

ELECTRICITY: ANALYSIS OF THE GLOBAL INVENTIVE ACTIVITY, TRENDS AND OPPORTUNITIES OF INNOVATION

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Abstract

The present analysis identifies study variables such as main inventors, countries, patents, technological dynamics, technological variability, among others, whose purpose is the construction of a technological profile to find trends and innovation opportunities for the market, technological companies, development of new inventions, improvements and investigations related to the H classification of the International Patents Classification (IPC). Studies such as technology bulletins, the European commission technology surveillance reports (Holst Jørgensen, 2017), and technological surveillance investigations in the solar thermal electricity (Jürgens et al., 2017), determined the trends and opportunities for technological application sectors, in addition to the study of some patents as referents for this research.

The methodology was based on a patent analysis (patentometry) Contemplated in four phases and as a result of the construction of the profile of the inventive activity of section H (electricity) three fields of application were highlighted, solid state devices using organic materials as active part; adapted specialized procedures for the treatment of semiconductor devices; and arrangements, apparatus, circuits or systems. The main country for the production of this type of technologies United States, and the leading applicants include (Yamazaki Shunpei) China (Zhou and Li Mingjie Zongcheng) Japan (Yamazaki Shunpei and Wang Wei). Referent companies include Huawei Technologies, Qualcomm, LG Electronics, Samsung Electronics, International Business Machines Corporation and Taiwan Semiconductor Manufacturing Company, among other findings.

This document is useful for technological development centers, Researchers, and technology companies; since the knowledge of technological trends as a key indicator appears for the decision making of large investments, execution of projects, creation of new patents, innovation of new products or Processes according to the Studied area of electricity and other fields of application.

Keywords: Patents, Trends, Patentometry, Electricity, Innovation, Databases, Indicators.

INTRODUCTION

Finding, analyzing, and processing information is necessary for the execution of exercises regarding competitive intelligence and technological surveillance, providing key indicators for enterprises, academic institutions, niche markets and economic sectors. Patenting activity in sectors such as electricity have a high growth worldwide in different fields of application, mainly the technology sector where large investments in innovative products are becoming more frequent and high quality processes.

The construction of inventive profiles identifies key sources of innovation to determine production trends allowing the knowledge of the behavior of a field or technological area under the subject of technological competitive intelligence (Escorsa & Maspons, 2001). This fact provides an overview regarding the behavior of the technological sector, and is presented as an indicator for decision-making in matters of investment projects, because if it is known if a technological area has a positive or negative trend then it becomes easier to hit in the right decision and mitigates financial risks involved in these investments (Pérez & Aneón, 2008). The success of many projects depends largely on the feasibility of the study, and the knowledge of technology trends is presented as a significant factor in this context. In the same way, those who decide to invest in future actions can use the technological trends, to expect better results in their investments.

The study of patents databases provides important technological indicators according the study scenario. H section, electricity, (according to the international patent classification) is constituted of a large number of subclasses and different levels of detail that allows the exploring of a group of patents depending on the case. Thus, it is important to know how to find patent information, how to analyze the results of these inventions, and what database is

indicated for the study (Newton, 2000). Addressed these questions, identifying technology trends requires performing a patentometric analysis based on statistical studies of inventive activity trying to find new technology markets and technological variability of patents which is a tool for generating knowledge and technological development.

This article presents a study of the Section H (electricity) for patents' production worldwide, building a profile of its inventive activity. Using records of inventions and innovations of the database selected by performing the calculation and analysis of innovation indicators, providing fields and application areas, leading companies, countries, among other indicators according to the study period (2012- 2015).

OBJECTIVES AND METHODOLOGY

For the development of this exercise of identifying trends and opportunities for innovation in section H (electricity), construction of the database, data analysis and processing of results, were considered the objectives and methodology detailed below:

General

Create a profile of inventive activity worldwide in section H according to the International Patent Classification (IPC).

Specifics

- i. Identify existing databases worldwide to construct the inventive profile in section H according to the CIP.
- ii. Review and process concerning the basis of the inventive global section H according to the CIP for 2012-2015 selected data.
- iii. Analyze the information obtained from the review and processing of existing databases worldwide in Section H.
- iv. Identify technological trends in H section, according to the CIP.

Methodology

Phase 1. Identification of the databases: Investigate and study the different official databases worldwide that record the inventive activity in order to define the optimal database for the development of the creation of the profile.

Phase 2. Collection and processing of the information: Taking as reference the database already defined, the information from the patent registers is extracted for the design of an own database according to the aspects required in the inventive activity profile and Section H of the IPC.

Phase 3. Analysis of information: During this phase an analysis is made through graphs and tables that show in a statistical way the results obtained in each corresponding disaggregation; as for example the subsections of each section, geographic context, impact it generates, among others.

Phase 4. Identify the trends: We proceed to classify the inventive activities with the greatest impact on innovation worldwide in order to reach a general conclusion regarding the most significant technological trends in section H of the International Patent Classification.

FINDINGS

International Patent Classification Structure

CIP: Hierarchical classification system used to classify patent documents (patent applications, granted patent specifications, models for general use, etc.) according to the technical fields to which they belong.

Section H - Electricity

- i. The basic electrical elements
- ii. Generation of electricity
- iii. Applied electricity
- iv. Basic electronic circuits and their control
- v. The communication technique

Selected database

The selected database for the development of the profile for Section H was Patentscope, due to the advantages of this source such as easy access, large number of records that can be downloaded in each iteration, and the fact that covers much of inventive activity worldwide, and different variables of each useful record for an analysis of the most solid information can be obtained. It

also has an added value regarding free virtual training on handling platform for those who signed up for free.

Once the database of the H section, corresponding to Electricity, was downloaded, we proceeded to analyze the information obtained according to the categorization proposed by the International Patent Classification level section, subsection, class, subclass and main group. First, it has the general level section, related patents and published concerning electricity, 2012-2015 finding a total of 2'356.015 patents issued during this period in section H. The behavior for this section in terms of inventive activity every year is shown in Figure 1.

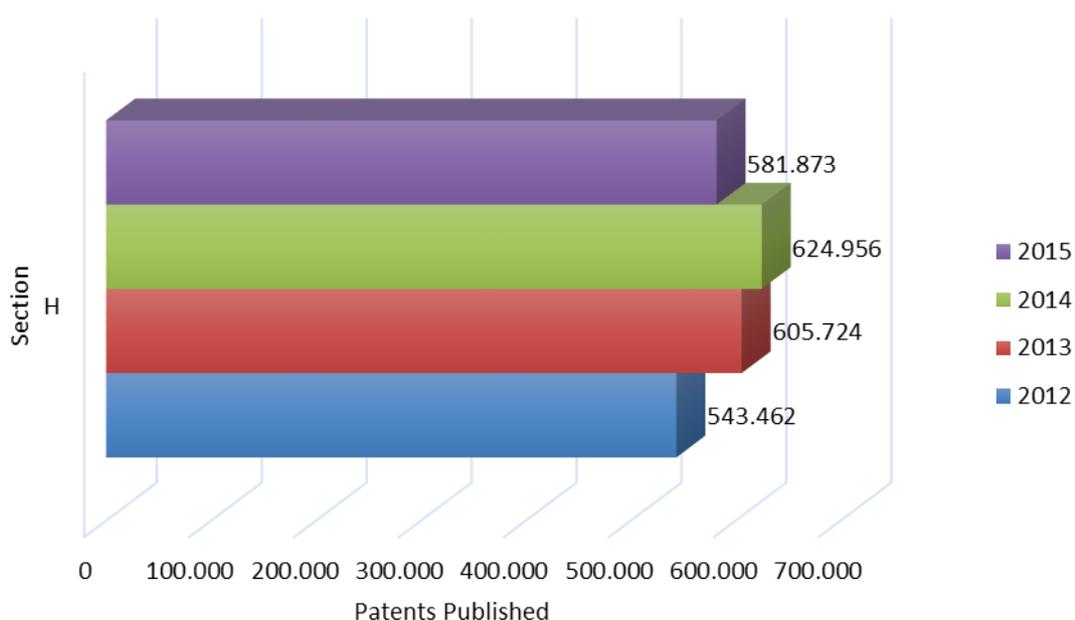


Figure 1: Patents issued to section level for the period 2012-2015 Electricity, Source: Own elaboration using Patentscope. Consultation date: February 24, 2017.

At the Figure 1, can be observed that Section H has a positive trend over time, increasing the number of published patents every year except for 2015, which may be due to the date of consultation and preparation of this research, because patent records take approximately 18 months to be published. Therefore, for the date of preparation and consultation of this study (Dec-2016) the number of published patents in the Electricity Section during 2015, decreased in nearly 40,000 patents compared to 2014.

Analysis of the information

Sample selection

The first step for achieving the profile was to define the information to be studied in detail and in more depth. Since the H section has 548 main groups, studying the whole section at this level of information difficult the analysis, given the

extent of the same and requiring a considering amount of time for the work required. Because of this, it was decided to study the H section at the subclasses level, containing 52 subclasses to be analyzed.

Thus, it was necessary to define the number of subclasses to work, seeking to improve work efficiency, but without losing valuable information. For this, the Pareto principle is applied, as seen in Figure 2.

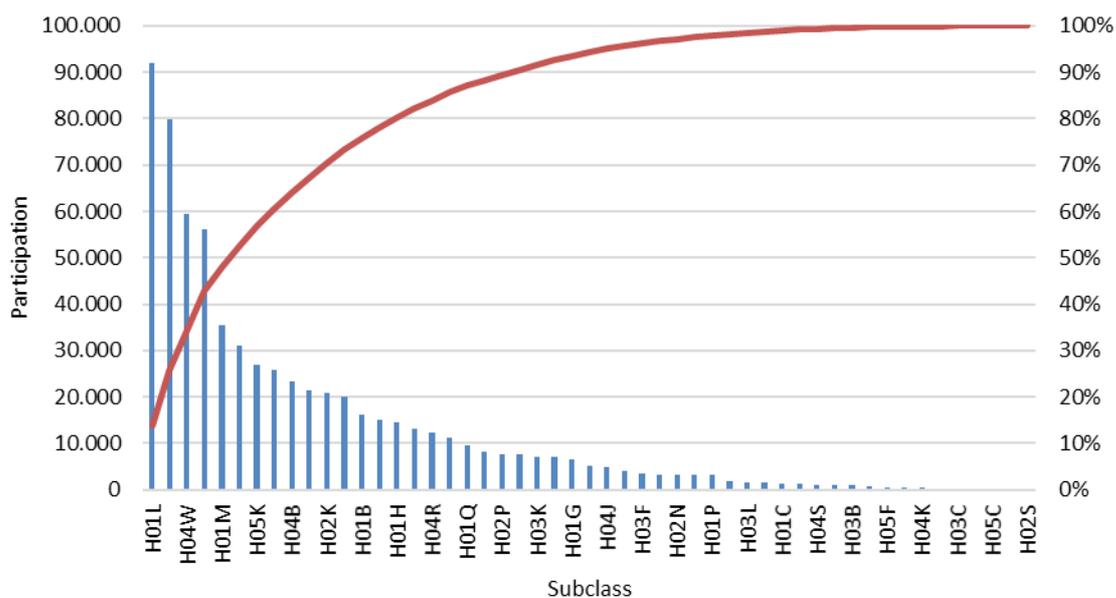


Figure 2: Pareto diagram for publishing activity by subclasses, Source: Own elaboration using Patentscope. Consultation date: March 10, 2017.

The Pareto Principle states that 80% of the effects are the product of 20% of the causes, which allows to quickly identify the essential part of an activity. Thus, it is possible to separate the "less vital" from the "much trivial" (Levine & Berenson, 2006). From this analysis, two main subclasses are defined, representing only 4% of the subclasses, but in terms of volume of information they contain approximately 27%. These subclasses are:

- i. H01L- SEMICONDUCTOR DEVICES, SOLID STATE ELECTRICAL DEVICES NOT PROVIDED ANOTHER PLACE.
- ii. H04L- TRANSMISSION OF DIGITAL INFORMATION (TELEGRAPH COMMUNICATION).

Chronological analysis and trends

It was proceeded to conduct an analysis at higher level of detail for the subclasses already defined, finding first, the technological trend of each subclass, and considering the amount of new inventions published in each subclass for every year of the study period, as shown in Figure 3.

From this figure the increasing trend year after year for both subclasses is observed, with the exception of 2015 for subclass H01L. A similar event is presented for the subclass H04L, where there is a growth in the last year, but not as large as the prior period. On the same way, the behavior is studied throughout the century, from 2000 to date. This information is presented graphically in Figure 4, where it is possible to note that both subclasses have a slight tendency to grow, with certain periods of restraint for each one, specifically for the years 2009-2010 for the subclass H04L and H01L in 2008.

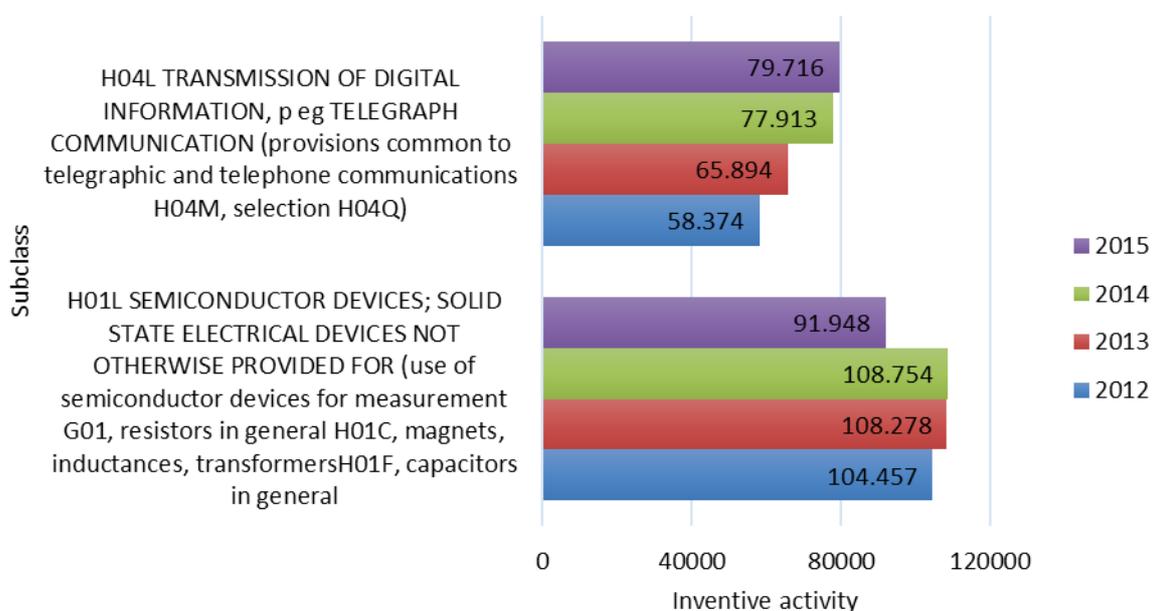


Figure 3: Technological trend major subclasses section H for 2012-2015, Source: Own elaboration using Patentscope. Consultation date: March 18, 2017

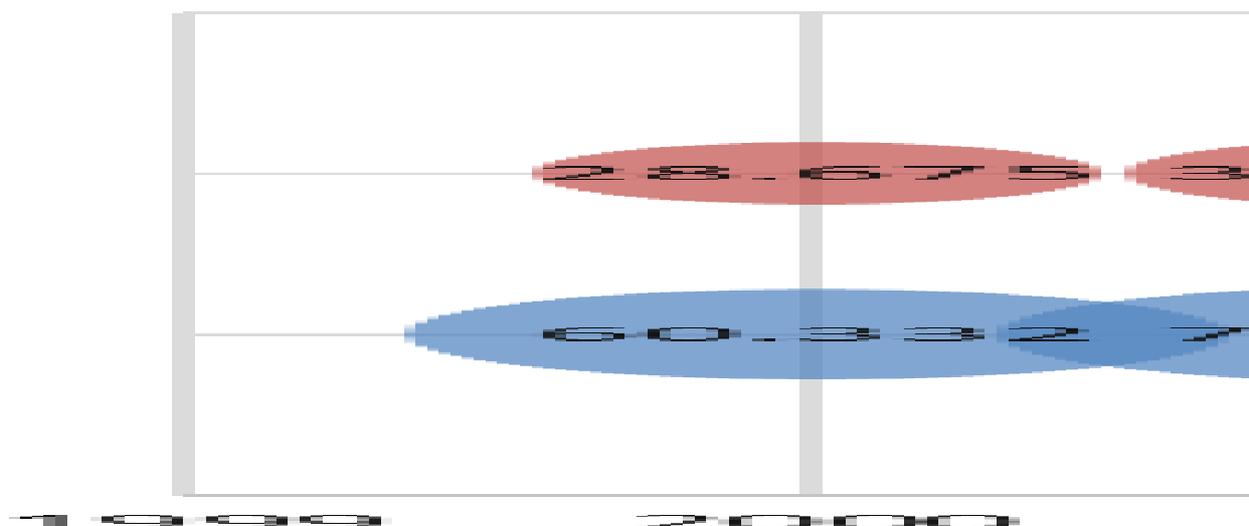


Figure 4: Chronological evolution of the major subclasses of section H for the period 2000-2015, Source: Own elaboration using Patentscope. Consultation date: March 18, 2017.

Indicators of Inventive Activity

According to the analysis of the information in the Table1, the main leading countries, inventors and applicants according to Section H and according to the sample selected in subclasses H01L and H04L are presented. In this table, are highlighted countries such as the United States with 26,921 inventions during the period corresponding to 2015, China with 23,935 inventions, Japan with 16,036, South Korea with 6,896 and the office of the World Intellectual Property Organization (WIPO) with 9,160 inventions. Additionally, inventors of Asian origin stand out as the main authors and companies recognized as Samsung Electronics Co with 833 inventions in their last period of study and IBM International Business Machines Corporation with 250 inventions, these results are related to the category H01L. Within the results of the other subclass analyzed, H04L, China stands out as the leading country with 25,213 inventions in 2015, followed by the United States with 31,931 inventions. In addition, in the analysis of inventors, Asian inventors stand out and in some registers various inventors has presented their names reserved, and in this analysis, important applicants with high recognition stand out, such as Huawei Technologies Co., Ltd. with 5,011 inventions, and Qualcomm Incorporated with 4,289. Another important applicant is LG Electronics INC. with 3.851.

Table 1: Main Inventors, Offices and Applicants for H01L and H04L subclasses.

Subclass	Inventors	Offices/Countries	Applicants
H01L Dispositives Semi- conductores	1. Zhou Mingjie	1. United States	1. Samsung Electronics Co.
	2. Yamazaki Shunpei	2. China	2. International Business Machines Corporation IBM
	3. Wang Ping	3. Japan	3. Taiwan Semiconductor Manufacturing Company, Ltd.
	4. 山崎 舜平 (Yamazaki Shun Ping)	4. South Korea	4. Kabushiki Kaisha Toshiba
	5. Shunpei Yamazaki	5. World intellectual property organization (WIPO)	5. Samsung Display Co., Ltd.
H04L Transmission of digital information	1. Li Zongcheng	1. China	1. Huawei Technologies Co., Ltd.
	2. The Inventor Has Waived The Right To Be Mentioned	2. Unites States	2. Qualcomm Incorporated
	3. Wang Wei	3. World intellectual property organization (WIPO)	3. LG Electronics INC.
	4. 不公告发明人 (The Inventor Is Not Announced)	4. European patents office	4. International Business Machines Corporation IBM
	5. Hanbyul SEO	5. Japan	5. Samsung Electronics Co.

Source: Own elaboration using patentscope

Technological variability for subclasses H01L - H04L

The technological variability per applicant in subclass H01L, describes which were the applicants with the highest number of inventions for the period under study, and how many areas or technology fields they used in their inventions. The summary of this information is presented in Figure 5, where the 20 main applicants in this field are highlighted.

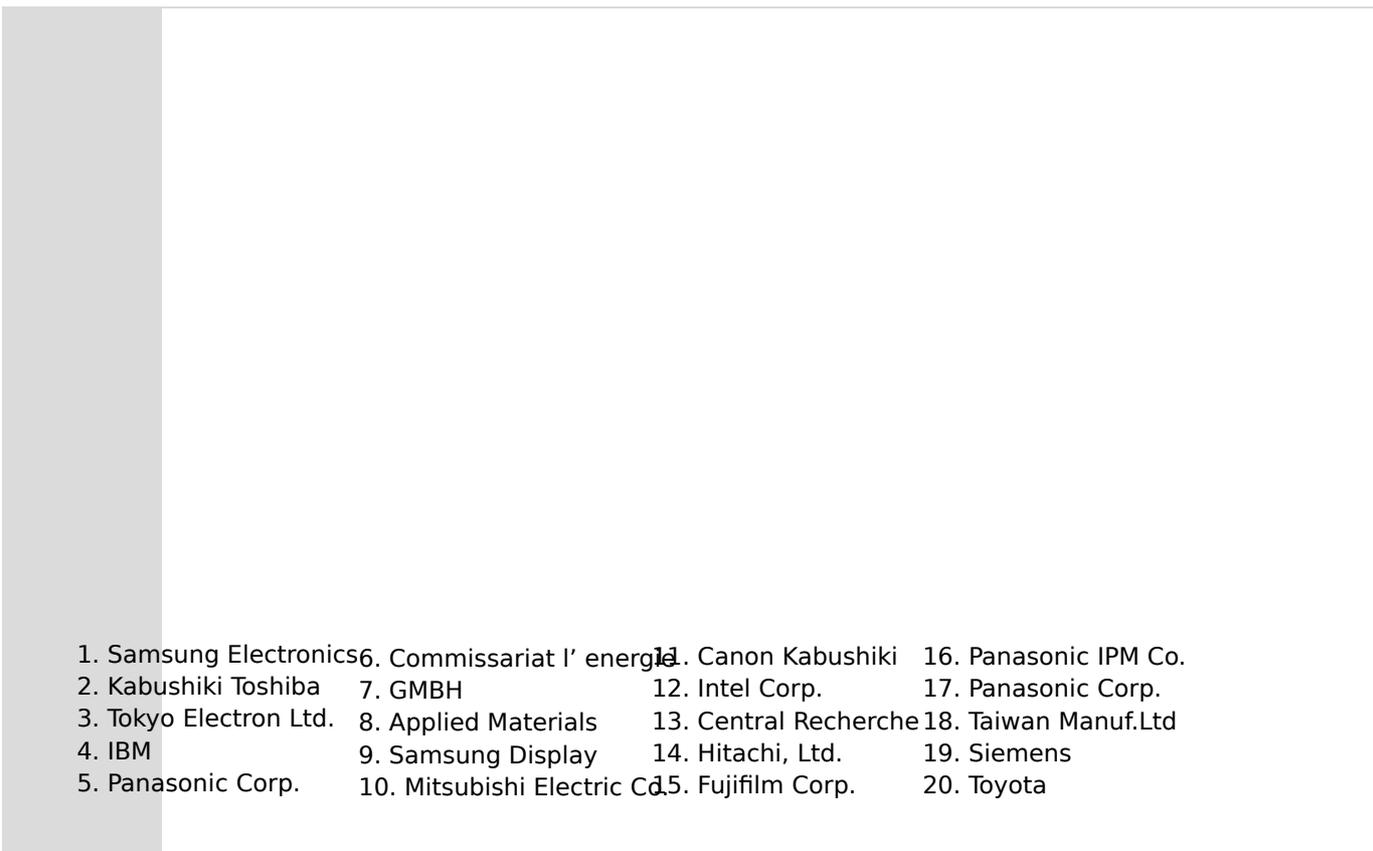
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1. Samsung Electronics
 2. Kabushiki Toshiba
 3. Tokyo Electron Ltd.
 4. IBM
 5. Panasonic Corp.
 6. Commissariat l' energie
 7. GMBH
 8. Applied Materials
 9. Samsung Display
 10. Mitsubishi Electric Co.
 11. Canon Kabushiki
 12. Intel Corp.
 13. Central Recherche
 14. Hitachi, Ltd.
 15. Fujifilm Corp.
 16. Panasonic IPM Co.
 17. Panasonic Corp.
 18. Taiwan Manuf.Ltd
 19. Siemens
 20. Toyota

Figure 5: Technological variability for subclass H01L, Source: Own elaboration using Patentscope. Consultation date: February 18, 2017.

This section highlights the South Korean multinational Samsung Electronics Co, Ltd., which has about 1500 applications, using about 110 technology sectors. Similarly, the American company International Business Machines Corporation IBM conceives about 1700 inventions, which involve 80 fields of technology.

In addition, the life cycle of the subclass was studied, starting from the year 2000 until the date of consultation, being able to notice the behavior over time of the inventive activity of subclass H01L. This information is presented in Figure 6. This figure shows that the life cycle is in decline, because since 2000 the life cycle of these inventions is normal and in constant growth, but the last period of study is affected by the use of inventions and the creation of new technologies. Presenting a downward trend and the life cycle of some inventions is about to end.

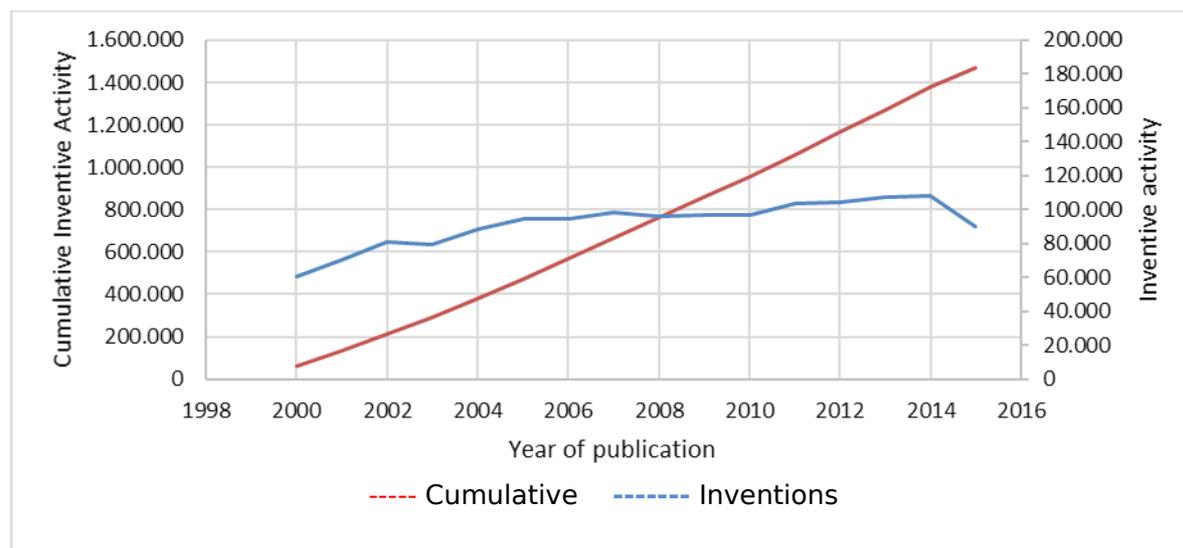


Figure 6: Lifecycle of subclass H01L for the period 2000-2015, Source: Own Elaboration using Patentscope. Consultation date: April 5th, 2017.

On the other hand, the technological variability per applicant is also identified for subclass H04L, showing the applicants with the greatest number of inventions for the period under study, and how many areas or fields of technology they have used in their inventions. The summary of this information is presented in Figure 7, where the 20 main applicants in this field are highlighted, including Qualcomm Incorporated with 4142 inventions in 60 areas, International Business Machines Corporation (IBM), with 4000 inventions in 60 areas, and Huawei Technologies Co., with 8400 inventions in 50 areas.

- | | | | |
|----------------------|-------------------------|-------------------------|-------------------------|
| 1. Qualcomm | 6. Samsung Electronics | 11. Electronics and Tel | 16. Siemens |
| 2. IBM | 7. Telefonaktiebolaget | 12. LG Electronics INC. | 17. Panasonic Corp. |
| 3. Google INC. | 8. Apple INC. | 13. GMBH | 18. BlackBerry Limited. |
| 4. Sony Corporation | 9. Kabushiki Kaisha | 14. Broadcom Corp. | 19. Samsung |
| 5. Intel Corporation | Toshiba | 15. ZTE Corporation | Electronics |
| | 10. Huawei Technologies | | 20. Mitsubishi Electric |

Figure 7: Technological variability for subclass H04L, Source: Own elaboration using Patentscope. Consultation date: February 18, 2017.

In addition, the life cycle of the subclass is studied, starting from the year 2000 until the date of consultation, being able to notice the behavior in time of the inventive activity of subclass H04L. This information is presented in Figure 8. In the graph, it can be noted an increase in the inventive activity year after year, with a notable exception of the year 2008, and a slight decrease in the year 2005, but with an accumulation of increasing inventive activity in general terms.

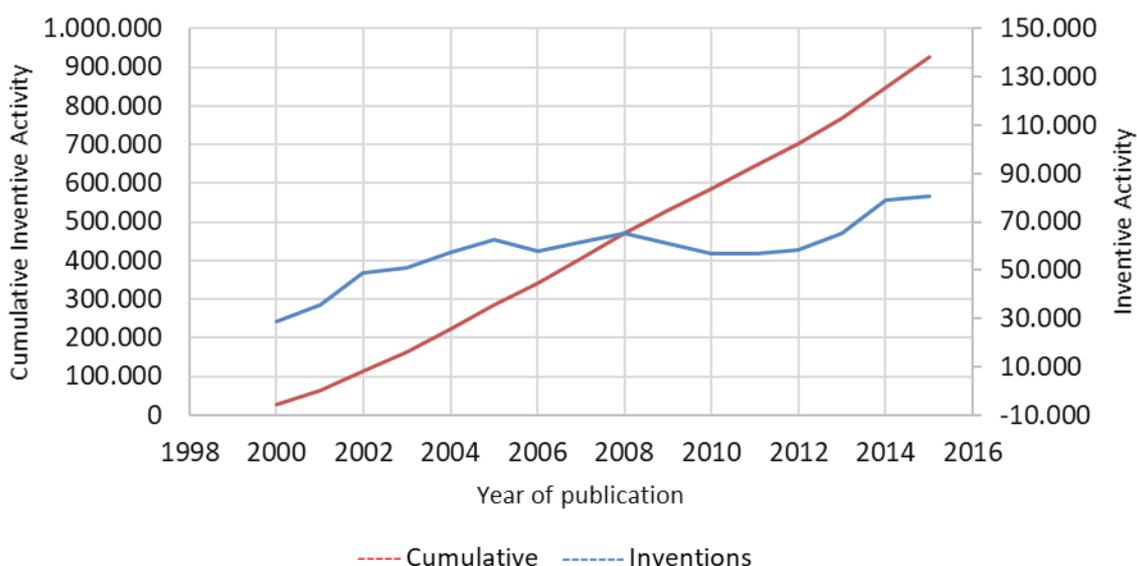
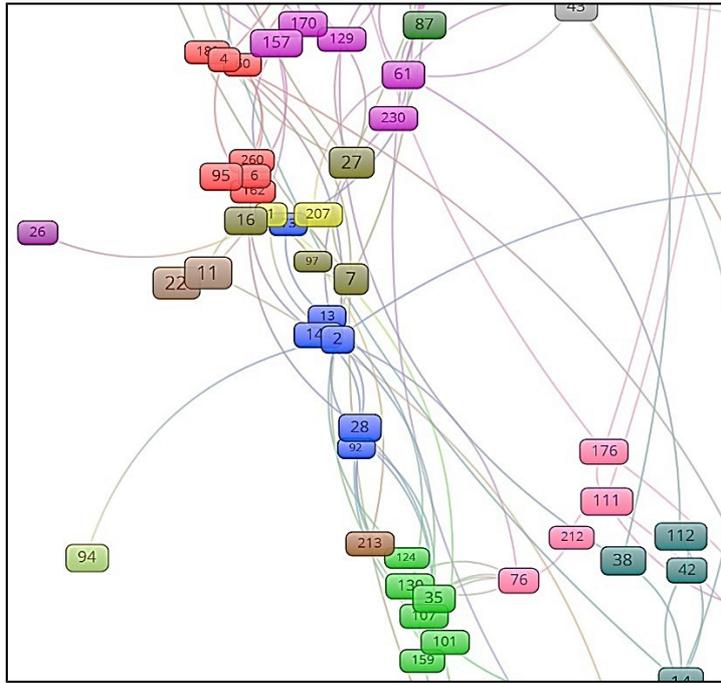


Figure 8: Lifecycle for subclass H04L for the period 2000-2015, Source: Own elaboration using Patentscope. Consultation date: April 5, 2017.



Analysis of co-occurrence for subclasses H01L and H04L

The collaboration networks include graphs of the main clusters for each network among applicants, which the renowned economist Michael Porter defines as "a group of companies and related institutions, belonging to the same sector or market segment, which are geographically close and that collaborate to be more competitive".

At the Figure 9, shows applicants for section H01L,

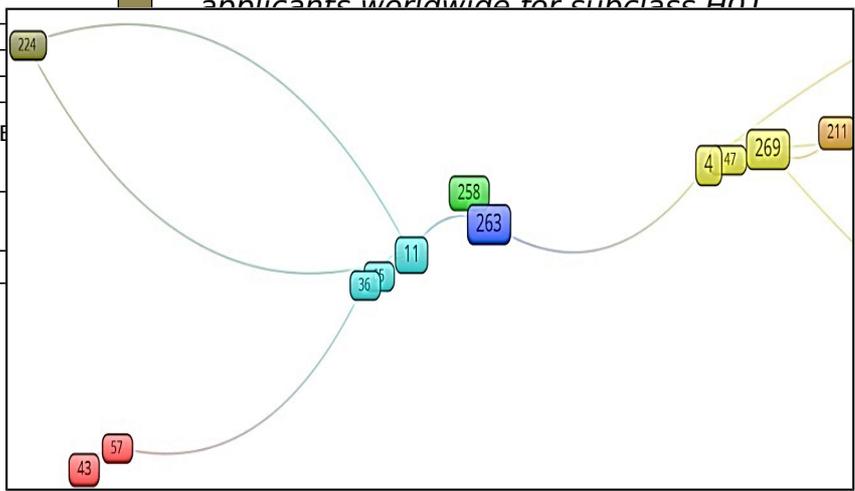
such as International Business Machines Corporation and Globalfoundries Inc., Ltd., which are two of the applicants who requested the highest number of patents in collaboration with other applicants during the period of the study. Other companies such as Tokyo Electron Limited present a small number of collaborations with other applicants despite being one of the applicants with the largest number of applications. This figure has been developed using VOSviewer®. The collaborative network among applicants for subclass H04L-

Semiconductor Devices, Solid State Electrical Devices Not Provided Elsewhere is shown in Figure 10. The names of the main applicants in the network map are Huawei Technologies Co. and Tencent Technology.

Id.	Name
6	Fraunhofer-Gesellschaft
95	Commissariat À L'énergie Atomique Et Aux Énergies Alternatives
260	STMicroelectronics
101	IMEC
107	COMMISSARIAT À L'ÉNERGIE ATOMIQUE ET AUX ÉNERGIES ALTERNATIVES
124	STMicroelectronics S.r.l.
159	FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
2	International Business Machines Corporation IBM
13	GlobalFoundries, Inc.
28	LAM Research Corporation
92	Applied Materials Inc.
14	The Board Of Trustees Of The University Of Illinois
16	MERCK PATENT GMBH
97	Seiko Epson Corporation
7	Tokyo Electron Limited
27	東京エレクトロン株式会社 (Tokyo Electron Limited)

Id.	Name
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Figure 9: Network of collaborators among applicants worldwide for subclass H01L



43	Huawei Technologies Co., Ltd.	Red
38	Tencent Technology (Shenzhen) Co.	Red
57	Zhong Xing Telecommunication Equipment Company ZTE	Red
11	Sony Corp.	Light Blue
36	Panasonic Corp.	Light Blue
25 8	BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS	Green
18	中兴通讯股份有限公司 (Zhongxing co., Ltd)	Green
8	ZTE CORPORATION	Blue
26 3	Tsinghua University	Blue

Figure 10: Network of collaborators among applicants worldwide for subclass H04L, Source: Own elaboration Patentscope from using the software VOSviewer Development. Consultation date: April 25, 2017.

Subclass analysis contingencies H01L - semiconductor devices; solid state electrical devices

Table 2: Contingency between applicants and inventors for subclass H01L.

Applicant/Inventor	Shunpei Yamazaki	Cheng Kangguo	Yamazaki Shunpei	Kamatani Jun	Amir Hossain Parham	Christof Pflumm	Kangguo Cheng	Zhou Mingjie	Chen-Hua Yu	Zhu Huilong	Total
Semiconductor Energy Laboratory Co., Ltd.	276	-	167	-	-	-	-	-	-	-	443
International Business Machines Corporation	-	190	-	-	-	-	132	-	-	9	331
Yamazaki Shunpei	273	-	-	-	-	-	-	-	-	-	273
Merck Patent GMBH	-	-	-	-	115	118	-	-	-	-	233
Amir Hossain Parham	-	-	-	-	101	71	-	-	-	-	172
Cheng Kangguo	-	141	-	-	-	-	-	-	-	-	141
Canon Kabushiki Kaisha	-	-	-	124	-	-	-	-	-	-	124
Shunpei Yamazaki	-	-	118	-	-	-	-	-	-	-	118
Zhou Mingjie	-	-	-	-	-	-	-	106	-	-	106
Taiwan Semiconductor Manufacturing Company, Ltd.	-	-	-	-	-	-	-	-	103	-	103
Kamatani Jun	-	-	-	100	-	-	-	-	-	-	100
Total	549	331	285	224	216	189	132	106	103	9	2.144

Source: Own elaboration using Patentscope. Consultation date: April 15, 2017.

Note: The sign (-) indicates that the information is not available for this relationship.

In the Table 2, shows that among the main applicants of this subclass (H01L - semiconductor devices, solid state electrical devices), the Japanese company Semiconductor Energy Laboratory Co., Ltd. stands out with two trends within the main activities followed by the American multinational IBM with three inventors. On the inventors' side, the name of Yamazaki Shunpei stands out, which presents the highest number of inventions for companies and natural persons, and in the same way but a step below, is Cheng Kangguo.

The relationship between countries and inventors for subclass H01L is summarized in Table 3. From this table, it is inferred that the main countries in the patent application for semiconductor devices; solid-state electrical devices includes the presence of China with five trends within the main inventors, followed by Japan with three trends and the United States with more trends but fewer inventions. On the inventors side, the name of Zhou Mingjie stands out, which presents the highest number of inventions in China and a little presence in the United States, followed by Yamazaki Shunpei, with high representation for Japan, the United States and South Korea.

Table 3.: Contingency between countries and inventors for subclass H01L.

Country/Inventor	Zhou Mingjie	Shunpei Yamazaki	Wang Ping	Shunpei Yamazaki	Yamazaki Shunpei	Zhou Mingjie	Zhang Zhenhua	Cheng Kangguo	Yamazaki Shunpei	Wang Xinchao	Kangguo Cheng	Total
China	2240	-	923	-	-	386	309	-	-	269	-	4127
Japan	-	735	1	931	-	-	-	-	-	-	-	1667
United States	41	416	25	-	548	-	2	267	-	-	265	1564
South Korea	-	172	-	-	-	-	-	-	271	-	-	443
European Patent Office	58	39	31	-	1	-	-	-	-	-	-	129
World Intellectual Property Organization (WIPO)	-	-	-	-	-	41	-	-	-	-	-	41
Germany	-	13	-	-	-	-	-	5	-	-	1	19
United Kingdom	-	-	-	-	-	-	-	10	-	-	2	12
Singapore	-	-	-	-	2	-	-	-	-	-	-	2
Total	2339	1375	980	931	551	427	311	282	271	269	268	8004

Source: Own elaboration using Patentscope. Consultation date: April 15, 2017.

Note: The sign (-) it indicates that the information is not available for this relationship.

The relationship between the countries and the applicants of this subclass is also studied, and is shown in Table 4.

Table 4: Contingency between countries and applicants for the subclass H01L.

Country/Applicant	Samsung Electronics Co., Ltd.	Huawei Technologies Co., Ltd.	Taiwan Semiconductor Manufacturing Company, Ltd.	Kabushiki Kaisha Toshiba	Samsung Display Co., Ltd.	Intel Corporation	Semiconductor Energy Laboratory Co., Ltd.	APPLIED MATERIALS, INC.	Tokyo Electron Limited	Sharp Kabushiki Kaisha	Total
United States	45763	4044	3.250	2.728	2.447	1.574	1.896	1.128	1.186	1.318	24.334

World Intellectual Property Organization (WIPO)	65	379	-	195	13	673	323	939	634	322	3.543
South Korea	151	15	-	13	117	3	6	4	36	9	354
China	26	2	5	6	-	-	-	-	-	-	39
Germany	3	20	-	3	-	-	-	-	-	-	26
Singapore	-	1	-	-	-	6	2	4	6	-	19
Canada	-	5	-	-	-	-	-	-	-	-	5
Spain	-	-	-	-	-	-	-	2	-	2	4
Total	5.008	4.466	3.255	2.945	2.577	2.256	2.227	2.077	1.862	1.651	28.324

Source: Own elaboration using Patentscope. Consultation date: April 15, 2017.

Note: The sign (-) it indicates that the information is not available for this relationship.

In the Table 4, shows that of the main countries / offices in subclass H01L, highlights the US leadership with trends in all the main applicants and a high number of patent applications, followed by the World Intellectual Property Organization (WIPO). For the applicants, the South Korean multinational Samsung Electronics Co., Ltd. stands out; presenting the highest number of applications in the United States, and in the same way IBM is included with a greater presence in their country of origin.

Contingency analysis subclass H04L - Transmission of digital information

The first contingency analysis is presented in Table 5 showing the main applicants for this subclass. The Korean company LG Electronics Inc. is leading this indicator with three trends within the main activities, followed by the Chinese inventor Li Zongcheng with a notorious presence through their inventions. The inventors include the same Chinese inventor Li Zongcheng who presents the greatest number of inventions, followed by Christopher P. Ricci, with inventions for two large companies, Flextronics AP LLC and AutoConnect Holdings LLC.

Table 5: Contingency between applicants and inventors for subclass H04L.

Applicant/Inventor	Li Zongcheng	Christopher P. Ricci	Hanbyul Seo	Suuckchel Yang	Jean-Philippe Vasseur	Esmael Hejazi Dinan	Jason K. Resch	Akihiko Nishio	Aris Papasakellariou	Seunghee Han	Total
LG Electronics Inc.	-	-	643	538	-	-	-	-	-	206	1.387
Li Zongcheng	688	-	-	-	-	-	-	-	-	-	688
Cisco Technology, Inc.	-	-	-	-	511	-	-	-	-	-	511
Flextronics AP, LLC	-	396	-	-	-	-	-	-	-	-	396
Cleversafe, Inc.	-	-	-	-	-	-	395	-	-	-	395
Panasonic Intellectual Property Corporation of America	-	-	-	-	-	-	-	331	-	-	331

Samsung Electronics Co., Ltd.	-	-	-	-	-	-	-	-	305	-	305
AutoConnect Holdings LLC	-	276	-	-	-	-	-	-	-	-	276
Esmael Hejazi Dinan	-	-	-	-	-	253	-	-	-	-	253
Ofinno Technologies, LLC	-	-	-	-	-	223	-	-	-	-	223
Total	688	672	643	538	511	476	395	331	305	206	4.765

Source: Own elaboration using Patentscope. Consultation date: April 25, 2017.

Note: The sign (-) it indicates that the information is not available for this relationship.

The relationship between countries and inventors for subclass H04L is summarized in Table 6. From this table it is inferred that among the main countries the presence of China with six trends within the main activities is highlighted, followed by the European Office of Patents with four trends and the United States with more trends but fewer inventions. On the side of the inventors, the name of Li Zongcheng that presents the greatest number of inventions in China stands out, followed in order by "The inventor has waived the right to be mentioned" (The inventor has renounced the right to be mentioned), with high representation for China.

Table 6: Contingency between countries and inventors for subclass H04L.

Country/Inventor	Li Zongcheng	The inventor has waived the right to be mentioned	Wang Wei	不公发明人 (No Se Anuncia El Inventor)	Hanbyul Seo	胡加明 (Hu Jiaming)	李东声 (Sonido Dong)	Chen Wanshi	Ko Woo Suk	Zhang Wei	Total
China	344	217	137	159	-	124	87	-	-	113	1.181
European Patent Office	-	-	13	-	-	-	-	105	84	11	213
United States	-	-	8	-	156	-	-	30	6	7	207
World Intellectual Property Organization (WIPO)	-	-	-	-	-	27	56	-	-	-	83
Portugal	-	-	-	-	-	-	-	-	45	-	45
United Kingdom	-	-	1	-	-	-	-	-	-	-	1
Germany	-	-	1	-	-	-	-	-	-	-	1
Total	344	217	160	159	156	151	143	135	135	131	1.731

Source: Own elaboration using Patentscope. Consultation date: April 25, 2017.

Note: The sign (-) it indicates that the information is not available for this relationship.

The relationship between the countries and the applicants of this subclass is also studied, as shown in Table 7.

Table 7: Contingency between countries and applicants for the subclass H04L

Country/Applicant	Huawei Technologies Co., Ltd.	Qualcomm Incorporated	LG Electronics Inc.	International Business Machines Corporation	Samsung Electronics Co., Ltd.	Telefonaktiebolaget L M Ericsson (publ)	ZTE Corporation	Intel Corporation	Huawei Technologies Co., Ltd.	ZTE Corporation	Total
United States	6.026	9.167	10.073	12.413	7.581	7.337	3.402	7.205	-	-	63.204
World Intellectual Property Organization (WIPO)	4.605	4.082	1.358	423	1.163	3.183	4.240	875	3.886	4.107	27.922
China	5.329	-	-	-	266	4	1.406	-	3.969	3.611	14.585
Spain	1.443	798	497	-	73	353	181	53	-	-	3.398
South Korea	2	-	1190	-	1.998	-	2	2	-	-	3.194
Canada	132	249	32	19	104	145	16	23	-	-	720
Germany	10	3	4	125	15	7	-	134	-	-	298
Japan	-	245	-	-	-	-	-	-	-	-	245
Singapore	14	59	7	1	-	53	4	9	-	-	147
Brazil	11	69	-	7	8	-	4	6	-	-	105
Total	17.572	14.672	13.161	12.988	11.208	11.082	9.255	8.307	7.855	7.718	113.818

Source: Own elaboration using Patentscope. Consultation date: April 25, 2017.

Note: The sign (-) it indicates that the information is not available for this relationship.

In the Table 7, shows that from the main countries / offices of this subclass (Digital Information Transmission) it can be highlighted the leadership of the United States with trends in almost all the main applicants and a high number of patent applications, followed by the World Organization of Intellectual Property (WIPO) and China, both with presence in all the main applicants. For the applicants, the Chinese multinational Huawei Technologies Co., Ltd., with the highest number of applications in the USA and in China, stands out, and in the same way below appears the US Company, Qualcomm Incorporated, with the greatest presence in its country of origin.

Profile of the Inventive Activity

Electricity, conceived as one of the sections (H) in the International Patent Classification, presents a total of 2'356,015 patents published for the period 2012-2015, with an increasing trend year after year. This volume of information is represented mainly in two of the six classes in which the section is divided, which are H04, Technique of Electrical Communications, and H01, Basic Electrical Elements, and which in turn are strongly represented by the subclasses H01L Semiconductor Devices and / or Solid State Electrical Devices Not Provided

Elsewhere, and H04L Digital Information Transmission (Telegraphic Communication).

For this reason, the profile of the inventive activity of the H - Electricity section focuses on these subclasses, considering first the subclass with the most activity of the section, that is to say the Semiconductor Devices and / or Solid State Electric Devices Not Foreseen in Other Place (H01L). This subclass, which has the highest volume of activity in the Electricity section, has a greater number of patents published in its subgroup H01L51 / 50-Solid-state devices that use organic materials as an active part, or that use as an active part a combination of organic materials with other materials, specially adapted for the emission of light; followed very closely by subgroup H01L21 / 336-Procedures or apparatus specially adapted for the manufacture or treatment of semiconductor devices or solid-state devices, or of their constituent parts, with insulated door. Third, with a slightly lower level of activity, subgroup H01L29 / 78-Semiconductor devices adapted to rectification, amplification, oscillation generation or switching that have at least one potential or surface barrier, the effect being produced field by a door isolated.

In the first subclass H01L, the countries with the largest number of publications are the United States, China and Japan, in that order, with very similar amounts of patents published among them. In the same line, the main applicants or applicants are large multinationals leaders in technological sectors of the electricity, ranking first in the South Korean multinational Samsung Electronics Co. Ltd., one step below is the International Business Machines Corporation (IBM). and in third place appears the Taiwanese company Taiwan Semiconductor Manufacturing Company, Ltd.

On the other hand, as far as inventors are concerned, the fact that the main ones are of Asian origin stands out, and in order of activity, starting with the largest number of publications in the study period, Zhou Mingjie appears, followed by Yamazaki Shunpei, and thirdly Wang Ping.

In relation to technological variability, stands the fact that applicants with the largest number of patents published in the study period appear again lead in this field, that is, in the first place, Samsung Electronics Co. Ltd., which has about 1500 inventions during the study period, and for which it uses about 110 fields or areas of technology. In the same way, the presence of International Business Machines Corporation (IBM) stands out, with a greater number of inventions, close to 1700, but a slight decrease in areas of technology covered, with 80.

The next subclass, in order of importance, is the Digital Information Transmission (H04L). This subclass, is the second with the largest number of patents published in the Electricity section, and has greater representation in its subgroup H04L29 / 06-Provisions, appliances, circuits or systems not covered in other groups of the same level and characterized by a protocol; followed very closely by subgroup H04L29 / 08-Provisions, appliances, circuits or systems not covered in other groups of the same level, transmission control procedure.

The countries that lead the patent publications in this subclass are China and the United States, in that order, with very similar amounts of patents published among them, and a considerable gap with the other countries / offices that appear in this list. On the other hand, with regard to the main applicants are large multinationals leaders in technological sectors such as electricity, highlighting first the Chinese company Huawei Technologies Co. Ltd., followed by the American Qualcomm Incorporated, and in turn followed by the South Korean multinational LG Electronics Inc.

In the same context, as regards inventors, most of the main inventors are of Asian origin, and, in addition, there is a large number of publications in which the inventor renounced the right to be mentioned. In this way, the order for the inventors with the largest number of publications is headed by Li Zongcheng, followed by a special category where the inventor has renounced the right to be mentioned, in third place appears Wang Wei, and in fourth position the category appears again that is not announced to the inventor, but this time it is in Chinese language, unlike the previous one (English).

Regarding technological variability, it is worth highlighting the fact that applicants with the largest number of patents published in the study period are once again leading in this field, finding the US multinationals Qualcomm Incorporated and International Business Machines Corporation (IBM), both with a number of inventions slightly higher than 4000, during the study period, and for which they use 60 fields or areas of technology. In the same way, the presence of the Chinese company Huawei Technologies Co. Ltd. stands out, with a greater number of inventions, close to 8400, but a slight decrease in areas of technology covered, with 50.

Conclusions and limitations

Electricity as section (H) of the International Patent Classification presents an increasing trend in relation to the number of patents published for the period 2012-2015, adding a total of 2'356,015 patents in the entire study period. Much of this inventive activity is concentrated in 2 of the 55 subclasses in which the section is divided, and between them, they make up approximately 26% of the patents published throughout the section during the study period. These subclasses are, in order of volume of contained patents, Semiconductor Devices and / or Solid State Electrical Devices Not Provided Elsewhere, (H01L) and Digital Information Transmission (H04L).

The leading countries in the publication of patents related to Electricity are world leaders, highly industrialized countries, characterized for being economic powers, concentrated mainly in Asia, and in the United States. The Asian giants in this section are China, Japan and South Korea. The principal offices that stand out are: The World Intellectual Property Organization (WIPO), a specialized agency of the United Nations (UN) dedicated to promoting the use and protection of works of the human intellect, as well as the European Patent Office, the entity in charge of granting patent concessions in the member countries.

Similarly, the main applicants in the Electricity are big companies in the technology sector with an international presence in each of the leading countries in the publication of patents in this section, many of them of Asian origin, such as the Chinese multinational Huawei Technologies Co., Ltd. or the South Korean Samsung Electronics, each located in the first place as applicant in the two main subclasses of the Electricity section. Along the same lines, big companies appear that have their origin and presence in the leading countries in the publication of Electricity patents, such as the American Multinationals International Business Machines (IBM) and Qualcomm Incorporated, the South Korean LG Electronics (in addition to Samsung Electronics) and Taiwanese Taiwan Semiconductor Manufacturing Company, Limited (TSMC).

On the other hand, the knowledge of technological trends is presented as a key indicator for decision making of large investments or development and execution of projects, since this behavior that shows the trend indicates that it can be risky to invest in this technology if it is in decline and carry significant losses, or, conversely, if the trend is growing means that you can enter that market because they are running many technologies in this area, which also indicates the existence of a target market willing to acquire the services offered.

The processing of information was complicated, given the large amount of information that was available to analyze, as well as the technological capabilities available for processing, as there were times when waiting for processes of computers enabled for this purpose was very long, coming to present errors and lose progress sometimes. For this limitation, it is recommended to perform the analyzes and tabulations with patience and

planned time, as well as to save the modified document every so often, in order to avoid these losses.

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