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Service Innovation | A Service Blueprinting for Industry4.0

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Abstract

This research aims to conceptualize a service blueprinting framework to map the digital interaction and shared access to service system resources in Industry 4.0 operations. From the literature review we found that in Industry 4.0 operations, customer and provider are value co-creators, and thus, mapping the service process using such service blueprinting becomes useful to boost new dynamics generating positive and measurable innovation outcomes using either quantitative or qualitative indicators, indexed to the different stakeholders' concerns. As recommended by the of Service Science, wealth comes from service innovation among service systems, so, it is necessary to know at the outset which resources are involved in value propositions along the service process. With this research, we have conceptualized an innovative service blueprinting framework for the digital innovation to visualize the bridge between the physical world and the virtual world in Industry 4.0 operations.

Keywords: Service Blueprinting; Service Science; Industry 4.0; IoT; Cyber-Physical Systems.

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1. Introduction and motivation

Among several methodological tools recommended by the emergent scientific discipline of Service Science [1], service blueprinting (s-bprint) has been widely used as a tool to represent shared access to resources throughout the service process [1]. In practical terms, *service blueprinting* (s-bprint) is a technique to visualize the entire service process and assist in process innovation analyses and assessment [2], providing evidence of the customer experienced service [2]. *Industry 4.0* (I4.0) has become a hot topic among academics, practitioners and authorities as the combination and integration of digital technologies such as advanced robotics, artificial intelligence, sensors, cloud computing, Internet of Things (IoT), analysis and sorting of big data, augmented reality, additive production and mobile devices, among other digital technologies, into an interoperable and shareable global value chain, regardless of geographical space [3,4]. While it is true that most of these technologies have been available since the late 20th century, manufacturers created them without any regard to their integration by users, so what is new in I4.0 is the collaborative way all these technologies interact with one another and with the products resulting from their operations. Referring back to Kropotkin's (1903) experiments, for whom evolution depends on the level of collaboration [5], once digitally linked, these technologies create a bridge between the *physical world* and the *virtual world* [6], thereby altering organizations' production and management at a global level [7]. Suitably adapted, the s-bprint tool can it be useful to managers in their decisions regarding their organizations' sustainable growth (Suhardi and his colleagues 2015), especially allowing comparison of the different service innovation structures of I4.0 with a view to easily extracting the Concern Indicator [8] variations, which the emergent Service Science designates as innovation outcomes [1]. This means that any s-bprint format to be adopted must avoid theoretical causes and organizational pitfalls during its usage [9]. According to the Service Science perspective, the customer and provider are co-creators of products [10], and thus, mapping the service process using such a s-bprint is necessary to boost new dynamics generating positive and measurable innovation outcomes using either quantitative or qualitative indicators, indexed to the different stakeholders' concerns [11]. As one of Service Science's main objectives is to innovate in value propositions, it means that to improve *innovation outcomes*, it is necessary to know at the outset what resources are involved in these propositions (Wong, Ignatius, & Soh, 2014). Improving a value proposition does not mean benefit for customer or provider, but rather adding value to all directly interested stakeholders, where competition is the main driver of innovation [12]. As service systems gain experience from lessons learned over time, systematic refinements will improve proposals, based on historical statistical and anticipated future standards, a lean thinking concept designated as *continuous improvement process* [13,14]. As Industry 4.0 is characterized by a new level of collaboration between providers and customers, boosted by the full digitalization of economic stakeholders, this research aims to conceptualize a new s-bprint framework, able to map digital interaction and shared access to service system resources as well as to visualize the bridge between the physical and virtual worlds in Industry 4.0 operations. The present study has a special relevance today, since the existing models are not adapted to the new reality of the processes. In this sense, the present study aims to contribute to the creation of a new model that already meets this new reality.

2. Service Blueprinting History and Evolution

As mentioned in the introduction, service blueprinting is a tool to visualize the service process towards efficient analysis and value assessment [15], also widely used to map the service process and assist researchers in understanding the service innovation process among stakeholders, to optimize the value co-created (Kwan and his colleagues 2016). First introduced by Shostack (1982), the s-bprint technique was initially developed to study processes related to commerce and services in general, which were represented as a sequence of actions, completely separating the customer from the provider through an abstract concept, designated the *line of visibility* (Shostack, 1982; [17]. In the late 1980s, Kingman-Brundage (1989) introduced a new s-bprint framework, replacing the *line of visibility* of the Shostack model by three new imaginary lines: the *line of interaction*, which separated the customer from the provider, the *line of internal interaction* which separated, inside the provider, support functions from customer service functions and the *line of execution* separating management functions from support functions [17] (Figure 1). Kingman-Brundage also proposed the concept of *back-stage* and *front-stage* lanes where providers move and develop their activities [2,18].

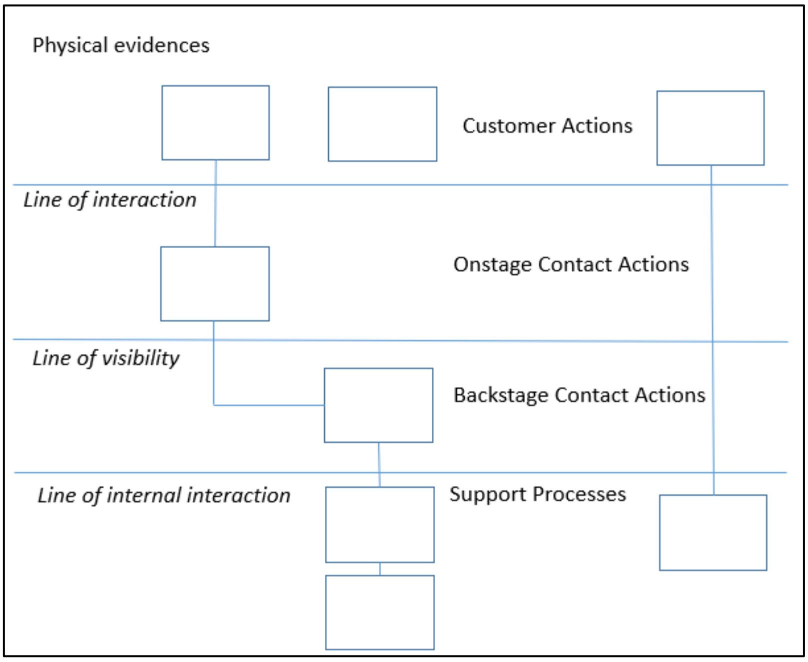

Figure 1: Service Blueprinting Classic Layout [19]

In its simplest form, the description of a service process by s-bprint is a linear representation composed of individual sequential steps, above the line of visibility, where all potential influences on the process, inputs and outputs must be represented [20]. In recent times, the s-bprint has proved to be a powerful tool (Kwan and his colleagues 2016), mainly because it is easily adapted to each case and is thus flexible and continuously improving. Although there is no standard symbology format, according to Suhardi, Doss and Yustianto (2015), actions must be represented by rectangles, transitions by arrows, start/end points by rounded rectangles and decisions or ramifications by diamond shapes [17]. For Suhardi, Doss and Yustianto (2015), the use of flow diagrams within the service blueprint is a good way to map the service process, proposing that actions be represented by rectangles, transitions by arrows, start/end points by rounded rectangles and decisions or ramification by diamond-shaped figures [17] (Figure 2).

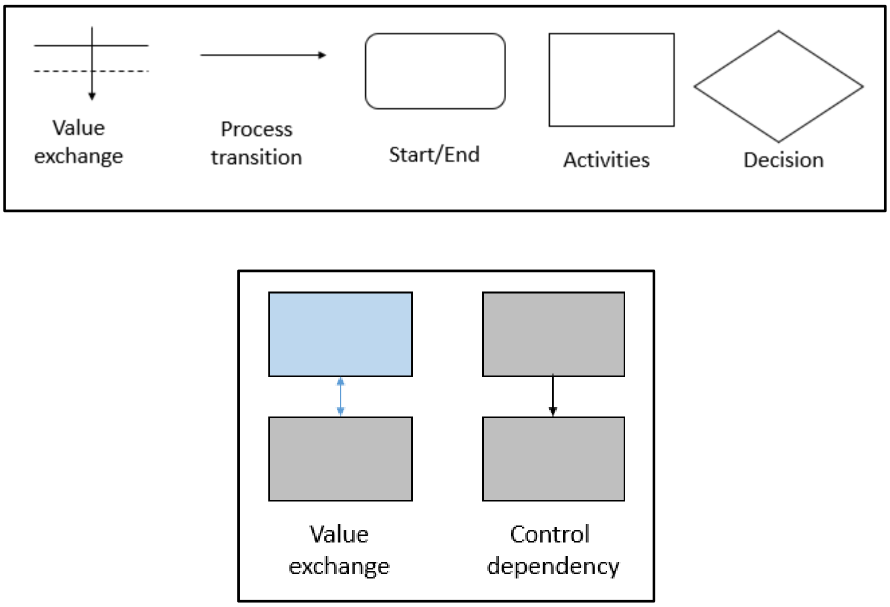

Figure 2: Service Blueprinting Symbol System [17]

The arrows have a very important symbolic meaning in s-bprint, because in addition to the direction of the value exchange, they indicate on which resource the outcome depends more in each step of the process [21]. When an arrow crosses a lane, the value is exchanged through the points of contact [17]. A single unidirectional arrow means that the source of the arrow has control of the value exchanged at that point, whereas a double arrow indicates it is necessary to agree between the two resources or entities for the process to move to the next step [20]. The description of a service process by the s-bprint tool entails placing the resources that make up each of the horizontal lanes as well as their activities, as much as possible supported by official documentation [19], from where the service process mapping begins in time [17], maintaining the rigour and constancy of the data collection methods recommended by S-S, such as observations, tracking and monitoring the step transitions [22]. The s-bprint tool maps the process steps in chronological order, so the description of the activities must be synchronized with the decomposition of the service process [23]. During each step of the process, the resources will carry out activities whose results must be measured and used as data to calculate the concerns of each main stakeholder, as recommended by [24]. However, for some authors [21], s-bprint loses its effectiveness if it is used to optimize the interest of multiple actors simultaneously [21], this being one of the limitations of this methodological tool. Use of the s-bprint tool in Service Science aims to process monitoring processes and design innovative interactions that generate additional value for the actors involved [24]. This means that a s-bprint map in Service Science must be more than just a representative game [1] where for each step the contact points between resources are interpreted and the results measured. Whenever any result is not satisfactory, it is necessary to innovate in that step in the form and content of the value interactions [25], in order to improve the output, that is, the value, for each of the S-Systems involved in the co-operative process [26]. In traditional service process mapping, the *Line of Internal Interaction* separates the provider activities related to the value proposition or order execution from the activities that support the value proposition or order execution as well as in the Kingman-Brundage model [18], with the understanding that beyond this line the CBP-Provider resources have no direct or indirect contact with customer resources [27]. For ease of viewing, the *Evidence and Outcomes*

Lane is usually placed at the top of the customers' actions, but in some s-bprint applications such as the "six-layers" [1], this designation is usually replaced by the *Innovation Outcome*, placed at the bottom of the s-bprint map . Regardless of the designation, these are the physical proof of the co-creative actions and their outcomes, in the form of facts, places, formulas, products or signs used or seen by the customer [18] along the co-creative journey. The *Customer Actions Lane* describes the customer's interactions with the provider throughout the service process as well as in the Shostack model [28]. If the customer does not interact, it simply ceases to be considered an S-System from the Service Science perspective [29] and there will be no more value co-creation [17]. The classic *Frontstage Contact Actions Lane* [19] is delimited above by the *line of interaction* separating independent customer activities from provider activities [17] and below by the *line of visibility*. The Frontstage Lane represents all the activity, people or physical evidence that the customer can observe during the service process [20]. The *Backstage Contact Actions Lane* is delimited in the traditional format [16] by the *visibility line* above, which separates visible activities from hidden activities [17] and the *line of internal interaction*, which separates the provider's activities related to the value proposition or order execution, from the activities that support that value proposition or order execution [18]. The *Backstage* Lane contains all the activities and means required to produce the service the client expects to receive, and in some variants of the S-Bprint, this is designated *Execution* Lane [1]. Support Processes are all means and actions that support the service and value co-creation from the provider side [20], and therefore, in the first phase of the service process they must be designated *Support Actions Provider Lane* and delimited at the top by the *Line of Internal Interaction* [26].

3. Service Innovation and Economic Paradigms

Emergent scientific disciplines such as Service Science aim to innovate in service, moving towards an increase in the value co-created among service systems [30]. With this purpose, different methods and tools have been introduced by academics and practitioners [9], to support service innovation improvement [31], in order to ensure that the service exchanged between suppliers and customers actually provides the desired value for both [21]. For activities related to the production of tangible goods (manufacturing companies), increasingly supported by digital technologies common to intangible assets, Service Science is also become an interesting discipline at several levels [8]. Today, information and communication technology (ICT) is an essential resource in the digital economy. Incorporating fundamental symbologies of valorisation and communication at work, both in communication among stakeholders' internal resources and among stakeholders themselves along the entire service process [30], we may consider that ICT incorporates true physical symbol systems in the more classical sense of the term [32]. Even so, since symbols guide internal behaviour and immediate interactions [30], co-creations of value often depend on a symbolic reasoning on the real value of proposals, and so we may believe that the symbology, organized in formal symbol systems, will tend to become a central component of markets and marketing in the digital context, incorporating the practices and meanings specific to each type of market [33]. In service innovation processes, for Service Science [34], symbols cannot be separated from phenomenological practices, institutions and values, since symbols and practices guide how actors evaluate themselves, evaluate others, or evaluate the value of propositions [29]. One possible way to consolidate knowledge about the nature and role of symbols in Service Science value co-creation may be by using a holistic perspective of how actors practise value co-creation and how these practices affect the rules and relations of signal interpretation, which constitute the role of symbols within service ecosystems and vice versa [35]. From this literature review, symbol-systems appear to play an important role in the co-creation of value. However, the way symbols influence and are influenced by the adoption of practices in the digital economy, specifically in the I4.0 context, will require a more in-depth analysis starting from a discussion of the reasoned value-creation of service Dominant Logic (Gronroos, 2011), and in the view of Service Science eco-systems (Kwan and his colleagues 2016). It will be necessary to integrate symbol sets into dynamic ecosystems of service exchanges. In the digital economy where IoT plays an increasingly important role, it will become increasingly interesting to study and integrate the symbols used by cyber-actors, thus facilitating their understanding, skills and competences, and develop tools that facilitate interpretation of cyber-practices, along with the various co-creative steps in which they participate.

3.1. Internet of Things and Cyber-Physical Systems

As we draw closer to the present day, the XXI century, we see the ability of industry to produce customized goods with a shorter and shorter lifespan. This intense increase in the variability of industry's capacity and consequent increased market volatility has led many observers to believe Industry is on the cusp of its Fourth Technological Paradigm [6], driven by the digitization of production processes combined with widespread use of the Internet [36]. The concept of the *Internet of Things* (IoT) may be described as the intelligent connectivity of smart devices by which objects can sense one another and communicate, thus changing how, where and by whom decisions about our physical world are made [8]. Associated with the IoT concept is the concept of Cyber-Physical-Systems (CPS), meaning the integration of software and hardware to control flexible physical processes (factories), where products and machines interconnect and communicate with each other and with the network they are part of, which also includes consumers [37]. In line with this interpretation, for researchers such as Lee, Baheri and Kao (2015), CPSs are systems which consist of management technologies for the interconnections between the digital world and physical assets, made possible by the great evolution in recent years of sensory technologies for acquiring and exchanging information [4]. Digital technologies in the form of Intelligent Connectivity of Smart Devices (ICSD) [38] are the basis that supports both concepts, representing the main common point between IOT and CPS, which once applied to the relationship between consumers (most common situation) is simple to understand, but when applied to factories, levels of complexity take on another dimension, and this may have been the reason why some authors, researchers and authorities use the term Industrial Internet of Things (IIoT) [6]. In any case, the industrial dynamics driven by digital technologies, such as ICSD or IIOT [39], seem to be reconfiguring the 21st century production model to the point that many authors, researchers and practitioners consider we are facing a fourth paradigm shift in History or a Fourth Industrial Era [6]. Nowadays, parallel to the growth of the IIoT where additive manufacturing is perhaps one of the most emblematic results [40], there has been a change in production, which has long since been boosted by the appearance of new sensorial media on the market [41], which gathers information in real-time in the most different forms. The exponential growth in the use of new sensor networks [41] will certainly increase the amount of information, generalizing the term "big data" [4], as dynamic generators of massive information (Lee and his colleagues 2015). Big data will challenge the ability of CPSs themselves to screen all the information generated in real-time. The paradigm resulting from big data in IIoT is seen as a reality for which we have to be prepared and is designated by some authors as "4V's Paradigm"[9], being interpreted as a sign contrary to the economic advantages of digitalization [42], since it requires systems to respond in an "immediate way", to generate "intelligence" [43], [44].

3.2. The Industry 4.0

The terms Industry 4.0 (I4.0) and Smart Manufacturing have attracted considerable attention namely as a result of a proposal by the German government and other initiatives from the USA, Korea and other countries [45]. In I4.0 mode, a Cyber-Physical System merges the *physical* environment with the *digital* one (Sehgal and his colleagues 2014). Products begin by being just a kind of co-created "digital DNA" [46] which, as a metamorphosis, will start as smart objects (S. Wang and his colleagues 2015) and later become physical during the production process, until the time they are dispatched to the consumer [47]. In this operations mode, product design and development tend to occur from virtual laboratories using customers as co-creators, and move forward to digital manufacturing, where the products themselves acquire their form by interacting with the production methods themselves [48]. The network of machines that make up the I4.0 factory floor will thus tend to become "conscious" and flexible systems, responding quickly, not only to human commands but also to their own perceptions transmitted through the interaction with the objects being manufactured [49]. Analysing some practical cases [50], most companies deciding to orient their operations to I4.0 have done so to achieve flexibility in production, which would allow them to mass-produce customization [51]. More than the search for a specific solution, if indeed it is true that we are transitioning to the Fourth Industrial Era, we can expect that as more companies gain competitiveness and sustainability in their businesses through I4.0, a mobilizing effect will be seen not only in industry but also in services [52]. A new generation of factories where CPSs are the production support [53] will thus arise, resulting in so-called “Smart Factories to the Internet of Things” [48] also designated “digital factories" [42] whose objective is to maximize flexibility combined with efficiency [44]. For this new concept, called smart production, [51] to be effective, some authors believe there must be performance simulation tools in upstream production, thus safeguarding the risk associated with physical experimentation in real time [44]. The reorganization of production processes resulting from this production concept will have unique consequences in each company, since each one will be required to interpret and adapt its specific profile and resources to the concepts associated with I4.0, which include IoT, CPSs and Big Data, among others [54]. With the widespread use of sensory media, the expansion of wireless Internet networks and the development of increasingly smart robotic systems, along with the growing capacity of computers at a lower cost, the problems arising from big data [54] are expected to be overcome, thus transforming the way goods are produced in Europe and in the rest of the world [6,55] From a holistic perspective, the Industry 4.0 concept will incorporate many other concepts, which are sometimes difficult to describe individually, such as the concept of a smart object [56] or the sensory network associated with products and means of production, integrated in CPSs, and sending, receiving and processing information, making autonomous decisions based on digitalization and previous simulations of product models [57].

4. Mapping and documenting Industry4.0 Service Innovation

Industry 4.0 relations, as described above, is mainly characterized by a digital and collaborative interconnection of manufacturing systems, products, value chains, providers, customers, business models and many others. The interconnection between the physical and virtual/cyber worlds – Cyber-Physical Systems and Internet of Things

– is a central feature [45]. Looking at the classic *Customer Interaction Line* as introduced by Kingman-Brundage (1989), this separates the customer's activities from the provider's activities, matching perfectly with the traditional economy in which customer-provider interactions normally involved close contact or a phone call or more recently email. In contrast, in Industry 4.0 [58], this line will be permanently crossed by the Internet and thus the customer becomes a *cyber-customer* connected to the digital Provider (I4.0-provider), which could be a simple 3D printer or a I4.0 factory. The cyber-customer and I4.0-provider remotely enter into co-creative mode, interacting through value-propositions and the *Customer Interaction Line* is renamed *Line of Cyber Interaction* and represented by a dashed line (Figure 3). For the customer, the traditional *Line of Visibility* separates the visible activities from the hidden activities [16], a situation which, like other lines, is perfect to describe the traditional economy where as the name itself indicates "Visibility" is associated with the extent to which something can be seen, or at the most, as far as the customer can reach a provider resource by phone or by email.

4.1. The Resources

Industry 4.0 is digital production supported by a cyber-physical system that merges the *physical* environment with the *digital* one (Sehgal and his colleagues 2014). From the literature review, *service systems* resources [59] once mapped by the s-bprint [20] may be subdivided into two main dynamic groups, which perform a permanent dynamic reconfiguration towards increased value co-creation [18]: (i) *Cyber-Physical System Resource Group* and (ii) Support *Resource Group* (Figure 3).

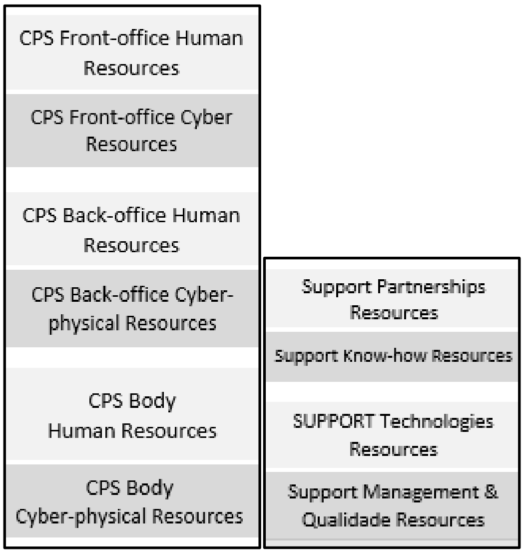

Figure 3: Two main dynamic groups of resources in Industry4.0 Operations context

The *Cyber-Physical System Resource Group* includes three sub-groups of resources: (i) *CPS Front-office Resources* - consisting of people and interface technologies, which interact directly with other digital service systems [60], providing specialized skills (knowledge and skills) through actions, processes and performance for the benefit of other entities; (ii) *CPS Back-Office Resource Group* - consisting of people and technologies that support the Front-Office actions, also providing specialized expertise, processes and performance for the benefit of other entities and, (iii) *CPS Body Resource Group* - consisting of people, means of production, partners, company management, specific know-how, accounting, marketing, public and private entities, among others, that interact directly or indirectly with all available resources, by providing specialized expertise through actions, processes and performance for the benefit of the other entity (Figure 3). In this way, during an I4.0 service process and according to Service Science [30], these represent a dynamic reconfiguration of physical and non-physical resources (either with or without rights), which guarantees the existence of digital service interactions with other digital service systems, realizing value co-creation interactions and thus continuous boosting of the service process [22], in which the formalization of continuous rights of access to resources is one of Service Science's challenges [60].

4.2. The Lanes

The lanes in s-bprint4.0 are used to visualize the resources of the I4.0-provider. These resources will be arranged in horizontal lanes from the left and the description at each step of their involvement requires knowledge of the access rights to each resource.

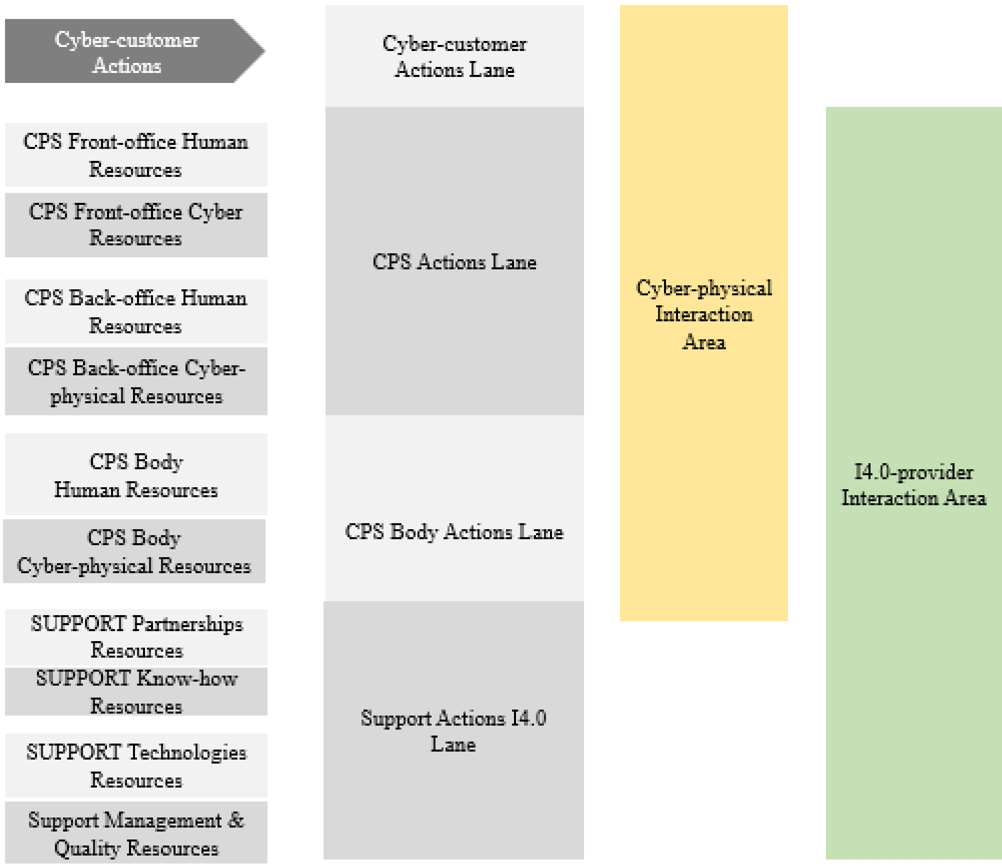

Figure 4: The Lanes definition in Industry4.0 Operations context

The *cyber-customer action lane* represents the actions of a *potential cybernetic customer* linked to a smart factory [61], whose evidence will be described in a lane immediately above, called *cyber-physical evidence*, and co-operation with the provider, represented by the *line of cyber interaction*. The *CPS actions lane* represents the area where the *Cyber-Physical System* is located, and the activities in which this resource participates in the form of value creation exceed the limits of this lane, as represented by the *cyber-physical interaction area* (Figure 4).

Figure 4: Lanes of Industry 4.0 operations

4.3. The Lines

The plan represented under the heading *CPS body actions lane* is the area of action of the smart plant shop floor resources, within which the means of production, among others, are separated by discontinuous lines, meaning that it interacts remotely in full vertical, even with the *cyber-customer* if necessary. The *support actions I4.0 lane* is where Support Resources carry out their activities in the service process, once again separated by discontinuous main lines, with some secondary dashed lines between them (Figure 5). The secondary line, *I4.0 front line*, separates human resources from technical resources inside the CPS. The cyber-customer interface must be separated by a virtual secondary line from the Technical Human Resources of the CPS with which the client does not interact directly, as is the case of the technical experts involved in smart objects' co-creation [8]. Also, the secondary line "*control I4.0 line*" separates the Supporting Resources belonging to subcontracted entities from the organization's Management Support Resources.

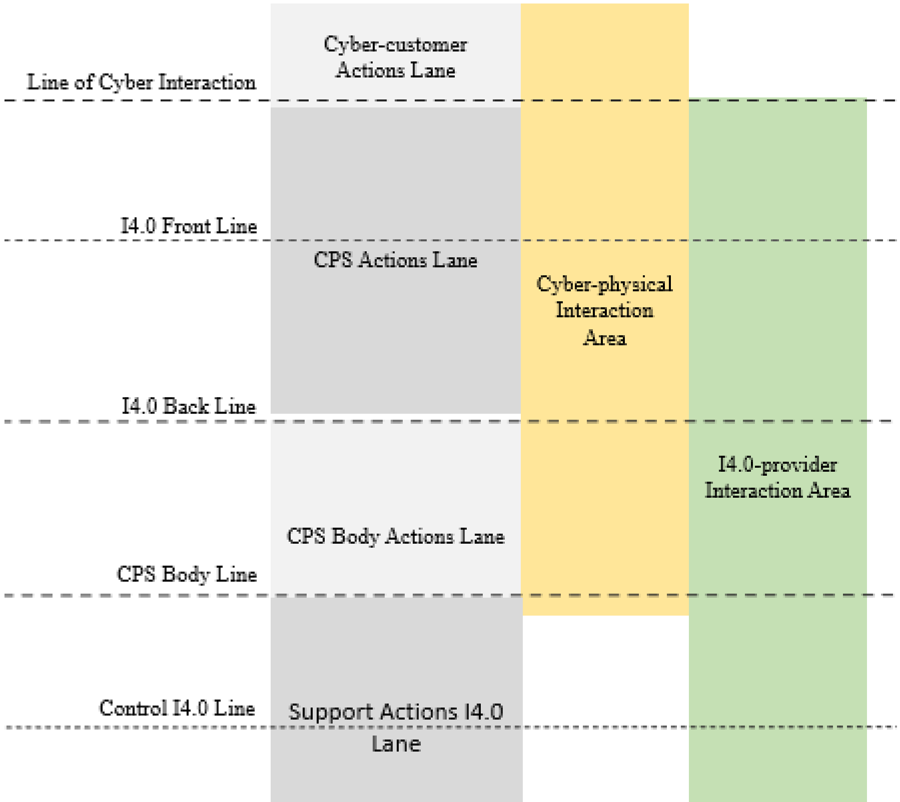

Figure 5: The Lines definition in Industry4.0 Operations context

Therefore, at the top of the s-bprint4.0 map along the service process, we have the Cyber or Physical Evidence or just the Outcomes [61] resulting from co-operative actions between the cyber-customer represented in the lane immediately below and the I4.0-provider, represented by the *I4.0 provider interaction lane*. The Human and Cyber Resources of the CPS Front-Office make up the lane immediately below the cyber-customer lane, which means proximity to cyber-customer resources. Immediately below will be located the human and cyber-physical resources of the CPS Back-Office immediately followed by the human resources and Cyber-Physical lanes related to the CPS I4.0 Body, that is, the shop-floor production means. In I4.0 operations mode, support resources including Partnerships and Specific Know-How (patents etc.), while maintaining support resource status, are also part of the CPS's own resources, so in s-bprint4.0 mapping, these resources must be located immediately below the *I4.0 Front Line*, at the bottom of the map as if they were supervising the entire service process, where the Organization's Management is located. For Service Science, customer and provider are products' co-creators [10].

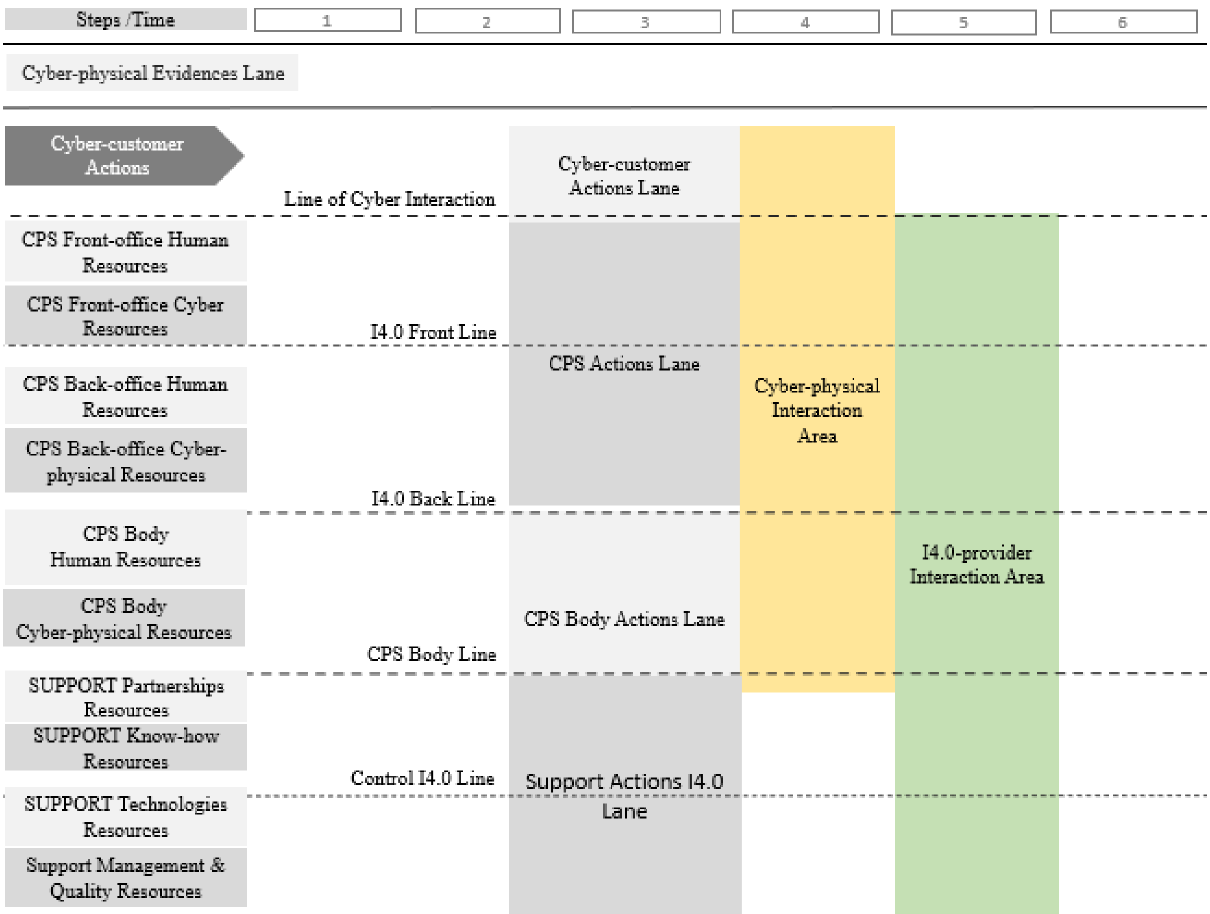

Figure 6: Service Blueprinting for I4.0 Operations context (s-bprint4.0)

As one of Service Science's main challenges is to innovate in value propositions, this means that to improve Innovation outcomes [30], it is necessary to know at the outset what resources are involved in these propositions (Wong, Ignatius, & Soh, 2014). Improving a value proposition does not mean benefit for customer or provider, but rather adding value to all directly interested stakeholders, competition being the main driver of innovation [12]. As stakeholders (service systems) gain experience from lessons learned over time, systematic refinements will improve proposals, based on historical statistical and anticipated future standards, a lean thinking concept designated *continuous improvement process* [13,14]. Thus, the s-bprint4.0 framework must have a new line type, replacing the traditional *Line of Visibility,* beyond which the cyber-customer only has indirect access, via CPS, representing the limit of the remote co-creative interfaces and functioning as a separation between the CPS-with rights resources from the CPS-Body, designated *I4.0 Back Line,* a dashed line since for I4.0, the Cyber-Customer can see beyond it (Figure 6). In the classic format [16], the *Line of Internal Interaction* separates the activities in some way linked to the value proposition or execution order from the activities that support those value propositions or order execution. To map the I4.0 service process, where production must be supported by a CPS which shares a huge amount of real time information (big data) [62] with all the other resources of the productive equipment, customers, products themselves and human resources. Thus, the classic *Line of Internal Interaction* must be renamed *CPS Body Line*, representing the frontier of the CPS itself and the *Support Actions I4.0 Lane*. A dashed line, since in I4.0 operations there are no "watertight compartments" for the Cyber-Customer. For some authors [1], it is common to use additional lines (secondary lines) to better visualize the activities of the provider resources (Kwan and his colleagues 2016). As detailed above, CPS is composed of four groups of resources, distributed between the *Front-Office* and *Back-office* groups of resources. *Front-Office* resources are the "front-line" of the CPS, available for the customer 24 hours a day throughout the year if possible and Back-Office resources are those that support the Front-Office upwards and the CPS-Body downwards, from the creation of smart-objects to supervision of the production process. To separate these two resource groups as defined by Inovstone4.0, the s-bprint4.0 must have a secondary helpline to identify possible innovative paths to the process of value interactions (innovation outcomes), designated *I.0 FrontLine*. Similarly, underneath the *Line of Internal Interaction* of the classic format [19], some authors add other secondary lines [18], delimiting activities inside the provider itself, to better detail the resources involved in co-creative actions [21]. Support Resources usually come from partnerships in the form of agreements, know-how, shareable information and from production technologies and the quality-management team. For this purpose, following the proposal of Seyring, Dornberger and Suvelza (2013), the s-bprint in OC3 must have a Control Line [17] dividing these two sub-groups of support resources designated *Control I4.0 Line* (Figure A.5). For the Classic s-bprint format, the *Physical Evidence Lane* represents the physical evidence of co-creative outcomes, such as facts and places, but also formulas, products or signs used or seen by the customer along the co-creative journey [19]. In I4.0 operations, besides this physical evidence there is new digital evidence such as that arising from the IoT, and thus for s-bprint4.0, the *Cyber Physical Evidence Lan*e must replace the classic [16] s-bprint *Physical Evidence Lane.* The traditional *Customer Actions Lane* is used to describe customer actions during the co-creative service process [28]. However, in I4.0 there may also be "IoT customer actions" and thus for s-bprint4.0, the *Cyber Customer Actions Lane* must replace the traditional s-bprint *Customer Actions Lane.* In the s-bprint4.0, the Frontstage Contact Actions Lane is delimited at the top by the Line of *Cyber Customer Interaction*, which separates the activities that the customer performs independently [17], and below by the *I4.0 Line*. Since in I4.0, the CPS Front-Office operates as a dialogue and interaction resource in the interactive process, both upwards to the customer, resulting in the Fingerprint4.0 [8] and downwards to the CPS-Body, resulting in the Smart Object, for s-bprint4.0 the *CPS Actions Lane* must replace the *Frontstage Contact Actions Lane.* For s-bprint4.0, production activities must be delimited upwards by the *I4.0 Front Line* and downwards by the *CPS Body Line*, where all the activities and means necessary to produce must be placed, i.e., the activities of the CPS I4.0 Body, and therefore, the *I4.0 Body Actions Lane* must replace the *Backstage Contact Actions Lane*. For s-bprint4.0, Support Actions must be delimited by the *CPS Body Line*, where all activities related to supporting value creation must be represented, and thus, for s-bprint4.0, the *Support Actions I4.0 Lane* must replace the classic *Support Processes Lane* The Connection Between Customer Value Creation and Innovation Strategy [63]. As mentioned above, in the traditional s-bprint format of Shostack, the *Customer Visibility Area* is the horizontal lane between the *Line of Visibility* and the *Line of Customer Interaction*, the *Customer Actions Lane* being the level immediately above the *Line of Customer Interaction,* where the customer's actions will take place, by steps. The first typical action of a *cyber customer* is likely to be connecting their digital BIM station to the Internet. Based on the proposal of some authors [17], for s-bprint4.0, levels where the Cyber-Customer actions take place, whether independent or co-creative actions, must be designated *Cyber Physical Interaction Area*. The Cyber-Customer resources carrying out activity at this level are the Frontstage group of resources which includes the human and cyber resources that interact directly with the provider, and the resources of the I4.0-Provider are the CPS Front-Office resources, which include both human and cyber-physical resources such as the main server, cognitive assistant systems, smart object generation systems and real-time smart object execution server, among other resources. The provider resource groups in the traditional s-bprint format are placed in three lanes: the *Frontstage Lane*, *Backstage Lane*, and *Support Lane* and all together define the *Firm Area* [19], which is equivalent to the whole area underneath the *Line of Interaction* (Figure 2). For s-bprint4.0, the lanes where the I4.0-Provider is active, either independent or in co-creation, must be designated as the I4.0 *Provider Interaction Area* (Figure 6). As described above, for I4.0 operations, the Cyber-Customer activities area must be designated the *Cyber Physical Interaction Area* and the I4.0-Provider area designated *I4.0-Provider Interaction Area*, meaning that the *CPS Actions Lane* becomes common to the Cyber-Customer and I4.0-Provider. This transparency (cyber-visibility) characterizing the I4.0 operation makes all the difference, since the Cyber-Customer can cross all the lines, and so the continuous lines will no longer exist in this fully digital operations mode, being replaced by dashed lines. However, the s-bprint4.0 must keep the no-contact activities performed by the provider, which will remain as in the traditional model in the lower lanes throughout the process steps [16]. In contrast to the Shostack model, in s-bprint4.0, co-creative tasks can go beyond the lane delimited by the *Line of "Cyber" Interaction* as well as the *I4.0 Front Line*, both dashed lines. For instance, the information on the cyber-customer's computer screen showing that payment was successfully made comes directly from an I4.0-provider Support Resource such as the bank. As described above, s-bprint4.0 must describe the I4.0-provider resources in horizontal lanes on the left side of the map, describing the involvement of the same resource in each step, following Shostack's (1982) model, the resources of the I4.0 provider being composed of six groups: (i) CPS Front-Office resources; (ii) CPS Back-Office resources; (iii) CPS Body resources; (iv) support partnerships, (v) support technology and (vi) Support Management & Quality Resources. To assess the service innovation, the data strictly related to each stakeholder Concern must be collected from observations and measurements in the field, among other scientific methods [35]. Once the directly perceivable activities are identified, the next step must be to define in each step the activities that are imperceptible to the Customer. In the horizontal s-bprint, Backstage and Support Processes, there are usually several simultaneous contact points, so some authors suggest subdividing these lanes [17]. Thus, for s-bprint4.0, the first phase of the service process is usually related to the Design, the second phase related to the Proposal Discussion and the third phase related to Order Processing. In I4.0 operations, the first phase means "convert into digital" what the customer expects to receive, the second phase is related to *Order Execution*, which means that the CPS may use the Smart Objects which are the digital outcome of the CPS

Front-Office. The third phase is related to *Shipping, Using & Recycling*, which for s-bprint4.0 means the ability to deliver, install use and recycle at the end of useful life.

5. Conclusions

Industry4.0 is digital production supported by a cyber-physical system that merges the *physical* environment with the *digital* one. In this operations mode, product design and development tend to consider the customer as co-creator, and move forward to digital manufacturing, where the products themselves acquire their form, by interacting with the production methods themselves. In describing and configuring stakeholder resources, and in accordance with the objectives of this research, we have found a possible service blueprinting framework able to map digital interaction and shared access to service system resources as well as to visualize the bridge between the physical and virtual worlds in Industry 4.0 operations. This new service blueprinting, here named as s-bprint4.0, keeps the classical structure, such as the separation of service interactions in individualized processes by horizontally represented steps where each individual component (activity) belongs to a different lane, ordered vertically with each one representing, as in the Shostack model, a level of proximity to the customer. The higher in the map the lane of the provider's resources involved in the actions, the closer the level of interaction with the customer stakeholder. Since each stakeholder is expected to make a different assessment of the value of the proposals, the concerns of the different stakeholders, it was possible by using *concern indicators* to assess the concerns in a qualitative and quantitative way and their evolution in the shifting context, through qualitative and quantitative *Innovation Outcomes*, as recommended by Service Science.

6. Limitations and Recommendations for Future Work

As a limitation we may consider the Industry 4.0 operations as a dynamic process which did not reach its mature stage yet. However, we may consider this new service blueprinting model, usable for the current status of the Industry 4.0 operations and therefore we recommend it to be operationalized and tested in future practical cases.

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