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Barriers for the digitalization of servitization

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Abstract

The use of digital technologies can increase firms' performance and competitiveness. In product-service system context, digital technologies can improve both the innovation process, by facilitating the orchestration and collaboration, and the outcome, since they can offer new functionalities and deliver value through a digital solution. Although the benefits and possibilities of digital technologies in the PSS have been previously addressed by research, several questions and gaps regarding the barriers encountered in the digitalization of the innovation process and the innovation outcome remain unanswered or unfulfilled. To that end, this article applied a qualitative approach with two focus groups to understand what barriers are perceived by researchers and consultants, and managers. Results show that consultants perceive more strategic barriers, whereas managers perceive more operational barriers. We also found that financial and data security barriers are among the most important for digitalization. Our results show that outcome barriers are perceived to a higher extent than process ones. In this sense, in the innovation process, barriers are more focused on operational and human-resource aspects, such as data security, and competences and training. Whereas in the outcome, the barriers are more related to strategic and operational aspects, namely: market acceptance, financial and short-term vision.

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1. Introduction and Theoretical Background

Digital transformation, or Digitalization, is understood as the process of using digital technologies to create and obtain value in new ways [1,2]. It is a new trend that has been enabled by the miniaturization of hardware, powerful microprocessors, and wide access to the internet [3–5]. According to [6], companies increase not only their performance but also their competitiveness when digitalizing. However, digitalization demands a holistic view in its management for navigating in this rapidly changing innovation landscape [7]. In this sense, according to [1,7], the dimensions of product, environment, and organization impact digitalization. Product is determined by user experience (i.e. usability and aesthetics) and value proposition, such as

segmentation and strategic pricing; environment demands a scanning of the digital innovation environment, such as new digital devices and channels. Finally, the organization encompasses two areas: skills and improvisation. Skills are the internal and external skills necessary for the new digital roles, while improvisation is the necessary organizational space to assure the maximization of creativity. These aspects show the broadness and complexity of the digitalization field, in which several factors may affect its outcomes.

By embracing digital technologies (DT), firms are more easily able to boost their servitization strategy [8,9]. The use of DT could lead to innovation outcomes or facilitate the innovation process [10]. The digitalization in the innovation outcome is comprehended by offering new functionalities and added value to product or service [10]. Such impacts can be

information technologies supporting service innovation through digital components that allow the provision of services [8] such as availability guarantees, predictive maintenance, condition monitoring, etc. [11–13].

Also, due to its possibilities digitalization is impacting and enabling innovative business models and products and services [2,7]. Business models severely affected by digitalization range from the musical industry, to e-commerce [7] and e-book [4] to mention a few. Another business phenomenon that digitalization is impacting is the servitization of the offer [2]. Servitized offers, initially product-centric, are increasingly adding digital services toward a more service-oriented offer [13,14]. This impact is so important that digitalization is seen as an essential enabler of servitized business models [2,15,16], since servitization nearly always requires digitalization and is often supported by it [2].

One of these digitalization-based innovations for servitized offers are Digitalized Product-Service Systems (hereafter DPSS) [13], also known as remote monitoring technologies [17], smart connected products [3] or smart product service systems. Examples of digitalized innovation outcomes through DPSS offers are jet engines that collect data from different aspects of engine performance (pressure, temperature, oil, etc.) allowing a business model that guarantees performance, and reducing risks by leveraging the use of the data collected [17]. Another example is a scooter sharing service developed by Piaggio that relies on digital technologies to enable a business model that charges the customer for the actual usage of the motorcycle based on GPS data and other data such as acceleration, fuel consumption and braking intensity [18].

Alternatively, digital technologies could also be used during the process of innovation to facilitate the effective orchestration and collaboration required for DPSS development and delivery [8]. This includes a broad range of digital tools such as PLM, data mining, decision support systems, virtual simulation, social media, digital collaborative working systems for making innovation possible [10,13].

While the literature shows increasing interest in digitally enabled servitization [15], the analysis of digitalization barriers is still emerging [4], especially in the context of innovation process and outcome [10]. Only a few studies reported some barriers encountered from empirical evidences. Examples of barriers for digitalization affecting servitization strategies are firms needing to externally recruit personnel for specialized digital roles or the development of new skills and internal capabilities inside the firm and among employees [7,11]. Also, the right combination of team skills is necessary, which may be a barrier for digitalization in the innovation process [7]. Barriers for digitalization in the innovation outcome are also present such as the uncertainty in the money invested [11], customers' experiencing unforeseen technical issues [11], customers' seeking more personal interactions [12], or even data hacking and privacy concerns [3,19].

Although these studies provide some barriers, they do not provide a detailed picture of the challenge of implementing a digital servitization strategy. Also, few research focus on the digitalization of a product-service system offer [2, 7,20]. Therefore, our study aims to identify the barriers of digitalization by distinguishing the two roles of digital

technologies in innovation, namely: the use in the innovation process and the use in the innovation outcome. For example DPSS can provide data for product R&D and also leverage digitalization in the final product, as for example an OEM that uses its digital capabilities to analyze data and improve the process itself [3,13].

2. Method

Considering the exploratory nature of the objective that guides this research, we adopted a qualitative approach to collect and analyze data. Therefore, two focus groups were conducted using direct procedures (i.e. participants were aware of what was being studied) to identify barriers to the digitalization of the innovation process and outcome for DPSS, following the suggestions of [21]. Focus group is a technique that builds on group discussions to provide insights and are normally conducted with the participation of 6 to 12 individuals who are similar in some aspect and which can provide rich information on the subject studied [22].

Since consultants' and researchers' view could differ from that of managers and practitioners, we decided to conduct two separate focus groups, each focused on one of the two views, as recommended by [21,22]. The aim of this procedure was twofold: first, collecting data from the two separate sources provided us with complementary information, that is, information overlooked from one group could arise in the other group, which helped provide a more comprehensive amount of data; second, given the different views from both groups of respondents, we were able to compare the different perspectives and their perception of the strength of impact of barriers.

2.1 Data collection

The two focus groups were conducted separately and lasted in average 1 hour each to identify barriers from actors with a good experience in digital servitization. The first focus group was organized during a one-day conference on innovation practices mainly dedicated to consultants and researchers. It was conducted in September 2018 in France. 11 participants took part in the focus group, being mostly consultants and researchers. In their majority, participants were from consulting companies, university or higher education institutions (HEI), and innovation centers.

The second focus group was conducted in October 2018 also in France during the annual Digital Technologies exhibition. This workshop focused on the perception of industrial actors, and thus, 9 managers from firms participated. Participants were mostly from metal-mechanic and automation, watches and sporting goods, and energy sectors. Their positions were mostly related to Information Technology, and Research and Development. Table 1 presents the characteristics of the participants from the focus groups.

Table 1 - Characteristics of participants from Focus Group 1

Focus Group 1 – Consultants and Researchers		Focus Group 2 – Managers	
Sector	n	Sector	n
Consulting company	5	Metal-mechanic/automation	3
University/HEI	2	Watches and sporting goods	2
Innovation center	2	Energy	2
Others	2	Other	2
Positions/Department	n	Positions/Department	n
Consultant	7	IT	3
Researcher	2	R&D	2
Others	2	Others	3

During both focus groups, participants underwent a brief presentation (15-minute slideshow) introducing the concept of digital technologies, and how they can be used as part of the innovation outcome and in the innovation process for DPSS. Although all the participants were aware of the concept and had previous contact with it in academic settings and practical environments, such as their firms, this step aimed to level the knowledge on the issue among participants and to avoid any misconception about the topic. To increase tangibility of the concept presented, we provided a few practical examples of how digital technologies can be used in the innovation process and in the innovation outcome.

After the concepts were presented, participants were first asked to indicate the barriers that firms encounter when they introduce digital technologies in their innovation process. Sticky notes were provided so participants could individually write the barriers and attach them to a board. The moderator of the focus group clustered barriers based on their qualitative similarity in short open discussions with the participants, and, clusters were named accordingly. This step was used to gain collective insights on the barriers indicated by participants and how they impacted firms.

In line with the research objective, researchers provided an online collaborative platform where participants were asked to rank the clusters of barriers based on their impact strength from first (highest impact) to last (least impact). This step was done individually, and it aimed to, ultimately, provide researchers with a rank of the most important barriers. As the final step, participants were debriefed, and a short discussion of the results was conducted. The same process was repeated for the barriers to the digitalization of the offer.

2.1 Data Analysis

Data collected in the two focus groups were exported in spreadsheets and analyzed considering the theoretical background presented in Section 1. Therefore, responses were compiled and frequency of ranking positions of each barrier was analyzed. To reach a final ranking of barriers, scores were calculated based on the frequency of each barrier on each position of the rank. Therefore, every time a barrier was ranked first, it was assigned 10 points; every time it was ranked second, it was assigned 9 points, and so on. This also helped balance the scores by not neglecting barriers ranked in

the last positions, since they were also assigned scores, although to a lesser degree.

Finally, scores were calculated, and barriers were ranked from highest (most impactful) to lowest. The rankings were used to analyze data and propose findings, which are presented and discussed in Section 3. Analysis of findings considered specially and the difference in barriers perceived in the innovation process and those in the innovation outcome of PSS. Additionally, we analyze the differences in the views of consultants and researchers, and managers.

3. Results and Discussion

In this section, we present the barriers mapped during the focus groups to identify what hinders digitalization during the innovation process and in the innovation outcome. We found that the barriers mapped can be divided into three major types: strategic, operational, and human resource barriers. Strategic barriers are related to strategic issues, such as the marketing of digitalized solutions, the ecosystem necessary for them to work, and the aspects related to risks, transparency of information, and trust. Operational barriers comprise the aspects involved in putting the digital technology to work in the process or in the outcome. Operational barriers involve functional aspects of the digitalization, such as the financial elements, data security, necessary resources and infrastructure, and how to use the DT, among other barriers. Finally, human resource barriers address the existing relationship between the DT and its impact on work organization. These barriers involve training, the necessary competences for DT, how employees view DT, and the resistance to change. Table 2 summarizes the full set of barriers mapped and their definition.

3.1 Process Barriers

The ranking of the barriers for digitalization of the process are presented in Table 3. As the results show, mainly, Human resources-related barriers are mentioned in this stage of innovation. Human resource aspects involve mostly the competences necessary for digitalization, the human aspect of job replacement for machines and robots, and the resistance to change due to ongoing mindset. This finding demonstrates a great concern of managers and researchers for the aspects related to employees' relation to digitalization in the process. However, for the Operational barriers, Financial was the most cited obstacle. It is also worth noting that strategic barriers are not ranked with such importance as the other barriers, since the first strategic barrier (e.g. Short-term vision) appears only after five barriers from the other two constructs. This finding shows a more practical concern of how digitalization can be implemented in practical terms, such as, for example, financial, data security, usage, and organizational instead of strategic in this stage of innovation through digitalization.

Finding 1 - Process barriers are more focused on operational and human resource aspects of digitalization.

Table 2 - Barriers and description

Barrier	Definition
Strategic	
Customer need	Understanding customer needs for digitalization is difficult and requires a close contact with the customer.
Ecosystem	Barrier related to being in an ecosystem with partners that are prepared for digitalization and integrated solutions.
Governance	Decision-making issues such as the fear of losing power.
Market acceptance	Barrier related to the uncertainty of a service-oriented business model that may not meet market needs
Market entrance	Barrier related to new market channels, technologies that are easily copied by competitors, and time-to-market speed.
Offer	Addresses the strategic and planned introduction of DT.
Risk taking	Barrier related to the risks involved in digitalization.
Short-term vision	Short vision of the future due to a focus on daily activities, neglecting long-term strategic potential of digitalization, thus not prioritizing DT.
Transparency	Transparency barriers comprise the fear of losing control of the information by exchanging/opening it
Trust	Digitalization includes trusting suppliers and customers (and being trusted by them) with confidential data.
Operational	
Data security	Data security barriers are related to the fear of hacking, lack of confidentiality, reliability, and data protection.
Financial	Related to the costs and investments of digitalization structure, the difficulty in quantifying return of investment
Industrial context	Company context and industrialization degree require adaptations and different starting points for digitalization.
Life cycle	Barrier related to the maintenance and support of the DT.
Obsolescence	DT tend to become obsolete after a short period of time.
Organization	The lack of operational processes that allow digitalization and the time necessary for DT implementation
Resource	Addresses the lack of appropriate tools, resources and infrastructure necessary for digitalization.
Usage	Includes compatibility with current technologies, difficulty in using DT, and how mobile and cloud-based DT are.
Human Resource	
Competences	Competences and knowledge for digitalization, such as: training, focus on hardware, digital maturity, and language
Human	Fear of machines replacing humans and new work relations
Resistance to change	Barrier related to the established mindset, the need for flexibility, and the redesign of processes and methods.
Training	Barriers related to the lack of specialized training on DT.

3.2. Outcome Barriers

As presented in Table 4, barriers of digitalization in the outcome mainly focus on strategic aspects (such as Market Acceptance, Vision and Market Entrance) and operational barriers (such as Financial and Data Security). The most mentioned Human Resource barrier was Resistance to Change, which ranked sixth.

Finding 2 - Outcome barriers are more related to strategic and operational aspects of digitalization of the servitized offer.

Also, as the results presented in Table 4, managers and consultants and researchers perceive more barriers in the digitalized outcome in comparison to those of the process. This fact may be explained by the uncertainty involved in the delivery of such offer, such as the necessary market acceptance and entrance, or the resistance of customers to change as well as the difficulties found in its use.

Finding 3 - Consultants and researchers and managers perceive more barriers in the digitalization of the outcome than the digitalization of the process.

Table 3 - Top ranked process barriers and their types

Barrier	Points	Type
Financial	126	Operational
Competences	104	Human Resource
Resistance to change	94	Human Resource
Human	72	Human Resource
Data security	64	Operational
Short-term vision	59	Strategic
Training	50	Human Resource
Risk taking	41	Strategic
Governance	38	Strategic
Usage	37	Operational
Transparency	35	Strategic
Industrial context	23	Operational
Organization	22	Operational

Table 4 - Top ranked outcome barriers and their types

Barrier	Points	Type
Market Acceptance	121	Strategic
Financial	98	Operational
Short-term vision	87	Strategic
Data security	73	Operational
Market entrance	63	Strategic
Resistance to change	50	Human Resource
Usage	45	Operational
Life cycle	45	Operational
Ecosystem	44	Strategic
Obsolescence	42	Operational
Competences	41	Human Resource
Trust	40	Strategic
Transparency	34	Strategic
Risk taking	33	Strategic
Customer need	29	Strategic
Offer	28	Strategic
Resource	15	Operational

3.3 Analysis of perceptions

The difference between the barriers perceived by consultants and researchers and manager were also analyzed, the results are presented in Tables 5 and 6.

Consultants and researchers identify different barriers than managers, whether in the innovation process or in the outcome. This is due to several factors but, as seen in the results of the focus groups, managers have an excessive focus on operational aspects, given that they are responsible for

day-by-day activities generating an immediatism in their view of barriers, such as Human, Resistance to Change, Training and Financial in the process side; and Competences, Trust and Risk Taking in the outcome side. Whereas consultants tend to see more strategic barriers such as Market Acceptance, Short-term Vision and Resistance to change on the outcome side, and Competences and Short-term vision on the process side.

Finding 4 - Managers have a short-term view oriented to operationalization aspects of digitalization whereas consultants have a long-term view oriented to strategic aspects of digitalization.

Table 5 - Ranking of digitalization barriers for the innovation process

Rank	Consultants and Researchers	Score	Managers	Score
1 st	Financial	77	Human	72
2 nd	Competences	74	Resistance to change	66
3 rd	Short-term vision	59	Training	50
4 th	Data security	43	Financial	49
5 th	Usage	37	Risk taking	41
6 th	Transparency	35	Governance	38
7 th	Organization	22	Competences	30
8 th	Resistance to change	28	Industrial context	23
9 th	-	-	Data security	21

Table 6 - Ranking of digitalization barriers for innovation outcome

Rank	Consultants and Researchers	Score	Managers	Score
1 st	Market Acceptance	121	Ecosystem	44
2 nd	Short-term vision	87	Competences	41
3 rd	Financial	78	Trust	40
4 th	Resistance to change	50	Risk Taking	33
5 th	Market Entrance	48	Data security	33
6 th	Life cycle	45	Customer need	29
7 th	Usage	45	Offer	28
8 th	Obsolescence	42	Financial	20
9 th	Data security	40	Market Entrance	15
10 th	Transparency	34	Resource	15

We found that financial barriers are among the most important barriers for both digitalization in the process and in the outcome. Regarding financial aspects, literature has not reached a consensus as to their impact. While [4] claims that financial barriers are nowadays not a notable barrier since technology, chips and memory have decreased in price, [23] states that this barrier highly affects successful digital innovations.

Specifically, we found that consultants and researchers rate financial barriers as more important than managers do, as Tables 4 and 6 show. According to [23], the financial barrier can be diminished with a flexibilization of the application of resources by the firms.

Finding 5 - Financial barriers are among the most important barriers for digitalization.

Another finding from the analysis shows that data security is an important barrier. Such finding is a frequently mentioned problem in digitalization (see [12, 19,24]). Since, although digitalization provides new uses and possibilities, both researched groups agree that the risks to data are still a problem. In this sense, as presented in the results, it is possible to see that managers are more concerned with data in the digitalized innovation outcome, whereas consultants and researchers identify such barrier to a higher extent in the innovation process.

Finding 6 - Data security is a major barrier to digitalization.

The development of digitalized offers may present challenges related to the ecosystem. This barrier, according to [23,25] is characterized as maintaining relationships with external stakeholders such as vendors, consultants and even customers. However, developing partnerships and exchanging information can be very hard and time consuming [16,26], which explains such barrier. Also, decisions such as make or buy hinder the development of digitalized innovation outcomes since several factors must be considered, such as collaboration in some fronts and competition on others [24,27].

Finding 7 - To managers, barriers related to the ecosystem are the main obstacle to digitalized innovation outcomes.

4. Conclusion

This article provides new insights both for managers and researchers. We showed an overview of the barriers found in the innovation process and outcome, which allows an understanding of the obstacles found when digital servitization is implemented. In this sense our study identified that the respondents identify less process barriers, which are more focused on operational and human-resource aspects. Whereas in the digitally servitized outcome more barriers are perceived, and the focus lies on operational and strategic barriers. Such findings allow decision-makers to better understand the variables that might difficult a successful use of digital tools and digitalization in innovation, more specifically these decision-makers can identify the barriers in the two innovation stages, namely: process and outcome [8] and leverage such information in each moment of innovation to develop solutions to overcome such barriers.

Also, we identified that, in general, managers are more concerned with operational aspects of innovation whereas consultants and researchers mainly focus on strategic aspects, which demonstrates that literature and practice still differ in their understanding of DT barriers.

Finally, we suggest future research to employ efforts on digitalized innovation, especially in the outcome stage, as according to respondents, this stage faces more barriers, due to the risks involved and the newness of the theme, such as those faced in the development and offer of digitalized product-service systems [11].

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