Emerging Technologies as Enabler of Sustainable Business Model Innovation: Evidence from Space Tech New Ventures

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Keywords: Business Model Innovation, Space Technologies, Emerging Technology, Sustainable Development Goals, Space Economy, Business Model, Lean Startup.

Abstract: The growing humanitarian and environmental challenges our planet and society are facing today made the United Nations ratify the so-called 2030 Agenda for Sustainable Development, which encapsulates 17 Sustainable Development Goals (SDGs) with the aim of promoting social, environmental, and economic objectives. For commercial companies, embarking into sustainability is not an easy task, because of different tensions between profit and impact that make it difficult to fully align the commercial activities with the sustainability ones within the company's business model. By mean of a multiple-case study analyzing 11 startups in the New Space Economy domain, this research sheds light on the use of the emerging satellite technology as enabler of sustainable business model innovation, adopting a technology-perspective in the mitigation of the so-called transaction obstacles to sustainability, making it clear how emerging technologies' features may represent a solution to embed SDGs in firms' business model.

1 INTRODUCTION

In 2015 the United Nations ratified the so-called 2030 Agenda for Sustainable Development, encapsulating 17 Sustainable Development Goals (SDGs) aiming at promoting social, environmental, and economic objectives. The SDGs has been welcomed on a global scale as a framework to be adopted by any organization pursuing sustainability (Saito et al., 2017; Mio et al., 2020). Anyway, when it comes to commercial companies, embarking into sustainability is not an easy task, because of different tensions between profit and impact that make it difficult to fully align the commercial activities with the sustainability ones within the company's business model (BM) – intended as the firm's realized strategy in terms of value creation, delivery, and capture mechanisms (Teece, 2010). In this context, technology may play a fundamental role in dampening these contrasts for both startups and well-established companies (Foss and Saebi, 2017). More specifically, new space technologies are drawing attention of researchers and practitioners as an unconventional though powerful means to foster the attainment of SDGs (Balogh et al., 2018): however, the relationship between these unconventional sources of innovation and the process of sustainable business model innovation is yet to be explored. An exploratory multiple case study was performed on eleven companies where new space technologies constituted the driver of sustainable business model innovation, with a specific focus on how new space technologies enable to embed SDGs in the business model components. Our study proposes a model of new space technologies levers for sustainable business model innovation. Our findings reveal that new space technologies' features – namely *Performance, Ubiquity*, and *Convenience* – can act as levers for the innovation of the different business model value mechanisms. Such innovation may become core for overcoming the transaction obstacles (i.e., *Unwillingness to Pay*, *Difficulty of Access*, *Inability to Pay*) generally faced by for-profit companies pursuing sustainable objectives, thus allowing them to embed SDGs in their business model without giving up profit. The contribution of our study is two-fold. First, it aims at filling the theoretical gap between business model innovation for sustainability and emerging technologies. To this extent, we shed light on the possibility to go beyond the consideration of technology diffusion features, showing how the their inner characteristics may

Manotti, J., Ghezzi, A., Rangone, A. and Balocco, R.
Emerging Technologies as Enabler of Sustainable Business Model Innovation: Evidence from Space Tech New Ventures.
DOI: 10.5220/0011828300003467
In *Proceedings of the 25th International Conference on Enterprise Information Systems (ICEIS 2023) - Volume 2*, pages 546-552
ISBN: 978-989-758-648-4; ISSN: 2184-4992

enable sustainable business model innovation. Second, the study adopts a technology-perspective towards sustainability, highlighting the association between the transaction obstacles to sustainability and the technology features that may represent a solution to mitigate them, allowing firms which adopt such technology to implement a sustainable business model innovation.

2 THEORETICAL BACKGROUND

In the last two decades, scholars have started to introduce the business model (BM) as a substitute concept for strategy-execution, given its boundary-spanning and holistic nature which at the same time privileges the decision-maker perspective (Lanzolla and Markides, 2020; Bigelow and Barney, 2020). Defined as the system of activities that a focal firm and its core partners perform in order to create and capture value, it has been highlighted how it may serve as "locus of innovation" itself, meaning a potential source of competitive advantage beyond the most traditional product and process innovation, thus coining the term "business model innovation" (BMI) (Amit and Zott, 2020). Defined as the "non-trivial" modification of one or more activities performed by the firm, as well as the potential mechanisms linking them, Foss and Saebi (2017) point out how relevant streams of research to further develop are represented by the use of technologies to enable BMI, as potentially with a sustainable-oriented purpose. Within literature, a sustainable business model innovation is defined as introduction of sustainable value inside the business model by incorporating economic, social or environmental benefits in its components (Geissdoerfer et al., 2018; Ueda et al., 2009; Evans et al., 2017; Shakeel et al., 2020). Santos and colleagues (2015) identified three transaction obstacles preventing sustainable projects to come to light, related to low perception of value embedded in the product or service offered, which leads to the unwillingness to pay of customers, especially when targeting individuals feeling the day-to-day pressure of poverty or those who are excluded and disadvantaged (Nicholls & Dees, 2015). A second problem found is that sustainable products and services are over expensive (Davies & Chambers, 2018), hence potential customers who would greatly benefit from them (Seelos & Mair, 2005), cannot afford their prices, due to their inability to pay (Santos et al., 2015). Finally, the difficulty of access represents a third major obstacle (Santos et al., 2015) since the attention must shift from targeting mainstream customers towards targeting niches of sustainable customers (Davies & Chambers, 2018) who usually live in remote or rural villages that are difficult to reach due to their location (Santos et al., 2015).

Despite the claimed potential in the role of technology as potential enabler of sustainability, very few papers open-up the inner characteristics of the technology itself, meaning looking at the inner characteristics enabling the creation of the innovation, taking instead a more high-level perspective. From the development of the Internet, new technologies are constantly emerging and taking their space in the firms' daily activities, possibly representing significant game-changers which deserve the necessity to be finer explored (Rotolo et al., 2015). Very often, new ventures take the role of explorer of new and emerging technologies to create innovative business models (Foss and Saebi, 2017).

3 METHODOLOGY

The theoretical background at the intersection of business model innovation, emerging technologies and sustainability, led us to formulate the following research objective: *how do new ventures may leverage the inner characteristics of an emerging technology as vehicle to achieve sustainable business model innovation*?

Since the topic of sustainable development has not yet been studied by researchers when referring to space technologies and firms' business model, we proceed by applying a qualitative approach (Gartner & Birley, 2002). In particular, the decision was to conduct an exploratory multiple case study (Yin, 1984; Eisenhardt, 1989; Eisenhardt & Graebner, 2007), which suits research questions responding to a "why" or "how", when the investigator does not have control over events and when the focus is on contemporary events (Yin, 1984) – all characteristics complying to our research objective. In particular, a multiple case study approach has been chosen because the literature has recognized that it is more robust compared to a single one (Yin, 1984), and it allows to obtain generalized results, enabling comparisons among different manifestations of the phenomenon (Meredith, 1998; Eisenhardt & Graebner, 2007).

3.1 Case Sampling

One of the most recent emerged technologies is represented by satellite technology (Pelton, 2019), recognized as potential drivers o foster sustainable growth for successfully implementing the 2030 Agenda (Balogh et al., 2017; Pelton, 2019). This opportunity is witnessed by more and more startups, , which see in space a possible area of business, driving the so-called "New Space" phenomenon (Dos Santos Paulino, 2020; Denis et al., 2020).

The selection have leveraged two main sources: an original database of space-based startups containing more than 500 companies, and LinkedIn through which it has been possible to attend different online events and get in contact with some of these ventures. Firstly, following Balogh et al. (2017)'s classification on how space technologies can support the 2030 Agenda, it was chosen to consider only startups with a contribution to the SDGs achievement. Second, following the definition of emerging technology proposed by Rotolo et al. (2015), we select satellite technologies in the fields of communication and earth observation. Particularly, the authors stated that to be considered "emerging" a technology must respect five key attributes: novelty, relatively fast growth, coherence, prominent impact, uncertainty, and ambiguity. It has been noticed that, while novelty, relatively fast growth and coherence are fully satisfied by all types of space technologies, when coming to the radical novelty and prominent impact characteristics communication and earth observation satellites are more representative than navigation systems. Indeed, the former allow to provide services that are unique and with an increasing value and have a high impact in terms of socio-economic benefits and number of industries affected. In contrast, the latter are more redundant and do not enable new and innovative applications (Pelton, 2019). Consequently, only startups leveraging either Earth observation or communication satellites were included in the final sample. At the end of the three main steps, a final skimming was performed in order to ensure the heterogeneity dimension, hence for each startup sub-criteria like the headquarter site, kinds of SDGs addressed, founding year and maturity stage (linked to the total financing raised) were considered. An overview of the cases and the informants' role is provided in Table 1.

3.2 Data Collection and Analysis

This research started with a lack of theoretical background, and it was not possible to identify the theory to which the findings could be connected to a priori (Eisenhardt, 1989; Bansal & Corley, 2012). For furthering empirical evidence, several interviews with founders and C-levels have been conducted (Meredith et al., 1989). The informants were considered *"*knowledgeable agents*"* able to provide evidence concerning their thoughts and intentions (Gioia et al., 2013, p.17). The researchers collected the data without influencing with their believing and knowledge the information gathered, and this approach led to the unveiling of new observations, rather than focusing on existing knowledge (Gioia et al., 2013). Ultimately an "analytic generalization" (Yin, 1984, p. 31) has been conducted to combine existing theories with the empirical evidence gathered from case studies. In order to provide evidence on the statements resulting from the qualitative research process and to increase the robustness of the results obtained (Eisenhardt, 1989), primary and secondary sources of information were used and combined to ensure the so-called data triangulation. The primary dataset mainly consisted of in-depth, semi-structured interviews carried out with informants from the companies. A predefined number of questions have been used by the interviewers to start the interviews and to explore focal issues identified during the study objective phase. Nevertheless, there was a relevant level of flexibility that enabled the exploration of new concepts holistically emerging during the open and unrestricted discussion (Yin, 1984). The focus was on understanding how space technologies characteristics can have an impact on each startup's business model in a way that fosters SDGs. Once analyzed every single case, a cross-case comparison between the different startups was performed in order to highlight and describe points of similarity and points of difference, being able to the identify the most relevant variables to address the research objectives. Each case has been studied by adopting the open coding practice from Grounded Theory methodology (Glaser & Strauss, 1967; Strauss & Corbin, 1998). Hence both informants' word (in vivo codes) and codes constructed on it by the analyzers have been used to develop an inductive coding tree to describe the themes investigated. This is a holistic approach to the inductive concept that provides rigor to qualitative research (Gioia et al., 2013).

Following the methodology proposed by Clark et al. (2010), codes belonging to the different cases have been iteratively compared to aggregate them in first-

order concepts. Afterwards, to ensure a higher level of abstraction, first-order concepts have been further grouped into second-order categories. A comparison of the eleven cases in terms of first-order concepts, second-order categories and overarching dimensions was performed in order to identify similarities and diverging patterns. This allowed to obtain novel findings by analyzing the available data (Eisenhardt, 1989) and consequently, to inductively generate an empirical model regarding how emerging technologies can enable startups to achieve sustainable business model innovation.

Table 1: Overview of the Cases.

Startup	Space Technology Leveraged	Informant Role
A	Satellite Communication	Co-Founder & COO
B	Earth Observation	CEO & Chairman
C	Satellite Communication	Co-Founder & CEO
D	Earth Observation	Co-Founder & CRO
E	Earth Observation	Co-Founder
F	Earth Observation	Co-Founder & CEO
G	Satellite Communication	Co-Founder & CEO
H	Earth Observation	Vice President, Sales & Marketing
I	Earth Observation	CEO
J	Earth Observation	Co-Founder & CSO
L	Earth Observation	Co-Founder & CEO

4 RESULTS

4.1 Space Technologies' Performance as a Solution to the Unwillingness to Pay

Several startups such as F, I, H, J, and L, declared that their business has the objective of solving the problem of low-quality products or services in their sector. For example, H's VP Marketing and Sales explained: *"if you start trading emission credits, you need to be able to have accurate measurements of these, because otherwise the whole system does not have as much integrity. [...] the measurement methods and the technologies that were being used were not accurate. They were not easy to use."*. From the analysis it has emerged that the consequence of such low-quality information is the loss of trust from the clients, as explained by J's Co-Founder: "*most farmers who have been in touch with weather forecast […] don't trust it because it was not good quality"*. Therefore, the startup took a couple of years of research to build a system that could overperform the standard global weather forecast models, with the main scope of building up the trust of their customers, who *"once they have started using the service […] tend to stay on. And that I think is the best evidence that service is useful for the farmers"* (Co-Founder of J). This concept of the lack of trust in services that are not accurate has been reiterated also by L's CEO, who, when talking about the incumbent technology, affirmed "*it was very prone to error, and as a result of that companies were not necessarily trusting carbon credits, and in parallel, forest owners and project developers were having a hard time certifying it"*. Also in this case, they "*use the satellite data to bring more transparency and trust to the relationship, but also to help the relationship happen"*.

Therefore, from the interviews it has emerged that with rough estimates and prone to error data, it is very difficult to provide valuable services and it is even more difficult to convince the customer of the value of the offer, leading to their *Unwillingness to Pay*. In this context, the innovation provided by space technologies' performance seem to be a valuable solution. Indeed, it seems that space-based services are more reliable and trustfulness and for this reason, it is easier for end users to recognize the value embedded in the offer, also when it comes to services that aim to provide positive impacts on the society, the economy, or the environment.

4.2 Space Technologies' Ubiquity as a Solution to the Difficulty of Access

In other cases, the main problem addressed by the startups resulted to be the difficulty of reaching remote areas. For example, when talking about the characteristics of space technologies that are key for their business, E's Co-Founder affirmed: *"I think the first one is ubiquity. So, the problem for smallholder farmers is that they are in very remote places. Usually in places where there are not real infrastructures"*. Hence, satellites' ubiquity is fundamental to their aim of addressing smallholder farmers excluded from traditional insurance services, because it offers a valid

solution to the issue of remote places lacking all the technological equipment. Along the lines of this is the example provided by G. Their mission is to *"bring connectivity in rural or remote places"* (CEO of G), where it is not accessible *"either because infrastructure did not exist, or existing solutions were prohibitively expensive"* thanks to their proprietary satellites' coverage. Moreover, J's Co-Founder affirmed to solve the problem that *"in Africa there are not many ground-based weather observations"*, by *"using satellite derived products [...]because we have access to these sorts of derived products in areas where you don't have ground observations"*.

Therefore, this demonstrates that the capability of satellites of reaching every part of the world can be leveraged to overcome the *Difficulty of Access* transaction obstacle that traditional companies face when targeting remote areas, especially with impact-oriented objectives.

4.3 Space Technologies' Low-Cost as a Solution to the Inability to Pay

The last problem – or market opportunity – emerged as tackled by the startups in the sample is represented by the high prices of the competitors. The CEO of G, about their customers affirmed: *"They also do not typically have large operating budgets to spend"*. Hence, they are "*committed to supporting these types of organizations and the work they do by giving them access to the type of communication network they need, at an affordable price."* Similarly, in the case of E, thanks to the fact that they use freely available data and thus have low costs, they can serve those microinsurance organizations that work with poor farmers in developing countries, which are traditionally excluded by insurance because too expensive for their low incomes. On this line is also the example provided by H, indeed for what concerns the traditional competitors providing emission monitoring services, *"the measurement methods and the technologies that were being used were also very costly",* whereas their technology "*allows them to do that, but to do that at the lowest possible cost"* (Vice President Sales and Marketing of H). Thanks to the low-cost of the data, also J is able to provide a service that costs only "*two euros cents per SMS […] If they want to receive every day for a whole year it would be 7€ per year"* which represents a *"very low cost compared to, for example, the price for other inputs like fertilizer, or pesticides. Something like 1 or 2% of the cost of that.* (Co-Founder of J).

Hence, it emerges that having a business model with a value capture mechanism able of lowering the final price of a product or service may allow many people traditionally excluded to be targeted as customers. Therefore, space technologies can be adopted to overcome the *Inability to Pay* of some potential customers, traditional obstacle encountered by commercial companies exploring sustainability purposes.

5 DISCUSSION

There is a common understanding that enterprises must have an active role in attaining sustainability, yet pursuing a dual orientation is complex due to tensions and contrasts between profit and impact (Pache & Santos, 2013; Doherty et al., 2014; DiVito & Bohnsack, 2017; Tykkyläinen & Ritala, 2021). These conflicts generally arise due to a series of obstacles and barriers to sustainability, which have been explored within academia and empirically emerged by the results of this study (Santos et al., 2015).

The empirical model we derived sheds light about how the inner characteristics of an emerging technology can act as levers for the innovation of the business model in sustainable terms. Specifically, we show how they enter the business model in the value creation component as originally conceived by Amit and Zott (2001), enabling three sustainable business model innovation mechanisms:

- *Sustainable Value Propositions Innovation* through the mitigation of the unwillingness to pay transaction obstacle, acting as a "sniper" since the high performance of those technologies provide valuable and reliable services, by catching up opportunities that were not addressed before and, most importantly, to establish a relationship with customers based on trust and transparency.
- *Sustainable Value Delivery Innovation* through the mitigation of the difficult to access transaction obstacle, acting as a "trojan horse" since the ubiquity feature of the technology allows to include customer segments previously excluded from the provision of the service due to their remote location.
- *Sustainable Value Capture Innovation* through the migration of the inability to pay transaction obstacle, acting as a "piggy bank" given the low-cost nature of space technologies, both in terms of satellites and space data, which may permit to significantly reduce the costs and, most importantly, to shift the cost savings on to customers by decreasing the price of the service.

We thus advance the literature on sustainable business model innovation providing one of the first insights opening the black box of emerging technologies' features, beyond the ones characterizing their diffusion (Rotolo et al., 2015). Specifically, the features of high performance, low-cost, and ubiquity may serve not only as a driver of diffusion of the technology, but also drivers to achieve sustainable business model innovation. These inner characteristics allows emerging technologies to work as transaction obstacles mitigation's mechanisms, thus driving innovation in the firm' system of activities beyond the creation of value, but carrying out successful and sustainable value proposition, value delivery, and value capture activities.

6 CONCLUSION

Drawing on the increasing attention of both scholars and practitioner towards the sustainability issues, as well as the role that private firms should play in achieving socio-environmental goals, this paper offers original insights from a business model perspective. Specifically, we highlight how the inner characteristics of an emerging technology may serve as enabler of sustainable business model innovation (SBMI), through the mitigation of transaction obstacles to sustainability that often represent the main hurdle in achieving no-profit oriented objectives. Further studies may develop this line of investigation looking at how other kinds of emerging technologies may represent other sources of SBMI, as well as how established firms with their articulated organizational structure leverage them to achieve SDGs.

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