

# Industry 4.0 Changes in Technology Providers' Revenue Streams: A Business Model View

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**Abstract** Industry 4.0 concept evolved from an advanced manufacturing view, toward a change of paradigm in the whole industry value chain, from design, through supplier and customer integration up to the final offer of smarter solutions. In this sense, this evolution is expected to impact the company's revenue streams, in special, for technology providers, as they must meet new demands and innovative value delivery forms. In this article, we address such an impact with five case studies from Brazilian companies that provide Industry 4.0 solutions through qualitative interviews. Our results show that the changes in the business model promoted by I4.0 are mainly due to the possibility of servitizing old or new offers through digitization. Thus, companies can improve processes and solutions leading to greater revenues with more recurrent payments from customers. Grounded on these results we discuss how each of them impacts providers' and the challenges companies face to capture more value and develop new offers that leverage this new paradigm, such as the provision of monitoring or a complete solution with consultancy based on the high amount of information shared by customers.

**Keywords:** digital products; business model; digitization; smart manufacturing; digital services;

## 1 Introduction

Industry 4.0 (hereafter I4.0) is the term adopted to characterize the new industrial revolution that has as focus the integration of physical machinery and devices through sensors and software (Dalenogare, Benitez, Ayala, & Frank, 2018; Kagermann, Helbig, Hellinger, & Wahlster, 2013). Such integration seeks to monitor, predict and control equipment and industry toward the optimization of results, improve product design, manufacturing, supply chain integration and data-driven decision making (Kagermann et al., 2013). As it has occurred in the other three revolutions, I4.0 is affecting not only the production aspects but also the company's whole ecosystem, such as work relations, products, and services, supply chain, sustainability, etc. (Alcácer & Cruz-Machado, 2019; Frank, Dalenogare, & Ayala, 2019).

The I4.0 concept is represented by four major smart components, as proposed by Frank et al. (2019). The first component stems from a socio-technical evolution of work, named Smart Working, toward more value-adding activities, with better ergonomic positions, assisted by Information and Communication Technologies, the so-called Smart Work dimension. This dimension is represented by technologies such as Collaborative Robots, Augmented Reality for training and maintenance, and online production monitoring (Wang, Gunasekaran, Ngai, & Papadopoulos, 2016). Smart Products is another dimension embodied in the I4.0 concept. They are capable of monitoring, controlling, automating and optimizing their operation given the ubiquitous connectivity and operation grounded on intense data (Porter & Heppelmann, 2014). Such

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“intelligence” enables an improved analysis of the operation data, providing means to enhance productivity, reliability and even flexibility (Frank et al., 2019; Grubic, 2018; Porter & Heppelmann, 2014). Furthermore, there is the concept of Smart Supply Chain, which addresses the horizontalization of the factory, enabling supplier, customer and units integration to improve raw material, customization and orders, impacting on operational costs and delivery time (Frank et al., 2019; Keller et al., 2014). Finally, the most addressed I4.0 topic is Smart Manufacturing. This concept addresses the journey toward flexible manufacturing lines, able of producing a large set of product families, with improved setups and exchange of dies (Wang et al., 2016) and optimizing all of the internal operational activities (Kagermann et al., 2013). Smart Supply Chain is characterized by technologies such as vertical integration, virtualization of the production processes, automation, and energy management (Frank et al., 2019; Jeschke, Brecher, Meisen, Özdemir, & Eschert, 2017; Kagermann et al., 2013).

As the four main components of the I4.0 show, in addition to the gains in productivity, efficiency and other operational aspects, the I4.0 revolution can reflect on companies’ whole relationships and business models (Alcácer; Cruz-Machado, 2019; Frank et al., 2019). Thus, as I4.0 technologies lead to more advanced offers, where the company is more connected to customers and suppliers (Alcácer & Cruz-Machado, 2019), and delivers not only turn-key technologies, but solutions (Dalenogare et al., 2018, Ayala et al., 2017). However, the expected benefits of such advanced technologies and the effects of I4.0 on the business models of the companies are still little known (Castelo-Branco et al., 2019; Dery, Sebastian, & van der Meulen, 2017; Dijkman, Sprengels, Peeters, & Janssen, 2015).

This impact is especially uncovered for the companies providing I4.0 technologies and solutions, even though some studies research has addressed these changes tangentially (i.e. Dalenogare et al., 2018; Frank, et al., 2019). Thus, this article has as objective to identify what are the new revenue streams enabled by I4.0 technologies for technology providers . This objective stems from empirical and theoretical findings showing a high cost and relatively low adoption of I4.0 technologies (Mittal et al., 2018), which pose challenges for researchers and practitioners in the context of this new industrial paradigm especially in developing countries (Dalenogare et al. 2018, Frank et al., 2019).

## **2 Theoretical Background**

Several technologies are aligned with the I4.0 concept (additive manufacturing, MES/SCADA, predictive analytics, sensors, smart products, etc.). Frank et al. (2019) identified that companies seeking to implement such technologies must implement a set of base technologies that enables further steps toward the I4.0, starting with cloud storage and computing, moving to the internet of things, big data and finally data analytics. In their study, the technology implementation maturity is composed of three levels (low, moderate and advanced adopters), which shows that as the company adopts I4.0 technologies, the complexity increases, from more internal focus (seeking productivity), to more comprehensive technologies that enable customer and supplier integration, toward production flexibility (Dalenogare et al., 2018). Thus, as companies follow a maturity path through the adoption of I4.0 technologies, their competences, costs, value proposition, and even the revenue streams can change (Dalenogare et al., 2018; Frank; Dalenogare; Ayala, 2019; Wei; Song; Wang, 2017). In this sense, companies can leverage digital technologies such as the Internet of Things and digitization as a means to offer new digital solutions for customers, as for example, internet-based services (Grubic, 2018; Rymaszewska, Helo, & Gunasekaran, 2017). Operational aspects may also affect companies’ business models, as now due to greater flexibilization, they are able to manufacture more customized products (Wei et al., 2017).

In this view of the impacts of I4.0, companies’ revenue streams are also expected to be impacted. Revenue streams describe how the company profits from each business segment (Osterwalder & Pigneur, 2010). In this sense, the company may have different pricing mechanisms for different segments of customers or according to their use patterns (Grubic, 2018). Thus, in the I4.0 context, companies are now

able to charge customers in many different, innovative ways. For instance, OEMs can now charge for the machine availability or by use (Lerch & Gotsch, 2015), companies can optimize the customers operation through big data and optimization (Frank; Dalenogare; Ayala, 2019), provide maintenance services more easily and accurately (remote support) (Frank; Dalenogare; Ayala, 2019; Lerch; Gotsch, 2015). In this sense, due to a more servitized focus, changes in the periodicity of the revenue are expected, impacting even customer loyalty (Frank et al., 2019).

### 3 Method

Given the empirical characteristic of the problem addressed, we employed a qualitative analysis in this research (Yin, 2009), since it enables a close contact to the subjects of study – i.e. I4.0 technology providers (Voss, Tsikriktsis, & Frohlich, 2002). In this sense, we analyzed the impact of I4.0 technologies on companies' revenue streams through 5 case studies. The use of case studies is due to its capability of providing a deep understanding of the problem and its complexity in its natural setting, through the actors that are part of its environment (Voss et al., 2002).

Even though the demanded resources are higher, we opted to analyze multiples cases to augment the external validity and generalizability of our research and avoid possible research bias. In this sense, this research used a theoretical sampling for case selection (Eisenhardt & Graebner, 2007). The cases selected were chosen due to their suitability for illuminating the phenomenon studied as the companies are early providers of I4.0 solutions in southern Brazil, and they present high I4.0 maturity, composing a cluster for the development of I4.0 solutions. The same cluster was addressed in the study of Benitez, Ayala and Frank (2020), due to its high relevance in the regional context. Table 1 presents the cases selected, as well as other information on the cases.

**Table 1** - Cases selected

	Company	I4.0 Solution	Technology Provided	Interviewee's position
1	Software Integration	Smart Manufacturing	Vertical integration + Big Data + Energy systems	CEO
2	Additive Manufacturing	Smart Manufacturing	Industrial 3D printing	Founders
3	Planning and Scheduling	Smart Supply Chain	APS software and Business Intelligence	Founders
4	Predictive AI	Base technology - Cloud, Big data, and analytics	Data analytics and AI for failure prediction	Founder
5	Industrial IoT	Base technology - IoT and Cloud	Platform of Industrial IoT	Product Manager

Data was collected using semi-structured interviews with questions regarding I4.0 impacts on the company's business and revenue. Along with these questions, preliminary questions on the company's market, products and strategy were also asked, which enhanced our analysis. The interviews occurred through video conference meetings with at least three researchers and one or more interviewees. Each of the interviews lasted an average of 90 minutes, from March to July 2019, and they were recorded and fully transcribed. The interviews were conducted within a broader project that aims to analyze the several impacts I4.0 may present, be they on work, revenue, business models, external environment, employees, etc.

The data collected were coded using Nvivo® 12 Pro software and the excerpts that the interviewee mentioned their companies' technology impact was highlighted, read and analyzed seeking evidence related to the company's revenue stream, as proposed by Voss et al. (2002). The analysis was conducted by reading the interviews and selecting the excerpts that mentioned the new revenue streams enabled by the I4.0

technologies provided. Then, we categorized these excerpts according to their similarity and analyzed the phenomena described to understand how companies were experiencing changes in their revenue streams.

## 4 Results

Our results show that there is a movement toward a service offer, thus I4.0 providers now are expected to provide business models that focus on recurrent revenues. The focus shifts from the delivery of a product to the delivery of more complete solutions, as mentioned by the Industrial IoT interviewee. In this case, the platform provided by the company generates revenue streams through customer purchases. This is corroborated by Predictive AI which offers monitoring services, and by the Additive Manufacturing interviewee that changed their business model to offer hardware-as-a-service, to overcome customer's resistance:

Hardware-as-a-service is becoming more important because many companies don't want to buy the machine, maybe because they don't know how to use the machine or technology and hardware-as-a-service is solving this, the cost-benefit ratio is becoming much more evident [also due to tax policies and incentives]. – Additive Manufacturing

In a complementary way, companies are also seizing these opportunities to provide a more extensive offers, in a modular form, whether by the single addition of consultancy services, as mentioned by the respondents from Additive Manufacturing and Planning and Scheduling companies, or by the sale of add-ons to the final product, which is the case of Software Integration company, who uses previous software structure in the offer of the company's most recent I4.0 software solution.

For example, within our own company we already know that for the consultancy we will have to teach 3D printing, so it's going to be a new job that will be created to deliver hardware-as-a-service for more companies. -Additive Manufacturing

The new software potentiates our previous software because it alone, cannot do anything. It is modular, synergistic. – Planning and Scheduling

A similar approach is adopted by Predictive AI company who can replicate their solution implemented in similar implementations with few adjustments. This practice enables economy of scale and higher profit margins, which are especially important for startups, such as the company mentioned, as described by the company's founder.

For each project, we update depending on the client and then the idea is once the module is done, I can just repeat this for all similar demands all around the world, so this is why we can profitable – Predictive AI

Therefore, current products or solutions transformation into new business models can be used to gain new customers and provide new solutions in the market focused on individual needs with lower costs for customizing the solutions. These new revenue streams are mainly enabled by digital technologies and sensors which allow data collection and analysis. In this sense, providers of technologies can use their specialized know-how on the machine operation and maintenance to develop value-adding services to gain recurrent revenue streams and maintain a closer relationship with customers.

## 5 Discussions

As the results presented and the I4.0 literature has pointed out, the I4.0 concept and its technologies impact in different manners TP. In this sense, companies that address this industrial paradigm can expect major changes not only on their revenue sources but also on the capabilities necessary for providing such an offer and achieve these gains (Marcon et al., 2019).

Our results also showed a trend toward the servitization of TPs offer, as companies are demanded to change their view toward adding value to customers due to a demand-pull pressure (Frank et al., 2019), instead of a market pulled offer. In such a context, providers must build service and sales competences to reaffirm the benefits delivered and to be able to charge for such an offer (Frank et al., 2019; Marcon et al., 2019). Such view is similar to Coreynem et al. (2015) and Frank et al. (2019) proposals, in the sense that the servitized offer is focused mainly on delivering value through process-supporting services that enable customers to achieve better operational results such as lower lead-times, cost reduction and incorporating internal knowledge to educate clients. Additionally, Metallo et al., (2018) state that other aspects important service companies can leverage to capture greater value could be licensing, fees for installation, subscription, or usage, etc.

In this sense, the delivery of servitized offers is highly improved through digitization (here understood as the digital means through which providers can deliver their offer digital technologies (Grubic, 2018)). In this sense, smarter products with increased connectivity provide means for customized solutions such as monitoring, remote control, and even optimization according to customer's needs (Frank et al., 2019; Porter; Heppelmann, 2014). In this sense, digitization must be seen not only as a means for companies to improve internal processes but also as a channel for providers to allow better integration among provider/supplier processes, organize field service and gather and use data (Coreynem et al., 2015). Finally, as servitization is mainly focused on outsourcing risks from customers to providers (Grubic, 2018), I4.0 providers can seize digital capabilities as a means to improve their knowledge on the servitized product/offer functioning due to the connectivity and thus be able to mitigate the risk assumed and increase revenues avoiding fines on availability contracts (Grubic, 2018). In addition, such data can also be used for the development of new products and services according to customers' use patterns (Lerch & Gotsch, 2015; Marcon et al., 2019).

Thus, in summary, the main aspects related to revenue streams identified are enabled by the increased connection between machines and actors, leading to new possibilities yet to be explored, such as licensing software on Industrial IoT platforms, asset monitoring and management or even more complex services enabled by the increased information sharing such as consultancy into the customers' operation, as TP are increasingly closer to the customers.

Thus, the new revenue streams enabled by I4.0 can be improved by the offer of services that can complement and extend current offers. Thus the trend of providing a servitized business model can be allow adding value to the current offer as companies by leveraging their knowledge as OEMs to provide consulting services on the current operation of the machine, enabled by the data monitored and analyzed. In addition, the modularization allowed by I4.0 technologies can enable building hardware or software to older machines allowing the increasing sales and other possibilities enabled by the digitization of smarter products (Kahle, Marcon, Ghezzi, & Frank, 2020). The development of these complex technologies to gain new revenue streams can a barrier to I4.0 offer which can be approached by SMEs through I4.0 innovation ecosystems (Benitez et al., 2020) or Smart Products ecosystems (Kahle et al., 2020), whereas larger companies can deploy internal resources and capabilities to their development (Metallo et al. 2018).

## 6 Conclusion

The study was carried out analyzing different technologies that compose the I4.0 concept in a structured I4.0 solution development cluster, composed of several I4.0 technology providers in southern Brazil. The broadness of cases studied allowed an extended view of the whole I4.0 concept. Results show that I4.0 TPs have experienced changes as customer companies expect more advanced offers focused on the provision of solutions and not only the sale of products. Thus, I4.0 TPs are expected to develop service and data analytics capabilities to both provide broader solutions but also smarter solutions, with data analytics, monitoring, and maintenance, to mention some. Such capabilities are necessary since I4.0 solutions are

heavily supported by the digitization of the factory and the integration of the available data. Thus, companies must leverage these means to create business models that enable more recurring revenue streams, and improve the value delivered by them, thus, generating more services and new forms of profit. To do so, I4.0 providers must adapt their offers to enable the provision of services and solutions that extend their capabilities of capturing value. In this sense, packaging OEMs can offer services of data monitoring for their customers, or even predictive maintenance as they own an important knowledge on the machine operation. Another offer could be upgrading their machines to collect data or even leverage already established data collection systems to integrate new solutions to increase product uptime or availability.

Therefore, companies should consider such benefits and challenges before endeavoring in the 4.0 journey as new revenue stream demand adaption and innovation to maximize results, especially for manufacturing companies that are still learning their path on servitized offers (Ayala et al., 2019). This can lead to increased customer relationships, more recurrent revenue streams, innovative products and solutions and new business models, leading to better I4.0 results (Frank et al., 2019; Kahle et al., 2020; Metallo et al., 2018).

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International Joint Conference on Industrial Engineering and Operations Management- ABEPRO-ADINGOR-IISE-AIM-ASEM (IJCIEOM 2020)

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