American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)
ISSN (Print) 2313-4410, ISSN (Online) 2313-4402

http://asrjetsjournal.org/

Technological Prospecting: A Mapping of the Patent Applications Related of Internet of Things

Sergio Silva Oliveira[a], Maria Emilia Camargo[b*], Suzana Leitão Russo[c], Mariane Camargo Priesnitz[d], Marina Bezerra da Silva[e]

[a,b,c,d,e]*Postgraduate Program in Intellectual Property Science, Sergipe Federal University, São Cristóvão, Brazil*
[b]*Postgraduate Program in Administration, Caxias do Sul University, Caxias do Sul, Brazil*
[e]*Business and Management Department, Federal Institute of Piaui, Oeiras, Brazil*
[a]*Email: sergiosoliveira11@gmail.com*
[b]*Email: mariaemiliappga@gmail.com*
[c]*Email: suzana.ufs@hotmail.com*
[d]*Email: dra.mariane@gmail.com*
[e]*Email: marina.silva@ifpi.edu.br*

Abstract

A new line of computers that interconnects through the Internet, also known as the Internet of Things, is a great challenge to be understood as a mechanism to generate new opportunities in the technology industry and society. This study aimed to analyze, by means of a technological prospection, the patent deposits on the Internet of Things in the world. Patent application searches were carried out at the bases of WIPO (World Intellectual Property Organization), called Patentscope and the European Patent Office (Espacenet). The study showed the prominence of China and the United States in the technological production of the area. Brazil is still not among the main countries originating from IoT technologies, however in 2019 it established Decree No. 9,854, which establishes the National Plan for the Internet of Things.

Keywords: Internet of Things; Patents; Technological Prospecting.

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* Corresponding author.

1. Introduction

The Internet is a resource of modern society that directly influences several areas, especially those related to innovations and the use of intelligent sensors and objects connected to a network. Its evolution occurred through several stages: the first, computer networks; the second, people and community networks; the third, intelligent objects and devices networks. This is the current phase and, at the same time, a phase of transition and transformation [1]. The term Internet of Things (IoT) has been mentioned in reference to a new generation of fairly widespread computing, representing the ubiquity of computer resources in consumer products and people's habits. Industrial equipment and products, such as automobiles, televisions, telephones and sensors, can now have connection capacity, communication, and built-in Internet access, with several new possibilities of use, such as remote control, customization, automation as well as performance analysis. The connections are possible by means of sensors installed in objects and verified locations that send the data to be analyzed. Physical objects are now capable of processing and communicating data, being able to feel the environment, perceive its state and that of others, interface what is requested, provide and transmit how to manage information [2]. The Internet of Things is an evolution within the ubiquitous computing model, which consists of the very diffuse presence of intelligent objects and things to the social environment, such as radio frequency technology, sensors and mobile phones. Although the concept is not new, it has become relevant from a practical point of view in business, due to advances in the development of hardware, especially in recent decades. IoT is understood as the technology that seeks interaction and dynamism in communication in an intelligent manner, promoting precision in processes, with speed in locating and retrieving information [3–5]. The Internet of Things, with its cloud storage capacity, scales and enables large-scale data processing and analysis. It uses mobile technology, with sensors installed in different devices, with capacity to capture and transmit information, giving a processing in an intelligent way, so that it is possible for these things to dialogue with each other, with total independence for decision making, being unnecessary the presence of a human. The connection between devices and appliances, as well as video cameras, smartphones, microphones and sensors of various types, represent the phenomenon called smart buiding in the context of the so-called Internet of Things [6–8]. The study of Things in the World aimed to analyze, by means of a technological prospection, the deposits of patents related to the Internet. With this approach, it is expected to present the technological panorama of this important area, identifying trends in innovation.

2. PCT system and the IPC classification

The Patent Cooperation Treaty (PCT) assists applicants in seeking international patent protection for their inventions, assists patent offices with decisions about granting patents, and facilitates public access to a wealth of technical information relating to such inventions. By filing an international patent application under the PCT, applicants can simultaneously seek protection for an invention in most countries of the world. The PCT is an international and multilateral treaty in which more than 150 countries participate, called contracting states. Thus, from the deposit via the PCT it is possible to realize the protection in several other countries, through a single deposit [9]. The decision regarding the nations in which a patent should be protected is a strategic one for companies. By means of this agreement, the Contracting States cooperate with each other in filing, searching and examining applications for the protection of inventions, as well as in providing special technical services.

This work is done within the framework of the International Patent Cooperation Union [10]. In turn, the International Patent Classification (IPC) was created in 1971 during the agreement formalized in the French city of Strasbourg. It establishes a division into classes and subclasses applied to the different technological areas and helps in the standardization of patent classification in several countries of the world. Classes are defined from A to H, and present groups and subgroups through a system that follows a hierarchical pattern [11]. Table 1 shows this classification [12].

Table 1: International Patent Classification Codes

Section	Classification
A	Human Needs
B	Processing operations; Transportation
C	Chemistry; Metallurgy
D	Textiles; Paper
E	Fixed Constructions
F	Mechanical Engineering, Lighting, Heating, Weapons, Explosion
G	Physics
H	Electricity

Source: adapted from [12]

The CPI Classification is composed of a combination of letters and numbers, as shown in the example of Figure 1 [12].

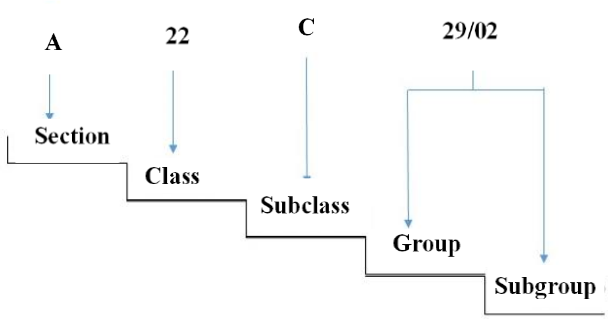

Figure 1: Classification of patent applications

Source: extracted from [12]

In addition, there is the Cooperative Patent Classification (CCP). According to [11] it was "created by the European Patent Office (EPO) and the U.S. Commerce Department's United States Patent and Trademark Office (USPTO)". It has a similar categorization to the IPC, but with greater detail of groups and subgroups. In a comparison, IPC has 70,000 groups, while CCP has an average of 200,000 classification groups.

3. Methodology

Prospecting studies use several databases and information to assist in social and business decision-making processes [13,14]. This impacts directly on technology management and innovation science development.

In this research, specifically, a mapping of patents was performed. According to [13], the mapping should be performed through the following steps:

1) Definition of the best databases to be consulted depending on the objective of the mapping;

2) Definition of the scope of the patent search, thus ensuring the quality of the methodology used;

3) Download the documents selected by the scope;

4) Removal of duplicity, redundancies and spurious documents;

5) Preparation of spreadsheets for statistical analysis and qualitative analysis.

The databases of the World Intellectual Property Organization (WIPO), Patentscope, and the European Patent Office, Espacenet, were consulted. These databases were chosen because of their global relevance, with the scope of patents filed in several countries [15]. The information was collected between September and October 2018. The patent document search protocols are defined below. The analyses were concentrated between the years 2008 and 2018, because that was when there was more intense activity of patenting in Internet of Things.

3.1. Search strategy at Espacenet base

In order to identify the patent applications on the Internet of Things in the Espacenet base, the following search strategy was used in the field "advanced search": International Patent Classification (IPC) search: In the field "advanced search" with keyword "Internet thing* with filter in the summary of documents. It should be noted that the asterisk (*) is a truncation character. Its use allows the return of results with zero or with other additional characters [15].

3.2. Patentscope search strategy

In the "advanced search" field, the filters for the keyword: "Internet thing*. The information collected was organized in electronic spreadsheets. Each document was analyzed individually in relation to the country of origin, year of deposit and their families, type of depositor, depositing institution, International Patent Classification, among others.

4. Results analysis

Both Patentscope and Espacenet have shown relevant results for patent applications related to IoT. Table 2 shows the number of documents identified.

Table 2: Total patent deposits on IoT by technology base*

Database	Number of patents deposited
Patentscope	9.532
Espacenet	2.151

Note - At Patentscope, the years between 2008 and 2018 were considered. At Espacenet, the interval between 2016 and 2018 was considered

Patentscope recovered more results, with 9,532 documents identified. According to [15], in addition to the patent collections of some specific countries, this base generates access to patents filed through the Patent Cooperation Treaty (PCT). The results of mapping by technology base are presented below.

4.1. Analysis of data recovered by Patentscope

WIPO's database recovered 9,532 Internet-related patent applications from Things in the period 2008 to 2018. The following information was analyzed: number of applications per year, countries originating from patents, offices and international agreements, principal inventors, principal applicants and International Patent Classification (IPC). The evolution of applications on the Internet of Things can be seen in Figure 2.

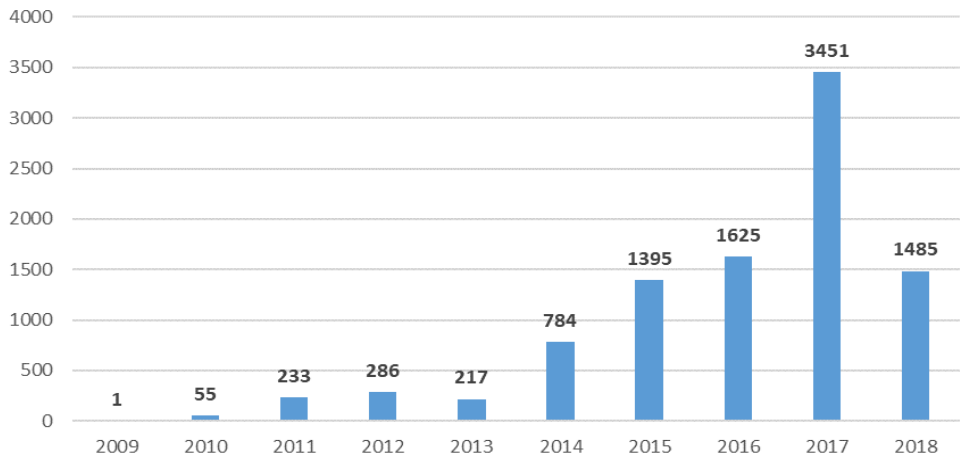

Figure 2: Time evolution of patent applications on the Internet of Things between 2008 and 2018 in Patentscope

Source: adapted from Patentscope (2018)

The sharp growth in the number of IoT-related patent applications is noticeable, with peak applications in 2017. This indicates the growing social interest in the area. These results confirm the importance of IoT [5]. It should be noted that the secrecy period influences the 2018 figures, with a drop in the number of applications appearing. It is configured as a period of 18 months counted from the oldest priority date, and the application is kept secret [16], that is, it is not revealed to the public. Figure 3 shows the world panorama of the countries of

origin of Internet of Things inventions.

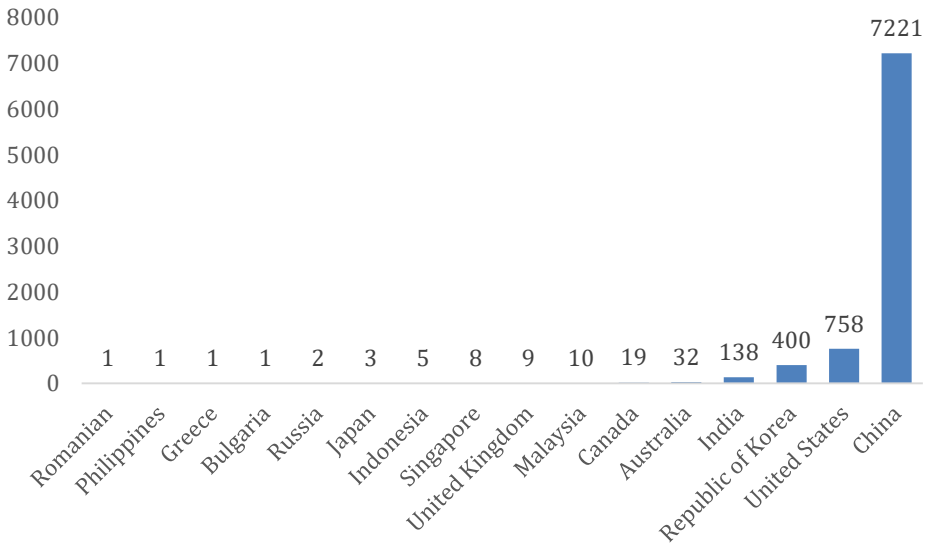

Figure 3: Countries of origin of Internet of Things patent applications between 2008 and 2018 in Patentscope

Source: adapted from Patentscope (2018)

It is noticeable that the market for this technology is largely dominated by China, which has 84% of the number of patents applied for. According to [17], "It is clear that China is determined to use all the tools in its arsenal to overcome the United States technologically and dominate the country economically. China's prominence is linked to its economic development and also to the approximation of more developed economies. Over the last three decades of the twentieth century, China was part of the group of countries with the highest growth rates, showing the highest rate in the last decade of the century. Moreover, over the last decades, growth rates of Gross Domestic Product (GDP) in the order of 10% per year, with GDP reaching the second place in the world in terms of purchasing power parity in 2009. This rapid growth contributed to China being the second most exported country in the world in 2007, with a world market share of 9%. This progress has also been made in Research and Development (R&D). Investment in R&D activities rose from 0.57% of GDP in 1998 to 1.49% in 2007, which may have been reflected in patenting activities, both internally and across borders, which, according to WIPO, more than doubled in the same period [18–20]. In addition, international patent agreements, which make it possible to register in several countries (provided they are member countries of the agreement), have also been analysed. The quantity of patents filed through these channels is represented in Table 3.

Table 3: Internet Patent Deposits of Things by Patent Offices and International Agreements between 2008 and 2018 in Patentscope

Patent Offices and International Agreements	Total
Patent Cooperation Treaty	763
European Patent Office	160

Source: adapted from Patentscope (2018)

There is a large volume of patents filed internationally. The PCT was an important legal instrument for the expansion of this volume, since it allows the protection of a patent in other countries [16], without the need for new applications. Table 4 presents the main inventors of IoT technologies, according to information retrieved in the Patentscope database.

Table 4: Principal inventors of patents on the Internet of Things between 2008 and 2018 in Patentscope

Principal Depositors	Quantity
Du Guangdong	260
Shao Zehua	85
Shang Zuoxu	63
Jiang Xuefeng	53
Liao Xiaoping	50
Qi Jincai	47
Wang Tao	46
Charles Howard Cella	41

Source: adapted from Patentscope (2018)

Note that Du Guangdong has stood out from the rest of the Chinese, with 260 patent applications. According to [21], under Lotka's Law a limited number of researchers produce a lot, while a large volume of researchers produce little. The area of knowledge is more productive, the more articles the authors produce in the course of their careers. Moreover, the area also becomes productive from the technologies developed. Table 5 shows the main applicants for IoT patents.

Table 5: Principal patent applicants for Internet Things between 2008 and 2018 in Patentscope

Principal Depositors	Quantity
Qualcomm Incorporated	90
Shenzhen Shenglu Iot Communication Technology Co., Ltd.	90
Chengdu Qinchuan Technology Development Co., Ltd.	74
Zte Corporation	61
Intel Corporation	57
Southeast University	57
Afero, Inc.	56
Shenzhen Shenglu Iot Communication Technology Co., Ltd	54

Source: adapted from Patentscope (2018)

North American Qualcomm Incorporated and Chinese Shenzhen Shenglu IoT Communication Technology Co.

Ltd. have filed the largest number of patents relating to the Internet of Things, with 90 documents each. These applicants are from the private sector. Figure 4 and Table 6 show the distribution of patents by International Classification codes (IPC).

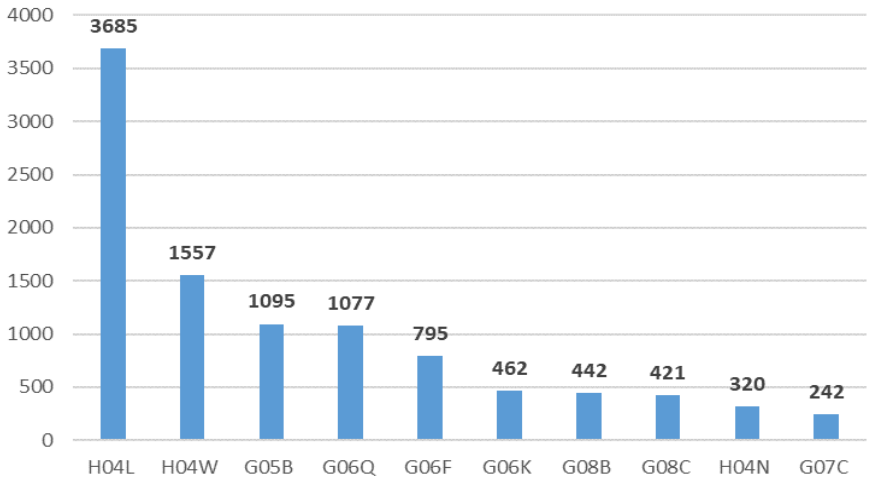

Figure 4: International Classification of Internet Patent Filings of Things between 2008 and 2018 in Patentscope

Source: adapted from Patentscope (2018)

Table 6: Specification of International Patent Classification (IPC) codes

Code	Specification (Families)
H04L	Digital Information Transmission.
H04W	Service or installation specially adapted for wireless communication network.
G05B	Control systems or regulation in general; functional elements of such systems; arrangements for monitoring or testing of such systems or elements
G06Q	System or processing method.
G06F	Entry arrangements for transferring data to be processed in a form that can be manipulated by the computer.
G06K	Data identification; data presentation; data carrier; data transport manipulation
G08B	Signal or call systems; telegraph order, alarm systems.
G08C	Transmission systems for measured values, control signals or similar
H04N	Image communication, e.g. television
G07C	Time or attendance registers; machine operation registers or indicators; random number generators; voting or lottery devices; arrangements, systems or apparatus for testing not included elsewhere.

Source: adapted from [22]

The classes with the largest number of Internet deposits of Things were H04L, H04W, G05B and G06Q. A total of 3,685 documents belong to CIP H04L, which includes digital information transmission technologies, such as telegraphic communication. Next, 1,557 patents fall under CIP H04W, which relates to wireless communication

networks. A CIP G05B apresentou 1.095 documentos referentes à IoT. Ela concentra os sistemas de controle ou regulagem em geral, os elementos funcionais de tais sistemas e os dispositivos para monitoramento ou teste destes sistemas ou de seus elementos. Com 1.077 depósitos, a CIP G06Q relaciona-se aos sistemas ou métodos de processamento de dados, especialmente adaptados aos propósitos administrativos, comerciais, financeiros, de gerenciamento, supervisão ou predição, bem como sistemas ou métodos especialmente adaptados para propósitos administrativos, comerciais, financeiros, de gerenciamento, supervisão ou predição, não incluídos em outro local. IPC G05B submitted 1,095 documents concerning IoT. It concentrates the control or regulation systems in general, the functional elements of such systems and the devices for monitoring or testing these systems or their elements. With 1,077 deposits, CIP G06Q relates to systems or methods of data processing, especially adapted for administrative, commercial, financial, management, supervision or prediction purposes, as well as systems or methods especially adapted for administrative, commercial, financial, management, supervision or prediction purposes, not included elsewhere. It should be noted that the technological scope is one of the important dimensions for measuring patent quality, according to [23]. Other important indicators, according to the author, are the size of the patent family, obtained through the number of institutes where the invention was protected; the time of granting, which is inversely proportional to the quality of the patent (those with higher quality take less time to be granted); citations of the state of the art; literature citations; patent claims; the number of citations that the patent receives in the development of subsequent technologies; inventions that may cause disruption; among others.

4.2. Analysis of the data recovered by Espacenet

Among the documents recovered from the search made at Espacenet, 11 were discarded because the term "Internet of Thing*" is not related to the object of the invention. From this basis, the following technological information was analyzed: deposits by years, originating countries, international organizations, main inventors and depositors, international classifications of the technologies Figure 5 shows the temporal evolution of patent applications in the period between 2016 and 2018.

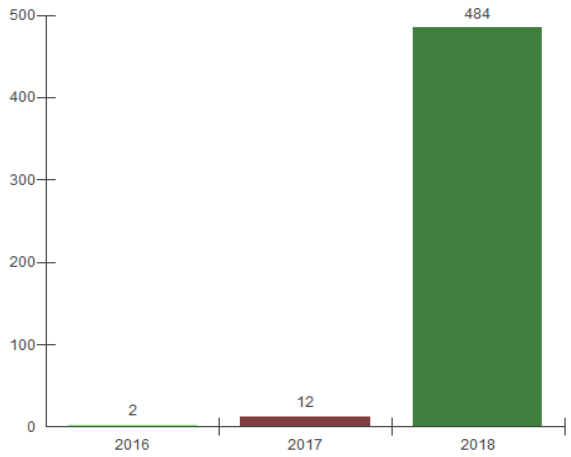

Figure 5: Time evolution of patent deposits in Internet of Things between 2016 and 2018 in Espacenet

Source: adapted from Espacenet (2018)

As observed, patenting in this area showed significant growth in the last two years of the analysis. In 2018 there were 484 deposits, indicating a growing interest in the production and protection of technologies on IoT. Figure 6 shows the origin of the depositors.

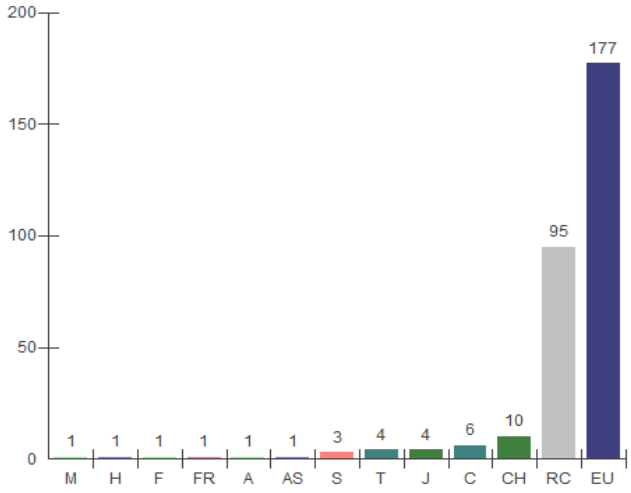

Figure 6: Countries originating from the patent applications on the Internet of Things between 2016 and 2018 in Espacenet

Note - M: Mexico; H: Hungary; F: Philippines; FR: Russian Federation; A: Australia; AS: South Africa; S: Singapore; T: Taiwan; Japan: J; C: Canada; CH: China; RC: Republic of Korea; EU: United States

Source: adapted from Espacenet (2018)

Through information from Espacenet, United States and China remain the largest patent applicants related to the Internet of Things. It should be noted that on this basis, unlike Patentscope, the USA led the ranking with 177 documents. Remarkable aspect in this case is the investment of these countries in research, science and technology, which results in outstanding numbers worldwide. In this regard, Brazil still does not achieve a prominent position in relation to the quantity of protected technologies related to IoT. In this case, it becomes relevant that the country also advances in this area, gaining strategic and economic competitiveness. Still in relation to patents filed in international organizations, we have Table 7.

Table 7: Internet Patent Deposits of Things by Patent Offices and International Agreements between 2016 and 2018 at Espacenet

Patent Offices and International Agreements	Total
World Intellectual Property Organization	189
European Patent Office	4

Source: adapted from Espacenet (2018)

Table 7 identifies significant numbers of patents filed internationally. It is important to emphasize that this is a strategic decision in companies, relating to factors such as insertion and exploitation of international markets, protection against competitors, among others. Table 8 shows the main inventors identified in the Espacenet database.

Table 8: Principal inventors of patents on the Internet of Things between 2016 and 2018 at Espacenet

Principal Inventors	Quantity
Xiong Yichong	33
Yi Jiaxin	11
Swierk Todd Erick	6
Talarico Salvatore	6
Ye Qiaoyang	6
Aho David	5
Britt Joe	5
Hammons Marc Randall	5
Liu Zhe	5
Zimmerman Scott	5

Source: adapted from Espacenet (2018)

The investments of China and the United States in technological production with added value are factors that provide the global prominence and leadership in the environment of innovations related to the Internet of Things. The principal depositors are listed in Table 9.

Table 9: Principal applicants of Internet of Things patents between 2016 and 2018 in Espacenet

Principal Inventors	Quantity
Samsung Electronics	40
Shenzhen Corporate	21
Veniam Inc	19
Intel Corp	18
Qualcomm Inc	15
Ibm	14
Electronics And Telecommunications	12
Intel Ip Corp	11

Source: adapted from Espacenet (2018).

According to Espacenet data, the largest patent applicants related to Internet of Things are in Korea, China, and

the United States, holders of industrial and technological leadership in the world, as the example of Sansung Eletronics. In Figure 7, the most prominent IPC classes in the area are presented. Next, Table 10 compiles the description of the International Classification.

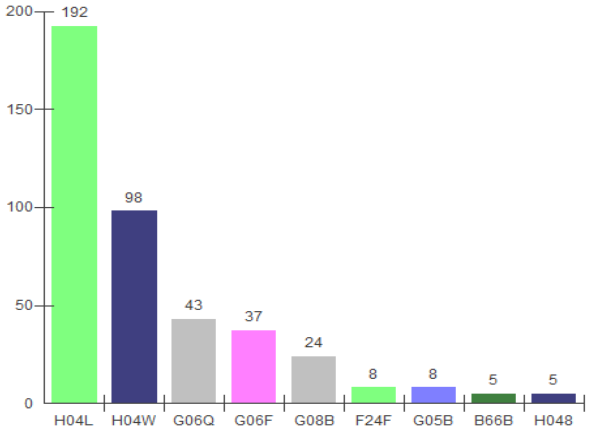

Figure 7: International Classification of Internet Patent Deposits of Things between 2016 and 2018 at Espacenet.

Source: adapted from Espacenet (2018).

Table 10: Specification of International Patent Classification (IPC) codes.

Code	Specification (Families)
H04L	Digital Information Transmission.
H04W	Service or installation specially adapted for wireless communication network.
G06Q	System or processing method.
G06F	Input arrangements to transfer data to be processed in a form capable of being manipulated by the computer.
G08B	Signalling or call systems; telegraph order, alarm systems.
F24F	Air conditioning; air humidification; ventilation; use of trailing air streams.
G05B	Adjustment or regulation systems in general.
B66B	Lift control systems in general.
H04B	Information carrier transmission systems.
G08G	Traffic control systems (rail traffic guidance).
H02J	Circuit arrangements or systems to supply or distribute electrical energy.

Source: adapted from [22]

It is realized that the IPC Ratings that present more technologies in patenting processes are the H04L, of the transmission of digital information, the H04W, of the services or installations specially adapted for wireless communication network, the G06Q, related to the systems or processing methods and the G06F, of the input

arrangements to transfer data to be processed in a form capable of being manipulated by the computer. Refining this analysis by countries, it was found that H04L was also the IPC Class that stood out in the United States, South Korea, China and Canada, with the largest quantity of documents.

5. Discussion of results

The analysis of the two technological bases showed the prominence of countries like China and the United States in the production of technologies related to the Internet of Things. In addition, it was observed that countries such as Canada, South Korea and Japan also have relevant numbers in the area. In Asian nations such as China, South Korea and Japan, the development of applications on the Internet of Things is already among the government priorities. In general, it is a technology that allies the sustainable issue with the projects of intelligent cities. The United States, in turn, stands out both in the number of IoT-related patent applications and in the pioneering use of Radio Frequency Identification (RFID) technology. This movement is explained by [24], who stresses that the Internet of Things is already a reality in the modern world. In Brazil, investments in the area are still limited and are essentially focused on the development of applications related to intelligent cities. In this case, the country is still developing its know-how in this technological area. It is worth mentioning that Europe has been conducting strategic research in IoT for more than 10 years, and counts on the support of partnerships with Brazilians in research related to this technology, directing efforts especially to the development of business models [25]. On June 25, 2019, Decree No. 9,854 was published in the Official Gazette (DOU). This is a presidential decree establishing the National Plan for the Internet of Things, whose purpose is to give more space to IoT in Brazil, implementing and developing new technologies while taking into account free competition and free movement of data, while giving due importance to the protection of personal data [26]. Art. 3º of this norm presents as objectives of the National Plan for the Internet of Things [26].

I - improving people's quality of life and promoting efficiency gains in services through the implementation of IoT solutions;

II - to promote professional training related to the development of IoT applications and the generation of jobs in the digital economy;

III - to increase productivity and foster the competitiveness of Brazilian IoT developers by promoting an innovation ecosystem in this sector;

IV - seeking partnerships with the public and private sectors for the implementation of IoT; and V - increasing the country's integration in the international scenario, through participation in standardization forums, international cooperation in research, development and innovation, and the internationalization of IoT solutions developed in the country.

In addition, the DOU's text also provides for the Chamber of Management and Monitoring of the Development of Machine to Machine Communication Systems and Internet of Things (IoT Chamber), which is "the advisory body intended to monitor the implementation of the National Plan of Internet of Things" [26]. According to [27], by means of this decree, the government will regulate the operation and development of novelties in the

area of connected devices, which include intelligent appliances, televisions, personal assistants, printers, routers and all kinds of devices with artificial intelligence or home automation that help people in their daily lives, bringing a new approach in usability between men and machines. Among the inventors who have produced the most IoT-related technologies, the Chinese rank first. These numbers are a consequence of financial investments in education, research and innovation applied to technological development [28] in countries like China. The technological classification (CPI) was also another important aspect observed. Reference [29] explains that classes G06 and H04 are related to communication, calculation, counting and/or electrical communication techniques. These areas stood out not only for their dynamism, but also for being related to the quality analyses of technologies on IoT.

6. Final considerations

With the two mappings, it was possible to identify the main centres originating from IoT-related technologies. Among these, it can be seen that the United States, China, Canada, South Korea have invested a lot in R&D (P&D) in the area, generating results in terms of patents. Brazil does not have a relevant number of IoT technologies and needs to advance in the area. Nevertheless, it has started to establish important regulatory measures that bind the country to this technological agenda, such as, for example, Decree nr. 9.854/2019, which institutes the National Plan of Internet of Things [26]. With the prospecting, it was also possible to notice that among the technological areas in which there are more patents applied for, there is a highlight of those that prioritize machine-machine communication, with systemic and intelligent interaction, and with little or no human interference. This is also related to the aspect of connectivity, which is an essential factor for IoT. The Internet of Things is a technology that presents great potential in research and innovative projects. This can be applicable in the automated system of several areas, among which water resources, energy and telecommunications. An important concept in evidence is that of intelligent cities, environments that have several systems aimed at the continuous improvement of the quality of human life. In this case, intelligent cities are environments that demand the increasing and intelligent use of IoT. IoT is an area capable of promoting unprecedented changes in the interaction of humans with machines. It is an intelligent technology, which has the potential to become omnipresent. One of the limitations of the search was the use of SPACENET and WIPO databases only, as well as the scope of the period. As a research agenda in the area, new works can present the mapping of Internet technologies of things applied specifically to the areas of health, education or urban mobility.

References

[1]. L. Morgado, Internet das coisas. Completa: teoria, pratica e desafios. Recife: Cubzac, 2018.

[2]. K. Ashton and Others, “That ‘internet of things’ thing,” RFID journal, vol. 22, no. 7, pp. 97–114, 2009.

[3]. E. Fleisch and Others, “What is the internet of things? An economic perspective,” Economics, Management, and Financial Markets, vol. 5, no. 2, pp. 125–157, 2010.

[4]. F. Lacerda and M. Lima-Marques, “Da necessidade de princípios de Arquitetura da Informação para a Internet das Coisas,” Perspectivas em Ciência da Informação, vol. 20, no. 2. pp. 158–171, 2015, doi: 10.1590/1981-5344/2356.

[5]. F. Lacerda and M. Lima-Marques, "Ecossistemas de informação: novo paradigm para a Arquitetura da Informação," Transinformação, vol. 29, no. 1. pp. 81–90, 2017, doi: 10.1590/2318-08892017000100008.

[6]. M. L. Dutra and S. A. Toriani, "Internet das Coisas na prática: desafios e oportunidades," in Ideias emergentes em Biblioteconomia, J. D. Prado, Ed. São Paulo: FEBAB, 2016, pp. 86–92.

[7]. B. P. Santos et al., "Internet das coisas: da teoria à prática," SBRC 2016, 2016. [Online]. Available: http://www.sbrc2016.ufba.br/minicurso/minicurso-1. [Accessed: 06-Apr-2020].

[8]. R. M. A. Baracho, M. L. P. Junior, and M. B. Almeida, "Ontologia, Internet das Coisas e Modelagem da Informação da Construção (BIM): Estudo Exploratório e a Inter-relação entre as Tecnologias," in CEUR Workshop Proceedings, 2017, vol. 1908, pp. 141–146.

[9]. WIPO, "Perguntas e Respostas sobre o PCT," WIPO, 2017.

[10]. WIPO, "Tratado de Cooperação em matéria de Patentes (PCT)." 1970.

[11]. G. A. Santos, G. J. C. Machado, R. A. Almeida Junior, and M. S. Souza, "Internet of Things (IoT): Um Cenário Guiado por Patentes Industriais," GESTÃO. Org: Revista Eletrônica de Gestão Organizacional, vol. 13, 2015.

[12]. INPI, "Classificação Internacional de Patentes (IPC): Introdução - Módulo Complementar I." 2018.

[13]. A. M. S. Antunes, V. M. A. Parreiras, C. M. Quintella, and N. M. Ribeiro, "Métodos de Prospecção Tecnológica, Inteligência Competitiva e Foresight: principais conceitos e técnicas," IN: RIBEIRO, NM Prospecção Tecnológica, vol. 1, 2018.

[14]. Z. D. V. L. Mayerhoff, "Uma análise sobre os estudos de prospecção tecnológica," Cadernos de prospecção, vol. 1, no. 1, pp. 7–9, 2008.

[15]. C. M. Quintella, B. A. Almeida, W. P. C. Santos, L. M. T. S. Rodrigues, and S. A. Hanna, "Busca de anterioridade," in Prospecção tecnológica, N. M. Ribeiro, Ed. Salvador-BA: IFBA, 2018, pp. 109–140.

[16]. INPI, "Manual para o depositante de patentes." 2015.

[17]. O. Costa, "China x EUA: entenda a guerra pela tecnologia entre as duas potências," E-Commerce Brasil, 2019. [Online]. Available: https://www.ecommercebrasil.com.br/artigos/china-estados-unidos-guerra-pela-tecnologia/. [Accessed: 06-Apr-2020].

[18]. I. P. Mahmood and J. Singh, "Technological dynamism in Asia," Res. Policy, vol. 32, no. 6, pp. 1031–1054, Jun. 2003.

[19]. M. M. Godinho and V. Ferreira, "Analyzing the evidence of an IPR take-off in China and India," Res. Policy, vol. 41, no. 3, pp. 499–511, Apr. 2012.

[20]. X. Li, "Behind the recent surge of Chinese patenting: An institutional view," Res. Policy, vol. 41, no. 1, pp. 236–249, Feb. 2012.

[21]. R. Urbizagástegui Alvarado, "A Lei de Lotka na bibliometria brasileira," Ci. Inf., vol. 31, no. 2, pp. 14–20, 2002.

[22]. INPI, "Publicação IPC," 2018. [Online]. Available: http://ipc.inpi.gov.br/ipcpub/?notion=scheme&version=20190101&symbol=none&menulang=pt&lang=pt&viewmode=f&fipcpc=no&showdeleted=yes&indexes=no&headings=yes&notes=yes&direction=o2n&initial=A&cwid=none&tree=no&searchmode=smart. [Accessed: 10-Jan-2020].

[23]. M. Squicciarini, H. Dernis, and C. Criscuolo, "Measuring patent quality," 2013.

[24]. G. A. Marão, "Internet das Coisas (IoT)," 14º Seminário De Gerenciamento De Projetos do PMISP, 2015. [Online]. Available: https://www.google.com.br/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwiy6eD3vaT QAhUBgpAKHdvaCtAQFggpMAM&url=http%3A%2F%2Fwww.pmisp.org.br%2F2015-09-07-14-50-57%2F2015-11-17-02-24-45%2F14-seminario-internacional%2Fdoc_download%2F144-internet-das- coisas-iot&usg=AFQjCNEbjLm2E8qSQIDfgtyxwKnbuxjLOQ&cad=rja. [Accessed: Ago 18, de 2019].

[25]. P. Basílio, "IoT é a tecnologia com maior potencial para transformar negócios a curto prazo," Gazeta do povo, 2019. [Online]. Available: https://www.gazetadopovo.com.br/economia/iot-e-a-tecnologia-com-maior-potencial-para-transformar-negocios-a-curto-prazo/.disponivel. [Accessed: 18-Aug-2019].

[26]. Brazil, "Decreto nº 9.854, de 25 de junho de 2019. Institui o Plano Nacional de Internet das Coisas e dispõe sobre a Câmara de Gestão e Acompanhamento do Desenvolvimento de Sistemas de Comunicação Máquina a Máquina e Internet das Coisas." 2019.

[27]. L. Zaramela, "Como o Plano Nacional de Internet das Coisas mudará nossas vidas?," 2019. [Online]. Available: https://canaltech.com.br/internet-das-coisas/decreto-instaura-o-plano-nacional-de-internet-das-coisas-142751/.

[28]. B. Riboldi, "O que os países asiáticos têm a nos ensinar sobre educação," 2015. [Online]. Available: http://www.conexaolusofona.org/o-que-os-paises-asiaticos-tem-a-nos-ensinar-sobre-educacao/. [Accessed: 18-Aug-2019].

[29]. P. M. de O. Lages, "Análise de patentes nas classes G06 e H04 nos principais institutos de patentes mundiais: enfoque nas empresas tecnológicas mais dinâmicas," Instituto Superior de Economia e Gestão, 2016.