and planning of circular production processes / product-service systems sustainable to show the improvements that can be developed at economic level / technical production / service.

In addition to this, all the generated contents are available to the public in the Envienta platform¹¹ that allows both that the developments can be shared globally, and that they are improved via “cosmo-localization” Ramos, J. (2017).

Parallel to this academic exercise, the process has been applied to the design of interdisciplinary products in the design of a transfemoral prosthesis for the lower limb, following the parameters proposed by the Materialización 3D foundation under the tutelage of Camilo Salamanca from the company IKU¹². In this project, the objective was to develop a prosthesis that could be made through 3D printing technology, so that its components could be easily manufactured and repaired, using local raw materials and keeping manufacturing costs below 500 US dollars. The final result of the exercise is a prosthesis¹³, currently in the last element testing phase and working with a selected user.

[Figure 2] Documentation academic process / first industrial exercise, Transfemoral prosthesis Retrieved from <https://community.oscedays.org/t/action-prototype-a-circular-product-mod-re-co/5521/47>



ACADEMIC RESULTS

This exercise has generated a dialogue on the technical aspects and characteristics that a product must possess in order to be implemented in a circular economy in an open manner, a subject that is little discussed and known by educational institutions and local companies. A large number of the students who have developed the activity have expressed a quicker understanding of the topics discussed and, above all, the implications that this would have for the industry, both in logistical and productive aspects, as well as in economic issues. Another point that has been identified is that many of the functions proposed for the components are initially very basic and disjointed, which makes it difficult for them to understand the integration processes both between their components and between the products of the various teams.

CONCLUSIONS

So far, the results of 5 academic exercises and 1 practical exercise have shown that this proposed model can be useful to extend the application of sustainable strategies to different areas of product design, allowing us to understand that the sustainable approach is transversal to the different stages of product development.

The quality of the projects presented has progressed positively with the introduction of the updates mentioned in the activity and has been much more valuable for students the integration of equipment for structuring the shared components, in addition to it has served to better understand the product architecture and systems sustainable service product. As expressed by the students who have participated in the activities, the exercise has allowed to understand concepts of circular economy and product-service systems faster and more practical than in master classes.

As a future proposal, is to develop an activity integrating the academic exercise with local companies, which can be developed within their current processes and to test in industrial reality the concepts raised by students.

¹¹ <http://platform.envienta.org/>

¹² <http://iku.com.co/nos.html>

¹³ Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braugart & McDonough, Cradle to Cradle(C2C)

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RESEARCH AND TEACHING PRACTICE OF PRODUCT SERVICE SYSTEM APPLIED TO DISTRIBUTED ECONOMY

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ABSTRACT

In order to promote sustainable development and build ecological civilization, This paper firstly conducts a comprehensive study on the respective attributes and correlations of product service systems(PSS) and distributed economy(DE) which based on a large number of literature reviews and case studies, including method exploration, theoretical induction, practical applications and elements. Under the guidance of extracting the keywords and their potential relationships, then using the quantitative application of class III and cluster analysis methods to analyze the application status, organizational forms and method theory of the product service system applied to the distributed economy to explore more research gaps and potential development space. Secondly, the paper examines how to use the product service system to the distributed economy in the Chinese context by combining LeNSin's international network teaching practice in China with the practical design propositions, and design works cases, which based on seminars pilot courses, teaching practice, and student activities.

Keywords: Sustainable development,Distributed economy, Product service system design

1. INTRODUCTION

In September 2015, the United Nations Development Summit adopted the 2030 Agenda for Sustainable Development, which covers 169 sustainable development indicators in 17 major areas, and the globally sustainable development path from the economic, Social and environment dimensions(Pan jia hua et al,2016). At present, in the field of design with sustainability, domestic and foreign research have gradually expanded from product design such as green design, reduced design and full life cycle design to system level such as product service system design, social innovation design and transformation design(Xin Xiang-yan,2016).

2. LITERATURE REVIEW

A literature review was carried out to identify the primary classification of the distributed economy(DE) and the structure of product service system(PSS), and to summarise existing organizational model to apply DE to PSS development.

The concept of a distributed economy first appeared in the early 20th century. Johansson and Mirata define it as small-scale regional production units that are synergistically linked to each other and use local resources(Baranp,2009). VDD Annemieke proposed that the distributed economy is a more sustainable social and economic development model, with the ability to make full use of the production of small-scale enterprises in the local economic context(VDD Annemieke et al.,2009). The LeNSin International Sustainable Design Network project under the guidance of the European Union in 2016 defines the distributed economy as a local-based small-scale supply model. The result is a structured network collaboration. The distributed economy can be summarized as a decentralized production and consumption, transportation, operation, and marketing model organized in small, scattered and flexible units. it forms a local network and interconnects with similar systems in the vicinity to build a more extensive collaboration and co-creation network.

The distributed economic model advocates the design process of region-based customization activities and user participation,which is highly compatible with the product service system design. Therefore, the introduction of the concept of the product-service system into the development of the distributed economy has certain possibilities and development potential.

The distributed economy is not a new type of model that conflicts with large-scale centralized production methods. In traditional society, the small-scale peasant economy woven by women and men has already had distributed characteristics, but the development of information society has spawned more forms. From the perspective of resource classification, it can divide into Distributed Renewable Energy (DRE), Distributed Manufacturing (DM), Distributed Production of Information (DI), and Distributed Design (Distributed).The Distributed Production of Design(DD), and Distributed Labor (DL).

The driving force behind the development of distributed renewable energy (DRE) lies in the improvement of new energy acquisition technologies that gradually become individualized, low-cost, and democratized, such as home solar power systems or home wall-mounted gas heating systems (Emili S et al.,2016).The technology driving force of distributed manufacturing (DM) lies in the development of small-scale additive manufacturing technologies such as 3D printing. Like some small open community manufacturing workshops equipped with tools such as 3D printers, stereolithography, and selective laser sintering. Production units of the same character are composed of local collaborative manufacturing networks such as FabLab, Makespace, MakerNet and other laboratories (Cindy Kohtala, 2015).The distributed information (DI) network is the primary source of fragmentation, personalized information and services for consumers in the mobile Internet era. It is also related to user-created content, such as early Weibo, Facebook, and WeChat that produced with the patterns of Internet information.Distributed Design (DD) based on artificial intelligence-assisted, large-scale collaboration and participatory open design projects to achieve the goal that everyone can design, such as providing electronic banner generation services based on big data algorithms. Or the Internet and crowdsourcing models based design tasks such as Pig Eight Rings, Luo Ke.According to the trend of China's existing Internet development, the author proposes the concept of distributed human resources (DL), which emphasizes the role of personal resource power in the context of informationization, such as micro-business, self-media operation, etc. The driving force for its development lies in the construction of a networked personal resource pooling platform, and the centralized organization of human resources to play its role in the creation of a knowledge economy.The distributed economy has penetrated various economic fields such as energy supply, upgrading of manufacturing industry chain, the Internet economy, and sharing of surplus resources. It has become an emerging force that promotes supply-side reform and transformation, transforming old and new kinetic energy, and solving fragmented economic surplus. At the same time, with the support of policies, it is expected to promote the development of social innovation such as mass entrepreneurship, poverty alleviation and lifestyle change.

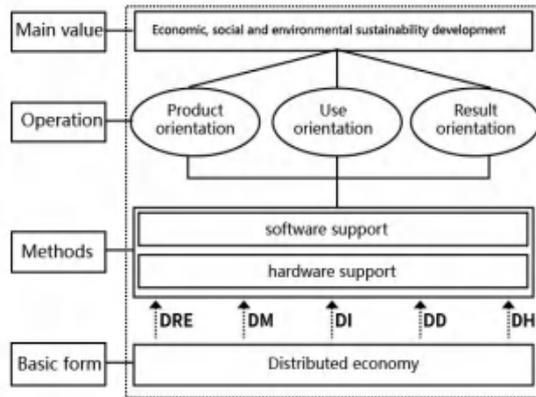
3. THE PSS APPLIED TO THE DISTRIBUTED ECONOMY

The concept of Product-Service System (PSS) was first proposed by the United Nations Environment Program in 1994, from the simple design and sales of "materialized products" to the provision of a comprehensive "product and service system" model to meet the unique needs of people. Manzini believes that Product Service Systems (PSS) is

an innovative strategy that shifts the economic model from focusing only on the production and sale of physical products to concentrate on the integration of products and services that meet customer needs (Manzini et al.,2001). Tischner U and Verkuijl proposed three major classifications that are widely recognized by the academic community: a product-oriented, usage-oriented and results-oriented product service system(Tischner U and Verkuijl,2006).

3.1 Organizational model

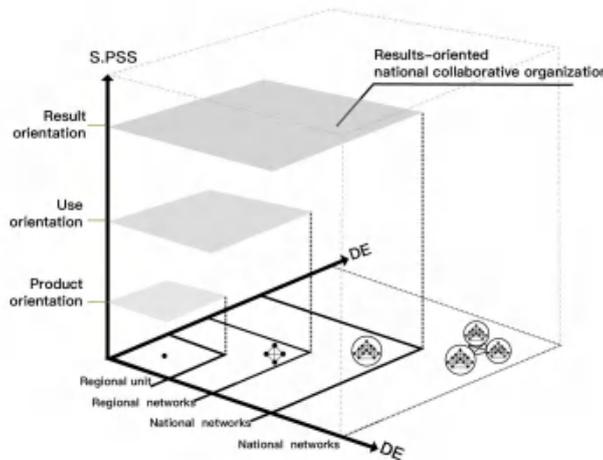
The product service system applied to the distributed economy can systematically think and plan information, funds, services, and materials in the region, and provide a variety of dimensionally oriented products and services to reduce costs and waste of resources(Fig1). The distributed economy of various forms is the underlying economic organization structure, such as 3D printing technology, laser cutting, cloud services, big data, natural language understanding, and other manufacturing technologies and artificial intelligence, which provides technical support and platform support to the operation of the service system. On this basis, we will gradually develop product-oriented, user-oriented, results-oriented products and services to meet the needs of users, effectively reducing energy consumption and commodity abandonment rate to achieve sustainable development goals.



[Figure 1] Organizational model of the product service system for a distributed economy

3.2 Collaborative network

According to the organizational scale of distributed production units, it divided into regional production units, local networks, national collaborative networks, and global collaborative networks. According to the classification of the product service system, it is divided into three levels: product orientation, use orientation and result orientation. Like a regional production unit, a small family-based power generation organization can purchase solar panels by itself and obtain related maintenance and after-sales services. This is a typical product-oriented product service. And if you get the energy you need by renting a solar panel, it becomes a use-oriented product service. you can also pay for the lighting function that meets the daily needs, without renting or buying. It is a result-oriented product service system. As we can see, In a distributed model, a large number of regional production units are interconnected to form a large collaborative network in Fig2



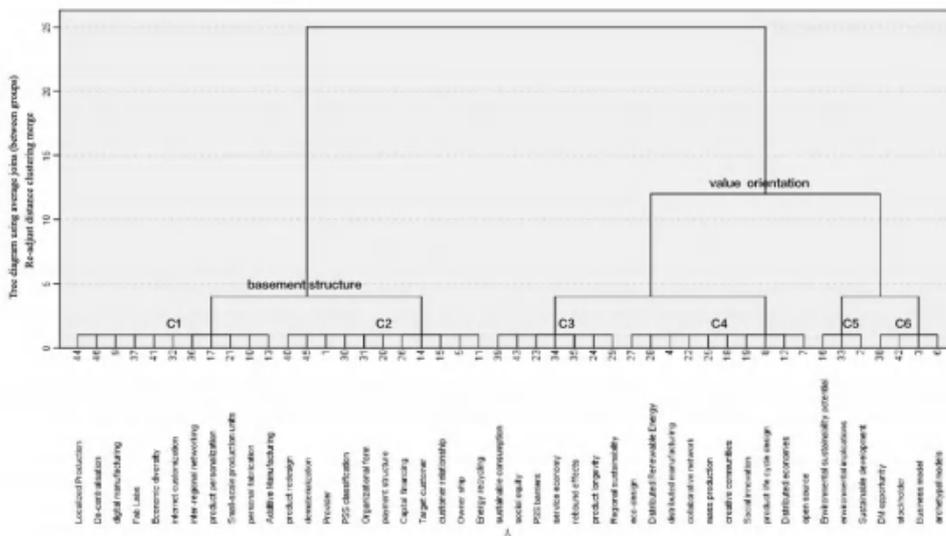
[Figure 2] Hierarchical Analysis of Product Service System Applied to Distributed Economy

3.3 Research focus and development trend

This article uses Python to crawl 15 important product service systems and distributed economic related research literature and calculate the word frequency distribution of keywords and represent these 46 keywords. The spatial

point is visualized to obtain a distribution map of keywords. Based on cluster analysis, 46 keywords divided into six groups of C1-C6(Fig 3).

C1 mainly studies the application of the product service system to the distributed economy from the perspective of the logical relationship between elements. The analysis shows the crucial components in this process: open source, payment structure, ownership, target customer, service provider, which are the fundamental guarantee for the operation of services. C2 mainly analyzes different scales and service scales from the perspective of organizational method management, such as regional network, personal customization, de-neutralization, economic diversity, localized production, etc., showing various forms of organization of the distributed economy. C3 mainly summarizes the value orientation of product service systems applied to distributed economy from the perspective of value proposition, such as extending product life, regional sustainable development, sustainable consumption, service economy, social equality, rebound effect and so on. C4 mainly discusses the research of basic service paradigm, which involves five primary forms of distributed economy, distributed energy, distributed design, distributed manufacturing, spread information, distributed software, etc, and also from the social level. Including social innovation, green design, product life cycle design. C5 is a breakdown of the factors influencing participants, focusing on the many obstacles and opportunities in the application process, such as the obstacles of PSS, the chances of DM, the limitation of business models, and the distinction of stakeholders. C6 emphasizes the application of product service systems to the assessment of sustainable potential in a distributed economy, such as sustainable development, environmental impact, and ecological sustainability.



[Figure 3] keywords analysis

3.4 Result

The current research mainly focuses on the logical relationship between organizational forms and elements, and refines the corporate scale and distribution of human and material resources of the product service system in a distributed environment. In the two areas of distributed energy(Silvia Emili et al.,2016) and distributed manufacturing(Petrulaityte A et al., 2017), we have achieved phased results. The author believes that the next phase of research focuses on how to improve service quality, service efficiency and coordination of the factors affecting participants. The methods and tools in the fields of management, engineering, and psychology can be learned.

4. CASE PRACTICE

4.1 background

The project depended on the LeNSin project with the European Union. The team of research comes from Hunan University and Tsinghua University. The project organized with the theme of “the sustainable of the human local food network” in conjunction with the Hunan Agricultural Internet brand “Huinong.com” in January 2018. From the perspectives of localized food and regional cultural heritage, sustainable agriculture.

4.2 Needs analysis

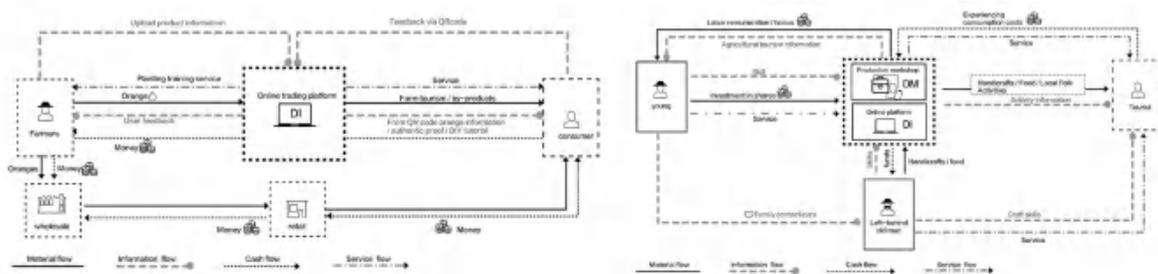
According to the survey, Chinese agricultural development still has problems such as the low degree of organization, relatively primitive and experienced production technology, severe shortage of infrastructure, and imperfect social service system(Xiang Ning,2018). It fully reflects the current industrial chain from agricultural has the features of distributed.

Therefore,In the early days, design tools was used to design from three dimensions: cultural inheritance, bottom-level people design, and agricultural production. The project has unearthed more than 20 demand points such as agrarian product cultivation training, agricultural product warehousing logistics, regional representative agricultural product promotion, left-behind elderly childrende so on.

4.3 System design

In the system design stage, with the help of design tools, it produces 14 design orientation based on distributed manufacturing (DM) and Information (DI) localized agricultural solutions. For example, in the design of community production service system based on distributed manufacturing (DM) for cultural inheritance and vulnerable groups, the needs of the left-behind elderly in the local community are included in the system thinking, through the establishment of an online service platform that displays information and skills sharing for the elderly. The sale of food and handicrafts hand-made by left-behind people is used to enhance and promote their sense of value and physical and mental health. At the same time, such distributed production workshops help young people in ethnic minority areas in Hunan Miao to make full use of local natural resources and cultural resources to promote local agricultural development and agricultural tourism activities. It not only meets the needs of tourists returning to nature, but also achieves the goal of reducing the number of young people going out to develop characteristic tourism in poverty-stricken areas, and promoting local poverty alleviation (Fig 4).

In term of designing a distributed information (DI) product service system for the distribution of specialty fruit and vegetable industries in Hunan Province, through the establishment of an online platform to open up information barriers between farmers and consumers, making enterprises, consumers, Multi-stakeholders such as farmers, governments and NGOs are considered in a system framework. Guided by consumption to avoid overproduction of food, and realize dynamic monitoring of production processes from production, processing, logistics, wholesale and retail to consumption. For the problem of local orange output, the online trading platform provides farmers with market information and agricultural planting knowledge. Farmers sell unsalable oranges to the platform and get a certain amount of compensation. Farmers sell oranges to consumers through distributed information online network platform. Consumers can understand the production process of oranges and DIY processing methods by scanning the two-dimensional code on the fruits, and conduct the online evaluation. The online platform collects these evaluations and feeds them back to the farmers to guide the production activities.



[Figure4] The example of case practice

5. CONCLUSION

By combining the relevant theories of distributed economy and product service system, this paper clarifies the organizational form, stratification strategy and design method of product service system applied to the distributed economy, and combines EU LeNSin project with Hunan local food network. It hoped that the sustainable product-service system (S.PSS) would be used to develop the potential of new economic and social forms, creating opportunities for promoting sustainable business models and innovative industries. At the same time, new tools and design methods will need to incorporate into this process. Helping the system continuously meets the requirements of economic, environmental and socially sustainable development.

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