# The Competitive Tensions and Dilemmas of Industry 4.0: a Capabilities Perspective

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## Abstract

This paper provides a conceptual framework for investigating the impact of Industrie 4.0 on the competitive landscape of servitizing companies. The introduction of smart factories and industrial products has the potential to provide more servitization opportunities for manufacturers, but it also poses challenges relating to: who can appropriate the profit (if there is any) from these new services, if and how these new developments may impact existing network structures and, last but not least, data ownership and security. We outline the theoretical background to these issues, propose a conceptual framework for their investigation and posit our initial research questions.

## Introduction

Servitization has been proclaimed as the saviour (Vandermerwe and Rada, 1988; Oliva and Kallenberg, 2003) and , paradoxically, a major challenge (Brax, 2005; Neely, 2008) for manufacturing companies and thus can be argued to have a complex impact on manufacturers' competitive advantage (Eggert, Hogreve, Ulaga and Muenkhoff, 2014; Turunen, Eloranta and Hakenen, 2015). As Industrie 4.0 begins to emerge and the Internet of Things (IoT) becomes a reality (Heng, 2014) the big data revolution can be seen to encompass more than simply the analysis of big consumer data, it can be seen to both underpin existing business ecosystems (Pattinson & Johnstone, 2015) as well as challenge their stability (Drath and Horch, 2014). Lightfoot (2016) posits that smart products are changing relationships with customers, because manufacturers are now able to stay connected to their products after sale. Smart data can be posited to add to disintermediation by providing a direct route for manufacturers to the end customer; Porter and Heppelman (2014) have already noted the transformational properties of smart connected products and recognize they provide not only competitive opportunities but also competitive threats.

However, just as servitization is not a panacea for manufacturing (Baines, Lightfoot, Bennedettini and Kay, 2009a) digitization faces similar challenges, transparency of markets and data (e.g. Brody and Pureswaran, 2015) can pose severe competitive threats and worse, facilitate cyber attacks, e.g. the attack on Sony in November 2014 (BBC news, 2014) and destabilize not only companies but entire states as witnessed by the fall-out from wikileaks and the need for its founder, Julian Assange, to seek asylum (BBC News, 2011). Many manufacturers are beginning to develop 'smart' systems but their impact on their competitive stance and business model (Pisano, Pironti and Rieple, 2015) is not yet clear either because of the challenges that servitization present or because of the additional challenges presented by the IoT. Lerch and Gotsch (2015) pg. 45, argue that "manufacturers cannot afford to ignore these emerging forces, which have the power to completely reshape the industrial landscape". Hence, as is the case with deploying servitization, manufactures will be required to develop new capabilities to ensure that competitive advantage can be fully maintained and exploited (Paiola, Saccani, Perona and Gebauer, 2013; Turunen *et al*., 2015). Hence, the objective of this paper is to explore the opportunities and challenges that 'smart' systems present to industrial manufacturers and the capabilities needed to fully exploit the opportunities and mitigate the challenges. The plan to move this forward through exploratory interviews with manufacturers will be presented and these will be used to further develop the managerial agenda associated with these developments.

## Literature review

### Servitization

Servitization is attracting increasing attention in both the operations and the marketing literature, although there is still a diversity of terminology referring to the phenomenon, for example there is also a large body of work on product service systems, see Beuren, Ferreira and Miguel (2013). In many senses both these areas provide a multidisciplinary interface for industrial and services marketing, operations and manufacturing management along with sustainability agendas relating to production (Lightfoot, Baines and Smart, 2013) thus providing a rich intersection of insight. Servitization has been suggested as a mechanism for manufacturers in developed economies to reinvigorate their revenue and competitive position (Neely, 2008). However, whilst the notion is that servitization is 'new', many manufacturers have always offered services, see the early work of Cunningham and Roberts (1976). Additionally, the early business models of computer companies reveal situations in which the revenue from the services (software and related support and installation) far outweighed the revenue from the hardware itself – perhaps evidenced by Xerox and IBM often been cited as highly servitized firms (Vandermerwe and Rada, 1988; Ahamed, Inohara and Kamoshida, 2013).

As theory in the area develops a number of frameworks are emerging to define the field, for example the taxonomy describing services supporting products (SSP) and services supporting customers (SSC) proposed by Mathieu (2001) that can be seen to underpin much understanding and theory development. For example, the suggested need to distinguish between services that complement products such as smoothing and adapting services and those that are substitutes for the products themselves (e.g. fleet leasing rather than ownership) (Cusumano, Kahl and Suarez, 2015). Although such straightforward and potentially simplistic dichotomies are not without their critics (Araujo and Spring, 2006).

Consensus has also not been gained around the profitability of servitization (Eggert *et al.*, 2014; Neely, 2008) and the servitization paradox where it appears that radical implementation of servitization is more successful than an evolutionary approach (Brax, 2005; Kastalli, Visnjic and Van Looy, 2013;). Evidence sufggests that there are a number of companies that simply decide to withdraw from or decrease their service endeavours (Finne, Brax and Holmström, 2013; Valtakoski, forthcoming). Servitization strategies also provoke extensive discussion with a great deal of diversity being illustrated in this area, see for example, Baines *et al.*, (2009b), Raddats and Easingwood (2010), Raddats (2011), Raddats and Kowalkowski (2014) and Lee, Yoo and Kim (2016). Amongst these discussions, an important thread relates to the how well servitization strategies ensure services are embedded into the company rather than just being seen as quick wins or 'add-ons' that require little real change of strategic direction (Weeks and Benade, 2015) without necessitating a change to service-orientation (Gebauer, 2009).

Closely related to the discussion of servitization strategies is debate relating to the capabilities needed for its successful implementation , see for example: Paiola *et al*., (2013) The majority of this work tends to focus on the capabilities required by single categories of actors, often, although not always, taking a manufacturer or producer focus. However, some work does also take a multi-actor and/or relational focus, e.g. Story *et al. (forthcoming)* and considers the interactive nature of capability development, e.g. Johnsen and Ford, 2006, Raddats *et al. (forthcoming)*. It is clear that understanding capabilities and the capability transitions needed for success is key to developing managerial insight into the topic.

Servitization researchers are already beginning to investigate the potential for digitization and big data to impact on manufacturing and the services provided by the actors involved. For example, Coreynen, Matthyssens and Van Bockhaven (forthcoming) identify different pathways to facilitate this, while Lerch and Gotsch (2015) identify different types of digitalized product service systems. Opresnik and Taisch (2015) go as far as to suggest that incorporating big data analysis into product

services systems is the future for servitizing firms and their opportunity to gain competitive advantage.

**Industrie 4.0 (Industrial Big Data)**

The technological revolution builds apace, fears of the potential disruption of the millennium bug (Machles, 1998) are long forgotten and many writers are now contemplating the advent of the 4th Industrial Revolution (Wan, Cai and Zhou, 2015; Monostori *et al.*, 2016). It is not clear who coined this term, it could be Oxford Professor Luciano Floridi, who has discussed the impact of information and communication technology (ICT) on society (Florid, 2014). Nonetheless, since the turn of the millennium we have witnessed a revolution in how consumer data, in particular, have been collected, shared and managed. Diebold (2012) provides an interesting discussion of how the term big data (and the associated discipline) has evolved. Other early discussants also include Laney (2001) who notes the need to consider data volume, velocity and variety (the 3 Vs framework) derived from growing ecommerce channels, which now can be seen to form a basis for understanding big data. On the other hand, Kitchin and McArdle (2016) argue that the 3Vs categorization is too simplistic, noting the existence of multiple forms of big data all of which require a more nuanced understanding.

Big data is acknowledged to be changing the face of consumer understanding (Erevelles, Fukawa and Swayne, 2016) and the competitive environment of consumer facing firms, for example Prescott (2014) identifies how data advances relating to big data technology have enables A.C Nielsen to regain its competitive advantage. Chen, Chiang and Storey (2012) recognize that much of the early focus on big data and data analytics was led by major Internet firms such as Google, Amazon and Facebook, forecasting major impact on consumer focussed applications across e-commerce, e-Government, smart health and security and public safety. However, its reach is now much wider spanning and generated from wider and wider sources ranging from Internet clicks to sensor networks (George, Haas and Pentland, 2014), but George *et al* ., (2014) continue to highlight the increasing recognition that big is not necessarily the most important factor but how smart the data set is, i.e. can it provide appropriate insights? In a similar vein Fan, Lau and Zhao (2015) also highlight challenges that big data analysis bring.

The IoT attract a great deal of academic attention in consumer-facing situations, such as the ability to control Internet-enabled smart devices such as central heating timers or boilers through an app on a smart phone. This results in the ability to develop smart services such as ambient assisted living (Wuenderlich *et al*., 2015) which are anticipated to have potential to further evolve the service landscape. With marketing academics devoting much attention to consumer perspectives, Wan *et al.*, (2015) note the potential of enabling technologies such as industrial wireless networks and Cyber-Physical Systems (CPS), facilitating a change in the control of manufacturing systems and which has the potential to remove traditional boundaries and allow consumers to input to product design.

However, behind this lies a much larger potential for CPS use in the industrial base, which demands attention from B2B researchers, e.g. Pattinson and Johnston (2015) identify how digitisation is emerging in a business-to-business context and suggest that viewing this as part of the business ecosystem will be become mandatory for our understanding of business networks. Distributed and industrial control systems will be transformed by the advent of smart technologies and industrial internet systems resulting in the emergence of intelligence factories. Monostori *et al*., (2016) predict that CPS will lead the emergence of new business models and services which may change many aspects of our life and business routines. They predict the emergence of cloud based maintenance routines for aspects of preventative maintenance such as condition monitoring which previously relied periodic manual intervention thus raising the possibility of new service and solution offerings. However, other authors, e.g. Mourtzis, Vlachou and Milas (2016) caution that more work still needs to be done before the rewards of industrial big data can be fully exploited.

## Competitive dynamics

Vandermerwe and Rada (1988) recognized that the move towards servitization compelled new forms of competition, suggesting possibilities of firms competing with themselves, their customers and their suppliers as well as potentially competing with other industries. Coopetition has been identified in these complex market places, e.g. Amazon and Apple collaborating over digital text platforms (Ritala, Golnam and Wegmann, 2014). Vendrell-Herrero, Bustinza, Parry and Georgantzis (forthcoming) illustrate how the publishing industry has been transformed by digitization while publishers have been able to survive the disruption by adding new digital services (ebooks) although the supply chain structure has been restructured. However, along with this digital transformation also has the potential to blur the boundaries between firms (Woerner and Wixom, 2015) and thus raise questions about who owns this digitized material and the balance between cooperation and competition.

IMP researchers have tended to focus on cooperation, interdependency and mutual adaption in relationships with an understanding that this stability pervades the network (Ford and Håkansson, 2013) and the long-term relationships are of value to all parties involved. Such relationships are built on mutual trust and expectations of win-win outcomes for all parties involved. However, not all business relationships take on this form, value appropriate from relationships is not always equal and it can be contended that this inequality of value appropriation has the potential to destabilize the relationship. Taking the well-known example of 'power by the hour' from Rolls Royce, it can be seen as a transfer of risk from the customer to the supplier, with Rolls Royce shouldering the risk of their engines not producing the desired power or long term stability. But there is potentially a darker side to this transfer. In order to achieve and improve the performance of the engines, Rolls Royce need to monitor the performance of their engines, in doing so if these engines are monitored using smart technology, Rolls Royce can capture and analyse data relating to how all their customers use their engines. On the one hand, this can be seen to give them a large data set and from this Rolls Royce should be able to better understand performance metrics and improve their engines' performance overall. On the other hand, they can identify how different customers use those engines. Potentially they could also see that one carrier gains superior performance through their way of using these engines. It may well be that this superior performance forms the basis of that customer's competitive advantage. Thus the question then arises – can and should Rolls Royce reveal this mode of operation to the customer's competitors? So we can see that smart manufacturing and Industrie 4.0 has a potential dark side.

## Research gap

Lerch and Gotsch (2015) note that the focus on servitization coincides with increased digitalization, yet research into the impact of this on manufacturing remains scarce despite the increasing attention being paid to Industrie 4.0. Monsostori *et al*. (2016) predict that CPS will result in life-changing services and new ways to develop value adding systems and will impact across the whole global supply chain. Opresnik and Taisch (2015) see servitization gaining additional leverage through such changes. However, such developments raise significant questions about how existing business relationships and networks will react to these new offerings and if the dark side of Industrie 4.0 will result in less success that is being expected or in new forms of relationship, networks and ecosystems emerging. Thus this research sets out to explore what the impact of Industrie 4.0 will be on servitization in particular and business relationships and networks more generally.

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