New business models in industry 4.0: An analysis from the value cycle of smart service providers

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Marco Antonio Araujo Ventura, Dimária Silva e Merelles (Mackenzie Presbiterian University, BR)

Abstract: Industry 4.0 is a concept from the last decade that reflects the combination of severaltrends in countries that lead the technological frontier, such as Cyber-Physical Systems and Artificial Intelligence. Together with Big Data and the Internet of Things (IoT), these technologies generate value for industrial activities, mainly from greater productivity, speed and efficiency in decision making. At the same time, companies face challenges when dealingwith new technologies, requiring the support of support services, with a high degree of digitalization, called smart services. However, smart service providers face significant challenges in structuring their business models, especially as we are at an early stage of contouring the industry's architecture. The objective of this paper is to understand how these companies are structuring their business models from the analysis of value creation, configuration and appropriation strategies.
Keywords: Industry 4.0, Smart Service Providers, Value Creation, Value Configuration, Value Appropriation

Introduction

Industry 4.0 is a concept from the last decade that reflects the combination of several trends in countries that lead the technological frontier, encompassing different activities and tools (Lasi et al, 2014), such as Cyber-Physical Systems and Artificial Intelligence (Zhong et al., 2017; Wang et al., 2016; Lee et al., 2014). Together with Big Data and the Internet of Things (IoT), these technologies generate value for industrial activities, mainly from greater productivity, speed and efficiency in decision making (Frank, Dalenogare, Ayala, 2019). For this reason, Industry 4.0 is also known as high value-added manufacturing processes (Lee et al., 2017) or high value-added services and products (Wang et al., 2020; Verdejo, 2016).

Companies face challenges when dealing with new technologies require the support of services with a high degree of digitalization, called smart services (Frank et al., 2019). However, smart service providers face significant challenges in structuring their business models, especially as we are at an early stage of contouring the industry's architecture. These are companies that are in the early stages of the value cycle of their business models (Silva e Meirelles, 2019), where there are an intense process of search and learning, be it from the perspective of value creation, configuration or appropriation (Teece, 2010; Osterwalder & Pigneur, 2010).

The question that guides the research is: how these companies are structuring their business models? The objective is to identify the value creation, configuration and appropriation strategies of their business models and to what extent they have already a well- defined business models.

The contribution of the paper is both from the theoretical and practical perspective. From a theoretical point of view, the analysis of the structure of a business model based on the value cycle provides a dynamic view suitable for contexts of changes in technological paradigms (Silva e Meirelles, 2021). We are facing what Jacobides, Knudsen and Augier, (2006) call a new industry architecture. The result of this new ecosystem of technologies, products and services is increased added value, both for companies and consumers and the public sector.

From a practical point of view, by focusing on intelligent service providers, this paper contributes to supporting the digital transformation process of companies, whether from the point of view of strategic changes or public policy. In research carried out by Project I-2027 (IEL, 2018) it was found that 36.8% of companies in Brazil are in a late stage of automation and that 38.8% had digital systems installed only for some functions (some monitored lines by PCPs, non-integrated management and control modules), that is, 75.6% of our industry is still far from the 4.0 paradigm and had not even completely mastered the stage of lean production.

Theoretical Background

Technology Use from Industry 4.0: scope and functionality

Industry 4.0 collectively refers to a wide range of concepts, without a clear classification against a discipline or a precise distinction: Smart Factory, Cyber-physical Systems, self- organization, new distribution and purchasing systems, new systems of development of products and services, adaptation to human needs and corporate social responsibility (Lasi et al., 2014)

Defined as smart manufacturing, it consists of delivering an intelligent product, where customer information and data are integrated into the production system.

Basically, the technologies that support Industry 4,0 are Artificial Intelligence, IoT, Big Data and Machine Learning. Artificial Intelligence is human intelligence displayed by mechanisms or software. It is one of the most recent fields of engineering and "has many definitions linked to process approaches. of thought and reasoning or behavior" (Norvig, 2013). IoT is the utilization of smart devices like sensors for enhancing manufacturing and industrial processes and "leverages the power of real-time analytics and smart machines and takes advantage of the data that machines have generated" (Bali, 2022 p. 10).

In turn, as stated Bali (2022 p. 16): "big data generated in IoT gives practical information concerning decision making and provides insight into the improvisation of functions". Finally, "Machine learning algorithms, associated with a sub-field called deep learning, provide computers with the ability to make predictions or recognize patterns in complex data" Bali (2022 p. 74).

Together, these technologies provide value creation for industrial activities, above all from greater productivity, speed and efficiency in decision making. For this reason, Industry 4.0 is also known as high-value-added manufacturing processes, generating high-value-added services and products (Dalenogare et al., 2018).

According to Frank et al (2019), it is possible to visualize a subdivision of technologies related to smart manufacturing into six main purposes: (i) vertical integration, (ii) virtualization, (iii) automation, (iv) traceability, (v) flexibility and (vi) energy management. There is a varied set of technologies for each of these purposes (Table 1).

Vertical Integration in Industry 4.0 consists of the integration and interoperability of information (Xu, Xu, Li, 2018) by modern sensors and software that allow remote control and planning of industrial process (Patnaik, 2020). It includes not only machine to machine communication, an evolution of the former concept of telemetry (Bali et al, 2022), but also and the whole activities of manufacturing planning, operation and execution system (Misra et. al, 2021). Other functions, such as virtualization, automation and flexibility, involve mainly robotics, artificial intelligence and 3D (design software and printing).

Table 1. Smart Manufacturing Technologies and Functions

Function	Smart Manufacturing Technologies
Vertical Integration	Supervise Control and Data Acquisition (SCADA) Manufacturing Execution System (MES) Material Requirement Planning (MRP) Enterprise Resource Planning (ERP) Machine to Marchine communication (M2M)
Virtualization (planning and prediction)	Virtual Commissioning Simulation and Modelling Machine Learning and Artificial Intelligence
Automation	Robots (industrial robots, autonomous vehicles, etc.)
Traceability (Inputs and final products)	Sensors, actuators, and programmable logic controllers (PLC)
Flexibility (Additive manufacturing)	3D printing and design software
Energy Management	Monitoring system Smart grids

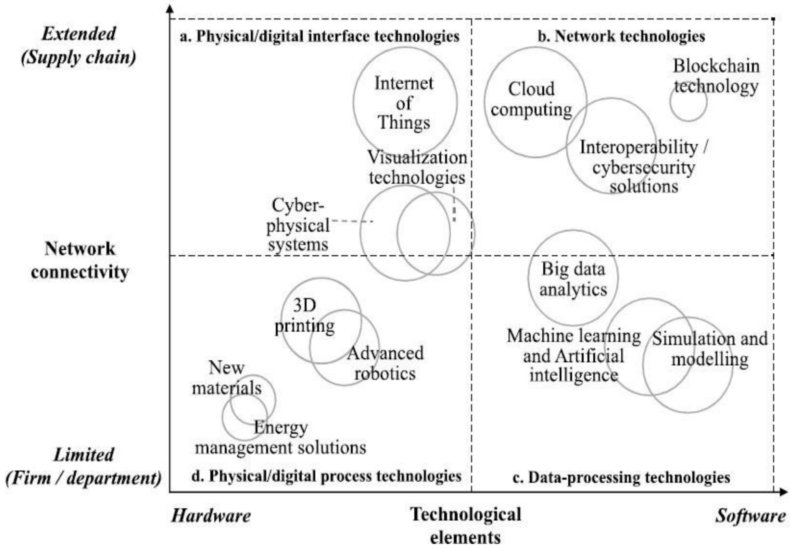
Source: adapted from Frank, Dalenogare Ayala (2019)

Seeking to map the technological components of Industry 4.0, Culot et al., (2020) proposed a classification according to predominance in hardware or software and degree of connectivity. An application of technologies (hardware or software) ranges from an isolated unit, such as a department or company, to a more extended business concept, that is, an entire supply chain. As shown in Figure 1 below, the first level (quadrant d) includes technologies focused on hardware and low network connectivity. These are local technology processes, more tangible, but which in recent years have become increasingly intertwined with digital technologies: 3D Printers, New Materials, Advanced Robotics, and energy management solutions. As this hardware increase connectivity, extending to the entire production chain, we find visualization technologies, the internet of things, and cyber-physical systems in general (quadrant a).

In the group of software technologies, which support the analysis of data and information for control and decision-making, there are those with low network connectivity (quadrant c), such as big data, machine learning and artificial intelligence, and modeling/simulation. High connectivity technologies, that is, network technologies (quadrant b) are those that provide online functionality, such as cloud computing, Blockchain technology, and interoperability/cybersecurity solutions.

Figure 1 - Industry 4.0 enabling technologies according to technical elements and network connectivity (bubble size proportional to the number of occurrences in the examined definitions).

Source: Culot et al (2020, p. 7)



Smart service providers are par excellence users of Industry 4.0 technologies, whether from the point of view of process technologies and physical/digital interfaces, as well as network technologies and data processing. As presented next, the different uses of Industry 4.0 technologies by smart service providers, as well as the different relationships with customers, involve different degrees of complexity in business implementation (Frank et al, 2019).

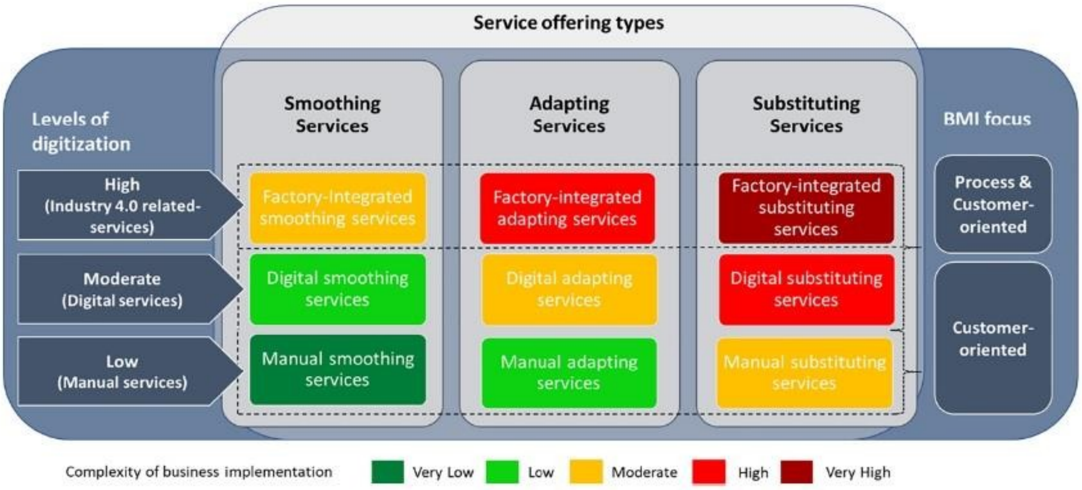
Smart Services' Business Model Structuration: an approach from the value cycleperspective

The business model describes how the company creates and delivers value to customers and then converts incoming payments into profit. However, it is a conceptual, hypothetical device that describes how the company reaches the market (Teece, 2010). Finding the ideal business model is not an easy task, especially when it comes to disruptive businesses, such as those smart services linked to Industry 4.0.

Business model structuration involves three strategic decisions: value creation, value configuration and value appropriation (Silva e Meirelles, 2019). Value creation is defined the composition of products or services offered, the customers segments selected, and the resources and partners needed to support the value preposition.

According to Frank et al (2019), there are three service offerings to Industry 4.0: support, adaptation, or replacement. In each of these modalities, there are varying degrees of digitalization and complexity of business implementation, resulting in different business models, whether oriented only to customers or to processes and customers (Figure 2). The first group includes services with a moderate and low degree of digitization (manual services). The second group is the one with an elevated level of digitalization, these are services effectively related to Industry 4.0, all involving high complexity of business implementation, both from the point of view of the use of technology and industrial integration.

Figure 2 - Conceptual framework for servitization and Industry 4.0 convergence



Source: Frank et al., (2019 p. 345)

As presented next in Figure 3, value creation in Industry 4.0 includes the gains and benefits offered, both from an economic point of view, as well as from a knowledge, market, and strategic point of view. Together these aspects result in increased market share; reduction of the innovation period; individualization/customization; product and production flexibility; mitigation of risks and uncertainty; decentralization of the decision-making process and efficiency, which includes both mechanization and automation as well as digitization and miniaturization (Lasi et al., 2014).

Value configuration is defined by the way activities are organized and how internal processes relationship with suppliers and customers. It includes a set of strategic decisions carried out in the configuration of value chain activities, as well as aspects of the governance structure of assets and the negotiation of internal negotiation of organizational structures, constituting a fundamental aspect of business models (Silva e Meirelles, 2019, p. 794).

In the specific context of smart service providers, the broader the integration of the technologies related to Industry 4.0, the greater the need to define a governance structure and mechanisms for internal coordination of organizational structures. These aspects of value configuration act in the value appropriation to allow an efficient and effective performance, especially in innovation efforts.

The value configuration decisions operate in the appropriation of the value, in order to allow an efficient and effective performance. Value appropriation is defined by the strategic positioning regarding prices, innovation and growth, in a dynamic perspective of value cycle renewing. Together These tree processes compose a continuous cycle of value. An evaluation of the strategic positioning directs future formats of products and processes to satisfy the dynamic goals of customers during the user experience, accompanying the evolution of the technology and the own perception that it has of the product/service.

The strategic decisions crucial to value appropriation are the definition of organizational limits most fitted to protect innovation from imitation and maximize results (Silva e Meirelles, 2019). Some aspects of the value configuration in Industry 4.0 can be understood from horizontal integration strategies across the value creation network, end-to-end engineering, throughout the product lifecycle, as well as vertical integration and network manufacturing (Stock & Selinger, 2016 p. 537).

However, smart service providers are part of the Industry 4.0 architecture, which is in a typical stage of a new configuration of the industry's architecture (Jacobides; Knudsen; Augier, 2006). At this stage, companies can create an architectural advantage, that is, they explore value appropriation without the need to engage in vertical integration (Jacobides; Knudsen; Augier, 2006). So, the profit of these companies' innovation depends on the creation of an architectural advantage, that is, the important thing is to be present in an articulated network of partnerships that signals consistent growth in the future. When a company has an architectural advantage, it can afford not to worry about protecting or investing in complementary assets (Teece, 1986). Instead, it should focus on maintaining its edge by staying in one part of the production process (or assets) while increasing mobility in the other part. The objective becomes to increase complementarity and mobility in parts of the value chain where companies are not active (Jacobides; Knudsen; Augier, 2006).

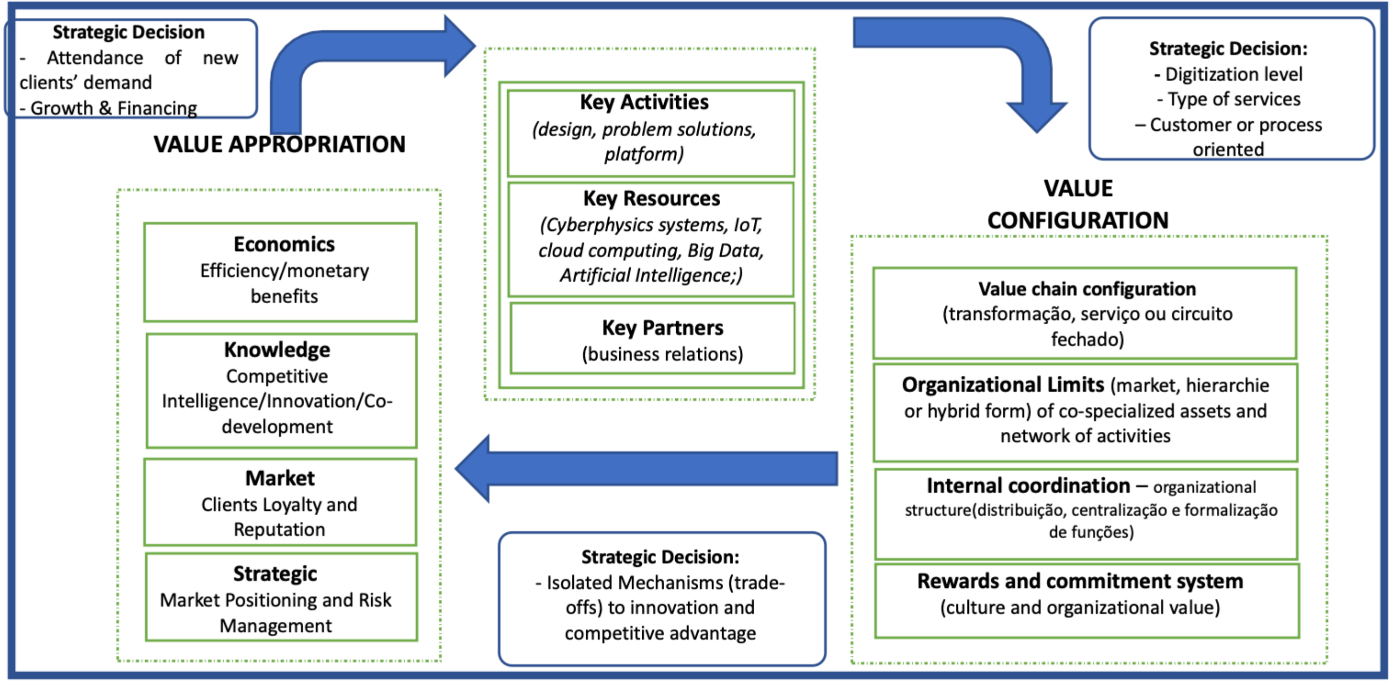
So, here in this paper, we adopt three propositions regarding each process of value creation, configuration and appropriation of smart service providers business model:

Proposition 1: Value creation is defined by the way companies use and develop the technologies and activities of Industry 4.0, expressed in the degree of digitalization, and customization of the services provided.

Proposition 2: Value configuration is defined by the way in which the smart service providers are articulated with the activities of the Industry 4.0 production chain.

Proposition 3: Value appropriation is defined by how the company will secure an architectural advantage in Industry 4.0.

Figure 3: Value Cycle of Smart Services Business Model Structuration



Methodological Procedures

This is qualitative research, based on the collection of primary data via a semi- structured interview script. At first, a specific branch of Industry 4.0 was not selected, since there are diversified experiences in other sectors, from the financial sector, agriculture, pharmaceuticals, automobiles, etc. Based on the analysis of enabling technologies observed on companies' websites, such as Artificial Intelligence, IoT, big data, and other disruptive technologies, 124 companies were initially identified with the potential to be interviewed. Of this total, seven were available for the interview phase (Table 2). The interviewers were owners, CEOs, Founding Partners, or Directors of Technology, mostly engineers, masters, or doctors, with extensive experience in the Industry 4.0 market, consulting, and projects.

Table 2 - Smart service providers

Company	Services	Total Employees	Annual Revenue	Number of clients	Age
Telefônica TEC	IoT and Big Data to agribusiness sector (solution to equipment, soil, clime, irrigation and transport)	27	2 million	11	10 months
iCubics	Consultancy to smart cities, health and environment, residential automation and IoT (sensor to collect information and monitor)	1	1 million	4	2 years
StackX	Training to Industry 4.0 (inspired in Lambda School)	19	500 thousand	250	2 years
Infinity	Modelling and Simulation	10 (Brazil) and 6 (Portugal)	2 and a half million to 3 million	20 - 25	5 years
SUIV	Autotech (smart register)	9	3.2 million	22	6 years
LSI-TEC	Project Consultancy (hardware, software and firmware)	15	-	5	23 years
IPFacens	Technological Institute	500	25 million	550	45 years

The interview script followed the dimensions of value creation, configuration and appropriation in the business model structuration, as presented before in the conceptual model here proposed (Figure 3). We used content analysis technique (Bardin 2009), to identify the categories that emerged from each aspect of the value process. First, we organized data (tabulation) that reduction (a single phase) and then categorization (two or more words).

Results

The value creation strategies developed by each smart service provider were analyzed based on the following categories: opportunity explored, products and services offered, customer segments served, product/process orientation, attributes desired by Industry 4.0, and form of service integration. As shown in Table 3, the companies here studied provide replacement services in factory integration and mostly are process and customer-oriented, operating in the categories of vertical integration, virtualization, automation, and traceability. Most of them are companies with an elevated level of digitization. Customers of smart service providers seek on the one hand, efficiency in processes and economic efficiency and, on the other hand, in the field of technology for decision-making, they seek connectivity, integration, innovation, big data monitoring in real-time, assertiveness in information, virtualization, and creation of scenarios, in addition to the potential provided by technology.

From the perspective of value configuration (Table 4), the following categories were analyzed: activity stream; application of technologies in departments; support activities; feedback on the service provided; partnerships; partners for application of advanced technologies; organizational structure; inventories and receivables; Supplier quality; service improvement information.

The companies here studied provide different degrees of complexity in their service supply chain and are structured in different ways to better apply technology. The activity flows are more complex in two companies (IPFacen and TelefonicaTEC), while in two others it is more concise (SIV and LSI-TEC). In two companies there is a medium complexity (Infinity and iCubics) and in StackX it depends on the customer's need, remaining undefined.

The application of technologies presents different aspects, being focused on the 8 R&D centers of IPFacens, on a single component of the company in iCubics, or on a specific sector, linked to data, in the others. Only one company, LSI-TEC, is verticalized, the others have support areas linked to support and Marketing activities. There are several ways to get feedback on the service provided.

For the most part, such companies seek partnerships to complement some expertise and enhance their ability to offer more advanced services. Several partner profiles were pointed out, the partnership procedure being very necessary to meet demands that are beyond the scope of the service offered or to complement internal needs areas of IT. With the exception of SUIV- Unified Vehicle Information System, which performs the service by itself, and Infinity, which tends to verticalize, all other companies frequently seek partnerships. Eventually, they were partners for specific technologies or, as in the case of Telefonica TEC, through partnership contracts coordinated by the headquarters.

Considering the diversity of possible projects to be attended to and the size of the client portfolio, these companies assume structures that range from the most hierarchical, with several divisions, to those supported by a single professional. There is a distinct flexibility in the feedback processes, characteristic of startups in their early stages, as well as in the processes linked to quality assessment by customers. Companies like SUIV see the possibility of achieving absolute integration with their customers through cloud computing and investment in big data, with the support of artificial intelligence, expanding their service beyond offering just one platform.

Technology applications were left to more technical departments and more informal feedback, with some presence of meetings or specific software. When monitoring supplier quality and internal processes, as well as information about partners, an informal process usually prevails, with companies very focused on customer feedback. None of the companies have inventories or receivables.

Finally, the appropriation of value (Table 5) was analyzed through the following categories: pricing and profit, growth rate, potential customers, new technologies / markets, competition, innovation and patents, abandoned opportunities, how the company is seen.

Price is defined by project or contracted module, specially through measuring man- hours. The companies LSI-TEC and IPFacens, TelefonicaTEC are focused on costs, StackX, on the customer's perception, and the other companies are based on hours worked on each project.

Most companies present high rates in addition to the search for new potential markets. SUIV's growth rate is around 150% and iCubics is 10%, while at the other extreme, TelefonicaTEC, the youngest company, is between 18% and 25%. The others show an average of 30% to 50%, and LSI-TEC is waiting for the market reaction and all claimed to have had difficulties during the pandemic period. However, profits are reinvested, There are a variety of options for potential customers, as well as ways to seek new technologies in new markets, with the exception of SUIV, which operates in a niche where the market owns it and it offers the platform. The competition is also very diversified in the performance of each company and, regarding the strategic level (innovation), most do not generate patents, only, eventually, the brand or the solution, and IPFacen has a patent office and TelefonicaTEC directs them for ANATEL. Only IPFacens and TelefonicaTEC did not abandon any opportunity, while the others voluntarily or involuntarily did so in their past.

The last dimension of value appropriation, how companies are seen, we identified that most of them are well regarded for several positive reasons, being references in their respective niches. The exception is TelefonicaTEC, who is not yet well defined in the market because, since it is still seen as a telephony company, VIVO's heritage.

Table 3 – Dimensions of Value Creation of Smart Service Providers Business Model

	Dimensions	Telefônica TEC	iCubics	StackX	Infinity	SUIV	LSI-TEC	IPFacens
Opportunity (product/services offered); customers	Initial idea	Telecommunications company	Master's project	Adaptation of training to the market	Society (Brazil and Portugal)	dificulties with Vehicle information	Technological Institute of USP	Research of the Institute
	Business Orientation	Process	Product	Process and Product	Process and Product	Product	Process and Product	Process and Product
	Benefits	Economic Efficiency	Costs and efficiency	Machine integration	Integration	Registration and cleaning information	connectivity and big data monitoring	virtualization and scene creation
	Service Integration	Production	Process analyses and evaluation	Consultancy	Total integration with product and process	Total integration with product and process	Manufacturing integration	Consultancy
Key resources and physical, intellectual, financial and human inputs	Digitization Level	100%	100%	10%	100%	100%	100%	100%
	Technological Resources	100%Machine learning, big data, AI	Sensing, AI	Cloud Integration	All technologies of Industry 4.0	Big data and cloud computing, by API	Platform and others tools of Industry 4.0	8 Technological Centers
	Human Resources	Engineers	Engineers	Masters and PhD (various)	Diverse	Technology and Data	Engineering (Masters and PhD)	Masters and PhD
	Needed skills	-	Business vision	Not offered in the market	Digital game experience and Engineering	APIs Customization	AI improvement	Student vision
key partners	Partners	Three suppliers (companies and startups)	Small companies	billing and contact	Hardware suppliers	Automobile supply chain	Manufacturing, Hardware and Cloud	Diverse
	Service Coordination	Contracts	By Project	Technology related	Service buying	Automation of adherence to machine components	Intermediation and link	Permanent suppliers

Table 4 – Dimensions of Value Configuration of Smart Service Providers Business Model

	Dimensions	Telefônica TEC	iCubics	StackX	Infinity	SUIV	LSI-TEC	IPFacens
Value Chain Activities	**activity stream**	complex	medium complexity	depends on the customer	medium complexity	more concise	more concise	more complex
	application of technologies in departments	Digital products team	sole member	Information Technology	R&D is the center	*big data*	data-base and Sync	8 innovation centers
	Support Activities	legal and marketing	outsourced finance; own marketing and sales, network	commercial, marketing, commercial, administrative, support and academic	Administration, Finance and Marketing	technical support and marketing	horizontal structure	*Shared Services*
	feedback on the service provided	Meetings	indication by the customer	*Net promoter score*	Design, networking tools	service audit	platform or communication tools	by Software
organizational limits	**seeks partnerships**	Often	yes	yes	tendency to verticalize, except hardware	acts alone	Cloud, AWS, and Manufacturing	yes
	partners for application of advanced technologies	supplier with own tool	AI Partners	integration of drawings, products and items	indicated by customers	direct with the customer	Industry 4.0	by *software* (NIMB)
Internal Coordination	**organizational structure**	hierarchical	Single component of the company	three divisions	100% horizontal	three partners	independent business units	Executive Board, a CEO and three verticals
	inventories and receivables	no	no	no	no	no	no	no
Servitization Activities	**Supplier quality**	There's no way to keep up	project management	depends a lot on suppliers	trust relationship	by algorithms	informal	informal process
	service improvement information	*customer feedback*	events	conversation with customers	customer controlled	system	direct customer feedback	*Project sprints*

Table 5 – Dimensions of Value Appropriation of Smart Service Providers Business Model

	Dimensions	Telefônica TEC	iCubics	StackX	Infinity	SUIV	LSI-TEC	IPFacens
Economic	**pricing and profit**	costs	time/consultancy	customer perception	working hours and square meter	contract/req-uisitions	man/hour and rein-vested profit	man/hour Profit is re-invested
	growth rate	From 18% to 25%	100% year	30%	From 30% to 35%	From 120% to 150%	waiting for market reaction	From 30% to 50%
Strategic	**potential customers**	BDM	Small and medium-sized industries	B2B, big companies	depends on the market	automotive chain	whatever comes from the market	market gaps
	new technologies / mar-kets	agribusiness fo-rums	Health, Smart Cities, In-dustries	global market de-mand	scale the supply chain of automakers	market owns	edge of technology	freedom to climb
	competition	Other telecommu-nications compa-nies	Small tech consultants	work on the Lambda School model	scanning companies	insurance company data-base	ICTs	other ICTs
Strategic	**innovation / patents**	yes (ANATEL)	There is not	in progress: brand	no (patent solutions)	Do not. Brand regis-tration.	no	patent of-fice
	abandoned opportuni-ties	no	Agribusiness	do not do initial filter	sports, smart cities and other	popular in-surance auto-mation	not having the plat-form as a service from the beginning	no
	how the company is seen	phone company	Small and depends on the owner	reference in the re-gion	well regarded in both countries	automotive data-base specialist	reference for being linked to USP	Reference in the re-gion

Discussion

The question that guided our research was: how smart service providers are structuring their business models?

The analysis has contemplated three declared propositions. First, regarding value creation. We proposed that value creation of smart service providers is based on the degree of digitization and customization of the services provided, with reference to the technologies and activities that support the creation of intelligent systems and Cyber Physical Systems.

It was observed that the origins of the companies interviewed in this research are diverse. While some are closer to technology retail than to Industry 4.0, as they migrated from sectors more linked to hardware and, opportunely, started offering automation infrastructure and offering services in projects for the autonomy of cyber-physical systems, others, migrated from sectors more connected to software and are looking to retail for a partnership to consolidate their position as intelligent providers.

As observed, there is a convergence toward Industry 4.0, reiterating central aspects of this paper, since emerging technologies can generate value for industrial activities and create a scenario industry, empowered by the internet of things (IoT), cloud computing, big data and artificial intelligence.

From the point of view of services offered, the field research suggested that there is an effort by service providers to offer a high added value service, oriented towards the client's process or product, however, clients are still becoming aware of the economic, knowledge, market and possible strategies. High technological content has not yet been explored. Customers' “pains”, shared by respondents in the process of proposing the service, are usually understood through an initial consultation, suggesting that Industry 4.0 customers often have problems and doubts that even they cannot explain.

Parallel to the irreversible trend of products being transformed into services, customers being transformed into users, audiences being transformed into communities and markets being transformed into networks, we realize that technologies such as “digital twins”, through virtual commissioning and gamification, they are migrating factory models to the metaverse and creating a new dimension of industrial plant simulation, reducing costs, and increasing efficiency.

While engineers with great knowledge of high technology seek sensors in digital retail for projects in different areas, such as health, smart cities and sensing, large higher education institutions invest in technological centers, which add the generation of disruptive knowledge to the potential of specialized laboratories.

In this scenario, companies in the telecommunications area are repositioning themselves to offer services related to agribusiness, while opening the market for professionals who integrate the offer of different services as platform with the possibility of strategic partnerships in technology. Some others adapt their functionalities to integrated customer service or take advantage of new teaching models, focused on software demanded by Industry 4.0.

Regarding value configuration, we proposed that this process is defined by the way in which the smart service providers are articulated with the activities of the Industry 4.0 production chain. The integration of the different enabling technologies predominantly begins with the capture of data by sensors. This data is stored in the cloud and, through big data and data mining tools, is used as information for service projects by providers, through Artificial Intelligence and machine learning solutions.

Finally, we proposed that the value appropriation is defined by architectural advantage in Industry 4.0. The interviewed companies usually create partnerships to obtain some support to meet specific demands and add value to products, in addition to composing the product/service mix, as presented in the servitization approaches.

Conclusions

The main conclusion of this research is that the business models of smart service providers here studied are not yet completed. The companies are in the initial phase of the value cycle, where there is an intense process of search and learning. There is a search for a business model that is more suited to the complexities of the markets and the diversity of disruptive technologies, dynamically integrated by Artificial Intelligence, IoT and big data, as analyzed, given the immaturity of an industry incipient and fluidity of concepts in this ecosystem.

So, these startups circumvent their limitations and are making the best possible use of opportunities, trying to make the market more aware of the potential value of their services and closer to the technological reality of more developed countries. Despite the State agendas, government programs, development institutes and various bodies, the challenge is to grow in a sector that is still at the frontier and that requires remapping and redesigning processes. However, some of them present well-defined value creation and configuration strategies, with a clear value proposition.

In order to promote further improvements of research, future studies of companies at different stages of business model development should be engaged.

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