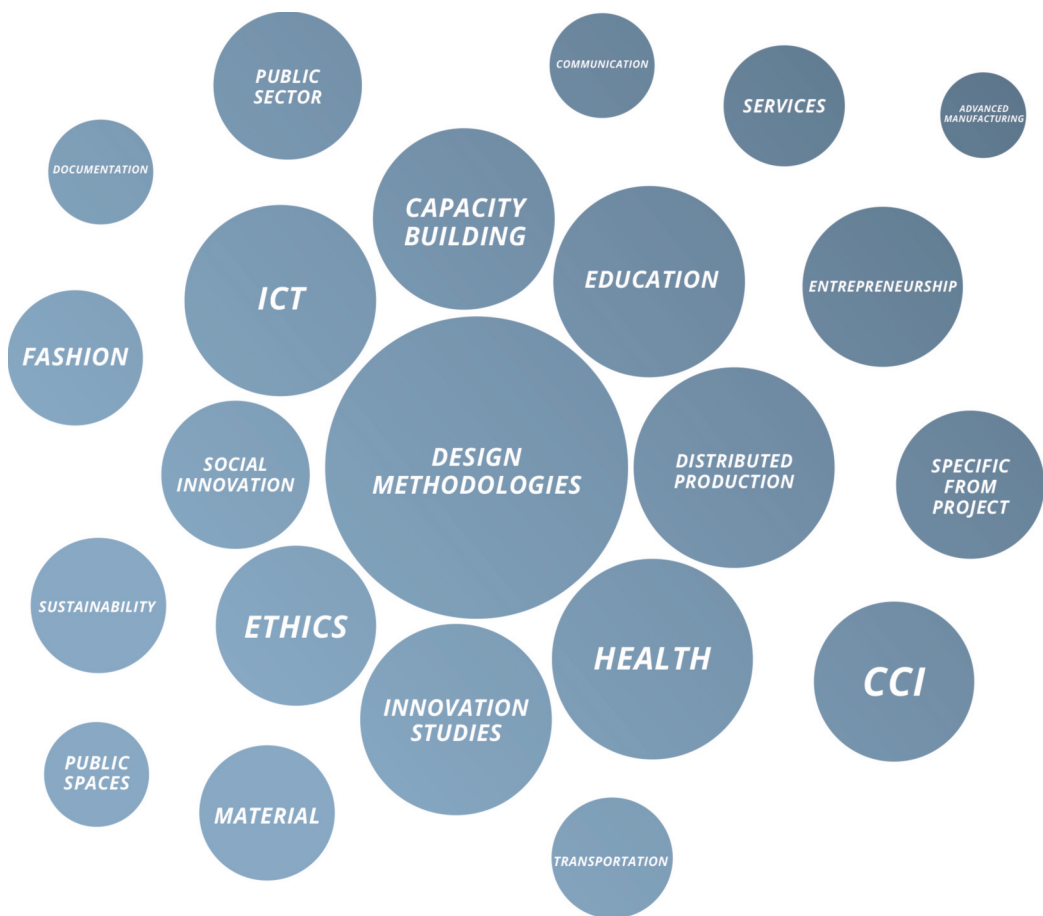


# SEVEN YEARS OF DESIGN RESEARCH AT POLITECNICO DI MILANO

Analysis of the funded research projects

edited by Francesca Rizzo



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Analysis of the funded research projects



edited by Francesca Rizzo

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## 5. The projects' outcomes: the analysis of the results in the medium-term

*Davide Spallazzo & Annalinda De Rosa*  
*Department of Design, Politecnico di Milano*

The chapter focuses on the outcomes of the design research, namely those results that can be defined as the achieved medium-term effects of an intervention's activities and outputs. It reports the results of the qualitative analysis conducted on 32 funded research projects, focusing on understanding the kind of outcomes of a project that is needed and able to contribute to achieving its objectives jointly. The study aimed at answering the following research questions: (i) what kind of outcomes have been produced in the projects? (ii) which outcomes are directly linked to the action performed by the Department of Design? (iii) are there commonalities among the diverse projects, or may we identify recurrent patterns? This analysis revealed how design research has a strategic role. Within interdisciplinary partnerships, the design discipline's contribution stands in the capability to bring and adapt its approaches, processes, and methods in the project to achieve objectives with scientific, social, and economic dimensions towards future transformations.

Despite the peculiarities of the diverse research projects, most share a common approach to the research and let emerge current evolutionary paths in the approaches and methods of the design research, widening its disciplinary boundaries, here discussed through the analysed research projects run at the Department of Design of Politecnico di Milano.

### 5.1 Framework

The desire to *scientise design* is one century old, as recalled by Nigel Cross in his renowned article for Design Issues (Cross, 2001) on the opposition between the design discipline and design science. It may be considered even a requirement when the design (science) must collaborate with others, as in the case of collaborative projects. The subjective speculation in art and

design, fiercely opposed by Theo van Doesburg already in the 1920' (Cross, 2001), must leave the floor to a recognizable and stable methodology (Koskinen et al., 2011) that must be applied to bring the expected results. Moreover, these results must be conceivable and, above all, measurable.

This tendency is even more evident in the Horizon Europe funding program that relies on *missions* (European Commission, Directorate-General for Research and Innovation & Mazzucato, 2018) that must be achieved with the contribution of every funded project, and necessarily, of every involved discipline. Suppose the missions' achievement represents the major impact of several projects (European Commission, Directorate-General for Research and Innovation et al., 2018). In that case, it is relevant to reflect on the smaller scale, analysing the results of every project and discipline.

Design makes no exception, and the present chapter is an attempt to analyse the outcomes achieved by the design research, namely those results that can be defined as the medium-term effects of an intervention's activities and outputs.

Outputs, outcomes, and impact are terms used to describe change at different levels. More in detail, INTRAC (2015) defines the outputs as the “products, goods and/or services which result from a development intervention”, and they have an operational dimension. In fact, they represent the short-term results of a research project: they must therefore be devised to produce outcomes, namely

The medium-term direct effects in the behaviour of target groups, under the control of the benefitting partner. The outcome is the likely or achieved short-term and medium-term effects of an intervention's outputs (European Commission, 2022).

The outcomes are close to the end of the results chain, following inputs and outputs and preceding the impacts, as they are informed by the outputs and, in turn, inform the impacts (long-term transformations).

It is clear, therefore, that outputs, outcomes, and impacts should never be independent elements, but are all needed components of a process that expands over time and, as said, by the scale of impact (short/medium/long-term). The European Research & Innovation agenda has clearly based its investment strategy on the so-called “Impact pathways” or “Pathway to impact”, defined in the Horizon Europe application documents as *the logical steps towards the achievement of the expected impacts of the project over time, in particular beyond the duration of a project. A pathway begins with the projects' results, to their dissemination, exploitation, and communica-*

*tion, contributing to the expected outcomes in the work programme topic, and ultimately to the wider scientific, economic, and societal impacts of the work programme destination.* A pathway is, notably, time-sensitive and reflects the non-linear nature and the complexity of R&I actions, based both on quantitative and qualitative methodologies and tools. As professor Mariana Mazzucato states, this overall strategy recognises that innovation has a direction: “by harnessing the directionality of innovation, we also harness the power of research and innovation to achieve wider social and policy aims as well as economic goals” in an ambitious, collaborative, and systemic way (European Commission, Directorate-General for Research and Innovation & Mazzucato, 2018, p. 4).

The ability to devise, achieve and then, analyse the outcomes reached in any research activity is of specific – and often undervalued – importance. In fact, if on one hand there is the need for measurable results and creating tangible and quantifiable outputs makes this need partially achievable, on the other hand addressing complex challenges requires a deep understanding of intertwined social, economic, political and technological aspects. Certainly, a future transformation represents an inspirational vision for any research project; however, any complex transition needs to be first explainable, understandable, accepted and then visible and effective to any target group involved to make change happen, especially beyond the project itself. Outcomes, in fact, have a strategic dimension and an ongoing role in facilitating the achievement of impacts. It is, therefore, relevant to analyse the outcomes reached by the design research, alone or in collaboration with other disciplines.

The chapter focuses specifically on the outcomes of the design research to provide a comprehensive view of those achieved by the researchers of the Department of Design of Politecnico di Milano in a sample of 32 funded projects. Does it report the results of a qualitative study aimed at answering three main research questions: (RQ1) What outcomes have been produced in the projects? (RQ2) Which outcomes are directly linked to the action performed by the Department of Design? (RQ3) Are there commonalities among the diverse projects, or may we identify recurrent patterns?

The main aim is to understand the nature of the achieved outcomes with a phenomenological approach, studying for each funded research project, which effects have been achieved in the medium-term (RQ1). Beyond this significant goal, the ambition is to track which outcomes may be directly linked to the role of the researchers of the Department of Design or, eventually, to identify specific contributions from the Design field (RQ2).

Despite the study being limited in terms of the sample (32 projects) and referring to a single institution (Politecnico di Milano), the study attempts to infer some shreds of evidence of the role of Design in funded projects carried out by consortia. Recognising commonalities across the different projects and identifying patterns (RQ3) is the strategy chosen to attempt the generalisation of the results that may primarily benefit the Polimi Design community and, eventually, the Design community at large.

Looking back at the projects carried out by the Department and analysing them is a precious opportunity to gain new awareness of the identity of the Department itself, understand where the research is moving towards, and open new perspectives. Accordingly, a further aim of the study is to frame the achieved outcomes both within the Department of Design and in the larger context (national and international), contextualising the Design research at different scales.

### **5.1.1 Methodology**

This study is part of a broader inquiry illustrated at the beginning of the book and analysed in detail throughout the chapters. Accordingly, it adopts the more general study methodology, consisting of the qualitative analysis of 32 funded research projects conducted by the Department of Design of Politecnico di Milano between 2014 and 2021.

In particular, the study described has analysed the projects' outcomes by triangulating data from official project documents (e.g., project reports, deliverables) and those collected through interviews with the principal investigators or their delegates. For each project, a list of outcomes has been created and further checked with the principal investigator or her/his delegate. The second action performed was to map the research projects' outcomes, aiming to contextualise them both within the Department and at the national/international level. The challenge here was to identify the criteria for grouping the outcomes, tagging them with categories relevant on the one side for the Department and, on the other, for the outer world.

In the first case, the choice was to stick to the keywords elaborated in 2015 on the delivery of the new Department website. They were proposed by each researcher with a bottom-up approach and then systematised. The resulting 113 keywords can be considered a self-portrait of the Department, made simultaneously as the projects under study were developed. They are organised into three broad categories: contents, approaches, and subject areas. Each category is, in turn, organised into subcategories containing key-

words, as later shown in the fig. 5.2. Each outcome has been analysed and tagged with one or more keywords taken from the list to identify commonalities and patterns. The PIs or their delegates then approved the selection of the keyword.

For the national/international level, the categories identified for the mapping are the 337 ERC keywords – and related descriptors – in their last available version dating back to 2020<sup>1</sup>. The choice of the ERC keywords is motivated by two factors: (i) The ERC sectors are recognized both at the national – Italian – and European level, being the analysed projects mainly at these two scales; (ii) They can be considered effective in covering all fields of science, engineering, and scholarship assigned to three research domains: Social Sciences and Humanities, Physical Sciences and Engineering, and Life Sciences. Furthermore, with the release of the new ERC keywords in 2020, the Department has been asked by the university research service to update the list of ERC keywords covered or partially covered by the research conducted.

Through a bottom-up approach, analogous to the selection of the Department keywords, every macro research group selected the ERC keywords more representative of the ongoing research. The result is another portrait of the research activity, dating back to 2020 and composed of 45 ERC keywords (out of 337).

Tab. 5.1 lists the selected ERC keywords. Moving from this selection, every project outcome has been associated with one or more ERC keywords.

<sup>1</sup> Panel structure for ERC calls 2021 and 2022: [https://erc.europa.eu/sites/default/files/document/file/ERC\\_Panel\\_structure\\_2021\\_2022.pdf](https://erc.europa.eu/sites/default/files/document/file/ERC_Panel_structure_2021_2022.pdf)

Tab. 5.1 – List of the 45 ERC keywords (out of 337) selected by the Department of Design.

Domain	Discipline	Keywords
Social Sciences and Humanities	SH1 Individuals, Markets and Organisations <i>Economics, finance, management</i>	SH1_9 Industrial organisation; entrepreneurship; R&D and innovation SH1_10 Management; strategy; organisational behaviour SH1_11 Human resource management; operations management, marketing
	SH2 Institutions, Governance and Legal Systems <i>Political science, international relations, law</i>	SH2_1 Political systems, governance
	SH3 The Social World and Its Diversity <i>Sociology, social psychology, social anthropology, education sciences, communication studies</i>	SH3_1 Social structure, social mobility, social innovation SH3_2 Inequalities, discrimination, prejudice SH3_4 Social integration, exclusion, prosocial behaviour SH3_6 Social influence; power and group behaviour SH3_8 Social policies, welfare, work and employment SH3_11 Social aspects of teaching and learning, curriculum studies, education and educational policies SH3_12 Communication and information, networks, media SH3_13 Digital social research SH3_14 Social studies of science and technology
	SH5 Cultures and Cultural Production <i>Literary studies, cultural studies, study of the arts, philosophy</i>	SH5_4 Visual and performing arts, film, design and architecture SH5_5 Music and musicology; history of music SH5_6 History of art and architecture, arts-based research SH5_7 Museums, exhibitions, conservation and restoration SH5_8 Cultural studies, cultural identities and memories, cultural heritage SH5_10 Ethics and its applications; social philosophy SH5_11 History of philosophy
	SH6 The Study of the Human Past <i>Archaeology and history</i>	SH6_1 Historiography, theory and methods in history, including the analysis of digital data SH6_13 Gender history, cultural history, history of collective identities and memories, history of religions SH6_14 History of ideas, intellectual history, history of economic thought

(continued)

Domain	Discipline	Keywords
Physical Sciences and Engineering	SH7 Human Mobility, Environment, and Space <i>Human geography, demography, health, sustainability science, territorial planning, spatial analysis</i>	SH7_4 Social aspects of health, ageing and society SH7_5 Sustainability sciences, environment and resources SH7_6 Environmental and climate change, societal impact and policy SH7_7 Cities; urban, regional and rural studies SH7_8 Land use and planning SH7_9 Energy, transportation and mobility
	PE1 Mathematics <i>All areas of mathematics, pure and applied, plus mathematical foundations of computer science, mathematical physics and statistics</i>	PE1_17 Mathematical aspects of computer science PE1_21 Application of mathematics in sciences
	PE5 Synthetic Chemistry and Materials <i>New materials and new synthetic approaches, structure-properties relations, solid state chemistry, molecular architecture, organic chemistry</i>	PE5_6 New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles
	PE6 Computer Science and Informatics <i>Informatics and information systems, computer science, scientific computing, intelligent systems</i>	PE6_8 Computer graphics, computer vision, multimedia, computer games PE6_9 Human computer interaction and interface, visualisation PE6_10 Web and information systems, data management systems, information retrieval and digital libraries, data fusion
	PE7 Systems and Communication Engineering <i>Electrical, electronic, communication, optical and systems engineering</i>	PE7_8 Networks, e.g. communication networks and nodes, Internet of Things, sensor networks, networks of robots PE7_9 Man-machine interfaces PE7_11 Components and systems for applications (in e.g. medicine, biology, environment)
	PE8 Products and Processes Engineering <i>Product and process design, chemical, civil, environmental, mechanical, vehicle engineering, energy processes and relevant computational methods</i>	PE8_9 Production technology, process engineering PE8_10 Manufacturing engineering and industrial design PE8_11 Environmental engineering, e.g. sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage PE8_12 Naval/marine engineering PE8_13 Industrial bioengineering PE8_14 Automotive and rail engineering; multi-/inter-modal transport engineering

(continued)



Domain	Discipline	Keywords
Life Sciences	LS7 Prevention, Diagnosis and Treatment of Human Diseases	
	<i>Medical technologies and tools for prevention, diagnosis and treatment of human diseases, therapeutic approaches and interventions, pharmacology, preventative medicine, epidemiology and public health, digital medicine</i>	LS7_11 Environmental health, occupational medicine LS7_12 Health care, including care for the ageing population

## 5.2 The outcomes of the design research

Describing the outcomes of 32 research projects (RQ1) is challenging since every project has its own aims and specificities. For the sake of brevity, we propose here a qualitative description of the outcomes of four projects as emblematic of the different nature of the research carried out between 2014 and 2021. The projects described in the following are three European-funded projects, *DeFINE – Developing a Fashion-Tech Innovation Network for Europe*<sup>2</sup>, *DDPM – Distributed Design Market Platform*<sup>3</sup> and *SISCODE – Society in Innovation and Science through CODEsign / Co-Design for society in innovation*<sup>4</sup>; the fourth one is *TAMBALI FII – Partiamo da qui*<sup>5</sup>, a social engagement and responsibility project developed in Senegal.

The selected projects' challenges and aims are presented below to briefly understand their general domains and then, to focus the attention on the role played by the design researchers in the achievement of such goals within the transdisciplinary context through their outcomes.

<sup>2</sup> DeFINE – Developing a Fashion-Tech Innovation Network for Europe” (2018-2020). Funded by the COSME Work Programme 2017. Polimi Principal Investigator and Project Coordinator: Prof. Paola Bertola.

<sup>3</sup> “DDPM – Distributed Design Market Platform” (2017-2021). Funded by the Creative Europe Programme (Support to European Platforms). Polimi Principal Investigator Prof. Stefano Maffei (2018, 2019) and Prof. Massimo Bianchini (2020, 2021).

<sup>4</sup> “SISCODE – Society in Innovation and Science through CODEsign / Co-Design for society in innovation” (2018-2021). Funded by the Horizon 2020 Programme (Integrating Society in Science and Innovation). Polimi Principal Investigator and Project Coordinator: Prof. Alessandro Deserti.

<sup>5</sup> “Tambali Fii, Ripartiamo da qui” [Let's start over here. E.d.] (2016-2018). Funded by the Polisocial Award, The social engagement and responsibility programme of Politecnico di Milano. Polimi Principal Investigator and Project Coordinator: Prof. Andrea Ratti.

DeFINE project aimed at developing European networks of Fashion-Tech business and financiers to support the growth and scaling-up of innovative start-ups and SMEs. Whereas the field of Fashion-Tech is still largely dominated by multinational firms (i.e., Yoox-Net a Porter, Google, and Apple), most of the European fashion industry is made up of start-ups and SMEs, which are struggling in adopting new technologies, market approaches and business models suited to foster their growth and their competitiveness in a global marketplace. To cope with these issues, the project's main aims were to: i) develop a European network of Fashion-Tech business to support organisations through mapping and networking events and a European Fashion-Tech Financier Network to support the growth and scaling-up of innovative start-ups/SMEs; ii) deliver a mentoring process to prototype products/services, processes, or market approaches for scale-up. Focusing the attention on the role that design played in the development of the project and in achieving the objectives, DeFINE is positioned in the design and entrepreneurship research area, where design-led research and approach to innovation could support vision and problem-framing/solving skills within managerial environments towards innovative entrepreneurial opportunities. More specifically, the design contribution here is not meant to support the development of ideas or innovation paths for specific ventures, but to play a core role in the change management of the whole system. To do so, the tangible actions delivered are the organisations of info days and bootcamps, training sessions towards a mentoring process to prototype either products/services, processes or market approaches, and community members platforms, to encourage transnational collaboration between incubators and accelerators, start-ups and SMEs, and financiers.

DDMP project has been developed under the Platform funding stream of the Creative Europe programme, supporting the development of connections between cultural and creative sectors with the related market environment through networking platforms, able to promote the role of Europe in the cultural sector and its connection with the development and coordination of global networks and supply chains. DDMP operated in the intersection of two global trends: the Maker Movement and the digitisation of the design discipline, focusing on the platform ecosystem for the Fab Lab network. Beyond the promotion and improvement of the connection between makers and designers with the European market, DDMP aimed at fostering the development and recognition of the emerging European Maker and Design culture by supporting makers, their mobility and circulation of their work, providing them with international opportunities, highlighting the most outstanding talent, and stimulating the creation of financially sustainable business

activities. The actions run to achieve these aims consists of both online and offline activities such as events, resources, workshops, fairs, and bootcamps that promote and advocate for emerging creative talent in Europe and their business productivity and sustainability through the resources put in place by the Fab Labs (project development, business models' definition, projects' labelling, promotion). Within the consortium, made up of fab labs and makers organisations, the Fab Lab of the Department of Design was the only partner with an academic profile: it promoted the creation of a common framework in each institution for the development, analysis, comparison and promotion of the projects through co-creation activities, workshops, interview results, pilot experiences; it also conducted a series of “design through prototyping” paths through training sessions, in order to design a repository guiding digital fabrication technologies as well as guidelines for documentation and repeatability of open source projects.

SISCODE project operated in the Responsible Research and Innovation (R&I) and Co-creation fields, experimenting with co-creation as a way to make R&I more responsible, integrating civic society in science and technology policy making. Public engagement and participatory approaches have gained momentum to address different scale societal issues, with the scope of mitigating the gap between the scientific community and society, making research more accessible, inclusive, relevant to practice, and responsive to real problems. Within these issues, the SISCODE focus and impact are twofold: experimenting with co-creation ecosystems under different societal, cultural, organisational, institutional, and regulatory conditions as (1) innovation communities where to grasp effective dynamics, and (2) playgrounds for policy makers where to gain knowledge on how co-creation and design methodologies can cross-fertilise RRI/STI practices and policies. In particular, the design researchers' role focused on ecosystems of co-creation, bridging the small-scale experimentations analysed and conducted within the project to potentially universally applicable co-creation. The importance of contextual factors and circumstances that need to be considered led to the development of a flexible model to understand and map the functioning and development of co-creation ecosystems through comparative analysis, co-creation and co-design sessions, towards the definition of assessment framework, operational tools (toolbox for co-creation and recommendations) and impact evaluation studies. A particular focus was taken on approaches to overcome the variety of barriers and challenges identified.

As the last project to be briefly presented, TAMBALI FII was in line with the European approach towards the migration issue, acting to combat the root causes of migratory flows. It aimed to generate a virtuous system that

fosters a process of social growth and economic independence for countries like Senegal, which is strongly conditioned by foreign economic interests and emigration phenomena. The project intended to develop nautical skills and promote research in the field of additive manufacturing technologies and Do It Yourself materials, to strengthen the local fish supply chain and promote entrepreneurial opportunities. TAMBALI FII supported the creation of a pole of technological and social innovation to transfer consolidated training models through courses and co-design workshops with students and local partner companies, enhancing the skills of local researchers, artisans, and entrepreneurs, and at the same time providing the tools to support the Senegalese fish market characterised by constantly growing local and international demand.

To better clarify the pathway to impact (European Commission, 2022), outcomes of the four analysed projects are grouped according to the project outputs that enabled the achievements of these results in the medium-term.

With the establishment of European networks through the creation of platforms and datasets, the constitution of a website mapping the network, and the building of online community members repositories, the DeFINE project achieved the enlargement of the Fashion-Tech network, increasing the interaction among incubators, accelerators, and other business support organisations able to then promote dialogue towards the growth and scaling-up of innovations. The development of capacity-building initiatives facilitated the realisations of those innovations, supporting the incubation of business ideas to get follow-up requests from financiers. On the other side, the organisations of info days and webinars, the building up of a mentoring program, and the creation of a toolkit were functional to stimulate knowledge sharing to further support the transition of business ideas to market, reviewing the business models. Finally, the creation of an impact assessment methodology and framework as well as an in-depth analysis of lessons learned were helpful to generate guidelines and recommendations for the creation of development policies and entrepreneurial support dedicated to the Fashion-Tech sector.

The framework defined and tested in the DDMP research brought out the enhancement of the role of design as discipline into the field of open and distributed production, demonstrating the effectiveness and replicability of i) “design through prototyping” scientific and project results to a broad and diverse audience to support the importance of prototyping, as well as ii) of a learning-by-doing process in real-life to advance digital fabrication knowledge and open design possibilities.

In SISCODE research project, the development of analytic outputs such as knowledge base construction, comparative analysis and assessment framework, built evidence-based knowledge on the effectiveness of co-cre-

ation and the adoption of design methodologies and tools for a better integration of society in science technology innovation policies, experimenting cross-sector co-creation methods as well as systematising RRI processes and tools. The development of co-creation/co-design sessions and events demonstrated the value of involvement of society in developing RRI solutions to explore responsible and impactful co-creation in innovation ecosystems and to strengthen and spread awareness on the culture of co-design.

TAMBALI FII achieved relevant outputs that contributed to the fulfilment of several outcomes. In particular, the creation of a framework for a training model, the setting up of training workshops, and the definition of guidelines for the replication of methods and practices contributed to the development of skills and knowledge. They were transferred to and taken by local actors and communities around the fishing sector on innovative manufacturing technologies and composite materials to promote an entrepreneurial mindset. The organisation of conferences, exhibitions, and co-design workshops, together with the development of prototypes and the starting of new projects, favoured the diffusion of wider acknowledgment and awareness of applying new technologies and materials as means to foster economic and social engagement growth.

### ***5.2.1 Recognising the design research contribution (RQ2): looking for commonalities (RQ3)***

What does it emerge in terms of medium-term effects of the above-mentioned activities and outputs delivered to address the specific challenges and to achieve the identified goals?

This analysis revealed how design research has a strategic role. Despite the peculiarities of the diverse research projects, most share a common approach to the research that appears human-centred, focused on actual needs, and keen on the implications of the actions conducted throughout the project, able to strategically face the relational, educational, and political transformations within the target groups. Research, by addressing complex transformations, needs to develop new knowledge creation paths to stimulate knowledge creation and sharing as well as its benefits towards educational, entrepreneurial, political and/or social opportunities and synergies. The analysed projects demonstrate the capability of design research to conduct practical and analytical explorations able to generate impactful new knowledge for system change, going beyond the sole – however fundamental – production of high-quality publications within the scientific community, therefore

favouring cross-fertilization. By committing to upskilling processes, design research has a role in strengthening human capital in research and innovation, favouring capability building and enhancing the impact of a design mindset through a high-quality intervention able to bring the whole system forward into a more desired state (Dorst, 2018).

The objective of creating networks of stakeholders is another common feature. The design research attitude demonstrates the capability to constitute a system, intensify cooperation between research bodies and other stakeholders, and create a system of transferred competencies in areas in which design is beginning to play a strategically important role. Multi-actor ecosystems become goals and means at the same time to reinforce collaboration and synergies between research and industry, government, and society. In this sense, design research at the Department of Design is progressively exploring the capability of adaptation and the evolution of its approaches and methods, making this an object of design.

Besides the evolution in the approaches and methods, the research portrays a continuous widening of disciplinary boundaries. Beyond the traditional fields of application – that appear somehow underrepresented in the analysed sample – the design discipline is progressively entering new domains. The distinctive feature of the design discipline to design innovations through its product (in the broadest sense, cf. Margolin in Buchanan & Margolin, 1995) is in fact applied to other fields by transferring evidence-based strategies for growth, scaling-up and replicability, always adapted to contexts. These innovations are not only product-based, ergo siloed into only technological or industrial advancements, but spread into policy solutions, social innovations, and life quality improvement.

### **5.3 Mapping the outcome inside and outside the Department**

The previous section described the outcomes of a sample of four projects, as representative of the 32 analysed, highlighting the design contribution in achieving those results and commonalities between the projects.

As already stated in the introduction, a further aim of the study was to map the outcomes achieved both within the Department of Design and outside it, to understand if the funded design research is in-line with Department identity and how it covers – or contributes to cover – the fields of knowledge. A mapping of outcomes according to different criteria may indeed provide an aggregate view, meaningful for conducting a critical analysis.

The methodology section introduced the strategy adopted for the mapping, based upon the Department keywords (inside) and the ERC keywords (outside). In the following, we show and discuss the results of the mapping.

### ***5.3.1 Mapping within the Department***

The 113 keywords defined by the Department in 2015 have been used as tags to mark the outcomes of the 32 research projects analysed.

As briefly introduced in the methodology sections, the keywords are organised into three typologies: contents, approaches, and subject areas.

Each category is, in turn, divided into other subcategories, as shown in tab. 5.2. In particular, the typology of the contents is organised into 9 sub-categories: Arts & Humanities, Design & Management, Health and Safety, Knowledge management, Production models, Representation systems, Responsible development, Social Innovation, and Urban landscape. The Approaches are divided into Design approach, Design process and methods, and Design research. Finally, the Subject areas are organised into 5 sub-categories: Communication, Interior, Service, Fashion, and Product. Each sub-category is then populated by the keywords.

Tab. 5.2 – The 113 keywords gathered grassroots from the community of the Department of Design in 2015 to describe its research.

Typology	Topic	Department Keywords
Contents	Arts & Humanities	Aesthetics Cultural and Creative Industries Cultural Heritage Design for Cultural Heritage Design History Museum Studies Semantics and Semiotics Visual Arts
	Design & Management	Change Management Competitive Advantage Design Policy Product Performance Service Assessment
	Health & Safety	Design for Older People Design for Subjective Well-Being Risk Evaluation Safety and Prevention Smart Systems Wearable Technologies
	Knowledge Management	Communication Process Data Visualisation Digital Archives Digital Platforms Information Design
	Production Models	(New) Craftsmanship Digital Manufacturing Distributed and Open Microproduction Local Craft Made In Italy Materials Networks
	Representation Systems	Augmented Reality Computer Aided Design Drawing(S) Parametric Design Reverse Modelling Virtual Models & Virtual Reality
	Responsible Development	Environmental Design Life Cycle Design Sustainable Energy Sustainable Lifestyle

(continued)



Typology	Topic	Department Keywords
Approaches	Social Innovation	Collaborative Services Corporate Social Responsibility Deintermediation Games for Change Gender Issues Welfare
	Urban Landscape	Mobility Smart City Spatial Design Temporary Living Traffic Management Urban Spaces
	Design Approach	Co-Design Creativity Cross-Cultural Research Design Driven Innovation Design for All Design Thinking Emotional Design Experience Design Metadesign Strategic Design User Centred Design
	Design Process and Methods	Case Studies Decision Making Envisioning Ethnography Interdisciplinarity Mapping Product Development Prototyping Scenarios Storytelling Transmedia Practices
	Design Research	(Design) Education Design Theory Epistemological Research Phenomenological Research Reflective Practice

*(continued)*

Typology	Topic	Department Keywords
Subject Areas	Communication	Basic Design Brand Communication Communication Design Game Design Graphic Design Interaction Design Media Studies Movie Design Packaging Design Synesthesia
	Interior	Exhibition Design Hospitality Design Interior Design Lighting Design Private and Public Spaces Retail Design Urban Design Yacht Design
	Service	Product Service System Service Design Transportation Design
	Fashion	Fashion Design Jewellery Design Knit Design Textile Design Texture Design
	Product	Car Design Colour Design Ergonomics Furniture Design Lighting Product Design Product Design Usability

The first analysis was conducted on the keywords associated with the project outcomes to highlight areas of density. Tab. 5.3 shows the results graphically. The areas coloured in dark grey highlight those keywords that were associated with several outcomes, while more desaturated versions of grey indicate a lower incidence of the keyword. Non-underlined keywords were not tagged to any outcome.

Tab. 5.3 – Frequency of association of Department keywords to the outcomes of the 32 projects analysed.

Typology	Topic	Department Keywords
Contents	Arts & Humanities	Aesthetics Cultural and Creative Industries Cultural Heritage Design for Cultural Heritage Design History Museum Studies Semantics and Semiotics Visual Arts
	Design & Management	Change Management Competitive Advantage Design Policy Product Performance Service Assessment
	Health & Safety	Design for Older People Design for Subjective Well-Being Risk Evaluation Safety and Prevention Smart Systems Wearable Technologies
	Knowledge Management	Communication Process Data Visualisation Digital Archives Digital Platforms Information Design
	Production Models	(New) Craftsmanship Digital Manufacturing Distributed and Open Microproduction Local Craft Made In Italy Materials Networks
	Representation Systems	Augmented Reality Computer Aided Design Drawing(S) Parametric Design Reverse Modelling Virtual Models & Virtual Reality
	Responsible Development	Environmental Design Life Cycle Design Sustainable Energy Sustainable Lifestyle

(continued)

**LEGEND**

**37-53% of the analysed projects**

33-20% of the analysed projects

16-10% of the analysed projects

3-6% of the analysed projects

0% not used

Typology	Topic	Department Keywords
	Social Innovation	<b>Collaborative Services</b> Corporate Social Responsibility Deintermediation Games for Change Gender Issues Welfare
	Urban Landscape	Mobility Smart City <b>Spatial Design</b> Temporary Living Traffic Management Urban Spaces
	Design Approach	<b>Co-Design</b> Creativity <b>Cross-Cultural Research</b> <b>Design Driven Innovation</b> Design for All <b>Design Thinking</b> Emotional Design Experience Design Metadesign <b>Strategic Design</b> <b>User Centred Design</b>
Approaches	Design Process and Methods	<b>Case Studies</b> <b>Decision Making</b> Envisioning Ethnography <b>Interdisciplinarity</b> Mapping <b>Product Development</b> <b>Prototyping</b> Scenarios Storytelling Transmedia Practices
	Design Research	<b>(Design) Education</b> Design Theory Epistemological Research <b>Phenomenological Research</b> <b>Reflective Practice</b>

(continued)

Typology	Topic	Department Keywords
Subject Areas	Communication	Basic Design
		Brand Communication
		Communication Design
		Game Design
		Graphic Design
		Interaction Design
Interior	Interior	Media Studies
		Movie Design
		Packaging Design
		Synesthesia
		Exhibition Design
		Hospitality Design
Service	Service	Interior Design
		Lighting Design
		Private and Public Spaces
		Retail Design
		Urban Design
		Yacht Design
Fashion	Fashion	Product Service System
		Service Design
		Transportation Design
		Fashion Design
		Jewellery Design
		Knit Design
Product	Product	Textile Design
		Texture Design
		Car Design
		Colour Design
		Ergonomics
		Furniture Design
Product	Product	Lighting Product Design
		Product Design
		Usability

The first consideration is that almost all the keywords were associated at least once with an outcome. This result opens up two considerations. The Department keywords (which are coeval with the projects) well represent the nature of the research projects running at that time (2015) and after (till 2021). Furthermore, the sampling of the 32 projects that were analysed in depth seems to well represent the nature of the funded research. In general, we may state that the two images of the Department, keywords and funded research, are partially aligned, resulting in a mostly coherent unique image. Looking more in-depth, it is evident that the typology Approaches counts most of the keywords in darker red, primarily related to design approaches and methods. In particular, co-design, design-driven innovation, user-centred design, and interdisciplinarity are the most cited keywords. This result

is largely predictable, as all projects were conducted in a fairly defined disciplinary area, sharing approaches and methods. Regarding the contents, it is evident that the keywords are more widespread and less polarised. This result entails a good coverage of the contents by the funded research with an exception: the area of the representation systems (e.g., augmented reality, parametric design, virtual reality) suffers from a lack of coverage of funded research in the considered timespan. The subject areas see a fair distribution of the keywords testifying to a good representation of the design subdisciplines in the funded research.

The second study on the keyword was more precise, in quantitative terms, counting every occurrence of the keywords in the outcomes. The results are graphically mapped in fig. 5.1.

The more detailed study confirms the previous results: larger dots, implying higher occurrences, are concentrated in the Approaches typology, while Subject areas and Contents see less polarised results, with smaller and more distributed dots. Looking more in detail at the subject areas, it emerges that fashion design has the larger dot, highlighting a very positive strand of funded projects in the field (e.g., DeFINE), followed by game design, product service system, and product design.

The Contents typology is the one showing more polarised results, with both big and small dots. This result is useful to understand which specific topics are sustained by funding within the same coherent group of topics. Taking the subcategory Arts & Humanities as an example, we may highlight how the Cultural & Creative Industries (CCIs) keyword is the most cited. On the contrary, more disciplinary topics such as Design History are much less represented. This result is not surprising, given the focus of Horizon 2020 on the CCIs, confirmed in the Horizon Europe Programme.

We may recognise the same behaviour in all the subcategories of the Contents. Bigger dots represent trending topics (e.g., production networks, design for subjective well-being, sustainable lifestyle, collaborative services, digital platforms). Smaller dots may indicate either a growing topic (e.g., gender issue) or a less represented one (e.g., environmental design). Instead, we can highlight thematic areas poorly covered by funded projects, such as the area of representation, which is characterised by small numbers of points and limited size. This condition may highlight the poor ability of the Department to get funding for trending topics such as virtual and augmented reality.

In summarising we may underline the most evident elements emerging from this mapping. The first is that the Department covers a great variety of topics in its funded research, as demonstrated by the rich use of keywords in

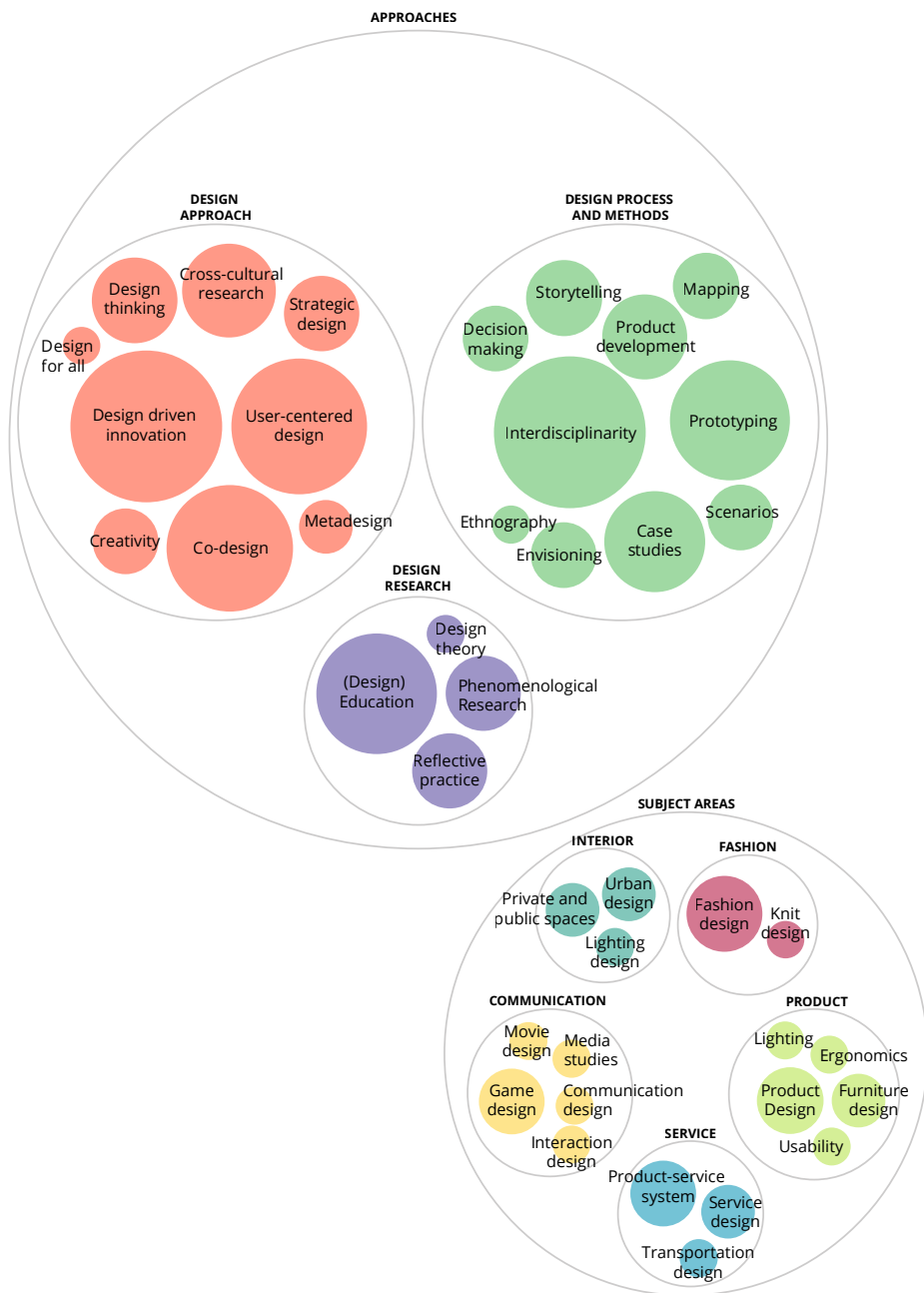
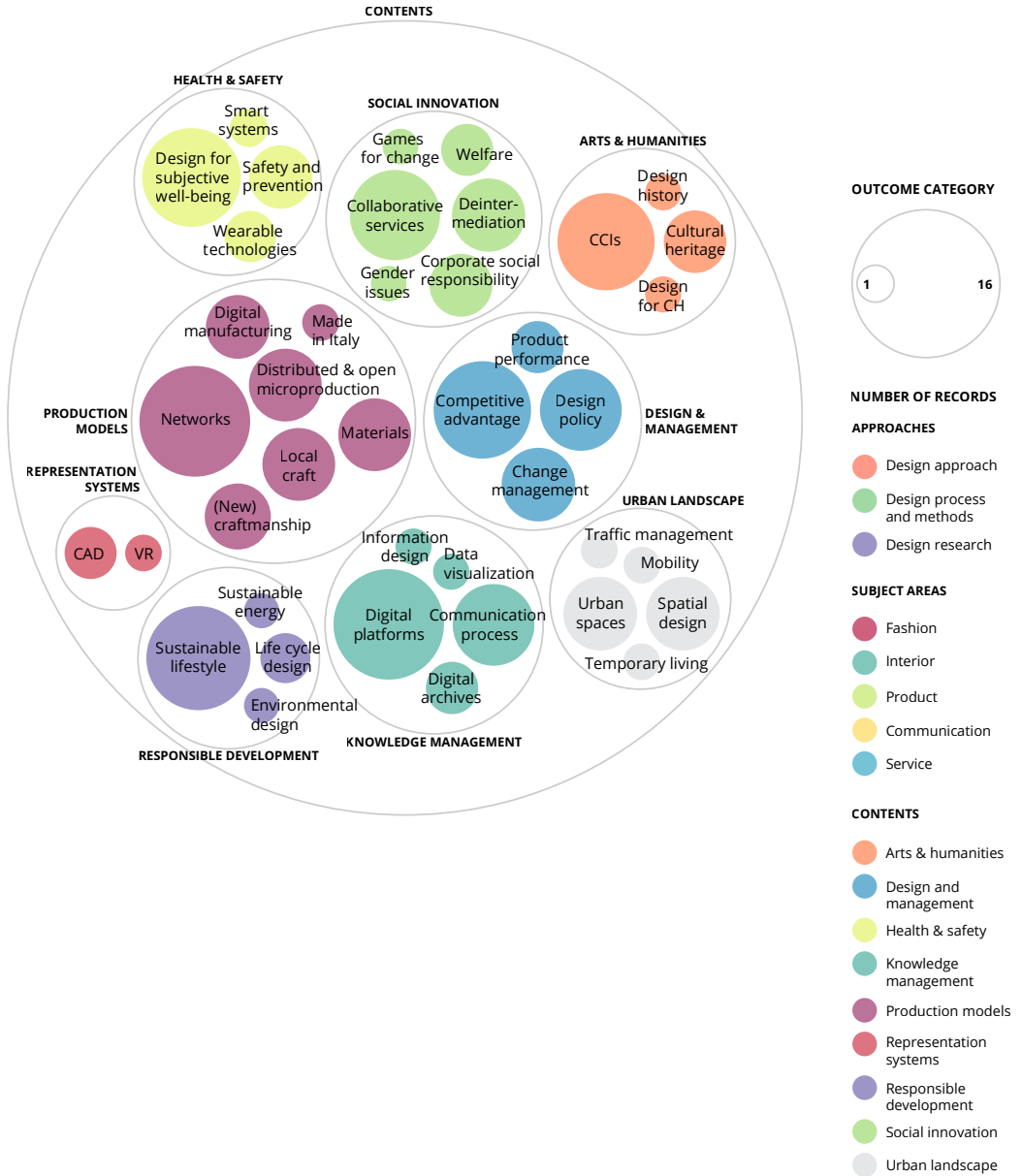


Fig. 5.1 – Occurrence of the Department keywords in the outcomes.





the outcomes. Common traits may be identified in the methodologies and in the approaches, that are the most shared keywords. Finally, we may pinpoint more popular topics (category Contents) that see higher occurrences in the outcomes.

### **5.3.2 Mapping in the national/European context**

The second mapping action was performed by looking outside the Department and precisely at the national and European contexts. More precisely, the mapping has been conducted against the 45 ERC keywords selected by the Department in 2020. As stated in the methodology section, one or more ERC keywords have been assigned to every outcome. The selection has been then discussed with the projects' PIs for approval.

The ERC keywords are essentially related to fields of inquiry and allowed to group the outcomes following a thematic approach efficiently. The considerations emerging from this part of the study are therefore primarily thematic and may highlight the Department-funded research's positioning.

The analytical inquiry has been conducted by counting the time every ERC keyword has been associated with the project outcomes. Fig. 5.2 aggregates the analysis results, grouping them according to the three main ERC fields.

At first glance, it is evident that most of the outcomes, and thus projects, settle in the Social Science and Humanities field, which counts a wider variety of selected keywords and more numerous occurrences. 19 keywords come from SH fields, 10 from PE and just 1 from LS. So, it is evident that not all the 45 ERC keywords selected by the Department to represent its identity have been mapped to the outcomes. Just 30, so two thirds of the total, have been associated. This result is not surprising. As we have repeated several times in the text, the sample of projects selected does not necessarily represent all the research conducted in the Department.

Delving deeper into the analysis, we can quantify the number of times an outcome was associated with an ERC keyword. Fig. 5.3 visualises the results by providing a ranking of the most tagged keywords with the number of occurrences. SH3\_11 – Social aspects of teaching and learning, curriculum studies, education and educational policies is by far, the most tagged keyword (17). This result is in line with the high number of research projects dealing with higher and vocational education. It is followed by SH3\_8 – Social policies, welfare, work and employment and SH1\_9 – Industrial organ-

isation; entrepreneurship; R&D and innovation both counting 12 occurrences. The first is related to social innovation projects, while the second returns a good presence of projects related to the field of Design & Management. PE8\_10 – Manufacturing engineering and industrial design is considered the ERC keyword par excellence of the Design discipline. It represents the main panel for evaluating projects stemming from that field in Italy. In the study, it only ranks fourth with 9 occurrences. Concurring with the general tendency to prefer ERC keywords from the SH field, this result is an important indicator to be carefully considered.

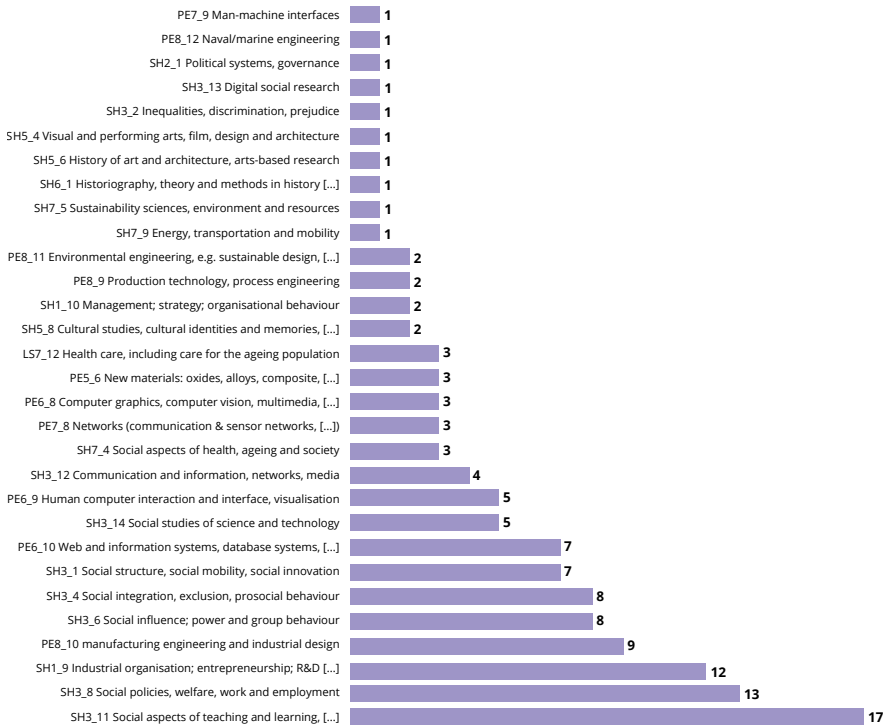
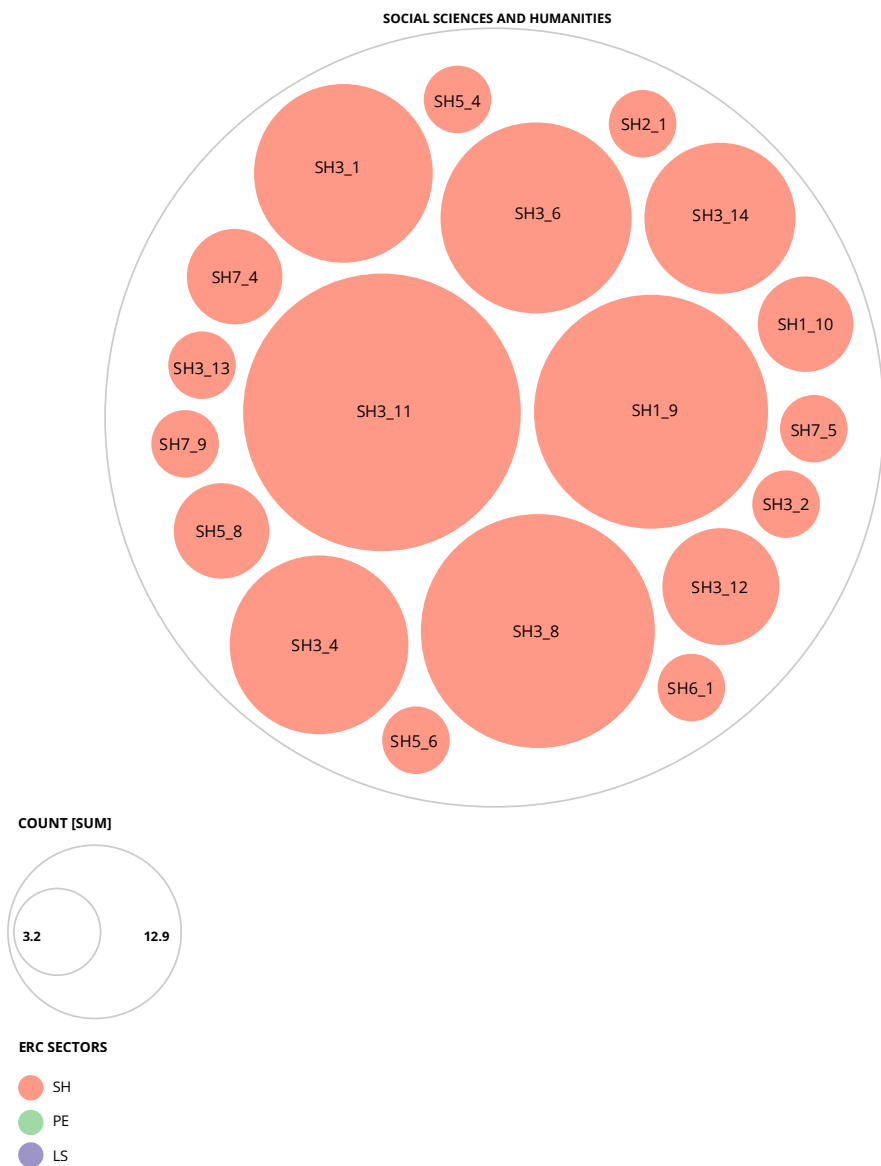


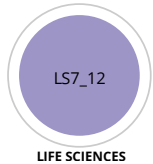
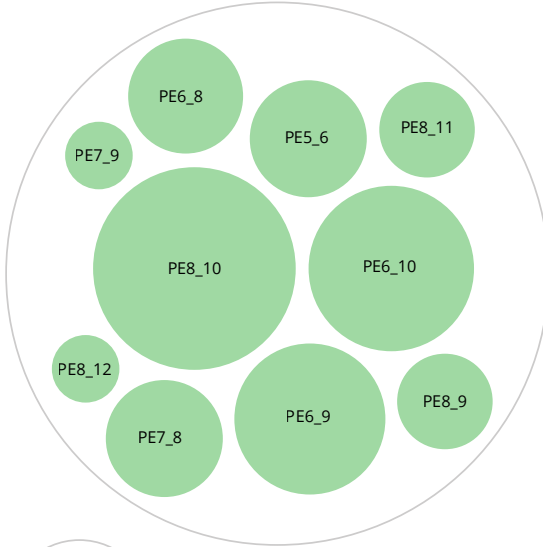
Fig. 5.3 – Quantified occurrence of the ERC keywords in the outcomes.

On the one hand, the result may be justified by the top-down approach of the funded research, which hardly funds projects strictly coherent with the traditional Industrial Design field. As seen in the previous section, it is more frequent that Design contributes to the projects with transversal approaches and methodologies adapting to the topics of the calls.



*Fig. 5.2 – Occurrence of the ERC keywords in the outcomes, grouped according to the three main ERC fields.*

**PHYSICAL SCIENCES AND ENGINEERING**



**LIFE SCIENCES**

- SH1\_9 Industrial organisation; entrepreneurship; R&D and innovation
- SH1\_10 Management; strategy; organisational behaviour
- SH2\_1 Political systems, governance
- SH3\_1 Social structure, social mobility, social innovation
- SH3\_2 Inequalities, discrimination, prejudice
- SH3\_4 Social integration, exclusion, prosocial behaviour
- SH3\_6 Social influence; power and group behaviour
- SH3\_8 Social policies, welfare, work and employment
- SH3\_11 Social aspects of teaching and learning, curriculum studies, education and educational policies
- SH3\_12 Communication and information, networks, media
- SH3\_13 Digital social research
- SH3\_14 Social studies of science and technology
- SH5\_4 Visual and performing arts, film, design and architecture
- SH5\_6 History of art and architecture, arts-based research
- SH5\_8 Cultural studies, cultural identities and memories, cultural heritage
- SH6\_1 Historiography, theory and methods in history, including the analysis of digital data
- SH7\_4 Social aspects of health, ageing and society
- SH7\_5 Sustainability sciences, environment and resources
- SH7\_9 Energy, transportation and mobility

- PE5\_6 New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles
- PE6\_8 Computer graphics, computer vision, multimedia, computer games
- PE6\_9 Human computer interaction and interface, visualisation
- PE6\_10 Web and information systems, database systems, information retrieval and digital libraries, data fusion
- PE7\_8 Networks (communication networks, sensor networks, networks of robots...)
- PE7\_9 Man-machine interfaces
- PE8\_9 Production technology, process engineering
- PE8\_10 manufacturing engineering and industrial design
- PE8\_11 Environmental engineering, e.g. sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage
- PE8\_12 Naval/marine engineering

LS7\_12 Health care, including care for the ageing population

On the other hand, the result may portray an increasingly pronounced tendency to widen the disciplinary boundaries of the Design discipline that is progressively entering new domains. Looking at the ranking in fig. 5.3, the impression is that, for what concerns funded research at Polimi, the traditional fields of application have already left the floor to less consolidated ones.

## 5.4 Discussion

This opening to new areas and disciplines entails on the one hand the enrichment in terms of outcomes that the design contribution may achieve. On the other hand, it requires a progressive acquisition of new vocabularies to enter constructive dialogues with new stakeholders. Within interdisciplinary partnerships, the design discipline's contribution stands in the capability to bring and adapt its approaches, processes, and methods in the project to achieve objectives with scientific, social, and economic dimensions towards future transformations. Through traditional design approaches and methodologies (i.e., phenomenological, constructivist, participatory, design thinking), and designerly methods and tools (i.e., co-design, workshops, toolsets, prototypes, seminars), design research acts towards the stimulation of knowledge sharing, and the diffusion of the wider acknowledgement and awareness of complex issues. In fact, the very notion of “research through design” (Frayling, 1993; Redström, 2017; Stappers & Giaccardi, 2017) – or “constructive design research”, as defined by Koskinen et al. (2011) to underline how design research outputs are key means in constructing knowledge – amplifies the nature of the design object and expands its sphere of influence in terms of enabling possibilities for actions (Margolin in Buchanan & Margolin, 1995, pp. 121–141).

Design research has brought into cross-sector and transdisciplinary collaborations its traditional capability to address complexity, with a relevant focus on the social (social innovation and sustainability, policy innovations) and entrepreneurial dimensions, where the educational one assumes a transversal role in transferring the design mindset (reflexive, contextual, iterative, hands-on skills, and process-oriented visions). A distinctive design trait also emerges here, with a tacit contribution that is gradually building its foundations related to research that must be necessarily explicit and measurable in methodology, analytical perspective, and result (Poggenpohl, 2015).

Therefore, by expanding the design object to what was previously unthinkable for design, new avenues open for design research as drivers to bring already established design approaches and processes to other areas. Of

course, this implies that objects that were previously unknown or unfamiliar to the design discipline require preparation because it means entering areas not traditionally covered and building the foundations for distinctive and scientific methodologies and tools.

Consequently, an extensive reflection on semantics issues still requires to be fully explored to sustain the dialogue with other disciplinary areas. Considering the cyclical evolution of complexity that knowledge faces, we know that disciplines (human, social, technical ones) need to reframe the way they approach it and how they relate to each other in a collaborative way: hybrid literacies are required as well as further reflections around the implications of transdisciplinarity, specifically in scientific research. Regardless of the domain, a specific transdisciplinary approach must be envisaged to break the boundaries and expand the approaches. For the design discipline, this also requires going beyond “the concept that makes design the glue that can hold different disciplines together and uses design thinking as the methodology” (Kelley & VanPatter, 2005, p. 3) to better understand internal and external tensions towards continuous transformation. To reflect on the continuous change of the positioning of design in relation to education and research, an evolutionary path on the same design transdisciplinary skills, knowledge and attitudes needs to be nurtured to adapt to the space of transdisciplinary research and innovation.

## 5.5 Conclusions

The presented analysis on the effects achieved in the medium-term and on the evidence of the role of Design in a sample of funded projects brought us to a wider reflection on the current drivers of change of design research, especially within interdisciplinary partnerships. Research projects developed within funding programmes like the ones considered in this study requires the clear explication of impact pathways, and therefore of achievable outcomes: this requires an operational approach and the setting of the direction for innovative change (European Commission, Directorate-General for Research and Innovation & Mazzucato, 2018). The study points out that the research projects run by the researchers of the Department of Design of Politecnico di Milano is strongly heading towards the social science and humanities field and is devoting its capabilities to strategic transformations at managerial, organisational and systemic levels in various fields. A transformation of internal skills, moving beyond the object of design and questioning its traditional and acknowledged focus. The top-down approach of the funded

research may have influenced this shift; our opinion is that, more than this, the inspirational goals of European and national funded research are opening to stimulating challenges to achieve effective change and to transformative objectives for the design discipline.

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Which are the main research funds currently accessed by the Department of Design? What are the topics explored through them and which are the interconnections with the Department core research activities? Also, what are the research products delivered, the reached outcomes, and the expected impacts BY these research projects?

The book synthesises the results of a qualitative analysis conducted over 32 research (out of 96) projects coordinated or participated in by the researchers of the Department in the timeframe 2014-mid 2021.

The results of the analysis confirm the high-level attractiveness of the Department research profile on core topics such as design methodology, service design, and health.

However, more interestingly, the analysis shows a significant variety of new topics and themes that emerge as new research questions for the Department, such as the role of design in public sector innovation, ethics, or policy design.

The publication provides a snapshot of the topics addressed through the competitive research projects, the dimension of such strands of investigations, the typology and features of results achieved, as well as their relationship to the Department's basic research lines.

The relationship and interplay among the outputs, outcomes, and impacts of the funded research is then elaborated in impact pathways, opening up reflections about the upcoming and future of Design research. The findings of the analysis aim to capture the present to understand future directions in terms of scientific, societal, technological and economic aspects.

The volume addresses an academic audience from long terms researchers the field of design and other closely related scientific-disciplinary fields at the national and international levels, to young researchers approaching the world of design research.