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Technological Surveillance for the Identification of Business Models for Internet of Things-IoT

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Abstract: Scientific and technological management is essential for regional and national development, especially in sectors with social and economic importance and projection. For this reason, this study presents a technological surveillance study for the identification of business models for Internet of Things (IoT) developments, based on search equations in the Scopus database. Likewise, a plan for the study was defined, considering the evolution of IoT research over time and the business models proposed and applied to the IoT. In this regard, around 10 proposals for business models for the IoT were identified. On the other hand, the recent field of study of the phenomenon was evidenced, placing it at the beginning of the 21st century.

Key words: Search equation internet of things, technological surveillance, scientific production, identified, phenomenon, considering

INTRODUCTION

Until a few years ago, organizations based their operation on the delivery of high quality products or services, competitive prices, brand positioning and the development of relationships with customers (Gierej, 2017). Accordingly, the planning and administration processes were intuitively advanced without having a detailed and visually comprehensible structure (Sun *et al*., 2012). However, the concept of business model developed by Osterwalder (2004) and Teece (2010) opened the doors to a new approach, according to which organizations had to consider their clients, production income, among other aspects (Fleisch *et al*., 2014) and rethink the way they create and capture value.

The current trend is then focused on the innovations of the business model as the way to improve profits and avoid long-term competitive threats. Other benefits of the business model innovations include cost reduction, strategic flexibility, the exploitation of new market opportunities and the reduction of capital investment risk (Sun *et al*., 2012). With the emergence of the Internet of Things (IoT) and its multiple applications to almost all sectors organizations begin to see the potential in its use to optimize their organizations (Gierej, 2017).

Regarding organizations that develop products or services based on IoT, traditional business models are not adequate (Ju *et al*., 2016) because technological gaps are evident as well as the availability of human talent and strategic allies that allow their successful implementation. This is because the efforts in IoT are oriented to the development of technological solutions; however, the business models that accompany these solutions or artifacts are still unexplored (Glova *et al*., 2014).

Internet of things: The internet of things is considered the third wave of the global information industry after computing and the internet (Wang *et al*., 2014). The "things" are everyday objects for which the IoT offers a virtual presence on the internet, assigns a specific identity and a virtual address and adds capabilities to self-organize and communicate with other things without human intervention (Bonomi *et al*., 2014). The IoT includes the hardware, software and network infrastructure services for "things", guaranteeing their interoperability. Among the fields of application of the IoT are transport, electricity networks, asset and inventory tracking, city automation and agriculture (Duan *et al*., 2014).

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It is expected that the application of IoT technology will greatly reduce the costs of agricultural production increase the economic benefits of the activity (Chan *et al*., 2015) and allow the producers and processors of the country to reach competitive capacities that will boost the sector within the national economy.

Structure of the IoT: The structure of the IoT is divided into 4 layers. The sensor layer is composed of any variety of devices or sensors that capture some data related to an important variable of measurement, among which are humidity sensors and temperature sensors. The network or transport layer receives the signals captured by the sensors in various types of protocols and converts them into bytes. The processing layer is the platform where data is temporarily transported to be unified and debugged. Finally, the storage layer is where the processed data is stored to move to the big data stage which can be in the cloud or in servers according to the defined architecture.

Business models: The relationship between customers and suppliers has changed mainly due to the access to technological tools-such as the internet that allow the development of businesses around the world (Ju *et al*., 2016). Customers have multiple options and in turn, much more specific needs which is why business strategies must focus on the customer rather than the company.

A business model articulates this logic and provides data and evidence that show how a company creates and offers value to customers. It also, describes the architecture of associated revenues, costs and benefits (Teece, 2010). One of the frames of reference for the construction of business models was developed by Osterwalder (2004). As a result, he developed a business model concept that includes the most important elements for its understanding.

"A business model is a conceptual tool that contains a set of objects, concepts and their relationships in order to express the business logic of a specific company. Therefore, concepts and relationships that allow a simplified description and a representation of what value is provided to customers, as well as how this is done and with what financial consequences, must be considered (Osterwalder *et al*., 2005)".

This model called Business Model Canvas allows the visualization of nine key elements that constitute the minimum elements to take into account when designing or adjusting a business model, so, it provides powerful ways to understand, analyze, communicate and manage strategically oriented choices (Al-Debei and Avison, 2010).

MATERIALS AND METHODS

For the realization of technological surveillance studies, there are several procedures described by recognized authors. The methodology used for the development of the study is explained below (Berges-Garcia *et al*., 2016; Gimenez-Toledo and Roman, 2001).

Identification of the tools to be used: For the elaboration of the research, the main databases that contain information related to the research topic were identified and accessed using.

Scopus: The largest database of citations and abstracts of peer-reviewed literature: scientific journals, books and conference proceedings. It has intelligent tools to track, analyze and visualize research, offering an overview of the global production of research in the fields of science, technology, medicine, social sciences, the arts and humanities.

Identification and definition of thesauri: Initially, a thesaurus or list of words with similar meanings or synonyms in English was constructed which allows to establish direct or indirect relationships with the concepts to be consulted and in turn, to build the search equations more precisely.

RESULTS AND DISCUSSION

Evolution of IoT research over time: For the identification of the current state of IoT research, a search was made in the Scopus database given the wide coverage in areas of knowledge. Search terms or keywords were defined to perform the query.

Keywords for the search:

Keywords related to Internet of things: Wireless sensor networks, IoT Internet of Things, embedded systems, big data, ubiquitous computing. The search for the period 2013-2017 was delimited because it is a relatively new trend. The search algorithm used was:

Algorithm 1; the search algorithm used:

((TITLE ("Wireless Sensor Network*")) OR (TITLE ("IoT")) OR (TITLE ("Internet of Things")) OR (TITLE ("Embedded System*")) OR (TITLE ("Ubiquitous Computing")) OR (TITLE ("Big Data"))) PUBYEAR > 2012 AND (LIMIT-TO (DOCTYPE , "ar"))

A total of 16,572 records that fulfilled the condition were obtained. In this regard, a marked trend is shown in

the increase in publications regarding IoT, 2016 being the year with the highest production, reaching 4,021 articles related to the area. The year 2017 is expected to exceed the previous year, since, given the date of the search, the indexation of articles may increase (Fig. 1).

Elements and reference framework of business models As a result of the literature review, Osterwalder (2004) identified the most important building blocks taken into account by the models studied. Product of the exercise, nine blocks that cover all the components mentioned by the authors emerged. These components were: value proposal, key allies, key resources, key activities, relationship with customers, marketing channels, customer segment, structure of costs and structure of income (Fig. 2).

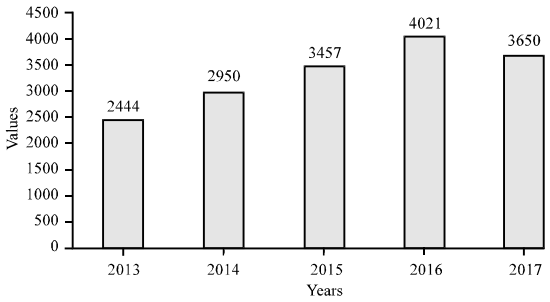

Fig. 1: Evolution of research over time for IoT

Based on these nine blocks, the Business Model Canvas proposes four main pillars: infrastructure (key allies, key activities, key resources), product (value proposition), customers (relationship with customers, marketing channels, customer segment) and financial perspective (cost structure and income structure). Table 1 shows each pillar in detail, its blocks and its description:

Business models applied in the IoT: Innovation in business models marks a key milestone in the evolution of contemporary business. However, the appearance of the IoT will force companies to change their current business models (Gierej, 2017), mainly due to the fact that the monitoring of variables using IoT offers a deeper knowledge of the clients, allowing to create direct relationships, improvements in the value proposition with efficient products with advantages and intuitive "value proposals", improvements in distribution channels and marketing channels and improvement in income sources. The IoT offers a large number of new services and opportunities for business models in an ecosystem of partners, forcing companies to reconsider their current models (Turber and Smiela, 2014). However, when marketing an IoT solution is wanted, traditional business models are not suitable for services or products (Ju *et al*., 2016), so, rethinking the business models is necessary.

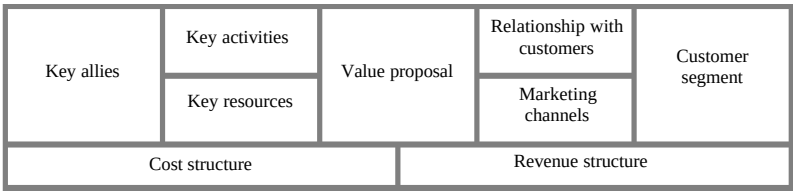

Fig. 2: Visualization of the business model and its nine constituent blocks

Table 1: Pillars and blocks of the Business Model Canvas

Pillars/Blocks	Descriptions
Infrastructure	
Key allies	They are the allies that develop activities or key stages in the process, adding more value to the business model. These also, provide indispensable resources for the key activities of the model
Key resources	They are physical, intellectual, human or financial resources indispensable for the business model to be developed successfully
Key activities	These are the key activities required by the business model to create and deliver value. These cannot be outsourced
Product	
Value proposal	Describes the products or services that add value for a particular segment of customers
Clients	
Relationship with costumers	What types of relationship should be established, so that, each client interacts directly with the value proposal
Marketing channels	Characterizes how the company reaches its customers and delivers the value proposal to them
Costumer segments	Describe the population segment for which value is being created. Identifying it precisely helps to define key elements for its characterization
Financial perspective	
Cost structure	Describe the most important costs for the proposed value to be delivered to customers
Income structure	It describes the best method for the user to value the product or service offered by the company and in this way the company generates profits

Based on Ju *et al*. (2016) and Osterwalder *et al*. (2005)

Table 2: Keywords for the search

Keywords related to internet of things	Keywords related to business models
Wireless sensor networks, IoT, internet of things, embedded systems, big data, ubiquitous computing	Business model, business value, value creation, value proposition, monetize, digital transformation

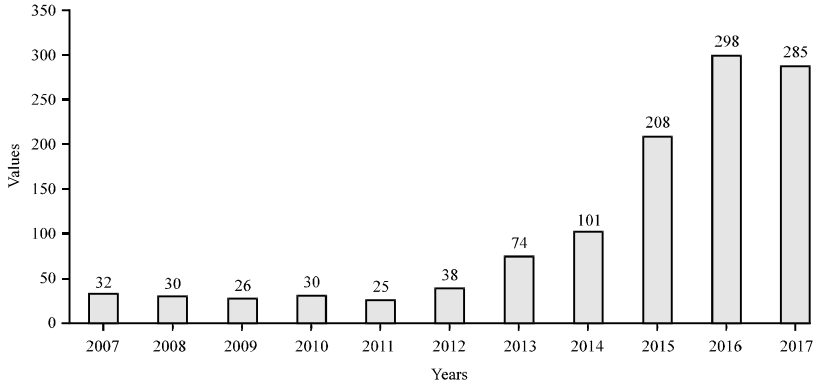

Fig. 3: Evolution of research over time

Evolution of research in business models applied to IoT over time: Several researchers worldwide have tried to rethink the construction of business models for IoT, so, it is important to identify the current state of research in this area. A search was performed with the following search terms or keywords (Table 2).

Algorithm 2; the resulting algorithm for the search was: ((TITLE-ABS-KEY ("Wireless Sensor Network*")) OR (TITLE-ABS-KEY ("IoT")) OR (TITLE-ABS-KEY ("Internet Of Things")) OR (TITLE-ABS-KEY ("Embedded System*")) OR (TITLE-ABS-KEY ("Ubiquitous Computing")) OR (TITLE-ABS-KEY ("Big Data"))) AND ((TITLE-ABS-KEY ("business model*")) OR (TITLE-ABS-KEY ("Business value")) OR (TITLE-ABS-KEY ("Value Creation")) OR (TITLE-ABS-KEY ("Value proposition")) OR (TITLE-ABS-KEY ("monetiz*")) OR (TITLE-ABS-KEY ("Digital transformation")))

A total of 1,196 publications related to business models applied to IoT were obtained, of which about 70% are concentrated in the last 3 years. The first scientific articles related to the search originated in 2002 which really shows the novelty of the topic. For the analysis of the results, the conference documents were excluded and only articles from scientific journals were used (Fig. 3).

Compared to the countries with the highest related scientific output, the United States, Germany, China and South Korea stand out. These 4 countries collect about 50% of the total scientific production (Fig. 4). On the other hand, among the institutions with participation in the subject include the Swiss, University of Gallen and ETH Zurich Federal Polytechnic School who have 14 and 11 publications, respectively.

The cooperation between the University of St. Gallen, ETH Zurich and the Bosch Group allowed the formal opening of Bosch's Internet of Things Lab in 2012. The Bosch IoT Lab is exploring new fields of products and businesses enabled for IoT with a focus on mobility, life and sustainable research, blockchain technology and IoT business models.

As previously mentioned for the analysis of the information, only the scientific articles were used which reduced the analysis to 337 articles. After a thorough review, 11 articles were chosen, out of which 5 are related to Bosch's Internet of Things Lab. Below, the reference frameworks defined by the authors for the construction of business models for IoT are presented.

Sun *et al.* (2012) propose a business model called Business DNA Model which simplifies the representation of business models focusing on design, needs and Aspirations. The researcher proposes a form of visualization and conceptualization based on the Business Model Canvas. This model is based on 3 blocks. The design block D refers to the elements of the system which result from the question "How" and focuses on allies, resources and key activities. The block N refers to external players based on the question "What" and focuses on channels, relationship with customers and customer segments. Finally, the block A refers to results based on the question "Why" and focuses on the value proposal income and costs.

According to the researcher, each block is complemented by the following logic: block A refers to the aims of the organization, block D is the means to achieve the ends and block N refers to the infrastructure to meet the needs of the customers, the market and allies. Unlike the Model Canvas, the DNA Model maintains a cause-effect logic "means and ends" by which it allows to more appropriately visualize the relationship between the organization and the industry (Fig. 5).

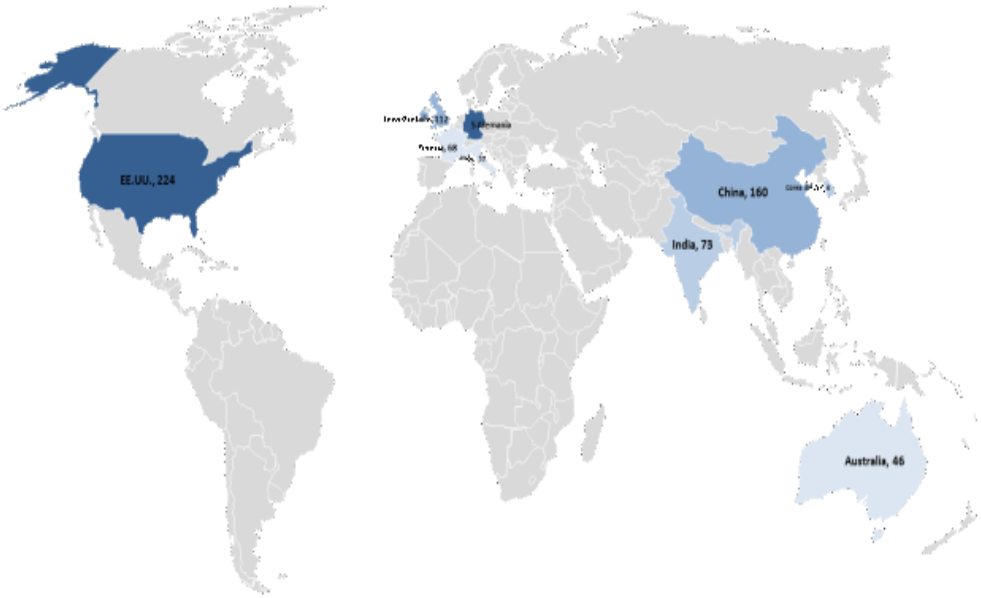

Fig. 4: Distribution by country of scientific production related

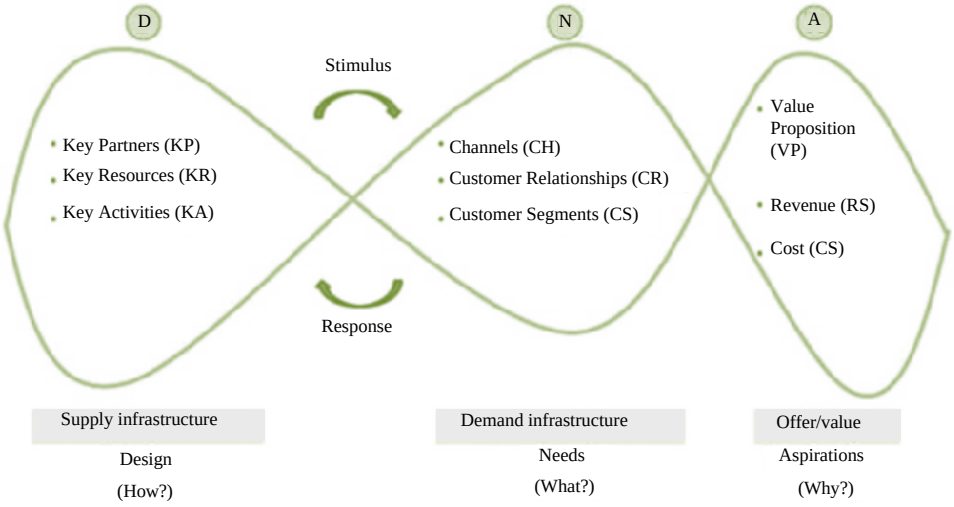

Fig. 5: DNA business model (Sun *et al*., 2012)

On the other hand, Gierej (2017) aims to develop a business model for companies that implement technologies based on industrial IoT in order to help them in the transition to the digital market. For the development of the proposal, the researcher takes into account 2 previous models: Canvas and Lean Canvas. The researcher proposes to include a new block to the Canvas model (reaching 10) called "Additional Digital Services" oriented towards the integration of digital solutions that improve physical products. This is due to the seasonality and low feedback that the business model canvas presents. The dynamics of the digital market determines the choice of techniques by the organization to highlight rapid changes in business model (Fig. 6).

Likewise, Turber and Smiela (2014) present a type of business model for IoT that recognizes the possibilities and impacts of digitization to allow companies to truly take advantage of new business opportunities. The researcher bases his model on three fundamental concepts: the nature of digitized objects, the emerging concept of business models and the dominant logic of the service. A research method was applied based on 6 stages

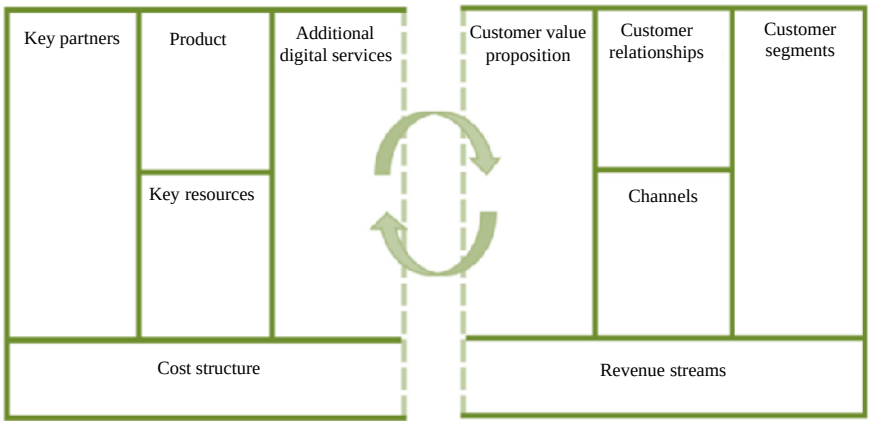

Fig. 6: Conceptual business model based on 10 blocks (Gierej, 2017)

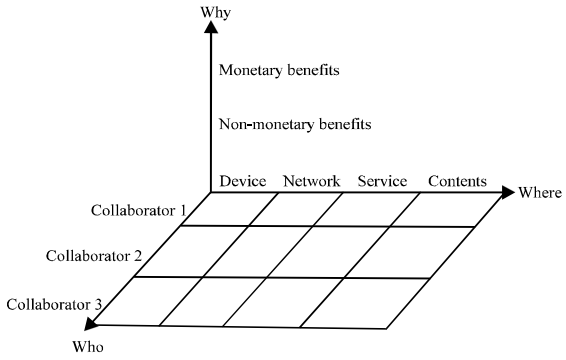

Fig. 7: Design framework of a business model (Turber and Smiela, 2014)

(definition of the problem, bibliographic review for the definition of solutions, prototyping and testing of solutions, proof of concept, evaluation and communication).

The defined model is called "Artifact of the Business Model Type for IoT" and was the product of an iterative process between stages 3. The model includes 4 dimensions (Al-Debei and Avison, 2010):

- Dimension 1, "who" involves all the participants of the ecosystem (allies, suppliers, customers and collaborators)
- Dimension 2, "what" incorporates the 4 layers of the IoT architecture (devices, networks, services and content) which help the creation of value
- Dimension 3, "why", defines the reason and the benefits for each participant of the ecosystem to be linked which can be monetary or not
- Dimension 4, "how", defines how the value is created implicitly from the link between dimension 1 and 2 (it does not appear explicitly in the model)

The conceptual proposal is interesting but the graphic representation of the model does not allow an easy understanding of the link itself of the dimensions proposed. The model of the proposal is presented next (Fig. 7).

On the other hand, Westerlund *et al.* (2014) are oriented to the identification of challenges, barriers and problems related to the design of business models for IoT. In this regard, they define 3 types of barriers:

Diversity of the objects: It refers to the multiplicity of connected devices and the lack of standardization which would be a problem if 50 billion connected devices are planned for the year 2020.

Imaturity of innovation: Many of the IoT products that are launched in the market do not have enough technological maturity to be adopted by users. In some cases this does not matter to the so-called "early adopters" but in the case of the "majority adopters" they want mature products.

Non-structured ecosystems: There are no governance structures, stakeholders and logics of value creation, due to the early stage of development that lives at IoT. They introduce the term "Business Models Ecosystem" as a potential measure that facilitates the successful creation of business models. Finally, it is important to note that they propose the key pillars of a tool for designing business models for IoT ecosystems (Value design, value drivers, value extracts, value nodes and value extracts) (Fig. 8).

Value drivers: They understand the individual and shared motivations of diverse participants and promote the birth of the ecosystem to satisfy the need to generate value, make innovations and make money.

Value nodes: It includes several actors, activities or processes (autonomous) that are linked with other nodes to create value.

Value extract: It refers to the part of the ecosystem that extracts value; in other words, it shows the significant value that can be monetized and the relevant nodes and exchanges that are required for the creation and capture of value.

Value design: It illustrates how value is deliberately created and captured in an ecosystem. On the other hand, Dijkman *et al.* (2015) present a frame of reference for business models specifically for IoT applications. Through a bibliographic review interviews and professional surveys, they identified the constituent blocks that are relevant in an IoT business model (Fig. 9).

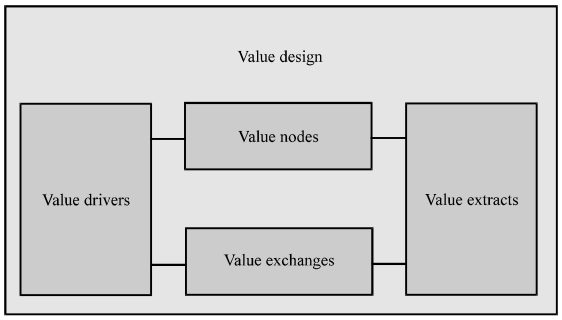

Fig. 8: Key pillars of a business models tool

In this regard, the model canvas is established as a starting point for its analysis, since, it was developed on an ontological basis. Identification of the most important elements in each one of the constituent blocks was carried out as well as the most important block. The value proposal, the relationship with the clients and the key allies were established as the most important building blocks to build models of business for IoT.

Finally, the researchers caution that the results may not be extrapolated to other geographies and recommend studying how business models for IoT are developed. From another perspective, Glova *et al.* (2014) propose a new methodology for the definition of the value proposal as a structural element of the business model. This methodology is called e3-value and aims to understand the creation of value with key allies to generate sustainability in the business. By applying the methodology, 3 points of view are created: the point of view of value, the point of view of the business process and the point of view of the information system.

Likewise, Ju *et al.* (2016) developed a frame of reference for the construction of IoT business models, based on bibliographic review and interviews. Then, a case was developed to test the reference framework of the developed business model.

In this understanding, existing IoT business models are analyzed under the focus of the Business Model Canvas, given its ease in understanding, discussing and creating. Thus, interviews were held with practitioners who knew about the development of IoT applications and prioritized key partners (Software developer, data

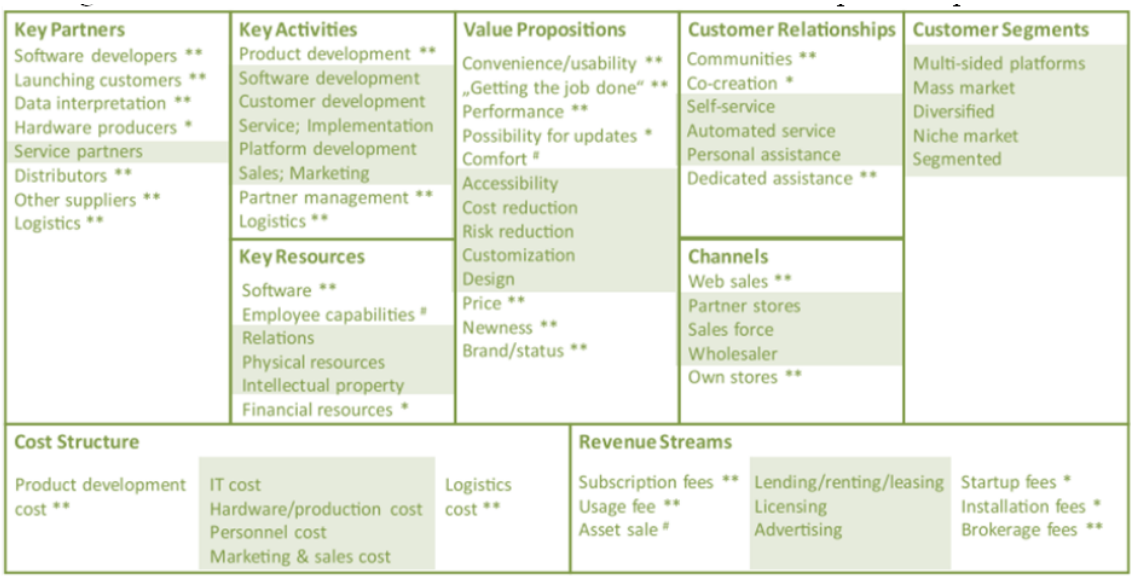

Fig. 9: Frame of reference for business models with relative importance per block

Analytics company, device manufacturer), key activities (Product development, partner management, platform integration) and key resources (Sensors, Cloud Service (Software), IoT dedicated network, capability for business analytics).

On the other hand, Chan *et al.* (2014) proposes a type of business model for IoT under 3 dimensions: Who where and why. Thus, he performs a bibliographic review of the business models for IoT and proposes a structure called "Three-dimensional Collaborator Model Framework", based on 3 key questions: who, where and why; the first describes the allied collaborators which constitute the "value network"; the second describes the sources of "value creation"; and the third describes how the allies benefit from the value network.

The model shows an approach oriented to networks of allies as a source of value which is why they are an essential part of the IoT ecosystem. The study excluded companies that were dedicated to the development or specific sale of sensors in addition to all the case studies, belong to Hong Kong.

On the other hand, Tesch *et al.* (2017) intend to identify the critical decision points in the design of the business model for IoT based on the Stage-Gate methodology. The study begins with the construction of an "interview" information-gathering instrument that was applied to 27 managers of 8 companies. The stage-gate system presents an innovation prototype model consisting of different stages (set of activities) separated by gates (decision points). The first gate or decision point focuses on a first stage of innovation where the necessary budget is released to evaluate a business model through a prototype Proof of Concept (PoC) which allows an immediate interaction with the client. Meanwhile, the second decision point refers to the decision to commit the organization in the implementation and deployment of the business model with all the risks involved.

The researcher proposes to apply agile design methodologies such as "lean start-up, MVP Viable Minimum Product or design thinking" in order to verify the potential of the model and scale it in gate 2. Finally, Hong (2016) establishes the key elements, "factors", to build frames of reference for business models based on IoT. These factors are evaluated to measure the relationships between them.

The researcher defines 5 key factors for the construction of IoT business models: "IoT technology", "Business strategy and process", "Cost structure", "Application area" and "IoT business performance". For each of the blocks, some attributes were defined for a total of 23 attributes that were later taken into account for the design of a Likert scale questionnaire. As a result, a new reference frame structure is established for the construction of IoT business models with 15 prioritized attributes (Manyika *et al.*, 2011).

CONCLUSION

The objective of the study was to conduct a technological surveillance exercise aimed at IoT business models which resulted in a tour of several proposals by recognized authors, especially from the study of experiences where around ten proposals were identified. In this respect, the recent studies related to the phenomenon stand out, placing the year 2002 as the beginning of the studies and the United States, Germany, China and South Korea as the leading countries, both of the studies related to IoT as of their business models.

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