Definition of requirements to pursue a Servitization Strategy in SME: the case of AMT firms in the Ornamental Stones cluster

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Abstract

The introduction of advanced services in a servitization business model is under close scrutiny for a SME supplying advanced technologies. The proposed conceptual model is based on three cornerstones, i.e. strategy, organizational structure, ICT requirements. It was developed and checked by using data from semi-structured interviews, unstructured observations and documentation surveying. The outcomes significance support the model usefulness within the Ornamental Stones cluster. Virtual Breeding Environments/Virtual Organizations, Digital Business Platforms, Industry4.0 and open innovation appear to be required to leverage progress towards advanced servitization and so, promote competitive advantage and cluster survival. INOVSTONE4.0 illustrates a collaborative initiative within this domain.

Keywords: Collaborative Networks (CN), Industry 4.0 (I4.0), Servitization, Product-Service System (PSS)

Introduction

Servitization is a relevant strategic choice to create differentiation from competitors by introducing value-added services (Ahamed, *et al*., 2013), and so, by moving from selling products to a Product-Service System (PSS) (Baines, *et al*., 2009). Neely (2007) also suggests that manufacturers should offer services and solutions, delivered through their products. In fact, nowadays, manufacturers cannot survive in developed economies if they stick to pure manufacturing.

This research introduces an innovative business model for a SME machine tool manufacturer, denominated AMT SME. The model is based on a servitization strategy (first part), organizationally supported by a Collaborative Network (CN) (second part) and also, by a Digital Business Platform (DBP) (third part). Despite SME importance, i.e. ≈95% of existing businesses employing around 60% of private-sector workers (Gasiorowski-Denis, 2015), they lack the scale and the resources to shift their business model to PSS. Thus, servitization has mainly been adopted by large manufacturers like Rolls-Royce, by charging engine customers a hourly rate, instead of selling the product

(Davies, 2004). Nevertheless, it is argued for a solution increasing the ability of SME to engage into servitization, by developing partnerships, aiming at a win-win CN relationship. This might prepare SME to deal with the managerial and technological challenges that are inherent to PSS.

Oliva and Kallenberg (2003) consider that many companies are not yet prepared to deal with the huge managerial challenges requiring different business models coming from the shift to servitization. In addition, Romero *et al*. (2009) argue for Collaborative Networked Organizations as a growing phenomenon in a highly globalized and competitive economy requiring collaboration for business success. In fact, Collaborative Organizations enable a quicker response to business opportunities by sharing competencies and resources (Camarinha-Matos & Afsarmanesh, 2003). Camarinha-Matos (2009) adds up that the support provided by Information and Communication Technology (ICT) to CN enables SME to overcome physical dispersion, also generating economies of scale and scope. A few research questions emerge from this background literature review, as follows:

- RQ1 – Does a SME pursuing a servitization strategy require a different organizational structure? If yes, which one?
- RQ2 – What is the role of technology within this scope?

This research will address a case study that is a SME that supplies other SME in the Ornamental Stones (OS) sector with Advanced Manufacturing Technology (AMT). Changes in the Industry have occurred due to the shifting role of OS towards a more decorative one and, also, because competition has become tougher. This is based on higher volumes, higher quality and on the high reputation of Italian firms. So, Business Operations have adopted both Product Customization and Make-to-Order strategies.

So, cutting on technology investment by transferring the concerns with maintenance & overhaul and, also with machinery updating to the equipment suppliers might be welcome by the OS SME manufacturers. This could even be more attractive if it includes the customization of technology and the reduction of downtimes together with the elimination of maintenance costs, by setting up an advanced services long-term deal (Baines and Shi, 2015) paid on a regular base. However, to provide this service the AMT SME needs to address real-time sensoring, data collection, data broadcasting and big data analytics to uncover hidden patterns of working behavior for the machines, correlations and other insights. Then, advanced prognostics & health management technologies will help to plan the interventions of a CN of maintenance experts, in order to enable the AMT SME supplier to change its business model to servitization (Greenough & Grubic, 2011).

The designed and tested descriptive model sets a holistic approach to AMT SME operations to address strategy, organizational structure and technological infrastructure in harmony. This will create the adequate conditions to such innovative business operations. Thus, the expected outcome of this model is a systematic process of inquiry to guide the study of servitization in the research sponsor (Simões, 2017). Primary data were gathered by semi-structured interviews and by in loco observation. Secondary data coming from the surveyed documentation were also considered. The outcomes significance provides a hint as regards the conceptual representation usefulness to discuss and appreciate these innovative business models in the sponsor, the AMT SME.

This investigation has already identified primary stages of servitization taking place into the AMT SME that might be further developed towards advanced servitization, if both a DBP associated with Industry4.0 and collaborative networks are implemented, as part of the organizational structure. Moreover, a requirement for open innovation in the OS SME arises in order to overcome the strong feelings of ownership concerning physical

resources, capital, information and data that holds the progress of servitization, providing an additional threat to the cluster survival.

The remaining sections of the paper concern the development of the conceptual business model, the methodology, the sponsor case study and the conclusions.

Development of a conceptual business model to introduce PSS

In this section, a conceptual business model to introduce Product-Service Systems in a AMT SME, in the Ornamental Stones Cluster, will be developed.

Long term customer relationships and co-creation of innovation have been highlighted as core topics in servitization (Tuli, *et al*., 2007; Vargo & Lusch, 2004). Therefore, sustainable competitive advantage (Martinez, *et al*., 2010; Greenough & Grubic, 2011; Davies, 2004), supported on customer differentiation (Brax, 2005; Malleret, 2006; Gebauer & Friedli, 2005; Ostrom, *et al*., 2015) to deliver product functionality (Slack, 2005), in an alternative way, has been based on use-oriented and result-oriented services. The main goal is to free the customer from heavy investment costs, as well as from inherent maintenance duties, concerning a product purchase, by transforming it into a long-term rent service (Baines & Shi, 2015). However, the new technological service providers are SME that do not have enough strength to assume on their own these responsibilities, so, a way out is to establish strategic alliances (Camarinha-Matos, 2009; Lee, *et al*., 2010), as a path to collaboration and co-innovation in value creation associated with the services (Camarinha-Matos, et al., 2013), related to servitization (Baines, 2013; Gulati, 2007).

Requirements for a new structure typology (Oliva & Kallenberg, 2003; Gebauer & Friedli, 2005; Vandermerwe & Rada, 1988; Monte, 2002), organizational change (Bustinza, *et al*., 2015), different stakeholders relationships (Monte, 2002; Oliva & Kallenberg, 2003; Gebauer & Friedli, 2005) and new technologies (Baines, 2015) have arisen as a consequence of the complexity introduced by servitization in SME organization. Therefore, it is expected that the introduction of Virtual Organizations (VO) may help to magnify competencies, resources and services that are needed to generate value, by solving the limitations of rules and hierarchies (Silva & Almeida, 2017). VO are based on setting breakthrough networks of relationships with the stakeholders (Reim, *et al*., 2015). Partner selection (Mont, 2002) in VO should be conducted by identifying and choosing potencial partners from a Virtual Breeding Environment (VBE) (Afsarmanesh & Camarinha-Matos, 2005; Camarinha-Matos & Afsarmanesh, 2007), which is a long term association that supports the way a collaborative network works as regards ICT, working rules and cooperation agreements (Afsarmanesh & Camarinha-Matos, 2005). In this way, one might conclude that **Business Strategy and Organizational Structure are interrelated, influencing each other choices** (Silva, 2009), **so CN appear to match organisational requirements for deploying PSS in SME** (**P1**).

Technology is a relevant topic in the pursuing of the advanced services supporting the adoption of a servitization strategy (Reinartz & Ulaga, 2008) **based on a collaborative network** (**P2**). In fact, technology acts on processes, strategies, business models and competition by changing and adjusting their nature (Porter & Heppelmann, 2014). Add-ons to ERP relational matrix might enable dealing with a constant stream of data (Neely, 2007). Extracting patterns of behaviour from huge amounts of realtime data is required to Remote Repair Diagnostics and Maintenance Technology (RRDMT) (Biehl, *et al*., 2004; Lee & Lee, 2015), which is based on Prognostics and Health Management (PHM) (Vichare & Pech, 2006), an implementation of condition-based maintenance (Greenough & Grubic, 2011). This is a critical enabler to compete through

a service provider business model, in which concerns AMT SME (Neu & Brown, 2005; Bigdeli, 2016). Moreover, Lapalme (2017) and Burton (2017) argue for a business architecture, e.g. the servitization, as the strategic path to guide the design of business processes that are strategically aligned – i.e. VBE/VO (Gartner, 2017a). This is followed by a Digital Business Platform (DBP), which is a path to the implementation of a common ICT platform supported by new digital business models (Gartner, 2017b) that could enable SME to challenge big size companies (Manyika, *et al*., 2017). DBP should provide information regarding a Product-Service System about availability and reliability of equipments, as well as, about service cost (Lightfoot, *et al*., 2011). Finally, the way to address Industry digitalization in a I4.0 context requires transparent data systems linking customers, suppliers and other partners (Vermeire, *et al*., 2017) by supporting innovative interfaces and services. Usual subsystems of I4.0 include Big Data, Cloud Computing, Cyber Security, Autonomous processing, IoT, Cyber-Physical Systems (CBP) and Smart Products (Huxtable & Schaefer, 2016).

One might conclude that a servitization business model needs an underlying interoperable ICT platform. The requirements for interoperability may concern busines objectives and processes, digital meaning of exchanged resources and, technology heterogeneity (Pagano, *et al*., 2013). Moreover, technology does perform a role by pushing PSS forward by providing the means for their implementation. Thus, it might help SME to overcome both their structural, human and technical limitations and, also, financial weaknesses that are stopping the deployment of the I4.0 procedures (Faller & Feldmüller, 2015). On the other hand, some of the usual issues in collaboration also show up. Thus, while data owners in CN should be open to share their assets, data consumers should be «educated» to trust them (Batini & Scannapieco, 2006). In summary, **technology appears to answer business requirements for innovative models, as well as, to push businesses to alternative ways to capture value** (**P3**).

The pursued literature review identified both the organizational and technological challenges to implement a servitization business model in a SME supplying Advanced Manufacturing Technology (AMT) for firms in the Ornamental Stones of Portuguese Industry. Therefore, it is argued for an organizational structure based on a collaborative network implemented through a VBE/VO approach. These are enablers of a network of partners aiming at providing maintenance both use-oriented and result-oriented services, a *sine qua non* condition for an innovative product-service system for a AMT SME. In addition, IT requirements for deploying a digital business platform to support the VBE/VO were also highlighted. These should enable collecting and treating big data at distance by the IoT from CNC equipments loaded with sensors aiming at finding out patterns of behaviour. Then, diagnostic tools would enable the design of condition maintenance interventions by the partners in the field in order to avoid breakdowns and, so reinforcing the feasibility of the servitization business model. Figure **1** describes the main graphical interactions of these three elements: business model, organizational structure and technology.

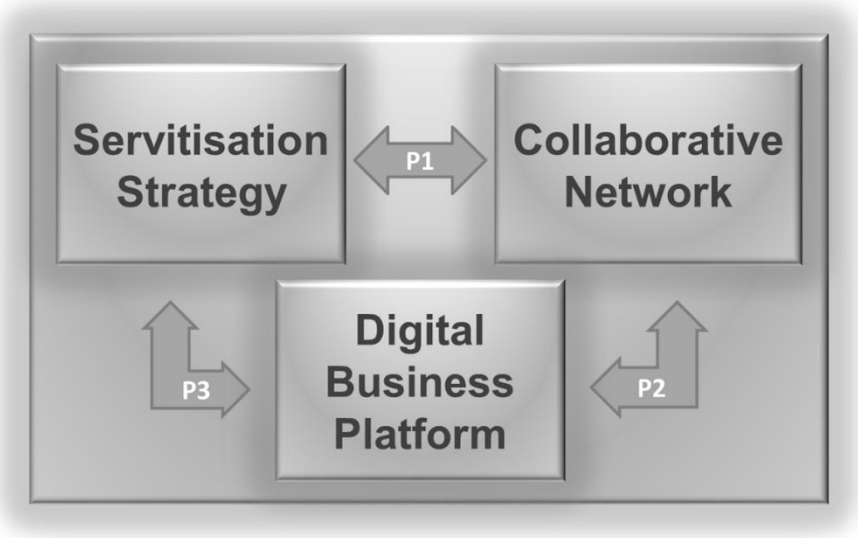

Fig. 1. The developed conceptual business model to introduce PSS in a AMT SME.

Methodology

This exploratory investigation addresses the level of adequateness among a Product-Service System, a Virtual Breeding Environment and a Digital Business Platform, as depicted in Figure **1**. A theoretical development, i.e. the conceptual model, is based on a hypothetical-deductive approach, which was operationalised by building up a descriptive representation arising from a literature review, in advance to the fieldwork. It was possible to identify three broad propositions (**P1**, **P2** and **P3**) that were also discussed in the case study findings section. A process of inquiry to question the possibility of developing a PSS in the investigated case study was designed, based on this model (Simões, 2017).

Semi-structured interviews and semi-structured observation generated primary data that were completed with secondary data coming out of documentation search. In this way, the triangulation of sources was pursued (Saunders, et al., 2009). Thus, a few top managers of a AMT firm were interviewed by following the interview guide developed from the conceptual model (Simões, 2017). A few open questions completed the questionnaire (Saunders, *et al*., 2009; Yin 2009), in order to cover new relevant topics emerging from the interviews. Feedback from the interviewees assured both construct validity and reliability. External validity might be pursued through analytical generalization (Yin 2009).

Case Study – the Advanced Manufacturing Technology SME

The case study AMT SME is part of the Ornamental Stones industrial cluster. While a sector is a grouping of companies grouped for administrative or statistical purposes, a cluster is a set of organizations with a similar operational purpose, i.e transforming OS, which is closely located and, by collaboration, achieve better results than firms working on their own (Porter, 2008). In fact, the cluster acts as a collaborative network limited by a geographic area, but accomplishing the requirements of a servitization business model (Gulati, 2097; Williams, 2007), since the contracting and delivery of services is dependent on the geographic relationship between customer and supplier (Baines, 2013; Kumar & Kumar, 2004). However, Camarinha-Matos *et al*. (2005) argue that belonging to a cluster in not a sufficient condition for a PSS strategy. Moreover, Camarinha-Matos (2009) also refer to a VBE as a more adequate environment for service providers; this

agrees with the understanding expressed by the interviewees that identified a VBE as acting as a "permanent internal network" by emulating an extension of the internal operations of the firm.

The case study company sells horizontal technologies, such as CNC cutting machines employing laser, water jet, etc. together with sensoring, vision among others and, advanced controlling software. It has used cross-fertilization innovation with the shoes industry due to the similar nature of the cutting operations. Moreover, it has been oriented towards selling products, despite a few services have been added. These regards to low levels of servitization, mainly offered in sales and maintenance. In sales, illustrative examples of basic services are machine delivery at the customer's door, laying out the technological solution, connecting and testing equipments at customer's plant, machine customization, operators training and machine revision. On the other hand, remote maintenance is offered at no cost during the machine lifecycle. Corrective maintenance is free for two years, as regards manufacturing defects. However, maintenance to fix other types of breakdowns is paid. Despite there is a high risk when PSS are offered to SME some factors may help to decrease it, as follows: business risk assessment, demand for specific marketplaces and customers, type of machine use by the customer, level of relationships closeness with customers, contractual conditions, customer characteristics (e.g. education, training, maintenance concerns, etc.), geographical location, typologies of local partners, etc. (**P1**).

SME find difficult to cope with a high rate of new technologies introduction together with decreasing times-to-market, increasing investments and more sophisticated equipments requiring specialized maintenance and new requirements, e.g. the ones of servitization and CN. The solution was to put together a consortium – INOVSTONE 4.0 – made up of AMT suppliers, their customers, Universities, Sector Technological Centers, Sector Associations and Competitors to address R&D projects and other types of collaboration, for instance innovative co-creation of advanced manufacturing technologies. Therefore, it appears attractive to expand this approach to the development of digital business platforms using I4.0 to support virtual breeding environments to enable a PSS business model, despite these requirements being different, in terms of scope and scale, from the ones set for the specific development of units of advanced equipments (**P2**). However, the interviewees mentioned that the currently pursued role of ICT was focusing on equipment development in five main areas, as follows: **i)** Production where CAD/CAM systems already in place enable production machines to comply with design formats and standards in order to receive remote execution commands; **ii)** Quality, where sensors, cameras and advanced proprietary software enable digitalization and optimization of the cut profile to avoid defects and improve pattern matching; **iii)** Production control, where production data acquisition enable reliable production management, i.e. actual schedule, used materials assessment, progress evaluation and control statistics (machine and operator times, set up times, down times, idle times, etc.); **iv)** Maintenance, where collecting, treating and processing of massive amounts of data about equipment condition (e.g. energy consumption, oil leakages, equipment performance) through sensors, augmented reality and proprietary software already enable remote maintenance procedures that save on travelling expenses, while maintaining the same level of service, i.e. on time (even more) and effective; **v)** general issues, where data security, data interoperability and real time operation are relevant instances. Nevertheless, as concerns the utilization of the external functionalities there is a pitfall associated with the huge off-line times of the equipments due to the lack of trust on sharing data from the customer side. So, it is suggested that this social issue should be addressed and solved. Moreover, focus on ICT development should also include a strong trend towards the

development of the Digital Business Platform aiming at supporting the Virtual Breeding Environment, as a recognized cornerstone for the adoption of advanced services in servitization. In addition, the search for other interests to be supported by the DBP should also be addressed. Therefore, it appears to be the right time to further develop a broader Enterprise Architecture (EA) (FEAPO, 2013; Lapalme, 2012) and to involve (both socially and operationally) more partners into the consortium initiative (Silva, *et al*., 2017) (**P2**). OS manufactures should be aware that a servitization business model enables them to focus on their core business, leaving the increasing complexities of technology to the experts. Thus, some already recognize that it is on their best interest to become active VBE participant partners as soon as possible (**P2**, **P3**).

Conclusions

This research has showed that a few AMT SME in the OS cluster already adopt basic services within the servitization scope, as a way to differentiate themselves from competition. Moreover, it was found that these organizations may face difficulties in establishing a worldwide collaborative network to support all their customers that are spread around the world, in order to assure the required high levels of service. However, for closer markets, namely Portugal, Spain and even other countries of Europe that option appears to be attractive, i.e. to develop a VBE/VO organizational solution based on a collaborative network (**RQ1**).

In fact, the research sponsor does have good relationships with the entities of the scientific and academic environment (universities, state laboratories, sectorial technological centres, etc.) and it shows enough strength to lead the development of a collaborative network to provide services. This is also supported by its equipments that already are "intelligent" in terms of control and production in real time of data/information based on the huge number of sensors that are installed in the machinery (**RQ1, RQ2**).

In addition, information technologies dedicated to the management of organizational systems must shift their focus from a transactional positioning to a relational one. In fact, the classical ERP systems (transactional in nature) cannot cope with PSS demands that are oriented to a relational approach to support the collaborative organizational structures required by a VBE/VO solution (**RQ2**).

On the other hand, the existence of a tradition of collaboration among the firms in the cluster, as well as the good relationships with external entities may facilitate the development of a prototype for a VBE/VO environment aiming at providing maintenance services. This multi-organizational structure might also support other cluster needs, by enabling the deployment of a Digital Business Platform (**RQ1, RQ2**).

Unfortunately, there is a drawback that has still to be overcome, concerning the OS SME fear to share data, in order to protect commercial know-how. In fact, it is not possible to implement condition based maintenance, if the machines are offline, despite equipments being technologically prepared for it. This is not a technological problem, but a social one that avoids data to be gathered in real time as Jardine, *et al*. (2006) suggest. Therefore, it is not possible to offer use-oriented and result-oriented services. The offer of services is limited to product-oriented ones and the AMT SME cannot minimize the maintenance cost under these conditions (**RQ2**).

At last, working within the I4.0 paradigm will increase the closeness between OS customer and AMT supplier towards a better alignment both strategic and operational. In this way, specific condition maintenance plans managed together with the AMT supplier might be expected to become the usual standard (**RQ2**).

In the scope of this research assignment, it is argued for a potential contribution to theory as concerns the development and preliminary test of a significant conceptual model. Then, a process of inquiry that appears to be relevant for the research of servitization in SME was operationalized, as an interesting contribution to research in operations; this simultaneously provides guidance for OS SME interested on PSS, as regards structural and technological needs, which appears to become a relevant contribution to the practitioner. The study results were slightly limited by the number of organizations available, despite a good dynamics was established with the ones that volunteered for being interviewed and so, for participation. These are mainly coming from the ones involved with the INOVSTONE 4.0 mobilizing project.

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