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Complexity Management in Service Businesses through Platform Adoption

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Abstract: In recent years, companies have started to offer solutions characterized by the presence of both products and services. This helps solving the challenges deriving from increased competition and market instability, through generation of new sources of competitive advantage. In the literature, this phenomenon is referred with the term "servitization". Implementing a servitization strategy increases environmental complexity because of the growth in the number of interrelations and interactions of the activities taking place in the service processes, as well as interorganizational and intraorganizational relationships between the different actors. Platform has been identified as an organizational paradigm which may have potential to support companies in managing the increased complexity. However, studies about platform approaches with this focus are limited. Therefore, this study links the theoretical knowledge on complexity management with that of platforms, revealing the potentialities of platforms in managing complexity in service business context. Furthermore, based on the empirical findings from two case companies, the paper elaborates the mechanisms through which platforms can help companies to manage complexity through reducing and absorbing it.

Keywords: platform, complexity management, servitization, service business.

1. INTRODUCTION

Companies operating in several industries are facing turbulent conditions and market instability (Thomas, 1996). For this reason, many companies are striving for innovative sources of competitive advantages. Numerous firms have started to offer bundles of products and services in the form of solution offerings through specific business model alterations (Lightfoot et al., 2013; Adrodegari and Saccani, 2017). This phenomenon goes under the name of "servitization" (Vandermerwe and Rada, 1988).

However, servitization may cause an increase of complexity environmental complexity for the company. Indeed, the number of interrelations and interactions of the activities taking place in the service processes is large and companies might be deeply embedded in networks generating numerous interorganizational and intraorganizational relationships (Gebauer et al. 2013; Henneberg et al., 2013). Moreover, digital infrastructures further intensify the co-creation of advanced services with extensive supplier and customer bases (Ardolino et al. 2017). Therefore, organizations active in service business need to manage complexity (cf. Brown and Eisenhardt, 1998). In order to do that, on the one side, organizations can try to reduce complexity simplifying the interpretation of the environment through abstraction and codification and, on the other side, they might absorb complexity holding sometimes even conflicting representations of the environment, (Boisot and Child, 1999). Nevertheless, mixing reduction and absorption is a challenging objective for organizations in service business (Gebauer et al., 2005) since complexity reduction requires standardized routines and processes and modular architectures, while complexity absorption requires the organization to adjust to specific customer needs through pure service offerings and agile processes and structures (Baines and Lightfoot, 2013).

Recent contributions present in the literature suggest that platforms are structures that may help in managing complexity in service businesse (e.g. Cenamor, Rönnberg Sjödin and Parida, 2017; Eloranta and Turunen, 2016; Pekkarinen and Ulkuniemi 2007) since they enable an adequate level of stability but also allow an extensive level of variety and generativity (Gawer, 2014; Thomas, Autio and Gann, 2014). However, the existing studies have been performed in general level, without shedding light on the role of platforms in managing complexity in service businesses specifically.

Hence, the objective of this paper is to identify the mechanisms through which platforms can help companies in managing complexity. This study has been conducted through a case study and the paper is structured as follows. The next section provides the background of the research focusing on the relationships of complexity and servitization as well as the impacts of platform adoption. Section 3 illustrates the research question and methodology adopted for this study. Section 4 shows the two case studies, and the complexity management mechanisms identified in the cases are presented in section 5. The final section draws the conclusions and presents the avenues for future research.

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2. BACKGROUND

2.1 Complexity and servitization

The economies of developed countries are becoming increasingly dominated by the service sector. Nowadays several companies have to cope with competitive turbulence, as well as the continuous introduction of disruptive digital technologies usually used to face the growing individualization of demand and turning heterogeneities into a source of profit (Brynjolfsson, Hu, and Smith, 2011). For this reason, traditional manufacturing companies have changed their focus from the provision of physical products towards benefiting from customer relationships. This phenomenon is referred as ”servitization” (Lightfoot et al. 2013). **Bundling of products and services can be beneficial because it can result in more efficiency and reduction of costs (Sharkey & Sharkey, 2012). Another benefit of servitization is to make a service more tangible and easier to understand and evaluate before a purchase (Jaakkola, 2011).**

Servitization can be seen as an effort to leverage the complexity of the business environment. Indeed, the complexity in service business derives from the processes, as well as their executional latitude (Shostack, 1987). In addition, complexity arises from the numerous interorganizational and intraorganizational relationships characterizing service organizations (Gebauer et al. 2013; Henneberg et al., 2013). Service innovation and delivery requires inter-organizational processes, exchanges and relationships (Basole and Rouse, 2008). This results in the creation of complex networks encompassing several actors co-creating value, where manufacturers act as focal companies, undertaking the role of an orchestrator (Paiola et al. 2013). Therefore, solutions networks can be understood as complex systems that develop and evolve constantly (Basole and Rouse, 2008).

Measuring and analysing complexity is challenging. The concept of requisite variety is one way to approach complexity (Ashby, 1991). The concept originates from the analysis of biological systems. According to this line of thinking, the entities can cope with their environment only if they can match their internal variety to the external habitat they encounter (Ashby, 1991). This necessitates that the entity has a range of responses that is at least comparable to the stimuli it faces (Figure 1).

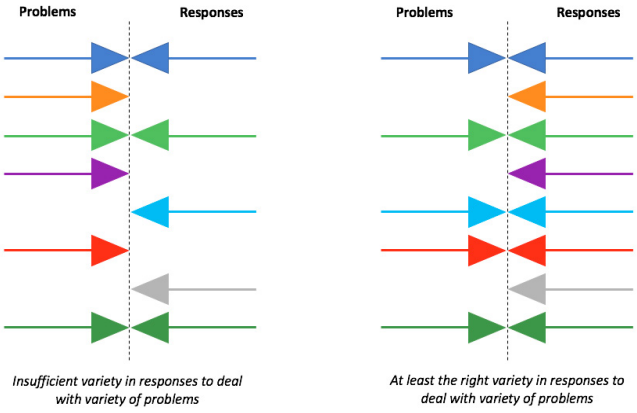

Fig. 1. Matching between variety of problems and responses (adopted from http://requisitevariety.co.uk/)

Same line of reasoning can be applied to man-made organizations, but differently from biological, interpretative systems make intentional decisions on how to interpret the environment (Beer, 1985). Two distinct ways have been identified to manage complexity (Boisot and Child, 1999). On the one side, the organizations can try to reduce complexity by lowering the perceived variance of the external stimuli. Complexity reduction can be achieved through abstraction and codification. On the other hand, the organizations can absorb complexity, that is, diversifying the responses to the environmental stimuli. This is performed by generating of multiple interpretations, many goals, and e.g. ad-hoc structures.

2.2 Platform and servitization

The increased complexity might be the enabler of numerous benefits for service providers if correctly managed, even though it has been identified as a critical challenge in servitization (Gebauer et al. 2005).

The recent literature about servitization has shown the benefits in adopting platforms for the service business (Cenamor, Rönnberg Sjödin and Parida, 2017; Eloranta and Turunen, 2016). The results are based on the long heritage of platforms research (Gawer, 2014). The general concept of platform has been investigated according to different research streams and lines of reasoning (Gawer and Cusumano, 2014). These differences are visible especially in the way platforms are perceived to manage complexity. Product innovation research stream describes platforms as a way to reduce complexity through the use of simple modular parts that combined to diverse sets of different types of products (Gawer, 2014; Meyer and Utterback, 1993; Wheelwright and Clark, 1992). In his way product portfolios and industries can be controlled in an efficient way (Thomas, Autio and Gann, 2014). **Economists, at the same time, have studied platform according to a marketplace perspective (Hagiu and Wright, 2015; Parker et al., 2016). Furthermore, the "multi-sided market" approach emphasizes the role of platforms in matching supply and demand (Gawer 2014; Gawer and Cusumano, 2014).** Platform owner can gain scalability benefits without too much resource depletion.

Platform research in economics domain, in turn, has steered the platform thinking toward a "multi-sided" paradigm. In this approach, platform is an intermediary, which brings different players together to contribute to the platform by bringing their own value (Hagiu, 2009; Eisenmann, 2008; Choudary, Van Alstyne and Parker, 2016). This perspective emphasizes the relevance of matching of supply and demand as well as fostering cross-side network effects (Gawer and Cusumano, 2014). In multisided platforms, the complexity management paradigm is rooted in focal organization's (market maker) power over other external organizations (market actors) through the market maker and mediator role.

The third major stream is the so-called meta-organizational approach (Gawer, 2014) based on the works of Ciborra (1996) and Kim and Kogut (1996). According to this view, the co-operation between members participating in the platform ecosystem is extended to all business processes, creating overlapping and nested structures consisting of many organizations (Gawer and Cusumano, 2014). Due to their adaptability, these platforms particularly facilitate the creation of new affordances and foster generativity (Nambisan, 2017).

In the servitization context, the investigation about platforms have been relatively scattered around different theoretical approaches, such as the use of platforms for i) exploiting modularization in service engineering (Pekkarinen and Ulkuniemi, 2008;), ii) service delivery (Brax and Jonsson, 2009), and iii) the orchestration of service innovation (Gebauer, Paiola and Saccani, 2013). Furthermore, the literature has discussed about the impacts of digital technologies and platforms for advanced service offerings (Cenamor, Rönnberg Sjödin and Parida, 2017; Ardolino et al. 2017).

In recent years, servitization research has also started to consider the meta-organizational perspective of platforms (Eloranta and Turunen, 2016). Perks et al. (2017) observe that the configuration of available resources can be seen as a "value platform" which must be managed by the focal firm in order to create value. At the same time, Gebauer et al. (2013) investigates this approach from different perspective and use the concept of platform referring to groups of actors potentially available to develop solution offerings. However, in all these approaches, the crucial action for the management of the platform is the orchestration of actors and their resource interdependencies in constantly changing inter-firm networks (Eloranta et al., 2016; Paiola et al. 2013). According to this line of thinking, platforms are approaching complexity primarily from the absorption perspective.

3. OBJECTIVES AND METHODOLOGY

Only anecdotal attempts are present in the literature aimed at understanding the role of platform as structures to manage and balance complexity reduction and absorption.

This paper aims at increasing the knowledge on these topics by exploring the different mechanisms through which platforms can manage the complexity in the servitization domain. In particular the study addresses the following research question: *In which way platforms are able to either reduce or absorb complexity in the service business?*

For this study, an exploratory research approach has been conducted since the topic addressed is at an early stage of maturity. A qualitative multiple case research has been conducted since it has been shown to be beneficial when a phenomenon is relatively innovative and not deeply investigated before (Yin, 2009). Based on the objective of the paper, a research framework (Figure 2) has been developed as suggested by Miles and Hubermann (1994).

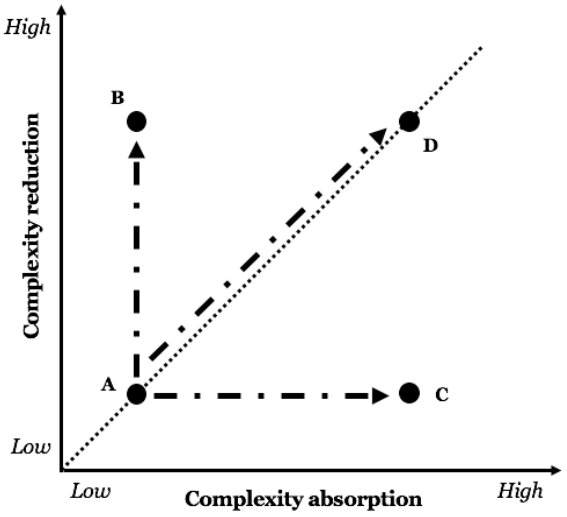

Fig. 2. Research framework

The framework consists of two axes, representing the directions of action through which it is possible to deal with complexity. On the vertical axis, there is the complexity reduction domain achievable through the simplification of the environmental stimuli (from A to B). Complexity absorption, represented in the horizontal axis, in turn refers to allowing generation of multiple interpretations of the environment (from A to C). **For example, the cooperation between platform members may be applied in order to nest structures involving many organizations.** In this paper, we assess how platforms provide mechanisms to both achieve complexity reduction and absorption (from A to D).

Research questions are addressed on the basis of findings from two companies. Both of the companies are either transitioning or transitioned from a product-centric company to a service provider. The cases explored in this study are the service platforms of those companies. The sampling was based on two criteria: (a) adequate level of maturity of the company providing the platform; (b) different levels of maturity among cases. Criterion (a) was judged to be satisfied if the cases are not in pilot phase and has already reached a substantial scale. The information about the two cases have been gathered through the analysis of secondary sources, because numerous companies operating in highly competitive and digitized industry sectors try to protect and hide internal information, and they only seldom disclose data about their business to academic researchers (Reddy and Agrawal,

2012). Thus, data about the case companies have been collected from secondary sources such as websites, industrial and company reports, webinars and recorded speeches in public workshops.

The analysis of the sources of data was carried out according to a precise protocol. All the extracted texts were analysed to seek mechanisms used in the cases to reduce and/or absorb complexity. All the identified mechanisms were then categorized and classified following the research framework. The final results were gathered to a table where the mechanisms for complexity management labelled, when possible using terms found in the literature (e.g. modularity, scalability, marketplace, etc.). The cases are described in detail in the next section.

4. CASE STUDIES

4.1 Theta

Theta is a platform created by a service business unit of a computer software and services company. The platform is proprietary and aimed at enabling developers to build applications in the IoT domains for industrial customers. Through a specific development environment, developers can rapidly and effectively design IoT applications. Moreover, *Theta* provides several tools and services to support end-to-end solutions facilitating the analysis of data gathered from different devices and machines, allowing the visualization with web-based applications. *Theta* has also launched a marketplace through which third party suppliers can sell the applications they have previously developed for industrial customers. The platform thus exploits the potentialities of IoT by enabling companies to achieve advantages in different industries. Majority of them concerns the field services on fleets and installed bases, allowing mainly remote access and preventive actions with the help of to data gathered by the products. In this way, it is possible to reduce field visits, enable self-service support, and reduce both down-time and MTBF (mean time between failure). Exploiting the advanced services developable with this platform, industrial companies can expand service portfolio, benefit from new revenue streams and increase customer satisfaction.

4.2 Sigma

Sigma is a platform created by a global technology company consisting of several divisions operating in different sectors such as industry, energy and healthcare. The platform focuses especially in digitalization and machine learning. The platform is equipped with specific application programming interfaces (APIs) and enables the development of applications from both *Sigma's* provider itself, and third-party suppliers. The platform also allows industrial companies to produce digital models of their factories with real data from the production processes. Hence, software applications and digital services can be deployed exploiting connectivity capabilities, tools for developers, and an extensive range of services. In particular, the platform provides a foundation for applications enabling companies to efficiently manage predictive maintenance, energy data management and resource optimization for distributed machine tools, industrial robots, and industrial equipment. In this way, on the one side, manufacturers of machines and industrial equipment benefit from high customer satisfaction and increased revenues due to reduced claims and warranty costs, while, on the other side, end customers can reduce downtime, increasing the lifetime of their installed base.

5. MECHANISMS FOR COMPLEXITY MANAGEMENT

This section shows the mechanisms for complexity management identified through the analysis of the two cases. The mechanisms are divided into two different categories: complexity reduction and absorption. In addition, with the help of two tables (Table 1 and Table 2), the application of the mechanisms in the two cases are shown.

5.1 Mechanisms for complexity reduction

Scalability – scalability refers to the capability of a system, network or process to handle a growing amount of work, or its potential to be enlarged to adjust to this growth.

Common rules - Interoperability is one of the biggest challenge of a platform that is connected with different devices and machines. This mechanism thus refers to a set of standards and protocols allowing connected-product suppliers to reduce the complexity deriving from the interoperability of different pieces of hardware and software. This mechanism also concerns security issues related to interconnected ICT systems.

Modularity - A system is modular if it is composed by a set of specific components that can be mixed and matched in several different configurations, to obtain from a low variety of inputs and a high variety of potential outputs. This mechanism allows complexity reduction because it structures system into parts and condense the internal complexity of the system inside the modules through the exploitation of standardized interfaces for the interaction with modules.

Marketplace – The last identified complexity reduction mechanism identified is called marketplace. With this, we refer to the mechanism of governing the transactions between different stakeholders of the platform. Complex interactions between developers and customers are structured to simple market transactions.

Table 1. Complexity reduction mechanisms

	Theta	Sigma
Scalability	The integration of Theta with different on-market cloud services provides a scalable approach to costs, so that the applications can scale to meet the needs of any company and easily accommodate continuous growth and change.	Sigma offers a cost-effective and scalable cloud platform as a service (PaaS). The company has intensified collaboration with an important cloud service provider through which the companies offer the service platform and affiliated apps.
Common rules	Third-party manufacturers can benefit from the set of standard tools with easily configurable role-based authorizations provided by	There is a suite made up of different elements to simply connect physical assets to Sigma. All connectivity elements

	Theta.	are designed to securely collect data from industrial devices.
Modularity	Theta provides a tool to combine data from diverse set of independent modules.	With the help of open application programming interfaces (APIs), customers can easily develop applications exploiting module software functions easily and in very short time
Marketplace	Theta's marketplace allows to both build and sell own IoT Applications and find market-ready solutions.	Third party suppliers as well as Sigma will market their applications through a marketplace.

5.2 Mechanisms for complexity absorption

Openness and networking - The first identified mechanism of complexity absorption refers to the promotion of openness and encouraging networking. Thus, the term "openness" refers to the degree of freedom to contribute to the platform by the users. This increases the number of stakeholders complementing the platform.

Self-development tools - Connectivity and development tools made for IoT enable developers to quickly create, test and deploy solutions. Thus, this complexity absorption mechanism refers to the enabling of self-development of solutions by both developers and industrial customers. Through different software development kits (SDKs) the platform makes it possible for the industrial users to develop solutions beyond the capabilities of the platform provider itself.

Tools to enhance collaboration - The last identified complexity absorption mechanism identified is aimed at enhancing collaboration between the platform users. Through this mechanism, the platform provider facilitates the creation of new relationships and interdependencies in the platform.

Table 2. Complexity absorption mechanisms

	Theta	Sigma
Openess and networking	Theta has created a large ecosystem of vendors and service providers of diverse technologies currently involving more than 200,000 partners.	Sigma is supported by an ecosystem with broad domain expertise and horizontal IT capabilities consisting of app developers, system integrators, technology partners and infrastructure providers.
Self-development tools	Theta provides all the tools and materials needed for developers to develop and customize their solutions.	Sigma offers a environment for developing applications that can be used by customers.
Tools to enhance collaboration	Theta incentivizes collaboration between developers through own collaboration tools, and the the related social media applications and communities.	Developers can collaborate through an open source platform which enables resources and libraries sharing among the users of the community.

6. CONCLUSIONS AND LIMITATIONS

Scholars have discussed about platforms as organizational structures enhancing the management of complexity deriving from service business (Cenamor, Rönnberg Sjödin and Parida, 2017; Eloranta and Turunen, 2016). This paper advances this line of thinking by aiming to understand how platforms may act as business organising paradigms allowing an effective complexity management in two different domains: complexity reduction and absorption. The findings show how, on the one hand, modularity and scalability as well as the adoption of common rules and protocols and the implementation of marketplaces might help companies in reducing complexity. On the other hand, the mechanisms of promoting openness, providing self-development tools and facilitating collaboration absorb complexity.

The findings of this paper have implications for practitioners in the service business within industrial companies since managers can more consciously evaluate the adoption of platforms to provide services to their customers. In addition, the two developed case studies identify and assess specific complexity management mechanisms that can be leveraged in platforms.

Finally, as any research, also this one comes with some limitations. The two case studies focus on the IoT context, which limits the extent to which the results can be generalized to other types of settings. Future empirical research should thus analyze platforms in different service contexts to validate the findings, and potentially identify other complexity management mechanisms.

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