# Smart services in manufacturing and their financial benefits: evidence from Brazil.

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**Abstract.** Technologies associated with Industry 4.0 are reshaping manufacturing production for good. Many companies have been using this opportunity to expand and further develop their smart service offerings, which consists of the integration of technologically-mediated services that exchange data between service providers and customers. Smart services enable manufacturing companies to shift from simple product providers, to service providers, offering considerable benefits for them and for their customers. The aim of this paper is to explore how manufacturing companies are financially benefiting from smart service provision, and if so, how are these benefits being evaluated and managed. In order to address the paper's objective, a qualitative research was conducted among nine Brazilian manufacturing small and medium sized enterprises (SMEs) from the electrotechnical industry, distributed along four different national states. The research consisted of interviews that were carried out in March 2022 with experienced managers, partners and executives from the case companies. All of the respondents have been implementing smart services into their offerings, for different specificities and purposes, presenting a positive response towards its implementation. The findings evinced that most companies indicated that smart services have been a lucrative source of financial benefits. However, companies lack a clear business framework to effectively capture financial value from smart services.

**Keywords.** Smart services, Manufacturing companies, Digital servitization, Industry 4.0, Brazil.

## 1. Introduction

The manufacturing industry is identified as a fundamental organism for the economy, capable of advancing technological leaps that lead to paradigm shifts, such as industrial revolutions. The fourth of these revolutions, commonly known as Industry 4.0, is already a feasible reality, and sets new challenges and opportunities for manufacturing production and services, since it is based on the integration of new digital and disruptive technologies [1], [2]. Some indispensable components consist of "Big Data", "Internet of Things" (IoT), Cloud Computing, Artificial Intelligence, among others, enabling the materialization of the so-called smart factories that offer smart services to their offerings [3], [4], [5].

Klein [6] describes smart services as technologically-mediated services that are delivered by the provider and accessed through a remote asset, and that exchange data through built-in control. Therefore, smart services provide exponentially expanding possibilities for new product functionality, reliability, utilization and capabilities, transcending traditional product boundaries [7]. Besides, these technologies present a varied range of benefits for manufacturing companies and service providers, enabling the improvement of value creation and profitability, positioning them as leaders in the market [8].

Therefore, smart services enable manufacturers to shift from an industrial product-centric production, to a more service-centric approach towards customer's needs [9]. Accordingly, when it comes to analyzing manufacturing's financial prospects, it is expected that these smart services generate significant transformations on how traditional business models are operated and on how they are able to deliver, capture and create financial value.

Scientific studies concerning the understanding of how Brazilian manufacturing small and medium sized enterprises (SMEs) are coping with smart service provision is still incipient. Apart from being largely technology oriented, previous studies lack a

broader assessment of smart service value creation potential and the financial benefits associated with them. In an attempt to fill these gaps, the main goal of this paper is to explore how Brazilian SMEs from the electrotechnical industry are benefitting from smart service provision. Thus, the paper is driven by two research questions (RQ):

RQ1: Are Brazilian SME manufacturers financially benefiting from smart service provision?
RQ2: How are the financial benefits from smart service provision being evaluated and managed?

In order to do so, a qualitative research was conducted among nine Brazilian electrotechnical companies, which have already started developing their smart service capacities, in different levels and ranges. The results evinced that even though companies are financially benefiting from smart service provision, they lack clear business frameworks, resulting in difficulties to effectively evaluate new digital business models.

# 2. Literature review

## 2.1 Smart services in manufacturing

Smart services are associated with five main characteristics that explain their potential benefits for manufacturing, as pointed by Marquardt [9]:

1. Connection between the physical and the digital world;
2. Upgrade of value creation and economic efficiency;
3. Extension of products and services with a digital level;
4. Transformation of the product into a part of service;
5. Change from product centred to customer centred business models.

Customers' ever-expanding quality requirements and demand for innovations, makes it primordial for companies to increase their flexibility and reorientate their service offerings in order to secure their future in the competitive world market, specially in the course of digital change [9]. Thus, according to Classen & Friedli [10], by adopting strategic moves, given the recent digital scenario and by taking smart services into consideration, manufacturers will be able to offer more safe and stable services, and consequently incur on higher profitable revenue margins and save additional costs.

Besides, smart services build the foundation for business model innovation opportunities. Business models describe mechanisms to create and capture value through the identification of new potentialities, essentially, by capturing innovations and making it possible to generate new revenue opportunities for firms [11], [10]. Thus, business models are the pathway for a company to earn money and fulfill the customer requirements, to grow its business, and to survive on the market by being competitive as it achieves uniqueness [12]. Therefore, business models with a strong foundation in smart services, smart business models, are those which, in Marquardt's [9] view, "provides a customer centered and solution oriented approach with higher service focus and preemptive acting to avoid unpleasantness from the customer" [ p. 794].

For Smit et al. [2] the escalation of digital technologies is constantly leading to radical changes in business activities, such as its value delivery, value creation, and value capture [13]. Value creation is the attempt to increase value, while value capture is the process of securing financial or nonfinancial return from value creation. Consequently, business models must provide a coherence between both, involving innovation and delivery [14], [15].

The starting point to create value from digitalization services are embedded in advanced services, operational services, and out-come based services, which enable firms to capture all its financial benefits [16]. Thus, manufacturers may struggle with the deployment of digitalization, and capturing value from its investments, so it is evident that they should not only invest on technological improvement, but also invest on complementary capabilities, such as servitization, in order to generate a sustainable financial performance [17].

## 2.2 Digital servitization in manufacturing

A strategic action towards service business growth often used by manufacturers in order to achieve their financial goals, relies on 'servitization'. The term was firstly introduced by Vandermerwe & Rada [18], and represents a value generation process via the increasement of the services offered to customers, securing a competitive position in the value chain. Moreover, servitization is a shift from product to service orientation, manifested by integrated solutions, like customized products and advanced services [19]. Therefore, digital servitization refers to the provision of digital services embedded in a physical product [17], [20]. The key premise in digital servitization of manufacturing is to provide IT-enabled solutions to customers, mainly through planned integration of products and services [21].

Pursuant to this, digital technologies inherent to smart services tend to enhance the decision making process of manufacturers, providing reliable data and analytics about customers and their fleets [22], [17]. Besides, these technologies can be directly integrated with fleet management, while providing opportunities to improve product lifecycle management, servicing its lifecycle, enabling customer consultation in regard to new investments. Companies are then capable to evolve their market

strategies, from the standpoint of pure products providers, to service providers [16].

Nevertheless, in the deployment of advanced digital technologies, technological capabilities alone are not sufficient to generate financial value, instead, they must be intertwined with sufficient organizational resources and processes, so that a company can effectively appropriate financial value from digital services [13]. Thus, according to Kohtamaki [17], the potential value of digitalization must be captured by service offerings, which are embedded with smart solutions, such as R&D, optimization, operational and performance services. Kim et al. [23] states that "only when the information technology is embedded into organizational processes (e.g., strategy making) is it expected to offer sustainable benefit" [p.170]. The sphere of the service offerings should, therefore, display the company's servitization strategy business model.

# 3. Methodology

In order to propose a broader understanding of smart services usage in Brazilian electrotechnical SMEs, a qualitative research was conducted among nine companies of the sector, distributed along four different national states. The present research explored which smart services are provided by manufacturing SMEs and how they are evaluated as a profitable financial source.

All of the nine case companies in this qualitative research are SMEs from the electrotechnical industry, and are all current associates of the Brazilian Electrical and Electronics Industry Association (Abinee), its selection was based on purposive sampling from Abinee's database. Moreover, all of the sampled SMEs consisted of 5 to 250 employees, in accordance with the classification of SMEs by number of employees proposed by the Brazilian Institute of Geography and Statistics (IBGE).

Succeeding the selection of case companies, the interviews were conducted following predefined themes and topics, consisting of open-ended questions. The interviews were entirely based remotely, via phone calls and emails, that were carried out in March 2022, with experienced managers, partners and executives from the case organizations. All interviews were recorded and transcribed posteriorly. The following aspects were explored: the type of smart products and services provided, different disruptive technologies performed, the specific reasons for providing smart services, the perception of financial gains and benefits, the evaluation methods of financial benefits and the financial metrics/Key Performance Indicators (KPIs) used.

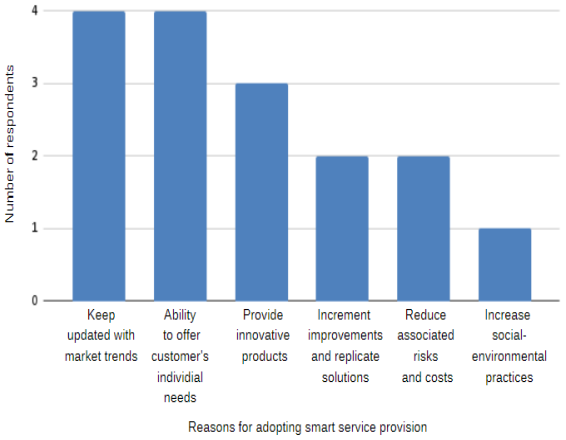
# 4. Results

All of the responding companies (100%) have been implementing smart services into their offerings, for different specificities and purposes. Apart from that, all of them have demonstrated a positive perception towards the implementation of smart service provision into their service offerings, in different levels and ranges. Evidently, their positive response in regard to this matter has been fundamental for the innovation of their service offerings and to the consequent financial benefits that may come from smart service provision.

According to the case companies, the most provided smart services were the following ones: remote monitoring and controlling of devices (44% of respondents), remote diagnostics (55%), data-driven equipments (33%), predictive and preventive maintenance (55%), software solutions (22%) and sensor solutions (44%). Furthermore, all selected companies claimed that smart service provision was enabled by the massive performance of digital disruptive technologies, specially those associated with Industry 4.0 phenomena, such as Internet of Things (IoT) (100% respondents), Big Data (44%), cloud computing (56%) and system integration (56%).

Subsequently, all of the respondents (100%) agreed on the importance of smart service provision for their productions, and highlighted a few individual reasons for providing them, which are responsible for the continued use of these technologies. Figure 1 summarizes these different reasons by each of the seven companies.

**Fig. 1** - Reasons for providing smart services according to Brazilian electrotechnical manufacturers



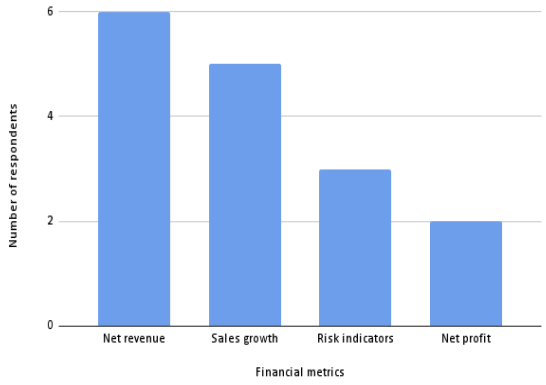

Therefore, it is clear that companies have been noticing benefits in different levels of their production, which have been fueling their decision of providing different smart services embedded into their offerings. As evinced, the case SMEs took into consideration different circumstances in order to formalize their opinions, such as: the importance of updating and evolving their technological capacities while the market shifts into new state-of-the-art

technologies; the ability to meet individual customer demands by product customization; the importance of providing different innovative and distinguished products; and even the importance of enhancing sustainable consciousness and productivity while tackling social-environmental challenges.

Moreover, this research also focused on investigating whether or not the provision of smart services has been a solid source of new financial gains and benefits. Financial benefits were perceived by 78% of the responding companies, while 22% of them did not perceive any substantial financial gains. It is important to mention that most of the responding companies do not usually maintain records of financial benefits specific to smart service-enabled products, however, all of the information and data shared were all specific to the results perceived after the implementation of smart service provision within the last few years.

Figure 2 exposes the financial metrics most performed to evaluate the financial benefits consequent to smart service provision according to the case Brazilian electrotechnical SMEs.

**Fig. 2** - Financial metrics performed by Brazilian electrotechnical manufacturers to evaluate the financial benefits from smart services.




Most companies perform two or more metrics (73%), from which they judged to be coherent to evaluate the financial performance of their smart service-enabled offerings. On the other hand, 18% of the respondents did not perform any specific metrics, since no financial benefits after smart service provision were observed. Thereby, each of the case companies evaluates the financial benefits of smart service provision through different financial metrics, evidently, by the ones that best suit specific variables and parameters that are important for their present and future financial goals and prospects over smart service offering.

Thereby, the respondents have emphasized that the performed metrics are chosen in order to provide insights to the specific smart service orientated products offered by the company. In this context, the current financial situation that the company is facing is also taken into consideration when choosing the proper metrics, since different parameters will be impacted depending on what is more favorable for the company. Besides, as stated by Kanovska [8], "the benefits of smart services can therefore only be measured and demonstrated in a particular company by monitoring the development of the parameters that a company wants to improve by implementing smart services" [p.52].

# 5. Discussion

This research has investigated the behavior of smart service provision for Brazilian SMEs from the electrotechnical sector and also the financial benefits associated with them. For doing so, a qualitative research was conducted among nine companies, from four different regions of the country.

The results of the qualitative research reveals that smart services are seen as a positive service offering possibility for manufacturers of the electrotechnical sector, enabling them to innovate on their usual offerings. According to the response of the case companies, their smart service offerings are mostly based on remote diagnostics, predictive and preventive maintenance, remote monitoring and controlling of devices, data-driven equipments, software solutions and sensor solutions. Therefore, these technologically-mediated services are certainly allowing the possibility of new product functionality, reliability, utilization and capabilities, as coherently indicated by Porter [7].

Furthermore, it was observed that disruptive technologies, mainly associated with Industry 4.0 technology paradigms, have an enormous influence on smart service development. Internet of Things (IoT), Big Data, cloud computing and system integration were the most mentioned technologies performed by the case companies. Evidently, the collection and application of real time data tends to connect not only the entire production chain, but also customer's experience, which increases product efficiency and its long-term costs [2], [4], [5].

When it comes to the different reasons that led to the provision of smart services, the respondents were emphatic. The most mentioned ones were: keep updated with market trends (5 times), ability to meet individual customer demands (5 times) and provide innovative products (4 times). In this context, these results are coherent with the findings of relevant researches that emphasize the general benefits for starting with smart service provision. For instance, Linde et al. [20] state that digital services create closer relationships between producers and customers, increase the improvement of competitiveness through product differentiation, and generate higher profit margins. Moreover, Kanovska [8] observes that benefits from smart service provision for electrotechnical SMEs include differentiation from competition, provision of cheaper and easier product maintenance and increasement in product reliability.

Thereby, 78% of the respondents indicated that smart service provision has been a lucrative source of financial benefits, which have been managed and evaluated by these mentioned financial metrics: net revenue (6 times), sales growth (5 times), risk indicators (3 times) and net profit (2 times). The respondents have emphasized that the performed metrics are chosen in order to provide insights to the specific smart service orientated products offered by the company. Thus, the current financial situation that the company is facing is also taken into consideration when choosing the proper metrics, since different parameters will be impacted depending on what is more favorable for the company. Besides, as stated by Kanovska [8], "the benefits of smart services can therefore only be measured and demonstrated in a particular company by monitoring the development of the parameters that a company wants to improve by implementing smart services" [p.52].

However, it is still unclear how firms are evaluating new digital business models. There is still a lot of misinformation among the case companies about the usage and opportunities that digital business models may provide to their business, which pronounces their ill preparation in dealing with the recent decisions associated with smart service's digital offerings. Apart from that, the case companies need to not only ensure clear business frameworks, but also ones that enable coherent evaluations, in order to effectively capture value from investments associated with smart services [24]. After all, while smart service offerings stand as a source of financial gain and competitive advantage, they still need to be accompanied by appropriate value-capture mechanisms, with properly designed digital business model frameworks [10], [17], [20].

# 6. Conclusion

The constant advancement of technology is reshaping manufacturing production, as the integration of new components such as Internet of Things, cloud computing and Big Data are consolidating the rise of Industry 4.0. Therefore, many companies have been using this opportunity to expand and further develop their smart service offerings, which provides a different range of benefits, such as the increase of a firm's competitiveness, enhancement of decision making process, provision of reliable data and analytics, and also product innovation [17], [22]. Moreover, smart services are understood as an important enabler of digital servitization, consisting in IT-enabled solutions integrating different products and services, shifting companies from simple product providers, to service providers [21], [16].

The paper focused on analyzing the financial benefits of smart service provision to Brazilian electrotechnical SME manufacturing companies. A qualitative research was conducted among nine responding companies, which have all demonstrated a good perception towards smart service provision as these technologies are fully impacting their product and service offerings. According to the exposed findings, 78% of the respondents indicated that smart services have been a lucrative business, while 22% of them did not perceive any substantial financial benefits prior to adopting smart services.

Thereby, these benefits so far have been managed and evaluated by formal financial metrics, the most mentioned ones were the following: net revenue, sales growth, risk indicators and net profit. However, the findings from the research have also revealed that manufacturers are struggling to evaluate new digital business models, revealing that they are still ill prepared to deal with the recent decisions associated with smart service's digital offerings and their benefits. Manufacturers lack clear business frameworks that provide them with effective value-capturing mechanisms from investments associated with smart services.

Thus, future studies should further investigate the financial impacts of smart service provision within other manufacturing sectors, as well as how these benefits are being processed and evaluated.

As technology evolves, so does business evaluation. Evidently, it is extremely important to keep track of both of them, especially in manufacturing, as it is a highly fruitful sector for international economies.

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