



Remote monitoring technology and servitization: Exploring the relationship

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ARTICLE INFO

Keywords:

Servitization
Remote monitoring technology
Multiple-case study
Benefits

ABSTRACT

Remote Monitoring Technology (RMT) is recognised as one of the key enablers of servitization. While servitization has been the subject of intense research for years, the role of RMT therein has been less explored. This paper aims to contribute to this important topic by addressing the following research questions: what are the benefits of RMT and how do they support servitization? An exploratory multiple-case study of four manufacturing companies, operating in aerospace, industrial equipment, marine, and transportation sector, was conducted. The research makes three contributions. Firstly, it is the first systematic study of the benefits of RMT and their role in servitization. Secondly, it recognises the centrality of the RMT challenge for the relationship between RMT and servitization. Finally, it explores the implications of the RMT challenge for this relationship. Three implications have been identified, which suggest a novel perspective on the nature of RMT, RMT-enabled services, and their role in servitization.

1. Introduction

In their seminal paper Vandermerwe and Rada [1] defined servitization as a process of creating value by adding services to products. A commonly commented case of Rolls-Royce is a prototypical example of servitization. The company has moved from selling gas turbines to delivering power-by-the-hour service to its customers, which pay only for the power delivered by the turbine [2]. Other example of servitization is Man Truck and Bus UK. This company provides a service contract known as a pence-per-kilometre [3]. This is based on the realisation that the cost of a truck or bus is less than 10% of its total life cycle cost. A pence-per-kilometre service aims to reduce this cost, for example, by helping customers to save fuel.

To support the servitization process companies are deploying a broad spectrum of information and communication technologies (ICTs). In Man Truck and Bus telematics is a key enabler of servitization [3]. Through telematics they track vehicles, record fuel consumption, and measure driver behaviour. In Rolls-Royce this role is played by engine health management [4]. By deploying sensor-based technologies on turbine blades they trace and track engine performance thus supporting servitization [5]. The importance of technologies such as telematics and engine health management for service provision is immense. Paluch [6] argues that remote services are predicted to become the fastest growing ICT-enabled services within the next years. According to Ref. [7] wider adoption of such technologies has the power to reshape the entire manufacturing industry while [8] see these technologies as the key catalyst for the most significant change in manufacturing firms since

the second industrial revolution.

While servitization has been the subject of intense research for years, the role of technologies such as telematics and engine health management therein has been less explored. This paper aims to contribute to this important topic. It addresses the following research questions: what are the benefits of Remote Monitoring Technology (RMT) and how do they support servitization? To address the questions we conducted a multiple-case study research. The remainder of the paper is structured as follows. Section 2 presents a review of literature at the intersection between RMT and servitization with specific emphasis on RMT benefits. Section 3 explains the research design while Section 4 introduces findings from four case studies on the benefits of RMT and their role in service delivery. Before we conclude, in Section 5 we discuss the study's key contributions while in Section 6 we explore their implications for research and practice.

2. RMT and servitization: literature review

2.1. Servitization

The key premise behind servitization of manufacturing is provision of solutions to customers by integrating products and services [9]. Through servitization manufacturers benefit from: growth in revenue [10], strengthening provider-customer relationship and greater customer loyalty [11], differentiation and robust market defence to competition [12], and building new revenue streams [13]. However, manufacturers considering servitization should proceed with caution.

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<https://doi.org/10.1016/j.compind.2018.05.002>

Received 6 December 2017; Received in revised form 28 March 2018; Accepted 1 May 2018
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For example, the servitization paradox, originally put forward by Gebauer et al. [14], states that the increase in revenues from services often leads to reduced profits. The latest research [15] collected evidence that servitization might even increase an organization's risk of bankruptcy.

Interest in servitization has dramatically increased and has now become an established [16] even mainstream field of study in many disciplines [17]. Kowalkowski et al. [18] found that over 180 scholarly journal articles on this topic are published every year while Rabetino et al. [19] identify 51 literature reviews that have accompanied this progress. The reviews suggest that servitization is not a monolithic field of study but formed by a number of disciplines and fields each bringing their own methods and terminologies. Thus, Lightfoot et al. [12] found that the principal research communities are services marketing, service management, operations management, product-service system (PSS), and service science. The review of servitization literature [19], which encompassed more than 1000 journal articles, that explores the structure of servitization research, identified three research communities: PSS, the solution business, and service science community. Their key conclusion is that servitization research is a fragmented multi-disciplinary domain composed of three sharply bounded communities indicating a theoretically nascent field. This resonates with Brax and Visintin [17] who found that the servitization phenomenon appears fragmented into separate streams and suffering from an abundance of concepts. In relation to the latter, Beuren et al. [11] identify a number of terms used to discuss this phenomenon, including: servitization of the products, PSS, service engineering, service-based businesses, industrial product-service systems, integrated product and service offering, functional products. Although numerous and diverse, these terms often refer to the same thing. In regards to the place of RMT in the wider servitization research, findings by Ref. [12] are revealing. Through a thematic analysis of servitization research they identify five key generic research concerns: product-service differentiation, competitive strategy, customer value, customer relationship, and product-service configuration. The concerns show that the role of RMT is overlooked topic. Identical is noticed from the most recent review of servitization research [19] that identifies a number of specific research clusters and streams with no mention of RMT whatsoever. Although recognised by some as an essential enabler of servitization, RMT topic holds a tenuous place in servitization research. This is explained by the unique nature of RMT. Namely, until recently the RMT research was concerned with technology development and was ignorant of its value-creation potential in a business context [20]. On the other hand, servitization research is focused mainly on topics such as customer value and strategy paying little attention to the role of RMT therein.

2.2. RMT: an essential but neglected enabler of servitization

The recent reviews of literature on ICT-enriched products in service delivery [21,22] identify a variety of terminology in use describing this phenomenon. In addition to telematics and engine health management, other terms include: smart technology [2], remote maintenance services [6], intelligent machines [7], remote monitoring technology [21], digitized products [22], smart services [23], remote diagnostics [24], intelligent products [25], prognostics and health management [26], smart products [8,27], and digitalization [28]. Nonetheless the key principle is the same: enriching physical products with digital components [22] that enable real-time monitoring, acquisition, and communication of data about various aspects of products' performance in service [21]. Here we have followed [21] by using the, more generic, term RMT.

RMT is increasingly being recognised as one of the key enablers of servitization. Oliva and Kallenberg [29] argue that RMT does not add value to customers *per se*; the real value of RMT becomes obvious only when it is used in the context of higher product availability value propositions. Johnstone et al. [30] assert that power-by-the-hour value propositions are too big risk without an on-going real-time product

monitoring. Through interviews with 22 manufacturing executives, Ref. [31] aimed to identify the key resources and capabilities required to deliver successful servitized offerings. Data on installed base product usage provided by RMT was identified as the key strategic resource and the capacity to process and interpret this data as the key organizational capability. According to Ref. [32], technology, particularly engine health management, was a powerful enabling factor facilitating the move of Rolls-Royce, and of the other two main aero engine manufacturers (GE, and Pratt and Whitney), to servitization. Baines and Lightfoot [33] explore the operations that deliver advanced services; defined as outcomes focused on capability delivered through performance of the product. They found as crucial that manufacturers use remote monitoring of product's location, condition, and use. This resonates with [34] who found that the collection of real-time data is critical for ability to offer advanced services such as outcome-based contracting.

The evidence about the importance of RMT for servitization is in contrast with the level of interest in this topic. For example, Ref. [6] reports a gap in the literature on remote services saying that very little, mainly descriptive, research exists that addresses RMT from a management viewpoint. Lerch and Gotsch [7] pointed out that while servitization has been widely discussed, the effect of RMT on servitization has been less well explored. Lenka et al. [28] say that although some servitization studies have recognised the role of digitalization therein, limited insights exist on how digitalization enables manufacturing firms in creating value. Similar is found by Ref. [32] who observed that in the literature the move to servitization is normally attributed to economic, demand, and competitive factors, with almost no concern given to the role of technology. This is identical to Ref. [34] who noticed that despite the central importance of technology in servitization this relationship has been neglected in the literature. Finally, Ardolino et al. [35] argue that the role of digital technologies in the service transformation of industrial companies has been overlooked by the servitization literature.

Therefore, although being important for servitization, the role of RMT therein has been less explored. This is especially evident in the case of the benefits of RMT and their role in servitization.

2.3. Benefits of RMT and their role in servitization

This section reviews studies that investigate the relationship between RMT and servitization (Table 1). The review was conducted to identify the benefits of RMT and their role in servitization. Namely, understanding the benefits that companies gain from an ICT investment and how these create value for their businesses is the first step of any attempt aiming to shed more light on the relationship between ICT and business. The results from the literature review fall into three groups: (1) benefits for the customer, (2) benefits for the manufacturer or service provider, and (3) the challenge of creating value from RMT-enabled services.

Benefits for the customer are manifested in: (1a) the minimization of downtime, and (1b) proactively stopping or preventing breakdowns. By using RMT the errors or faults may be remotely detected and activities involved in their resolution prepared for in advance [38]. This results in the minimization of downtime for the customer. Increased reliability [27] is another way in which RMT is found to minimize downtime. In terms of the benefits of proactively stopping or preventing breakdowns Greymyr et al. [39] termed these as "taking responsibility" and "creating security". According to Ref. [23] the benefits of RMT-enabled services for customers involve the removal of unpleasant surprises from their business. This is similar to Ref. [24] who found that customers emphasise risk reduction over cost savings.

The review of the literature revealed the following two benefits for the manufacturer or service provider: (2a) insight into customers' needs, and (2b) cost reduction. In respect to the former, data collected and processed by RMT can be used to learn more about customers and

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