The Digitalization and Servitization of manufacturing:

A review on digital business models

The digitalization and servitization of manufacturing lead to competitive advantages through innovative digital business models. Digitalization and servitization are key for Industry 4.0. The present paper offers a comprehensive literature review on digital business models which aims to facilitate the proposal of a conceptual framework which can be used for assessing the development and implementation of DBM.

Introduction

Industry 4.0 is being encouraged by the introduction of digital technologies that encourage the specialization of the value chain and also connectivity between actors. Industry 4.0 heralds greater operational efficiency and the development of new products, services and business models (Kagermann et al., 2013).

The symbiosis between traditional manufacturing and services, through processes of servitization, is at the core of innovative technologies initiating new sectors or upgrading existing ones (De Propis, 2016). Many firms have evolved from producing and commercializing a single product to offering customers need-based integrated solutions (Davies, 2004). In order to successfully introduce a digitalization/servitization strategy, companies must change, among other things, their strategies, their operations and their value chain (Wise and Baumgartner, 1999; Oliva and Kallenberg, 2003; Bustinza et al., 2013) and, in short, they must introduce changes into their business models. This will involve maintaining a constant flow of innovation, not only in terms of what the companies are offering the customer, but also in relation to how products and services are designed, produced, delivered and sold (Vendrell-Herrero et al., 2014).

Industry must face the challenges of digitalization and servitization in order to improve competitiveness, by generating sustainable competitive advantages (Myrthianos et al, 2014). This would also relate to a new business model, as digitalization and servitization give rise to Digital Business Models (DBMs).

Researchers have previously studied the business model concept in different domains (Al Debei and Avison, 2010), but this is not the case with regard to de DBMs, where most of the research focused on

business models in the context of digitalization has been linked with e-business. The aim of this paper is to deal with the review of the existing literature on DBMs, and so can to characterize the conceptual framework of them, in order to better understand the relationship between digitalization and servitization. This is very pertinent in the context of Industry 4.0.

Digitalization and servitization: New digital business models

Servitization can be understood as the process of increasing value by adding services to products (Vandermerwe and Rada, 1988). Authors such as Neely (2008) claim that the process of servitization can be viewed as the development of new organization's innovative capabilities in the sense that, rather than merely offering products, the organization can provide customers with complete product-service systems (Visnjic and Van Looy, 2013). In this context Information and Communication Technologies (ICTs) have had a major impact (Belvedere et al., 2013). It has increased efficiency and effectiveness in terms of the development of new products, and has contributed to the emergence of new kinds of product–service (Agnihothri et al., 2002; Simmons, 2001).

Previous literature recognizes the role played by the development of ICTs as enabler of servitization strategies (Brax and Jonsson, 2009; Kryvinska et al., 2014; Neu and Brown, 2005; Oliva and Kallenger, 2003). Recent developments in ICTs have allowed industrial firms to adopt new business models, based on the possibility of using real-time data, and to process them rapidly. ICTs enable service delivery and improve service-oriented strategies (Antioco, 2006); and facilitate servitization not only by enabling the provision of product-service systems, but also by reducing costs, improving internal efficiency and promoting the firm's service orientation (Kowalkowski et al., 2013; Lerch and Gotsch, 2015). Fast data processing is essential for efficient and effective decision-making processes. The role played by digitalization (encoding of analogue information into digital information) in service innovation and in the development of a servitization strategy is, therefore, clear (Parida et al., 2015).

Other authors recognise the development of ICTs as a driver of servitization (Belvedere et al., 2013; Persona et al., 2007; Peppard, 2011). The literature is in agreement that the most distinctive ambition which drives servitization is related to the desire to handle decreasing margins of manufacturing and selling goods (Gebauer et al., 2005; Neely, 2008). In this age of digital innovation, the boundary between

product-related service (e.g. after - sale services) and service-related product (e.g. training services) is diffuse, and hence hybrid servitization has born, enlarging the core-concept of servitization, that is, manufacture-cum-service.

Thus, digitalization and servitization must converge; firms must embrace the digital transformation of business. If digitalization, connectivity and data analysis go hand-in-hand, opportunities for new services will grow. Digital transformation change the customer's value proposition (how the organization creates value) and value capture (how the organization makes money) (Iansiti and Lakhani, 2014).

Digital opportunities move faster than the firms' ability to adapt, which creates a gap. Those firms which manage to transform digitally earlier and more efficiently will be in a better position to undertake servitization, and this involves the definition of DBMs.

Digital Business Models

In both the manufacturing and the service sectors, firms must operate within business ecosystems which have specific configurations and rules. A business ecosystem is a dynamic structure that consists of an interconnected population of organizations; it is an economic community that is supported by a foundation of interacting organizations and individuals – the organisms of the business world (Moore, 1993). Each business in the ecosystem affects and is affected by others, and diversity and the collective ability to learn, adapt and innovate together, are essential for long-term success. In the digital era, business ecosystems are also digital.

The concept of the business model seems to be especially well suited to facilitating a structure which is capable of strategically implementing digital age-related changes (Veit et al., 2014). A business model is a conceptual tool which makes it easier to understand how firms trade in a competitive setting, and thus it also helps to analyse, compare, manage and innovate (Osterwalder and Pigneur, 2005).

How can we define a digital business? Is it the same as an e-business? It is considered that digital business is the evolution of e-business. E-Business probably began with the exchange of electronic data in the 1960s. Melao (2008) suggests that it was in the 1990s, primarily via the Internet, that e-business

emerged as a core feature of many organizations. E-business refers to the business management practices and activities which result from the incorporation of ICTs into the operations of the firm. E-Business revolutionizes the ways in which organizations interact with customers, employees, suppliers and partners.

Authors such as Bärenfanger and Otto (2015: 17) characterise this evolution: following the e-business model hype in the late 1990s, "digital business" became fashionable in the 2000s. However, those who witnessed the e-business and e-commerce trend may wonder whether "d is just the new e". Digitalization impacts entire business models.

Digital business thus refers to the business management practices and activities which result from the incorporation of digital technologies into the operations of the firm. The most common technologies in digital business settings are mobile devices and applications, analytical tools, capacity-sharing platforms and the Internet of Things (IoT).

There are digital capabilities without which firms cannot build digital ecosystems. Without these ecosystems, companies have little network impact.

In this context, DBMs emerge which require special attention. The DBM supports digital business. "A business model is digital if changes in digital technologies trigger fundamental changes in the way business is carried out and revenues are generated" (Veit et al., 2014:48).

According to Veit et al. (2014), the earliest research on the impact of digital technologies on DBMs took place in the 1990s. Afterwards, research focused on value creation and value capture through DBMs (Amit and Zott, 2001), and then later still on ICT-enabled changes in product and service models, especially revenue models. Current research is especially interested in business ecosystems and, specifically, the digital technology-enabled relationship of the different components: individuals, groups, providers, customers and organizations, which carry out transactions such as payments, insurance, consulting… transactions which are enabled by digital technologies.

Cyber-physical systems (CPSs) emerge in the context of Industry 4.0. CPSs provide physical objects with computational and communication capabilities and thus turn them into smart objects able to cooperate with one another, creating distributed and autonomous ecosystems. This

leads to the design of smart products and processes in a context of smart manufacture connected with smart infrastructures; the term "smart" encompasses processes that create and use data and information throughout the product life cycle with the goal of creating flexible manufacturing processes that respond rapidly to changes. These systems anticipate business models (Kagermann et al., 2013). These business models are digital.

In the early literature, e-business models was often confused and mixed with DBMs. In business, ICT is often divided into two broad types: traditional computer-based technologies (things you can typically do on a computer) and digital communication technologies (which allow people and organizations to communicate and share information digitally).–DBMs respond to the use of digital communication technologies in business ecosystems and in the framework of Industry 4.0. Figure 1 illustrates this evolution.

Insert Figure 1

The figure illustrates the evolution of the process that, starting with enterprises that offered physical products, led to enterprises that offer product-service systems (PSS), solutions and smart PSS, which are based on cloud platforms and conceived as a multilayered technology aimed at covering the customer's needs. In this context, e-business has focused on physical products and product-service systems and DBMs on solutions and smart PSS; the point of intersection is the transition between product-service systems and solutions, which in turn reflects the transition between e-business and DBM.

Most research on business models in the context of digitalization has been related to e-business. The following section reviews the DBMs-focused literature.

Literature Review on DBMs

The methodology used for this review involved two phases. The identification and selection of relevant DBM-focused studies, and the analysis of these studies to recognise patterns in the research topics (Pateli and Giaglis, 2004).

Selection phase

In order to conduct this study, we searched articles ranked in the ISI Web of Science and SCOPUS. Search criteria included academic articles published from January 2010 to September 2016. Al-Debei et al. (2010) and Zott et al. (2011) establish an excellent conceptual framework for the topic of e- business, and are a good point of reference for DBM analysis. Based on these reference papers, the period under analysis was limited to papers published between 2010 and 30th September 2016. The search terms were: "Digital Business Models/Model", "Digitalization AND Business Models/Model/Modelling", "Digitization AND Business Models/Model/Modelling". These terms had to feature in the publication's title, abstract, keywords or subject. This process resulted in the selection of 311 articles.

Another search was carried out using the terms "e-business models/model". This search resulted in a total of 125 papers. This search was justified because the literature does not differentiate clearly between e-business model and DBM. Also, this search will allow establishing if there are differences between the uses of both terms.

To identify relevant articles, we adopted two additional criteria, following Zott et al. (2011). First, in order to be included in the review, articles had to deal with the DBM concept in a non-trivial and non-marginal way. Secondly, articles also had to refer to the DBM as a concept related to business firms.

An initial analysis, performed by reading article titles, and abstracts, revealed that not all the articles identified by our search would be useful for the purpose of this paper. Many of these articles were studies in which the DBM was not really the subject of the analysis. Also, some references featured in both databases. As a result, the final sample consisted of 52 papers, plus 13 more which resulted from the search carried out using the term "e-business model".

Analysis phase

In this phase, the selected articles were carefully read.

The following categories have been included (Pateli and Giaglis, 2004; Al Debei et al., 2010; Zott et al., 2011):

- Definition: research in this category concerns defining the concept, purpose and scope of a DBM.

- Components: Research in this category is concerned with analysing the DBM concept to further decompose it into its fundamental constructs.
- Taxonomies: Research in this category is related to possible categorizations of DBMs into a number of typologies based on various criteria.
- Representations and conceptual model: Research in this category focuses on identifying the constituent elements of a DBM, describing the relationship between these elements.
- Methods and tools: Research in this category concerns the development and use of methods, languages, standards and software to automate and leverage the process of designing a DBM.
- Capabilities: These are factors that affect the adoption of DBM.

In most works, more than one category may be identified. Based on these categories, the review of the literature generated around the DBMs aims to systematize our knowledge and to identify future research trends (Table 1). Many of the 65 articles under examination were published as part of the proceedings of important conferences indexed in ISI and SCOPUS, which indicates the novelty of the topic. Many of them use the terms e-business model and DBM indiscriminately, which suggests the close connection between both concepts, the persistence of some degree of terminological confusion, and the dialectical relationship between e-business model and DBM.

Insert Table 1

Certain works provide empirical evidence for different types of firm and sectors, for example the publishing industry (Hueberty, 2015; Karimi and Walter, 2016; Oiestad and Bugge, 2014; Peng, 2016; Tian and Martin, 2009; Vendrell-Herrero et al., 2016; Witell et al., 2014). Other sectors analysed are the recorded music industry (Bourreau et al., 2012; Moreau, 2013), automotive industry (Wedeniwski, 2015), capital equipment manufacturer (Nino et al., 2015), digital cinema (Perkis, 2009) and public service platforms (Ranerup et al., 2016; Tzeng et al., 2008). These works suggest that digitalization and servitization have promoted DBMs. Vendrell-Herrero et al. (2016) introduce digital servitization or the provision of digital services embedded in a physical product. This stresses the direct link between digitalization and servitization, both in Industry 4.0., and in the service sector, where the importance of digital services which define DBMs is increasing. Maull et al. (2014), analyse the impact of datafication

on four different types of service system: customer self, customer mind, customer belongings and customer information.

Framing Research agenda around DBMs

The review of the existing literature, allowed us to characterize the conceptual framework of DBMs in order to better understand the relationship between digitalization and servitization. This is very pertinent in the context of Industry 4.0.

The review stresses a number of general points, such as (1) the key role of the firm's digital transformation for the configuration of DBM, (2) the DBM as a unit of analysis, (3) a multidisciplinary view on how firms do business in the new digital scenario, and (4) an emphasis on value networks and business ecosystems. Also, this review identified certain gaps in research, around which DBM-focused research should focus in the future,–allowing for a research agenda to be set up. This agenda results from considering the research gaps in each of the dimensions under analysis, as well as some DBM-related global issues.

Definition: According to the literature review, digital business is an evolution of e-business. An effort must be made to clarify the meaning of DBM, for there is a lack of terminological clarity. No definition of DBM has been generally accepted to date, and it is often identified with the e-business model. The fact that only three works attempt to define DBM stands in sharp contrast to previous literature on business models, in which definitions are a strong focus of business model research (Pateli and Giaglis, 2004; Zott et al., 2011). The definition of DBM must be extended to include inter-organizational activities, roles and organizational elements.

Components: In almost any research in this domain, researchers follow Amitt and Zott (2001) and the CANVAS model options, by attesting that Content, Structure and Governance are the three design elements that characterize a company's business model.

Despite being a category that has been examined in several studies, more research is necessary in order to establish the elements that make up a DBM and determine how they relate to one another. Digital platforms are a very useful tool to link different components, since they are a focus of innovation and

value for the firm and its suppliers, partners and customers. Digital ecosystems should be regarded as an analytical unit.

Taxonomy, typology: Given that different classifications use different criteria, common criteria for classification should be established, facilitating comparability, as well as taking a step towards the establishment of a generally accepted holistic taxonomy and typology of the various types of DBMs. Further research should focus on defining a holistic taxonomy and typology of the various types of DBM.

Representations: In order to promote interdisciplinarity, analysis should avoid focusing on a specific part of DBM. Research on business model meta-models should be encouraged as a way to facilitate the description of DBM.

Design methods and tools: It is need methodological support to digital business, and for the identification of general design principles for digital business methods.

Capabilities: In order to undertake the digital transformation of the firm, a series of capabilities are required. Research on capabilities is framed within the resource-based view of the firm. Capabilities need to relate to other elements of the firm's architecture, such as processes, resources (both system-related and human resources) and key performance indicators (Wissotzki, 2015). The capabilities that companies need for operating successful DBMs should be explored further.

The literature review has also highlighted other dimensions that have received little attention to date and could be future research lines: for instance, the analysis of risk and opportunity related to the digitalization of multinational companies (Duhâneanu and Marin, 2014); the analysis of challenges and success factors in the transformation from traditional to DBMs (Kurti, 2015); the identification of barriers and enablers of DBMs transformation (Kurti and Haftor, 2015; Kim et al., 2016); the analysis of the drivers of digitalization (Molinari, 2012; Scheer 2016); and the analysis of the strategic implications (Militaru et al., 2009; Oestreicher and Zalmanson, 2013).

Although empirical works exist, a greater effort is needed to have larger samples of companies in order to be able to extrapolate the results. The study of the relationship between servitization and digitalization, and its synergic impact on business results, is also in need of more empirical analysis.

Conclusions

Digital technologies and servitization constitute a great opportunity for the industry. To a large extent, digitalization involves the introduction of services. It may be suggested that digitalization is an enabler and a driver of servitization. In turn, servitization promotes digitalization, for it designs new technology-based product-service systems.

Industry 4.0 is being encouraged by the introduction of digital technologies. In as much as enterprises bid for delivering personalized solutions, they will need collaborative innovation, integrating supply chains and connected production resources. This is Industry 4.0: digitalized, serviticized and smart.

Servitization and digitalization have a mutual influence and a joint effect on the transformation of business models, and thus facilitate the emergence of DBMs.

Digitalization makes it possible to turn the product into part of a smart service system, in places where digitalization and servitization clearly intersect, such as the IoT and the provision of digital services. This leads to the emergence of digital technologies embedded in the servitized product firms (digital servitization). In this context, DBMs are characterized by digital services, digital information systems (digital ecosystems) and digital platforms. The correspondence between servitization and digitalization is, in light of this, clear.

Academic implications

This paper presents the results of a systematic review of the literature on DBMs. This review aims to characterize the conceptual structure of DMBs and to examine the relationship between digitalization and servitization.

The methodology used in this review revealed that DBM is an evolution of e-business model. Some terminological confusion exists, and the expression ‘e-business’ is often used to refer to digital business. It is therefore essential to forge a generally accepted definition for digital business.

In addition, the analysis of DBM must be carried out within the context of digital business ecosystems, with the participation of different actors. Transforming the traditional business model into a digital one

requires the coordination of different actors and their particular logic. The variables according to which digital business operate are data, information and network, which determine the DBM.

Regarding the examination of BM as a mature field of study, the review of the literature reveals different areas which incorporate business modelling to their analysis. Components, taxonomy, representations, design methods and capabilities may thus be used to analyse DBM and their evolution. These categories also indicate the relationship between DBM research and other theoretical fields, for example those dealing with resources and capabilities view, transaction costs theory and networks theory.

Managerial implications

In the DBM, the capability modeling it could be a promising addition to process modeling in light of digitization and that it could combine well with services. Also, the analysis of organizational capabilities has the potential to highlight internal capabilities that firms should develop in order to successfully deal with digitalization. That is, it must be questioned what capabilities are needed by companies to operate successful DBMs.

The practical implications of this work assume that the digital era is characterized by the easy availability of information and knowledge, which thus become critical factors for the success of organizations. Digitalization and servitization offer firms new ways to compete; a good knowledge of both concepts and how they relate is essential for decision-making processes, especially those concerning strategy. Firms can respond by the adoption of new business models; systematizing the knowledge on DBM will help business managers to choose the best model for their organization. In terms of the business ecosystem, the firm must take into account that the interrelation between partners is essential for the success of the firm.

Further avenues of research

Future avenues of research include empirical analyses aimed at studying the relationship between servitization and digitalization, as well as its effects on digital business models in different industrial sectors.

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