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JISIB

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Stevan Dedijer
1911-2004

EDITOR'S NOTE **VOL 8, NO 3 (2018)**

Why you should be interested in intelligence studies

In this issue most articles are reflections (bibliometrics, scientometrics) on what has been done in intelligence studies in business (IS) and more particularly in competitive intelligence (CI) and business intelligence (BI), so some reflections and analysis on the subject proper seems to be appropriate for these notes.

Almost all articles in IS (CI, competitor intelligence, market intelligence (MI), BI, and competitive technical intelligence (CTI)) are empirical contributions that show how to work more effectively with need to know information in business. Authors submit empirical articles that solve new and specific problems. It can be a new method, the introduction of a new model or the application of some new technology.

During the past eight years, since the journal started, I have written articles on what customers expect from BI (Sabanovic & Søilen, 2012), about what vendors do to differentiate themselves in BI (Søilen & Hasslinger, 2012b), and I have done an analysis of previous and similar articles in *Journal of Competitive Intelligence & Management* (JCIM) and *Competitive Intelligence Review* (CIR), two journals that in many ways are the predecessors of *The Journal of Intelligence Studies in Business* (JISIB) (Søilen, 2013). In Agostino et al. (2013) we studied how both customers and vendors think about Cloud solutions to BI. In Søilen (2014) I did a spot check to see if the journal was writing about the topics that practitioners were concerned about, or interested in. The survey showed that JISIB was more or less on the right track here, but that practitioners prefer case studies to empirical research articles, which the journal is now soliciting more actively and also publishing. Good extensive cases are hard to obtain, but the journal has been publishing a number of empirical articles in the form of industry analysis connected to different countries around the world. In Vriens & Søilen (2014b) we show how the process of gathering intelligence for disruptive innovation is distinct from other forms of intelligence gathering. In Søilen (2015) I try to show some problems that CI has had in the past; with agreeing upon clear definitions, but more fundamentally by clearly showing how the field is different from other disciplines studying information, like the more established journals in management and information systems. The study shows that respondents could not list any analysis that is not used by other areas of study and that a majority of the analyses the respondents think are unique to their own study actually come from the area of strategy and military intelligence. Instead it is suggested in the article that what is different is that that intelligence studies bring a number of unique dimensions and perspectives to the social sciences, a new way of seeing and studying business which is an adaptation from military intelligence.

In the next article (Søilen, 2016) I suggest a research agenda for intelligence studies. I go deeper into the conclusion suggested in Søilen (2015): It is suggested that the difference between information science in business, business- and market research and intelligence studies is mainly one of perspective and scope and less one about the content of problems or scientific methods used. Intelligence studies in business see the organization much like an intelligence organization, the offspring of the study of state and military intelligence, where the aim is to find information that affect the business as a whole (as in "surrounding world analysis" or in Swedish "omvärldsanalys"). A study of intelligence studies –management information or information sciences - that does not explain what outside events affect the business becomes sterile and uninteresting. The essence of intelligence is to scan the world for relevant developments, to find out what is going on that effect our organization (need-to-know, strong signals, trends). How to do this should be the focus of the subjects' research agenda and what sets it apart from other disciplines studying information in a business context.

Sometimes this goal seems far away as when reading about how a new technique is applied to an industry in a specific market. Sometimes I miss hearing about how basic methods like traveling to foreign countries (the spirit of Marco Polo) and reading books may be the best methods for understanding what affects an organization. We must always remember that the technology is only there to facilitate the process, it never explains why things happen and it seldom helps us in the actual understanding of the data. Statistical analysis does not explain why or how things occur: at best it summarizes what has happened. Authors of articles I read in other journals too often miss the difference between correlation and causation.

What is then so special and different with intelligence studies? Intelligence studies - at the present at least - are less a series of theories than a new perspective on (micro and macro) economics. Intelligence studies is not exclusively about management, but also about economics as it's just as relevant for how nation states become competitive. It is the suggestion that competitive organizations of all sizes are best organized as intelligence organizations, focusing on the process of gathering, analyzing and delivering need to know information to decision makers. This is a different way of looking at organizations and what they do. Competitive organizations today all basically work with information. It is how they work with this information that decides whether or not they will succeed.

The importance of building a formal intelligence organization was realized more than two hundred years ago in the military domain with the Prussian and Russian armies. In the study of business this was first realized with the shift in thinking that came with the Information Age and the development of computers, the realization that competitive advantage is more about what you know than what machinery you own or how much money you have in your accounts.

If the introduction of IT represented the 1.0 version of this development, then the introduction of the Internet represents the 2.0. Many saw this development coming. Some experts thought that it would not only lead to intelligence studies being introduced as a special function in the organization but that we would see the implementation of separate departments of intelligence, or that the whole current division and structure of business activities, into marketing HRM, finance, would be abandoned for functions of intelligence gathering. When this did not materialize many started to question the value of the approach all together. Many still think that the approach failed, that the perspective has passed and been surpassed by other subjects and disciplines. I disagree. Even though things have not happened as quickly as many expected or hoped, we are still moving in that direction now more than ever. B2B digital marketing is a good example. Today it is less about push marketing and sales and more about gathering and distributing valuable information to potential customers. When customers see that we are knowledgeable not only about our products but also about the industry we are in, they start to trust us and we are able to build a customer relationship. This is not only changing how B2B marketing is done, but also the competences needed to succeed in B2B marketing.

On the state or macro level we are living in a period of (neo-) mercantilism and geoeconomics where intelligence is key. The states that are succeeding economically today are countries like China, Singapore, and South Korea, but also Norway. These are representatives of state capitalism, not free market liberalism. The individualist, liberalist model supported by neoclassical economics and its foundation in the writing of Adam Smith (not always fairly interpreted, so I prefer to call them the marginalist school), Walras, Marshall and Samuelsson, have greater difficulty convincing readers today. As Piketty showed in his vast empirical project about capital, their (our) societies led to an extreme wealth being assembled at the very top with very little trickle-down effects. When the crises came it was the rest of society had to take the hit, while the elites bailed themselves out to save a dysfunctional system. After a period of prosperity, which lasted for some four generations (and was only extended during the past two generations through massive debt), the populations in the Western world are experiencing a decline in their standard of living. These causes were all missed by the marginalist school whose members have been advising governments for more than half a century. The consequences of these policies have been massive protests and disbelief - almost hatred - of their own elites as in the US, but also in France, the UK and Italy. The point is that our leading social science paradigms and especially our economic and management theories that brought us here by not being relevant and, worse, by supporting the wrong policies; regardless of the good intentions, which many of my colleagues even doubt. Mainstream economics combined with too narrowly and fragmented studies of management obsessed with a method of small empirical investigations have become the supporters, not only of an elite – the status quo- but more worryingly of an uncompetitive society. Now, for business studies that is almost what we should call a contradiction. Our reigning business theories and research are making us less competitive.

The new economic powers in the East have copied what has been done well in the West, but it is unlikely that they will copy our leading social science paradigm. It is the message China sends out when it says "…with Chinese characteristics". Chinese leaders are following the thinking of Drucker, Schumpeter, and Michael Porter; more so than the winners of the Nobel prize in Economics and their schools of thinking. They are not reading our thousands of small business journals, even though their own scholars are taking a larger part in the work of running them and contributing to them. Instead they are first and foremost inspired by their own values, their own history and their own thinkers of strategy and philosophy.

China is already a superpower of intelligence gathering, which they see as essential for strategy. Not only have our theories of political science been contested, but there is now clear critic of Western Moralism. There are hardly any independent thinkers outside the Western world who believe in the good intentions of Western political and economic interferences anymore. As we in the West have failed to keep up the living standard of our middle classes (our promise to the voters) "Eastern arguments" are starting to convince a large part of our own populations in the West. The failure of the Western world to compete becomes a confirmation of the weaknesses of our strategic thinking (the weakness in our political system to make plans), and in our ideas which at the end is a critic of our reigning social science projects. Eastern ideas will be closer to practice.

The West is left with a number of paradoxes. For all our interest in strategy during the past two decades we have no strategy, no long term thinking and no major infrastructural projects. Instead we are consumed with our immediate problems and crisis handling. We are so obsessed with the critic of China as a dictatorship that we refuse to see that they are undertaking the largest infrastructural project in world history (the Belt and Road Initiative, or BRI), that their mercantilist ideas are engulfing our markets but also helping to improve the living standard of people living in the developing world. Our media is full of stories about Chinese exploitation in the developing world, which also exist, but forgetting that exploitation - even slavery - used to be our specialty for centuries and the hallmark of the British Empire.

Now, what does this all mean for business studies? It means we have to search for other paradigms other than the existing one if we want to become competitive again. We have to become more interested in what is actually going on in the world, more curious. This reality must be led by business disciplines.

Some of the more successful university groups in intelligence studies today, like the GREThA (le Groupe de recherche en économie théorique et appliquée de l'université de Bordeaux) at the University of Bordeaux, have left the idea of theory building and focus instead on applications and being relevant for industry. As such they have also left much of the article-writing world of academia except as when recording what they have accomplished.

The same thinking is well known in the development of new technology. Focus is on application. If you have developed something truly new you will try to patent it or apply it. If you publish something valuable in a journal not only will very few read it, but it will also be copied, or stolen.

This way of learning by doing is very much the Chinese way of doing business, but also of studying business. If society is structured in this way then the experts will be in the practical field, less moved forward by research at the universities. This is already happening in some fields today, as in Artificial Intelligence (AI). The most respected experts in the field are found in large corporations, like Google and Facebook. Another example is digital marketing. Most academics are just running behind, trying to figure out what is happening. A number of social science scholars are reasoning in the same way: to have real impact (not academic impact, measured as a popularity contest among peers of articles and citations in Google Scholar) they try to go out and change the world. There are many research institutes that think more like this now, particularly in the area of environmental studies, disillusioned by existing social science departments at the more established schools. One example is the IIIEE in Lund.

At the end both developments are important (theory and practice), as we also need to teach new generations of students how to work with intelligence, but it must be based firmly in practice, it must be relevant and it cannot be too narrowly defined. This does not mean we cannot develop theories or focus on causations.

I was reading one of the last books by Herbert Simon the other week, based on some lectures he had given. They reminded me of the last book by Schumpeter "History of Economic analysis", published posthumously. Both authors tried to explain how their ideas fitted with the evolutionary thinking of Charles Darwin, an attempt suggested earlier by the German Historical School led by Wilhelm Roscher. A generation after Roscher it also found support in the US for a short while, with Torstein Veblen (before it was picked up again many generations later by Kenneth E Boulding and others). They realized that a promising path for the social science was to connect to the theories of Darwin, but a new superpower demanded a new scientific paradigm. So the attempts halted, except for a few satellites in Germany (The International Joseph A. Schumpeter Society) and England (G. M. Hodgson). The historical school which was dominating in the 19th century, disappeared, basically I think because fellow economists stopped reading seminal books or even older articles, which are often in German and French.

Intelligence studies can continue to be relevant by helping organizations become more competitive. It can do this without developing theories. Still I think that it can achieve much more by being more rigorous: defining variables, setting up axioms, hypotheses and discussing causations.

For my own part, this led to my interest in combining intelligence studies not only with evolutionary theory, but with the disciplines of geopolitics and now geoeconomics. In the early 1990s I started to develop my own ideas of geoeconomics, based on observations of the Chinese eclipse and Western decline. It was followed by numerous travels and two stays in China, where I started to write the book "Geoeconomics", completed at Stanford in 2012. This was done independently of Luttwak who I read first much later, and before Lorot. Geoeconomics helps me understand intelligence studies on a macro level. In 2017 I published an article in JISIB called "Why the social sciences should be based in evolutionary theory: the example of geoeconomics and intelligence studies". The historical reasoning in the article basically comes from the same book.

At the end of his wonderful book "History of Management Thought" Witzel lines up present and future directions of management thinking. He talks first about what can be expected as Asia surpasses the Western world economically and he draws lines as to present directions of thinking: sustainability research, but also the information turn, starting with thinkers like Toffler, who is also well known in the literature of intelligence studies.

It is in this direction of the information turn that intelligence studies in business must be understood and placed, not as the primary venue, at least not at the present. That place has been occupied by the management of information systems (MIS) literature with a handful of journals, but as an alternative approach, a niche built around another tradition of management: the organization as an information gathering organism. Another established direction in management has focused on decision making. Intelligence studies looks as the process that leads up to decisions as decisions can only be as good as the information at hand (ignored by the marginalists, as they typically assume full information) and the (bounded rational) mind that is used to process it.

Intelligence studies as a discipline today has two main directions, how to work with the process of information gathering (1) and how to set up an organization to fulfill that aim (2). The initial answers to both are the same, much like successful state and military intelligence organizations. The problem is that military organizations and businesses are different, so a direct application is not possible, just like a direct adaptation of geopolitics is not possible. The size and goals of the organizations are different, technology is different, but also in terms of the legal and ethical framework the two forms of intelligence operate within. This is what warrants two distinct and different disciplines.

Today state intelligence services work less with economic questions but as the success of state capitalism spreads this is bound to change. Already today state and military intelligence is learning from the private sector, less vice versa.

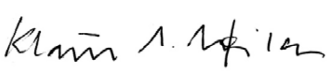
Looking back at more than three decades of studies in intelligence studies (with CIR, JCIM and JISIB) we now have a "discipline" – formally - in the sense that there is a catalog and archive for a new body of information produced by a scientific community. We also have a number of regular conferences dedicated to different forms of intelligence studies in business. Some of the larger of these conferences are dominated by practitioners, which I rather see as a healthy sign (but I realize that my thinking here is contrary to that of most colleagues). It is a challenge for this small group of scholars to convince the world that the problems studied under the umbrella of intelligence studies in business (a term coined by Sheila Wright and Arik Johnson at the ICI conference in Bad Nauheim in 2010) are worth undertaking. When work piles up like now before Christmas, I like to think that Stevan Dedijer, one of the founders of intelligence studies (social intelligence, he called it), would have been pleased if he had lived today and saw how his ideas have evolved and multiplied.

What is more fitting then, than to start with the largest bibliometric analysis that has been done on the field of intelligence studies authored by López-Roble et al. It shows what areas of IS are most popular, who the contributors have been and what their contributions have been. The paper by Ojinagar is also an analysis of scientific contributions to the field of intelligence studies in business, but is narrower. It analyses 72 papers published in Mexico between 2000 and 2015 on competitive intelligence. The paper by Garcia-Garcia and Rodríguez presents another form of bibliometrics, called scientometrics. It's an example of how scientometrics can be used to show the most influential authors and inter-institutional collaborations in a specific industry, namely additive manufacturing for hand orthoses. The paper by Svarre and Gaardboe is an analysis of business intelligence tasks, use and users in a workplace setting. The contribution by Ottonicar et al. investigates how information literacy and competitive intelligence are connected in business management and information science fields.

As always, we would above all like to thank the authors for their contributions to this issue of JISIB. Thanks to Dr. Allison Perrigo for reviewing English grammar and helping with layout design for all articles and to the Swedish Research Council for continuous financial support. We hope to see as many as possible at the ICI Conference in Luxembourg on May 5-7, 2019.

On behalf of the Editorial Board,

Sincerely Yours,



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Stevan Dedijer
1911-2004

Mapping the structure and evolution of JISIB: A bibliometric analysis of articles published in the Journal of Intelligence Studies in Business between 2011 and 2017

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ABSTRACT Today, organizations are facing technological, economic and social challenges that require the intelligent use of data, information and knowledge. To this end, organizations are developing capabilities around intelligence. From the organizational point of view, intelligence in business is a relatively new field study, so it is convenient to know and understand what the main themes are and their evolution in order to facilitate their integration. Taking this into account, the current research conducts a conceptual and structural analysis of the *Journal of Intelligence Studies in Business (JISIB)*. JISIB is one of the few academic journals devoted purely to publishing articles about business intelligence, collective intelligence, competitive intelligence, economic intelligence, market intelligence, marketing intelligence, scientific and technical intelligence, strategic intelligence, and their equivalent terms in other languages. This analysis is carried out by quantifying the main bibliometric performance indicators, identifying the main authors and evaluating the development of the main themes within it using *SciMAT* as a bibliometric analysis software. To this purpose, the documents published in JISIB from 2011 to 2017 were retrieved from two different sources: the JISIB official web page and the Web of Science. In this way, the bibliometric performance analysis evaluates the impact of the scientific output based on publications and their citations, while science mapping illustrates the intellectual structure of the journal and the evolution of the main research themes. Bearing in mind that JISIB provides an open platform for the publication of original research articles, opinion articles, book reviews and conference proceedings about the intelligence field, this research allows to understand its structure and evolution and all the themes associated with it. It provides a framework to support intelligence researchers and professionals in the development and direction of future research by identifying emerging, transversal, core and declining themes. Finally, this study includes a performance analysis of *JISIB*.

KEYWORDS Business intelligence, competitive intelligence, conceptual evolution map, co-word analysis, science mapping analysis

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1. INTRODUCTION

In an age of information, organizations face the challenge of improving their competitiveness and agility through the intelligent use of data and information in the research, development and innovation process. This makes it possible to predict situations, improve decision-making processes, increase profitability and thereby the success of organizations, mainly. Both companies and educational organizations seek to respond to this challenge through the effective development of areas of knowledge such as: *competitive intelligence, business intelligence, market intelligence, scientific and technical intelligence, collective intelligence* and *geoeconomics*. Nevertheless, in comparison with other fields of knowledge, intelligence in business is relatively novel, so there are not many ways in which academics and professionals can improve and share their advances and proposals.

The concept of intelligence has its origins in the military and national security fields, through the processes of adaptation that organizations develop to respond to the information use challenges that they face today. It was not until 1958 when Luhn defined *business intelligence* as the ability to apprehend the interrelationships of presented facts in such a way to guide action towards a desired goal (Luhn, 1958). This definition can be considered to be one of the first in the intelligence field, because it mentions the systematic process by which the organization collects data and organizes them in the form of useful information to later analyze them and convert them into intelligence, providing the necessary criteria for the decision making process. However, the term *business intelligence* is more often used for internal or transactional aspects of an organization, giving space for the use of *competitive intelligence* in a broader, external framework.

In this way, Prescott and Gibbons said that competitive intelligence is a formalized, yet continuously evolving, process by which the management team assesses the evolution of its industry and the capabilities and behavior of its current and potential competitors to assist in maintaining or developing a competitive advantage (Prescott and Gibbons, 1993; Prescott and Bharadwaj, 1995).

Bearing this in mind, it is possible to observe that the intelligence is implemented in different areas of the organization, which means that the approach given to it varies according to the people who develop it or the area where it is developed. This has given rise to different intelligence terminology, within which can be highlighted the following: *business intelligence* (Gilad and Gilad, 1985; Søilen, 2017), *collective intelligence* (Devouard, 2011; Sheremetov and Rocha-Mier, 2004; Shimbel, 1975), *competitive intelligence* (Calof and Dishman, 2007; Davenport and Cronin, 1994; Du Toit, 2003; Du Toit and Sewdass, 2014; James, 2014; Tuta et al., 2014), *economic intelligence* (Larivet, 2009; Menychtas et al., 2014; Perrine, 2004; Seiglie et al., 2008; Smith, 1953), *market intelligence* (Maltz and Kohli, 1996; Navarro-Garcia et al., 2016), *marketing intelligence* (de' Rossi, 2005; Kelley, 1965; Zhou and Lai, 2009), *science and technology intelligence* (Castellanos and Torres, 2010; Chang et al., 2007; De Coster et al., 2013; McCormick et al., 2015; Mortara et al., 2009), among others, such as *financial intelligence, public intelligence,* and *competitor intelligence*.

Nowadays, there are few scientific journals focused exclusively on the publication of intelligence articles which the practitioners of intelligence can use to share and further develop their knowledge. One of the most recognized and specialized sources in this field is the *Journal of Intelligence Studies in Business (JISIB)*, which is an open publication journal, indexed in the main scientific databases and that gathers contributions from many authors of international prestige.

Considering the heterogeneity, novelty and evolution of this field, intelligence professionals are interested in evaluating the evolution of the main themes and the relationship between them, in order to identify opportunities and challenges in the future. In this regard, authors such as Du Toit (Du Toit, 2015) and Søilen (Søilen, 2013; Søilen, 2015; Søilen, 2016) have carried out research to identify trends in the intelligence literature by analyzing publications, journals and authors.

The objective of this article is to identify and analyze the main themes in the field of intelligence used in peer-reviewed articles published in *JISIB* from 2011 to 2017 and its performance through the use of bibliometric techniques and tools (Cobo et al., 2011b).

Finally, this paper is organized as follows: Section 2 introduces the methodology (including the bibliometric analysis tool) and the data set. Section 3 and Section 4 present the bibliometric and science mapping analyses, respectively. Section 5 shows the conclusions and future research lines.

2. METHODOLOGY AND DATASET

Scientific journals represent one of the main knowledge sources today, so their analysis is of interest to academic, scientific and business communities (Bjork et al., 2009; Dewatripont et al., 2006). Within the research aimed at

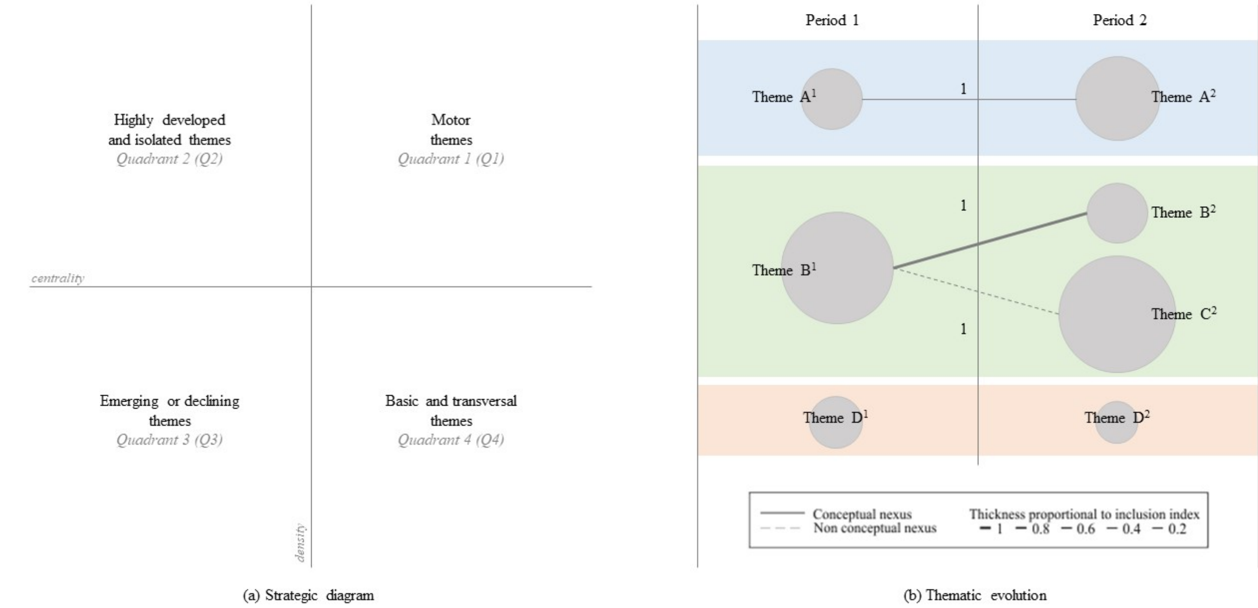

Figure 1 Strategic diagram (a) and thematic evolution (b) structure. The structure of the strategic diagram (a) and thematic evolution (b) used to describe the evolution of the themes related to intelligence and the field). The strategic diagram is dived into four sections: motor themes, highly developed and isolated themes, emerging and declining themes and basic and transversal themes, according to the centrality and density of the themes. The thematic evolution shows the evolution of these themes in the period defined. This figure groups these themes into thematic areas (color areas).

evaluating the performance of scientific journals, three main approaches can be identified: (i) bibliometric analysis based on performance indicators, (ii) thematic analysis, and (iii) research methods and techniques.

In this contribution, a complete bibliometric analysis based on performance indicators and a thematic analysis of the *Journal of Intelligence Studies in Business (JISIB)* has been carried out (Batagelj and Cerinšek, 2013; Börner et al., 2003; Gutiérrez-Salcedo et al., 2017).

The performance analysis is based on bibliometric indicators that measure the production of different actors, and the international impact achieved. The most cited articles (Moral-Munoz et al., 2016) in the field are identified using the H-Classic approach (De la Flor-Martinez et al., 2016; Martínez et al., 2014), which is based on the well-known h-index (Hirsch, 2005). In general terms, the H-Classic uses the h-index in order to establish the threshold cut, that is, the number of highly cited documents that correspond with the most cited paper.

A longitudinal conceptual science mapping analysis and a strategic diagram based on a co-words network are developed by means of the software tool *SciMAT* (Cobo et al., 2012). This thematic analysis is based on a four-stage approach: (i) *research themes detection, (ii) visualizing research themes and thematic network, (iii) discovery of thematic areas and (iv) performance analysis*.

To do this the research themes are set out in a strategic diagram and thematic evolution map (Figure 1). The first is a two-dimensions map divided in four areas according to their relevance (centrality and density rank values) where the themes are represented as a sphere and its volume is proportional to the number of documents associated with the theme (Cobo et al., 2011a):

a. *Motor themes (upper right quadrant – Q1):* The themes within this quadrant are relevant to the structure and develop the research field.

b. *Highly developed and isolated themes (upper left quadrant – Q2):* The themes within this quadrant are relevant but are not important enough to be considered more than a very specialized or peripheral activity for the research field.

c. *Emerging or declining themes (lower left quadrant – Q3):* The themes within this quadrant are weak, but this weakness can be understood as emerging or disappearing themes.

d. *Basic and transversal themes (lower right quadrant – Q4):* The themes

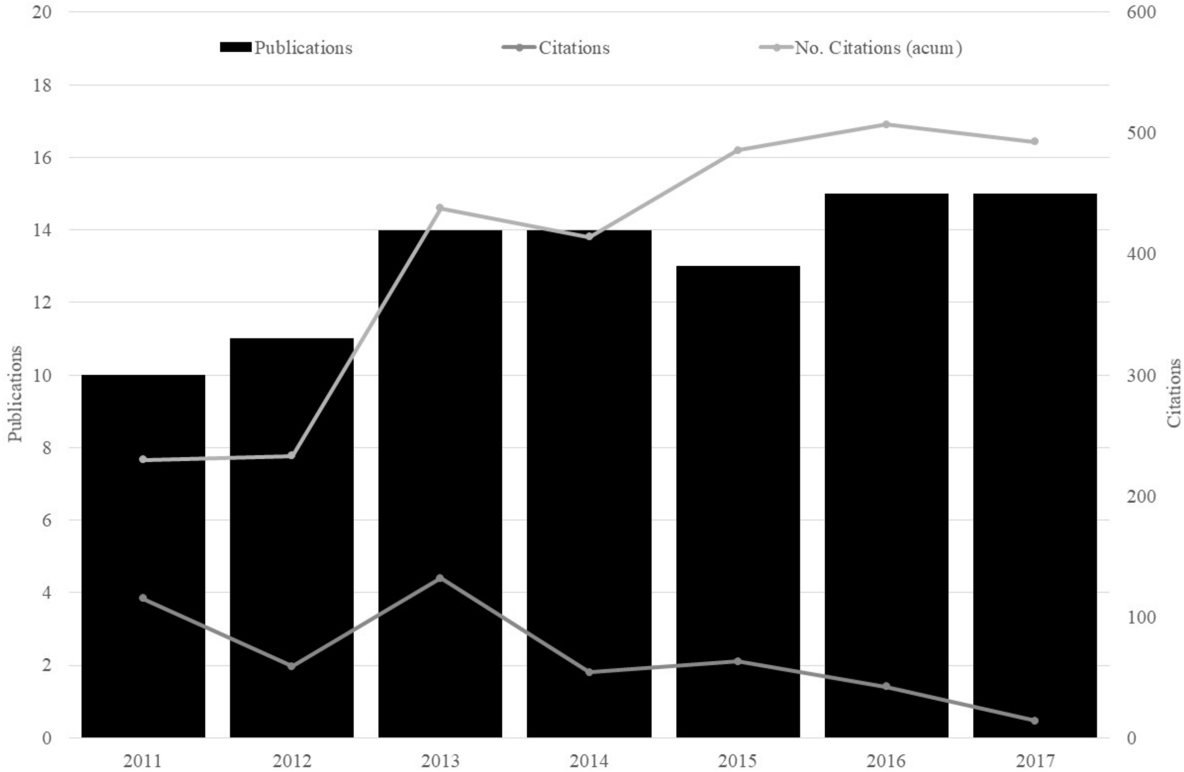

Figure 2 Distribution of publications and citations by year and period (2011-2017). This figure shows the distribution of publications and citations included in JISIB per year. The bars represent the publications by year and are related to the left axis. The continuous lines represent the citations corresponding to each year (nominal and accumulated) and are related to the right axis.

within this quadrant are not well-developed, but are relevant for the research field.

Finally, the second diagram is a longitudinal framework, which allows us to analyze and track the evolution of a research field throughout consecutive time periods. In addition, a performance analysis of a thematic area using the main bibliometric indicators was developed.

This analysis focused on the documents published in the *Journal of Intelligence Studies in Business (JISIB)*. The publications and their citations included in this analysis were collected on May 1st, 2018.

The publications belonging to the intelligence research field were retrieved from two different sources: *JISIB* (official web page) and *Web of Science*. The publications were manually downloaded and included in the knowledge base. The publications available on the *Web of Science* were retrieved using the following advance query: *IS=("2001-015X")*. These publications were compared with the publications obtained from the official website to guarantee that the publications are consistent in both sources. Finally, the knowledge base was further refined and limited to *Articles, Proceedings, Opinion* and *Reviews* published in English.

This process retrieved a total of 92 publications from 2011 to 2017. According to methodology used for this research (Cobo et al., 2011a), to evaluate the evolution and to avoid smoothing the data, the best option was to choose comparable periods in terms of duration and characteristics. In the case of the journal JISIB, the entire time period analyzed was divided in seven comparable periods: *Period 1: 2011, Period 2: 2012, Period 3: 2013, Period 4: 2014, Period 5: 2015, Period 6: 2016 and Period 7: 2017*. The analysis provides a good input to the strategic diagrams and thematic evolution map (co-word analysis) to detect the main themes.

3. PERFORMANCE OF THE BIBLIOMETRIC ANALYSIS OF JISIB

To understand how the *JISIB* has progressed in terms of publications, citations and relevance, its performance was evaluated through the analysis of the main bibliometric indicators: *publications, citations, most cited articles, most cited authors* and *h-index.*

For this purpose, the bibliometric performance analysis was structured in two parts. Firstly, all the publications and their citations were evaluated with the objective of testing and evaluating the scientific development. Secondly, the main authors and publications were analyzed to assess the impact of these in the field of research.

Table 1 Top 10 most productive authors (2011-2017). When a tie is recorded between authors all are listed in alphabetical order. Pub = publications. N=92.

Authors	**Pub**	**%**
Søilen, K. S.	16	17.39
Rodríguez Salvador, M.	6	6.52
Calof, J.	4	4.35
Du Toit, A. S. A., Erickson, G. S., Quoniam, L. and Rothberg, H. N.	3	13.04
Baaziz, A., Barnea, A., Bisson, C., Bleoju, G., Capatina, A., Dousset, B., El Haddadi, A., Hoppe, M., Oubrich, M., Paletta, F. C., Richards, G., Vriens, D. and Xinzhou, X.	2	28.26

Table 2 Top 10 most cited authors (2011-2017). This table is completed with the information of each author in terms of production. When a tie is recorded between authors all are listed in alphabetical order. C = Citations. % is given out of N=479. Docs = documents.

Author	**C**	**%**	**Docs**	**%**
Søilen, K. S.	83	17.33	16	17.39
Adamala, S.	56	11.69	1	1.09
Cidrin, L.	56	11.69	1	1.09
Du Toit, A. S. A.	45	9.39	3	3.26
Carayannis, E.	29	6.05	1	1.09
Kabir, N.	29	6.05	1	1.09
Hoppe, M.	23	4.80	2	6.52
Rodríguez Salvador, M.	23	4.80	6	2.17
Calof, J.	15	3.13	4	4.35
Oubrich, M.	15	3.13	2	2.17

3.1 Performance and impact indicators

The distribution of publications and citations included in *JISIB* per year is shown in Figure 2. From the first publication in December 2011, the number of publications remains constant, with the exception of 2015, when there was a slight decrease. It is important to highlight that during the last years there has been a constant increase in the number of publications, which can be understood as a growing interest in the intelligence and consolidation of the journal.

In addition, it is important to highlight that *JISIB* is one of the few active intelligence journals indexed in the most important academic and scientific sources (*Web of Science* and *Scopus*), an aspect that has allowed it to grow in terms of publications and adherents.

Considering these results and the previous analysis of the state of the art, it is possible to expect that the positive trend will continue. However, it is important to note that in recent years there was a false negative trend in the number of citations. According to Wang there is a window period between the publication of an article and the moment when it begins to be cited, ranging from 3 to 7 years (Wang, 2013). Furthermore, it must be borne in mind that the evolution of the citations also depends on where journals are indexed and in how many sources they are indexed.

3.2 Most Productive and Cited Authors

To complete the bibliometric performance analysis of the *Journal of Intelligence Studies in Business (JISIB)* and to assess the main actors in the development of this field of knowledge, the most productive and cited authors are shown in Table 1 and Table 2, respectively. In both tables a tie was recorded between different authors, so all are listed in alphabetical order.

It is important to highlight that all most productive authors are among the most cited authors during the evaluated period. Furthermore, the authors' correspondence in terms of country of origin are: *Sweden, France, Iran, South Africa, USA, Canada, Mexico, Brazil* and *Spain*.

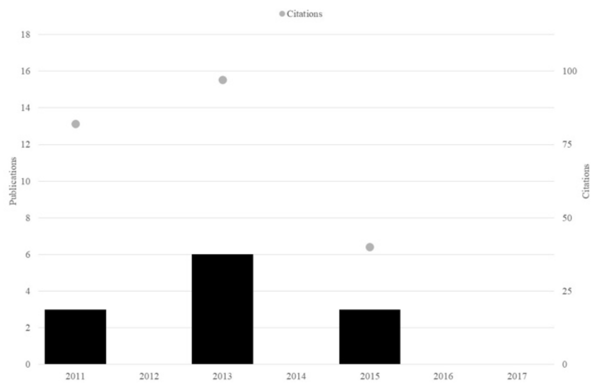

Figure 3 JISIB h-index publications (2011-2017). The distribution of the most cited publications and their citations according to the h-index and H-Classics. The bars represent the publications by year and are related to the left axis. The points represent the citations corresponding to each year (nominal) and are related to the right axis.

Table 3 H-Classics of JISIB (2011-2017). This table shows the citation classic papers identified by means of the H-classics concept. These publications are considered the main reference base within the journal. Percentage of citations is indicated out of N=479.

Rank	Title	#Citations (%)
1	Key Success Factors in Business Intelligence (Adamala and Cidrin, 2011)	56 (11.69)
2	Big Data, Tacit Knowledge and Organizational Competitiveness (Kabir and Carayannis, 2013)	29 (6.05)
3	Comparative Study of Competitive Intelligence Practices between Two Retail Banks in Brazil and South Africa (Du Toit, 2013)	18 (3.76)
4	Competitive intelligence research: an investigation of trends in the literature (Du Toit, 2015)	14 (2.92)
5	Intelligence as a discipline, not just a practice (Hoppe, 2015)	14 (2.92)
6	Competitive Intelligence and Knowledge Creation - Outward insights from an empirical survey (Oubrich, 2011)	14 (2.92)
7	Competitive intelligence in the South African pharmaceutical industry (Fatti, 2013)	13 (2.71)
8	Competitive Intelligence and Information Technology Adoption of SMEs in Turkey: Diagnosing Current Performance and Identifying Barriers (Wright et al., 2013)	13 (2.71)
9	A place for intelligence studies as a scientific discipline (Søilen, 2015)	12 (2.51)
10	The Relationship between Strategic Planning and Company Performance – A Chinese perspective (Jenster and Søilen, 2013)	12 (2.51)
11	A Risk and Benefits Behavioral Model to Assess Intentions to Adopt Big Data (Esteves and Curto, 2013)	12 (2.51)
12	Information Design for "Weak Signal" detection and processing in Economic Intelligence: A case study on Health resources (Sidhom and Lambert, 2011)	12 (2.51)

The main other journals related to intelligence in business are: *Marketing Intelligence & Planning, South African Journal of Information Management, European Journal of Marketing, Aslib Proceedings* and *Interdisciplinary Journal of Contemporary Research in Business*.

3.3 Citation Classics

To understand the productivity and impact of a group of publications a summary analysis of *h-index* and *H-Classics* is presented (De la Flor-Martinez et al., 2016).

The *JISIB* has an *h-index* value of 12. This means that relevant publications have more than twelve citations. The results of the publications retrieved for each period are shown in Figure 3.

According to Figure 3, the relevant publications are concentrated in 2013, 2011 and 2015. This coincides with the fact that 2013 and 2011 are also the most frequently cited years.

Table 4 Authors with the highest number of publications and their citations according to the H-Classics (2011-2017).

Name	Citations	% N=219	Documents	% N=12
Du Toit, A. S. A.	45	20.55	3	25.00
Søilen, K. S.	24	10.96	2	16.67
Adamala, S.	56	25.57	1	8.33
Alistair Duffy, C. B.	13	5.94	1	8.33
Carayannis, E.	29	13.24	1	8.33
Cidrin, L.	56	25.57	1	8.33
Curto, J.	12	5.48	1	8.33
Esteves, J.	12	5.48	1	8.33
Fatti, A.	13	5.94	1	8.33
Hoppe, M.	14	6.39	1	8.33
Jenster, P.	12	5.48	1	8.33
Kabir, N.	29	13.24	1	8.33
Lambert, P.	12	5.48	1	8.33
Oubrich, M.	14	6.39	1	8.33
Sidhom, S.	12	5.48	1	8.33
Wright, S.	13	5.94	1	8.33

Table 3 shows the “citation classic” papers identified by means of the *H-Classics* concept. The authors with the highest number of publications and their citations are shown in Table 4.To compliment the results described above, the evolution of *JISIB* is analyzed below, using *SciMAT*.

4. SCIENCE MAPPING ANALYSIS OF JISIB

Following the methodology described above, an overview of the science mapping and the relations between core themes in *JISIB* is provided. This section is organized in two sections: (i) analysis of the content of the publications and (ii) a thematic evolution map.

4.1 Analysis of the Content of the Articles Published

In connection with the previous sections, the research themes were set out in a strategic diagram, in order to analyze the main themes published in *JISIB* in the seven periods defined.

First period (2011): Four research themes can be identified (Figure 4). Three themes can be highlighted as key themes (*motor theme and basic and transversal themes*) of the knowledge field: competitive-intelligence, data-warehouse and competitive-technical-intelligence. The significant features of the *motor themes*

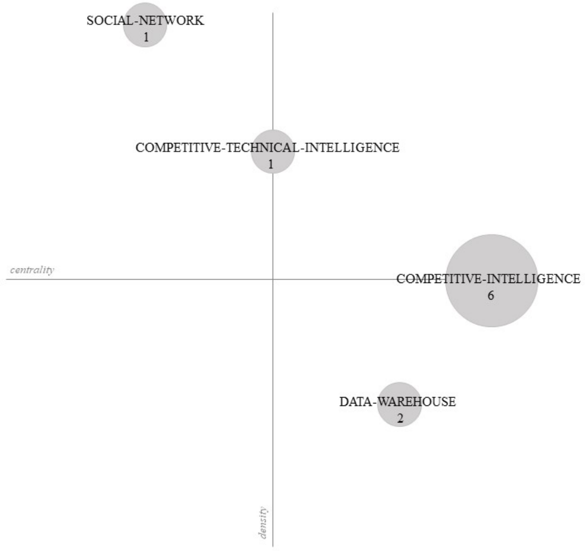

Figure 5 Strategic diagram for 2011. This figure sets out the research themes in four categories according to their relevance. These themes are related to intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and Themes included in Quadrant Q4 (Basic and transversal themes).

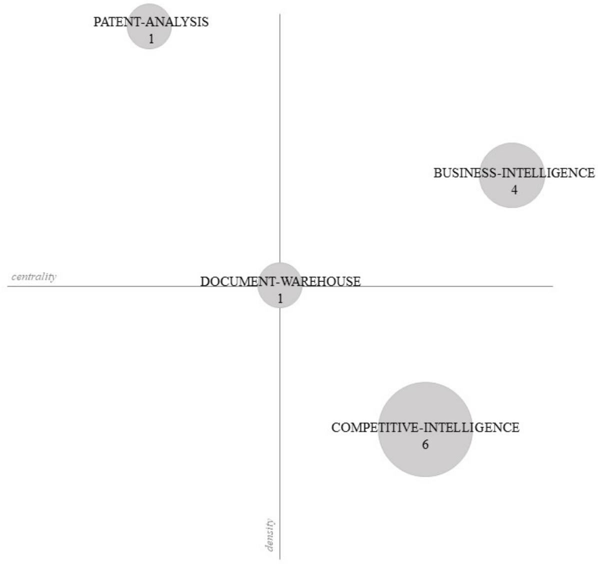

Figure 4 Strategic diagram for 2012. This figure sets out the research themes in four categories according to their relevance. These themes are related to Intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and Themes included in Quadrant Q4 (Basic and transversal themes).

identified in this period and their main research areas are below:

- Competitive-intelligence: Competitive intelligence system, economic intelligence, text mining, weak signal, real-time business intelligence, semantic network and continuous evolution

- Competitive-technical-intelligence: Blue ocean strategy and knowledge transfer

Second period (2012): Continuing with the analysis, four themes are identified in Figure 5. Three themes can be highlighted as key themes of the knowledge field: business-intelligence, document-warehouse and competitive-intelligence. The first two themes identified as key themes are new in the analysis and the last one changed quadrant. The significant features of the *motor themes* identified in this period and their main research areas are below:

- Business-intelligence: Customer expectative, visualization, strategic early warning system, pet model, pricing strategies, security issues and

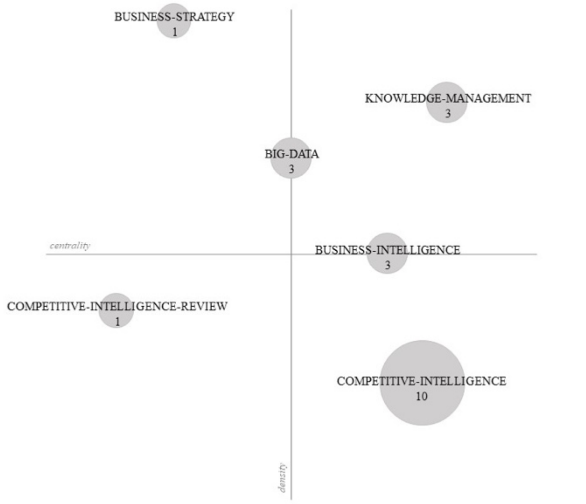

Figure 6 Strategic diagram for 2013. This figure sets out the research themes in four categories according to their relevance. These themes are related to Intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and Themes included *in Quadrant Q4 (Basic and transversal themes).*

software (design, production and evaluation)

- Document-warehouse: Multiversion documents and multidimensional analysis

Third period (2013): According to the strategic diagram showed in Figure 6, six themes research themes were identified and four of these are considered key themes knowledge-management, big-data, business-intelligence and competitive-intelligence. In this period two new key themes appear and maintain business-intelligence and competitive-intelligence. The significant features of the *motor themes* identified in this period and their main research areas are below:

- Knowledge-management: Knowledge activism, knowledge creation, knowledge strategy, organizational change, strategy, tacit knowledge, analytical conversation and big data strategy

- Business-intelligence: Data management, business analytics software and cloud computing

- Big-data: Organizational knowledge, risk management and data benefits

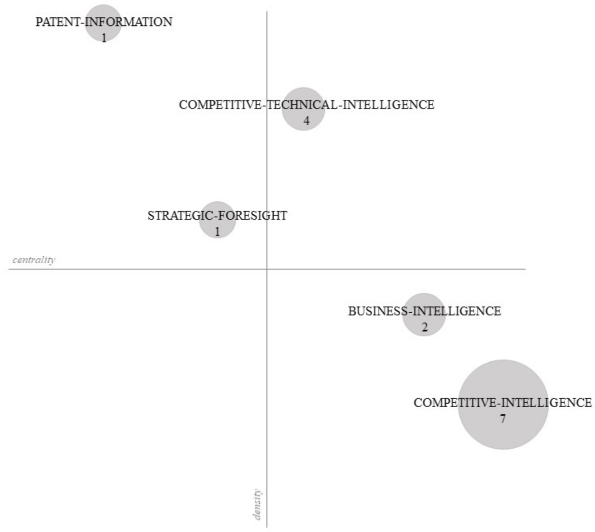

Figure 7 Strategic diagram for 2014. This figure sets out the research themes in four categories according to their relevance. These themes are related to Intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and Themes included in Quadrant Q4 (Basic and transversal themes).

Fourth period (2014): According to the strategic diagram shown in Figure 7, five research themes can be identified for this period and the following themes could be considered key themes: competitive-technical-intelligence, business-intelligence and competitive-intelligence. In this period, one new main research theme was identified but the *motor themes* just include one theme. The significant features of the *motor themes* identified in this period and their main research areas are below:

- Competitive-technical-intelligence: Evaluating intelligence, intelligence impact, patent analysis, technical intelligence, citation analysis and CTI impact

Fifth period (2015): Seven themes were identified in this period (Figure 8). Four themes can be highlighted as key themes: social-network, business-intelligence, erp-system and competitive-intelligence. In this period two new key themes appear and others are maintained: business-intelligence and competitive-intelligence. The significant features of the *motor themes* identified in this period and their main research areas are below:

Figure 8 Strategic diagram for 2015. This figure sets out the research themes in four categories according to their relevance. These themes are related to Intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and Themes included in Quadrant Q4 (Basic and transversal themes).

- Social-network: Enterprise 2.0, information systems, networking organization, social computing, social learning, social medial, social organization, strategic management, competitive advantage and computer supported collaboration

- Business-intelligence: Enterprise resource planning, e-word of mouth, internet discussion, unstructured data and custom relation management

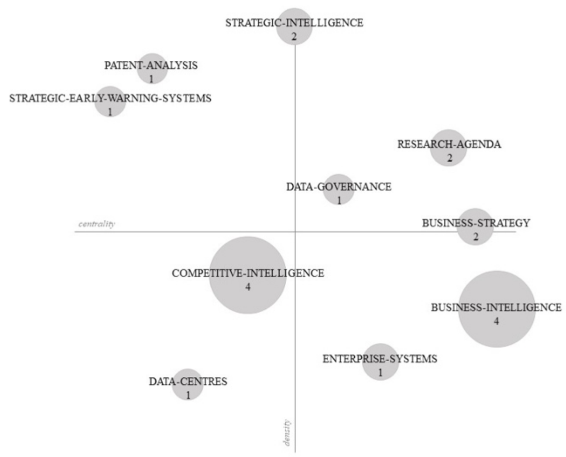

Figure 9 Strategic diagram for 2016. This figure sets out the research themes in four categories according to their relevance. These themes are related to Intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and

Sixth period (2016): According to the strategic diagram shown in Figure 9, ten themes can be identified and six of them are considered key themes: strategic-intelligence, research-agenda, data-governance, business-strategy, business-intelligence and enterprise-systems. In this period five new key themes appear and one is maintained: business-intelligence. The significant features of the *motor themes* identified in this period and their main research areas are below:

- Strategic-intelligence: Disruptive intelligence, open innovation, perspective, technology management and technology brokers

- Research-agenda: HHRR management, intelligence studies, market intelligence, predictive analytics, talent management, competitive advantage and employee engagement

- Data-governance: Intelligence as a service, data management and ethics

- Strategy: Organizational performance, organizational level competencies and organization systems research

Seventh period (2017): According to the strategic diagram showed in Figure 10, ten themes are identified and six of them are considered key themes for the knowledge field: open-innovation, business-intelligence-projects, technology-intelligence, strategic-intelligence, decision-making and social-media. In this period five new key themes appear and one is maintained: strategic-intelligence. The significant features of the *motor themes* identified in this period and their main research areas are below:

- OPEN-INNOVATION: Organizational performance, knowledge, big data, big data analytics, emerging technology and competitive intelligence

- TECHNOLOGY-INTELLIGENCE: Technology monitoring, patent bibliometrics, patent indicators, patent information, patent statics and strategy

- Bi-projects: Key success factors, BI success and data saturation

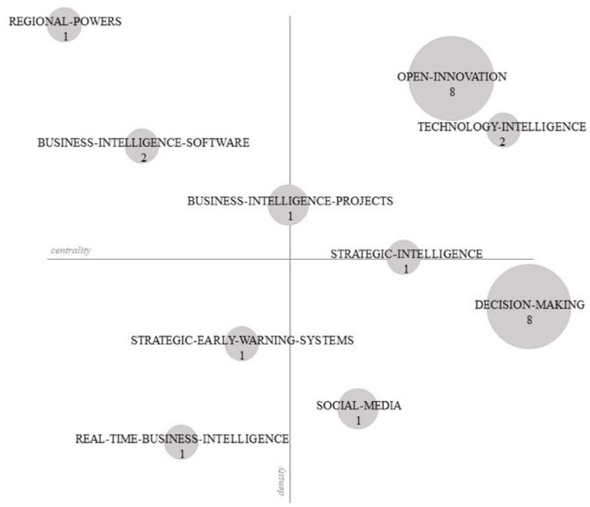

Figure 10 Strategic diagram for 2017. This figure sets out the research themes in four categories according to their relevance. These themes are related to Intelligence within JISIB for a specific period of time. The four categories are: Themes included in Quadrant Q1 (Motor themes), Themes included in Quadrant Q2 (Highly developed and isolated themes), Themes included in Quadrant Q3 (Emerging or declining themes) and Themes included in Quadrant Q4 (Basic and transversal themes).

- Strategic intelligence: Knowledge discovery, balanced scorecard, corporate performance management and corporate strategic management

It is important to highlight that business-intelligence, competitive-intelligence and strategic-intelligence are considered key themes in most of the periods, and the rest of themes are closely linked to patents, technology, innovation, information management and social networks.

4.2 Conceptual Evolution Map

In light of these pictures, Figure 11 shows the pattern of development within the knowledge area throughout the periods analyzed and the relationships among research themes. The characteristics of the line define the quality of the relation.

In the *JISIB* thematic evolution map three kinds of main thematic areas can be identified: strategic intelligence, competitive intelligence and business intelligence. These thematic areas consolidate the main themes and research areas covered in *JISIB*.

In relation to the evolution of the *JISIB*, competitive intelligence (green area) is the most strongly representative research thematic area in the period evaluated. This thematic area has 52 documents and 319 citations. The intellectual structure is composed mainly by motor themes and basic and transversal themes in all periods evaluated (Q1: 6 themes; Q2: 4 themes; Q3: 3 themes; Q4: 6 themes).

Business intelligence (red area) is the second thematic area within the thematic evolution map. This thematic area has 24 documents and 127 citations. The intellectual structure is composed mainly of motor themes in all periods evaluated (Q1: 6 themes; Q2: 1 themes; Q3: 2 themes; Q4: 4 themes).

Strategic management (blue area) is the last representative thematic area within the thematic evolution map in terms of production. This thematic area has 16 documents and 39 citations. The intellectual structure is composed mainly of motor themes and highly developed and isolated themes (Q1: 6 themes; Q2: 6 themes; Q3: 1 themes; Q4: 1 themes).

Finally, business intelligence, competitive intelligence and strategic intelligence could be considered the most representative intelligence terms developed in *JISIB*. It is important to highlight that other intelligence terms are also identified in the thematic areas and these support the growth of this research field and complement each other's development.

5. CONCLUSIONS

This research presents the first bibliometric analysis of the *Journal of Intelligence Studies in Business (JISIB).* It covers 92 original research articles and it identifies the main themes and related research areas developed from 2011 to 2017.

In bibliometric performance terms, the amount of literature covered by *JISIB* shows a noticeable increase in the last years. This increase coincides with the growth of the research field in other knowledge areas, such as computer and information, business management, marketing and education. Considering phenomena external to *JISIB* but related to the concept of intelligence such as big data, smart industry and regional intelligence, it is expected that their use will be synergistic for the growth of this field of knowledge.

Another significant aspect of bibliometric analysis is the fact that the main authors in terms of production and citations are also referent in other knowledge fields. It reconfirms the growing interest around intelligence and its multiple approaches.

Based on the results of the bibliometric analysis, the main themes used in the *JISIB* literature are the following: business intelligence, big data, competitive intelligence, information management, social network

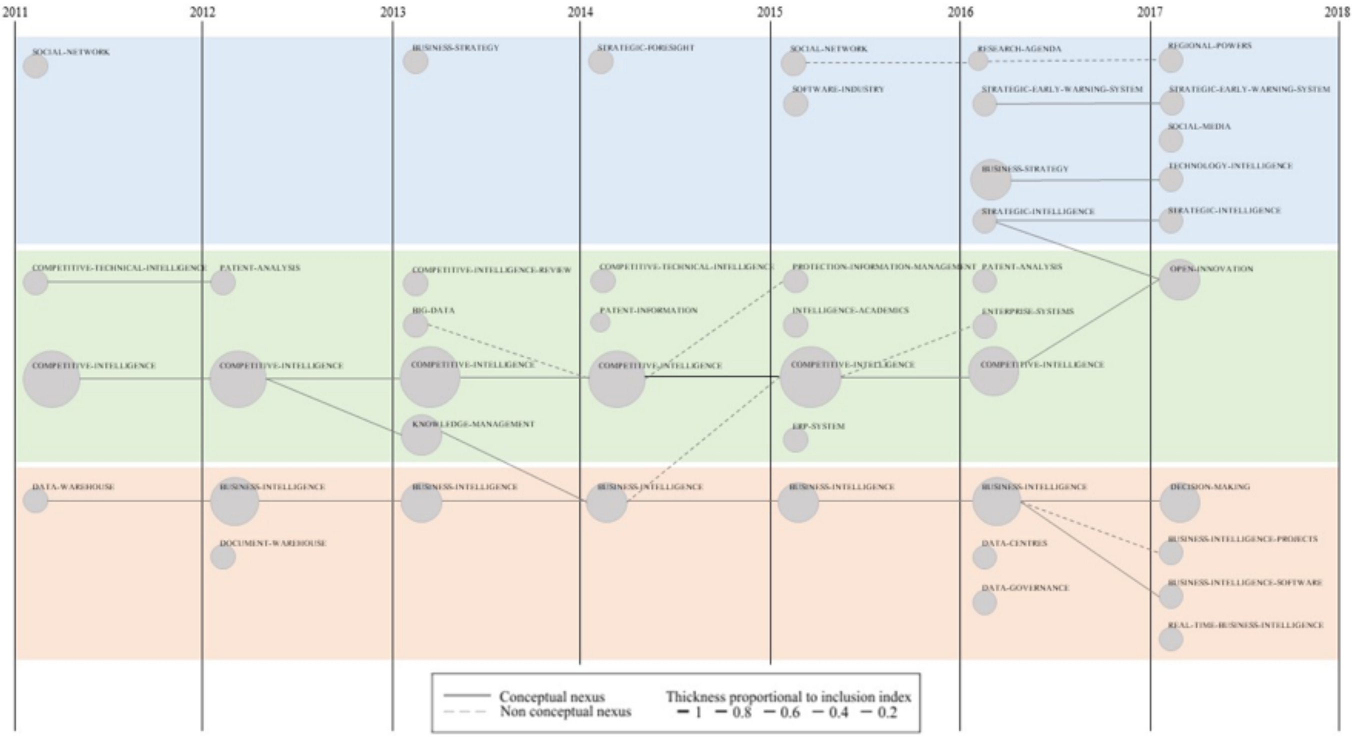

Figure 11 JISIB conceptual evolution map (2011-2017). This figure shows the pattern of development within the knowledge areas throughout the periods analyzed and the relationship between each research theme. Furthermore, the characteristics of the line define the quality of the relation. In JISIB, conceptual evolution can identify three kinds of main thematic areas: business intelligence, competitive intelligence and strategic intelligence. These thematic areas form the main themes and research areas covered in JISIB.

analysis, innovation, technology intelligence, strategic intelligence and intelligence maturity models.

Furthermore, the *JISIB* evolution map reveals that it has two different main approaches. The first is about competitive intelligence (competitive intelligence system, knowledge management, competitive advantage, innovation, knowledge strategy, organizational change, decision making and strategic planning) and the second is close to business intelligence (reporting and visualization technologies, software evolution, security issues, data warehouse, data management, analytics, cloud computing, OLAP, processing, architectures, algorithms and WEB 2.0).

Finally, it is important to highlight that this analysis allows for the identification of common themes that can be used to reach the research lines related to *JISIB*'s aim and objectives. In this way, the following themes could attract the interest of the academic, scientific and business communities: social media and networks, internet, artificial intelligence, machine learning, open innovation and collaborative intelligence. In addition, these research lines should be focused on all kind of organization, particularly small and medium-sized enterprises, which by volume and capabilities can serve as a driving force for the consolidation of this area of knowledge.

Finally, it is important to highlight that the main research themes are aligned with *JISIB*'s objectives and its community but these could not be confirmed as trends in the intelligence field study. A further research opportunity could be to compare the main research themes in the intelligence journals and intelligence literature. Moreover, it could include a detailed analysis of the authors and research groups and their research themes.

6. ACKNOWLEDGMENTS

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Exploratory study of competitive intelligence in Mexico

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ABSTRACT In order to increase their competitiveness, companies need information for problem analysis, to develop strategies and for decisions making. One way to achieve this is through methodologies, among which competitive intelligence stands out. For Pellissier & Nenzhelele (2013) competitive intelligence is a process or practice that produces and disseminates actionable intelligence by planning, ethically and legally collecting, processing and analyzing information from and about the internal and external or competitive environment in order to help decision-makers in decision-making and to provide a competitive advantage to the enterprise. Because of its importance this paper presents an investigation using a meta-analysis methodology of 72 papers published between 2000 and 2015 of applications of competitive intelligence in México. In recent years the practice of competitive intelligence has been increasing in México, though its use is not yet widespread. This is why it is important to disseminate and promote the growth of competitive intelligence theory.

KEYWORDS CI practices in México, competitive intelligence, meta-analysis

1. INTRODUCTION

Companies need useful information to develop strategies, make decisions and implement them through the organization in order to increase their competitiveness and market share. Competitive intelligence (CI) is a designed methodology that stands out to improve decision making. For Prescott & Miller (2002) CI is any intelligence function that provides a competitive advantage. CI has become an important part of North American business due to the need for companies to keep abreast of technological changes, reduce associated risks, and invest in the acquisition of advanced technology (Calof & Smith, 2010). However, in Mexico, its use is only beginning and there is an opportunity to determine where and how it is being applied.

To identify the critical factors in Mexican CI practices, a systematic review (SR) of literature was carried out using a meta-analysis (MA) (Moher et al., 2009). For Basu (2017), MA is essentially a systematic review, but the analysis also pools the results of the studies and provides conclusions. Glass (1976) proposed MA as a method of analysis of disorganized knowledge for its integration and organization. It is a process based on statistical methods, or the statistical analysis of a knowledge body searching for valid synthesis. MA uses statistical techniques to integrate the results of the included studies. Even though the methodologies developed for MA have been carried out mainly in the social, medical and psychological areas, some recent MA applications have been in the Mexican manufacturing industries such as Demand and Kanban Flow (Valles et al., 2006); manufacturing (Collins, 2007); cellular manufacturing (Noriega et al., 2010); and project management (García, 2016).

In Mexico the majority of the theoretical and empirical publications on CI theory are focused on describing the implementing process of CI. Publications also cover different approaches where CI can be applied successfully. However, most of these articles do not identify or mention the contributors in which the success of CI practices reside. Therefore, it is necessary to carry out a review of the published literature to thoroughly analyze each paper and identify critical factors in the success practices of CI in México. The present article carrys out a MA in order to identify the main contributors that impact or influence the success of the application and implementation of CI in México.

1.1 Description of the Problem

In Mexico, the majority of theoretical and empirical publications on CI theory are focused on describing the implementing process of CI. Publications also cover different approaches where CI can be applied successfully. However, most of these articles do not identify or mention the contributors in which the success of CI practices reside. Therefore, it is necessary to carry out a review of the published literature, thoroughly analyzing each paper/article and identifying critical factors in the success of CI practices in México.

2. LITERATURE REVIEW

CI is defined as any processable intelligence that can provide a competitive advantage (Porter and Millar,1985). It is a systematic, goal-oriented, ethical and timely effort to compile, synthesize and analyze information of the external environments, such as competition and markets (Fleisher, 2009). It also is considered a process of legally and ethically gathering and analyzing information about competitors and the industries in which they operate (SCIP, 2016). Ideally, the use of such information in decision making process aims to adjust activities to improve performance (Wright et al., 2009). Corporate intelligence, business intelligence, market intelligence, and other similar terms are often used interchangeably, and more often than not, any difference between them is one of semantics more than substance (SCIP, 2016).

The CI process consists of the following steps: monitoring business environment (external data, information and knowledge), gathering, analyzing, filtering and disseminating intelligence that will support decision making process in order to increase competitiveness and improve position of organization (Nasri,2012).

The cycle of intelligence provides a frame of reference for the management of CI research projects, in such way that projects can be continuously developed, systematically and ad-hoc (Tena & Comai, 2001). It is a fundamental basis of the strategic decision-making process (Dishman & Calof, 2008). In the literature, coincidence is identified in relation to the following processes of the competitive intelligence cycle (Miller, 2001; Rodriguez, 2005; Bose, 2008; Dishman and Calof, 2008): planning and direction, collection of information, analysis of information, dissemination and feedback.

The first phase (planning), focuses on the identification of the needs to gather the relevant information (second phase); then, in the third phase the information collected must be evaluated, determine its usefulness and objectivity, and with this information generate intelligence (third phase) and subsequently, communicate it appropriately to the interested

Table 1 Description of three themes

Generic themes	Description	No. papers
Applications in the industry, services and environment	Papers related to competitive intelligence practices in the private or public sector with impact on their performance, operations, strategic plan, environment or commercial strategy	21
Applications in academia	Papers related of competitive intelligence application in higher education schools related to the teaching-learning process, areas of research and development, design of laboratories or linkage with the productive sector	9
Disclosure / dissemination articles	Papers related to CI state of the art, proposal of application in different sectors, relation with other areas of knowledge (capacity of innovation, knowledge management)	13

parties (dissemination). The fourth phase requires adequate policies and procedures so that the CI can make a positive contribution to the organization. The importance of the CI cycle lies in its understanding of the stages and support for its application in organizations.

In order to identify papers on CI practice in Mexico, a search for publications from 2000 to 2015 was carried out. They were identified through the BIVIR Database Integrator (of the Autonomous University of Juarez-UACJ), which has 30 databases (including Annual Review, Ebsco, Elsevier, Emerald, Sciencedirect, and Wiley), and then perform a debugging of the papers found based on reading the introduction, summary and conclusions.

After the phases of identification and selection of the SR, 43 articles out of 72 were considered. To facilitate the review, the articles were grouped into three types: 1) applications in industry, services and the environment; 2) applications in academia and 3) articles of disclosure / dissemination; as presented in Table 1.

2.1. Narrative summary of the literature by generic themes

2.1.1 Applications in the industry, services and environment

Alcántar (2001) describes the development of the practice of CI in the oil industry in Mexico; Lozano (2003) proposes a pragmatic view about the advantages and disadvantages of patent analysis; Huerta et al. (2003) identify basic design elements to create a CI unit; Rodríguez (2003), presents a patent analysis of an advanced materials case; Lechuga et al. (2007) apply CTI in the search of information about several seawater desalination processes; Esquivel et al. (2008) propose to perform information extraction tasks from corporate news published on the web to provide intelligence; Saad (2009) uses CI to determine technological trends in biotechnology-phytoremediation; Chávez et al. (2010) make use of CI in hotels and restaurants; Vera (2011) proposes an intelligence strategy for Mexican wine companies to increase their competitiveness; López & Alcántara (2011) describe the implementation of a system of competitive and technological intelligence (CTI) to sustain strategic decisions in wastewater treatment; Rodríguez & Tello (2012) present a methodology that integrates patent analysis in a study of CTI applied in a plastics industrial sector.

Millán (N.A) identify the most used practices related to CI of export companies in Sinaloa; Rodríguez & Salinas (2012) apply CI to investigate and identify drivers that support the decision making of a plastics company; Rodríguez-Borbón et al. (2013) present the design of a CI model for horticulturalists in southern Sonora; Montiel et al. (2014) use CI in the bond industry in Mexico; Rodríguez et al. (2014a) apply patent analysis as part of a CTI methodology on open die forging, also develop a patent analysis on additive manufacturing (Rodríguez at al., 2014b); Ahumada & Perusquia (2016) propose a set of factors for the development of the capacity to manage the knowledge applied for the expansion of business intelligence. Regarding to the integration of CI with other approaches, some papers are about a QFD - deployment of the quality function application (Rodríguez-Salvador et al., 2006), Kansei Engineering in the design of stoves (Rodríguez and Moreno, 2011), blue ocean strategy (Rodríguez and Bautista, 2011), and applications of total quality management with CI (Rodríguez et al., 2007).

2.1.2 Applications in academia

Rodríguez & Gaitán (2002) propose a holistic model for teaching CTI, integrating collaborative learning; the learning of CTI for future strategic improvements (Rodríguez & Mora, 2000) and to improve the identification of opportunities (Rodríguez et al.; Fuentes et al.) present a methodology that incorporates CTI with methodologies of design and product development for a learning environment of an engineering laboratory; Gutierrez et al., analyze the degree of acceptance of high school students in the business intelligence and development program as a proposal for competitiveness in Universities. For research and development centers, Lopez & Alcántara (2010) present the first results of a methodology proposed to implement a CTI System; and López-Martínez (2011) proposes the application of CI and data mining for the identification of patterns that reveal the structure of scientific research and applied research, as well as their concordance in the surroundings of a country; Luna & Solleiro (2007) explain intellectual property

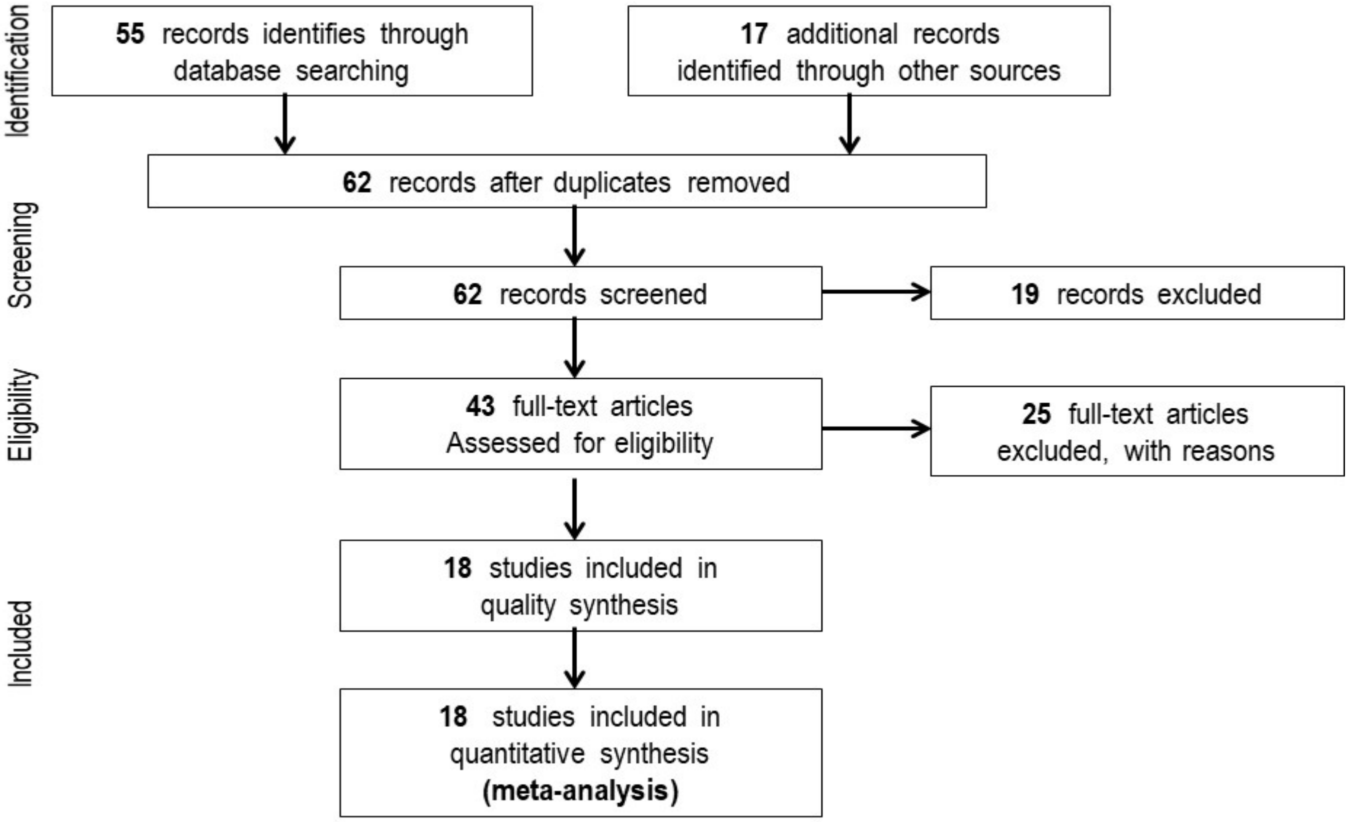

Figure 1 Four Phases flow diagram of the meta-analysis.

management in centers of Mexican research: the case of the institute Mexican oil.

2.1.3 Disclosure / dissemination articles

Rodríguez & Valdez (2003) present a review centered on the importance of the CTI systems for the detection of innovation opportunities and threats; Mier (2003) emphasizes the importance of CI as a factor to build a technological tradition in organizations; Rincón-A & Ortiz (2005) present an overview on the analysis in technological intelligence; Güemes and Güemes & Rodríguez (2007) clarify the situation of the innovation structure used by Mexican Companies and their relationship with CI practices; Bertacchini et al. (2007) present a case studies in Mexico & in Gafsa university from territorial intelligence to CI & sustainable system; Solliero et al. (2009) identify the state of the art and trends of the CTI through the analysis of the literature; González (2011) describes the link between two tools of Technology Management: the CTI and the management of knowledge to achieve business competitiveness through technological innovations; González (2012) proposes an electronic cluster for the competitive development of Small & Medium Companies based on CI actions.

Vizcarra et al. (2012) offer information that highlights the usefulness of CI by analyzing concepts that describe the application of this development and entrepreurship; Cantú et al., (2011) deepen the analysis of previous work concerning the building of National System of CTI and suggest a theoretical systemic framework to constitute it; and Sánchez-López (2012) presents the implementation of a CI and technological surveillance portal; Perez-Villarreal & Valdez-Zepeda (2014, 2015) propose a system based on CI as a fundamental factor to increase chances of electoral success in political campaigns.

3. METHODOLOGY

The flow of information of the phases (identification, screening, eligibility and included) of a SR/MA proposed by PRISMA statement (Mohoer et al., 2009) is shown in Figure 1.

The eight steps of the MA methodology (Noriega et al., 2010) were applied to generate statistical support and to obtain a high grade of confidence about the papers for the study. The steps of the MA methodology are described as follows:

Table 2 Data for all papers used in the meta-analysis.

Author (year)	Name of Paper
Mier (2003)	Competitive intelligence: an important factor in building a technological tradition
Rodríguez & Gaitán (2003)	Holistic Model for the Teaching of Competitive and Technological Intelligence: Integration of Collaborative Learning
Rodríguez (2005)	National System of Competitive and Technological Intelligence: Education for the Innovative Development.
Guemes & Rodriguez (2007)	The relationship between Competitive Intelligence and the Innovative Capacity of Mexican companies
Lechuga et al. (2007)	Analyze the Desalination Processes of Sea Water by Applying the Competitive and Technological Intelligence
Ezquivel et al. (2008)	Business News on the Web as a Source of Competitive Intelligence
Solleiro et al. (2009)	The state of the art of competitive technological intelligence: trends and perspectives
López-Martínez (2011)	Use of Data Mining and Technological Intelligence Tools to Identify Patterns of Publications and Patenting in National Environments, as well as their Matches
Rodríguez & Moreno (2011)	Proposed integration of Competitive and Technological Intelligence with *Kansei Engineering* in the Design of Magnetic Induction Stoves
Rodríguez & Tello (2012)	Applying paten analysis with Competitive Intelligence: The case of Plastics
Rodríguez & Salinas (2012)	Applying Competitive Intelligence: The Case of Thermoplastics Elastomers
Vizcarra et al. (2012)	The Competitive Intelligence in the Companies of the City of Tijuana B.C.
Rodríguez-Borbón (2013)	Design of a Competitive Intelligence System of the Pumpkin Market for Producers in Southern Sonora, México
Pérez & Valdez (2014)	Competitive Intelligence in electoral campaigns
Montiel- Campos et al. (2014)	A Competitive Intelligence Model Where Strategic Planning is not Usual: Surety Sector in México
Rodríguez et al. (2014)	Strategic Foresight: Determining Patent Trends in Additive Manufacturing
Rodríguez, Palacios & Cortez	Technical Intelligence Approach: Determining Paten Trend in Open Die Forging
Millán (n.a.)	The Competitive Intelligence of Sinaloan Exporting Companies

1. **Problem definition**. In this step the problem must be clearly and precisely defined. In this case, it was defined as the determination of CI factors that can be obtained in successful CI practices.

2. **Identification of the information sources and the studies to be analyzed**. Once the boundaries of the meta-analysis are determined, then, all the studies that fit within those bounds are to be determined. The purpose of this step is to list the sources of the literature. In this research the total number of studies considered was 72, among them are research papers and conference proceedings.

3. **Information discrimination**. In this step, the information is classified according to the degree of scientific strictness, credibility and confidence. For this purpose, a set of inclusion and exclusion criteria is developed and it is applied to all the documents, excluding the papers that do not fulfill the criteria. This is one of two quality filters. In this step, it was reduced from 72 to 43 papers.

4. **Publications database**. The purpose of this step is to generate a papers database with the aim of facilitating the management, localization and treatment of the information gathered.

5. **Evaluation of articles.** The purpose of paper evaluation is to determine, based on the stated criteria, whether or not an article should be included in the MA. At this stage, a questionnaire of 13 items (adapted from García, 2016) was applied to all the

Table 3 Success factors identified

Code	Success Factor	Freq.
A	Source of information	2
B	Analysis of information	13
C	Selection of information	2
D	Information extraction/Search	4
E	Dissemination of information	4
F	Generation of information / intelligence	4
G	Opportunities and Threats	12
H	Decision making	13
I	Organization information	1

documents. Each document is judged and assigned a grade according to a Likert scale from 1= not important to 4= most important. In this step, it was reduced from 43 to 18 papers.

6. **Classification and coding of information**. In this process, the extraction of data from each study is based on a coding sheet that specifies what data to extract and a key that interprets the various aspects conducted. The coded information is summarized to identify moderating variables, to be used to group studies for conducting MA.

7. **Statistical Analysis**. In this step, the aim is to apply the statistical methods to the studies that were selected for inclusion in the MA. The selection of the appropriate ones depends on the specifications of the comparisons to be made. For this research, the statistical treatment began with the normality test applied to the final results, an Anderson Darling test was applied (for sample size, n<30). If the data shows a normal behavior, a difference in means test is to be used in the next step. The differences in means test was done to determine the relative contributions of the factors and to establish the most important factors. Minitab was used for statistical analyses.

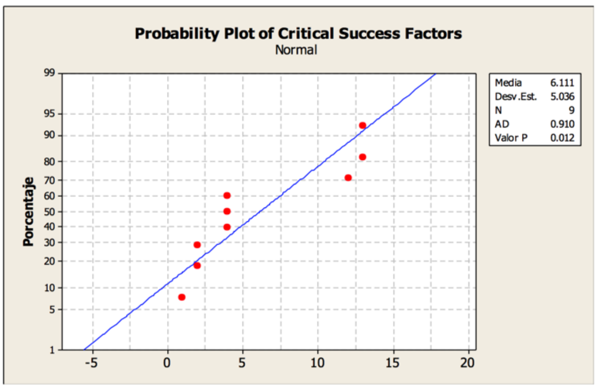

Figure 2 Normality test for the nine success factors identified

8. **Generation of conclusion**. This is the last step of this methodology, which consists of interpretation of the results obtained and generates the conclusion for the defined problem. A MA result is simply evidence that may be used in the attempt to integrate results from multiple studies. Also, the assumptions necessary for the MA should be evaluated for the adequacy of the study.

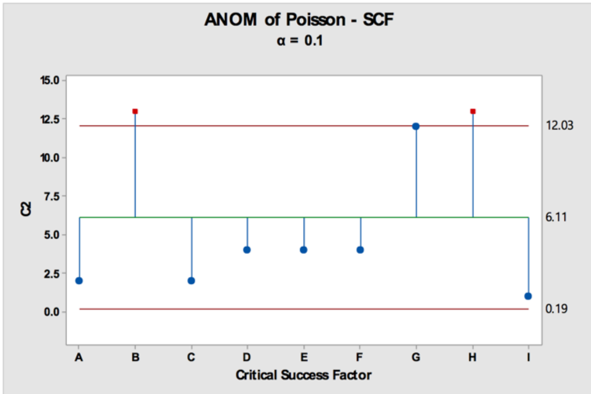

Figure 3 Analysis of means for the success factors identified.

4. RESULTS

In this section, the results obtained from the MA of CI practices literature are presented. The total number of studies considered was 72, including research and conference proceedings. In the identification phase, it was reduced to 62 papers. Later, a first quality filter (screening phase) excluded 19 records, and then each document was judged and assigned a rating according to a Likert scale (second quality filter). In this step, the records were reduced from 43 to 18 items (eligibility phase). Table 2 shows the author, year and title of each paper.

The next step was the determination of the success factors that are critical for CI practices (Table 3). For this step the frequency of each factor was summarized. A total of nine critical factors (CF) were found in the documents reviewed. The CFs in order of decreasing importance are: analysis of information; decision making, opportunities and threats; information search and extraction, dissemination of information; generation of information/intelligence.

Once the total frequency was tallied, a normality test was required. The results are shown in Figure 2. The approximate P-value = 0.012, and the significance was above 0.01, so it is safe to assume that the data is normally distributed and it is adequate to perform a parametric test.

The next step was the application of a Poisson Analysis of Means (ANOM). The test determined that 3 of the 9 factors can be considered critical (with the exception of factor 7 having sufficient evidence). These were number 2 (information analysis); 8 (decision making), and 7 (identification of opportunities and threats), shown in Figure 3.

5. FINAL REMARKS

This research shows, as a first approximation, the critical success factors (CSF) identified for the practice of CI in Mexico. This research takes over the interest of identifying the variables of competitive intelligence (Güemes & Rodríguez, 2007), and intends to present a new perspective for CI professionals and researchers in Mexico. The findings show that at least 18 articles out of the 43 mentioned CSF in different cases or approaches. Therefore, research to find the most important CSF in the practice of CI is a contribution to the field. Regarding the application of MA in engineering areas, as well as the adaptation of MA procedures to the CI framework of research practices, this can be considered successful.

In Mexico, the main practice of CI is a variation with a strong emphasis on science and technology and its impact on research and development activities (Dou & Massari (2001) quoted by Dou and Manullang (2004)). In this study the term CTI is understood as a type of CI.

Results supports the claim that in Mexico CI is an emerging practice. Although it is taking place in both the public and private sectors, it still has a long way to go in policies to improve its development, as well as in infrastructure and the creation of entities to support this activity (Rodríguez, 2005). As shown in this review, some Mexican companies conduct CI practices to anticipate future changes, innovations with a high impact on the market, and to enter new market niches and develop new products.

The main limitation of the study is the sample size (43). Although we consider several issues that may allow for the validity of this study, Hunter and Schmidt (2000) say that for sample sizes in the range of 25 to 1600, the Type I error for random effects is 5% for fixed effects with homogeneous cases. However, this search was exhaustive. Both MA and CI are relatively new theories in Mexican academia and industry. Close to 95 % of México´s businesses have less than 16 employees, so we figure the sample is close to representative of the population. These results pinpoint the critical success factors of CI practice in México and help to define the course for new studies of this sort.

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Competitive and technology intelligence to reveal the most influential authors and inter-institutional collaborations on additive manufacturing for hand orthoses

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ABSTRACT Additive manufacturing (AM) is revolutionizing the health industry, where it provides innovative solutions for the production of personalized devices, such as hand orthoses. However, the scientific research dynamics in this topic have not yet been investigated. This study aims to fill this gap through the application of a competitive and technology intelligence (CTI) methodology enhanced by a scientometric and network map analysis. Major advances in the fabrication of hand orthoses using AM, the presence of collaborations, and the most influential authors were determined. Specifically, network map analysis, bibliographic occurrence and bibliographic coupling were conducted on documents retrieved from Scopus and the Web of Science (WoS), and on patents from more than 104 authorities. Results showed only nine published patent families and 34 research articles on this topic from 2006 to 2016. Ten papers concern static orthoses, while 24 deal with dynamic orthoses and exoskeletons. The indegree and outdegree parameters and the betweenness centrality of these documents enabled us to determine the most cited authors and instances of collaboration (papers co-authored between institutions). Dr. Paterson A. M. J. was the most influential author, with four publications with the highest betweenness centrality in the network (189), which accounted for the most cited document with five citations. The institution with the most publications was Loughborough University, with four papers, and the collaboration between affiliations was rare. These documents review important aspects of manufacturing orthoses using AM, and additionally pay particular attention to the importance of personalised orthoses where AM contributes. Notably, these papers focused primarily on studies for the development of a methodology for the fabrication of hand orthoses using AM, but they do not present any application. This research provides insights to better understand the dynamics of research and development in the orthopaedics domain, specifically for hand orthoses.

KEYWORDS 3D printing, additive manufacturing, betweenness centrality, bibliographic coupling, competitive intelligence, hand orthoses, network map analysis, scientometrics

1. INTRODUCTION

The competitive and technology intelligence (CTI) methodology is a process where information is systematically and ethically gathered to be analysed and further transformed into valuable results that can strengthen decisions for innovation and product development (Rodríguez-Salvador and

Tello-Bañuelos 2012). Public documents, such as patents or scientific publications, represent useful sources of information for CTI purposes.

While patents register technological inventions (Archibugi and Pianta 1996), scientific documents aim to publish original research advances. Both represent valuable resources to identify and monitor the progress of science and technology (S&T) including predominant research areas, emerging technologies, top researchers, most active institutions in the field and collaborations. They also support decision-making processes for research and innovation efforts (Archibugi and Pianta 1996; Bonino et al. 2010; Fabry et al. 2006; Rodríguez-Salvador et al. 2014).

When analysing such documents, applying scientometric methods with CTI can provide a better assessment of S&T production (Bornmann and Leydesdorff 2014; Mingers and Leydesdorff 2015). These methods use complex tools to process information from dozens to thousands of patents or scientific publications, not only from well-established research areas, but also for emerging technologies such as AM (Bakhtin and Saritas 2016; Leydesdorff et al. 2015; Leydesdorff and Milojević 2015; Oldham et al. 2012; Porter and Youtie 2009; Rotolo et al. 2015).

Although new developments have less information available than established technologies, using scientometric tools is required to significantly dispel the uncertainty surrounding emerging technologies. Tools like bibliographic occurrence and bibliographic coupling can be applied to determine the impact, growth or evolution of science (Biscaro and Giupponi 2014; McCain 1990; White and Griffith 1981; Zhao and Strotmann 2008). While bibliographic occurrence evaluates the presence of specific references contained in scientific documents, bibliographic coupling refers to the frequency of references shared between two or more scientific documents. The higher the bibliographic coupling, the higher the impact of the cited documents (Biscaro and Giupponi 2014). Of the two tools, bibliographic coupling is more suitable for the identification of fundamental research domains (Kuusi and Meyer 2007; Small 1973; Zhao and Strotmann 2008). Additionally, the authors with more influence in a certain area of research can be determined using indegree and outdegree parameters or centrality measures, which are commonly applied in network map analysis. The indegree parameter counts the times that each analysed document is cited by other publications, and the outdegree counts the publications cited in the analysed documents. Furthermore, the betweenness centrality measurement has high value for network map purposes. It enables grading of nodes according to their positions. A grade is applied based on the shortest number of paths that pass through a particular node. If a node is in a position that connects different aggregates of nodes, this node will have a higher betweenness centrality (Brandes 2001). This measure was used in this research to determine the most influential author by noting if an author is connected to more authors, not only to documents in reference lists. Institutional collaboration can be clearly visualised and analysed through network map analysis, which shows the interaction between them.

Recently, Rodríguez-Salvador et al. (2017) applied scientometric tools on scientific and patent literature from 2000 to mid-2016 to uncover the knowledge landscape of 3D bioprinting. We also presented a first approach to study the incursion of AM on hand orthoses at the 3rd International Conference on Progress in Additive Manufacturing (Pro-AM) held in Singapore in May 2018 (García-García and Rodríguez-Salvador 2018). This research determined that AM is already used in the production of hand ortheses. Materials, processes and methods for data acquisition were also detected. However, the current study focuses on the identification of the most influential authors and co-authoring institutions that have carried out research for the use of AM in hand orthoses.

Such orthoses are of significant relevance for treating hand disabilities related to broken bones, congenital conditions or cerebrovascular diseases (Colditz 1996; Colditz 2002; Coppard and Lohman 2015; Fess 2002; Imms et al. 2016). They are used as part of rehabilitation programs to support the affected limb by immobilising it. The most common orthoses are static, but there is also another type of orthosis: the dynamic orthosis. This type of orthosis provides the patient with a limited amount of movement through a mechanical assembly—such as rods, pins, and springs connected to the orthosis's main body—which is made using the same materials as conventional, static orthoses. Static orthoses are fabricated using diverse materials. Plaster of Paris is the most common, but thermoplastics is also widely used (Cassell et al. 2005; Colditz 2002; Coppard and Lohman 2015; Fess 2002; Fess 2005; Schultz-Johnson 2002; Schwartz and Janssen 2005).

Normally, orthoses can be manufactured in batches using standardised hand measurements (such as small, medium or large), but using personalised orthoses according to the patient's anatomy and type of treatment, allow for better patient recovery (Fess and McCollum 1998; Kim and Jeong 2015; Paterson et al. 2015). AM is a technology that can be used for the fabrication of personalised orthoses.

AM, also known as 3D printing, rapid prototyping or free-form fabrication (FFF) (Espalin et al. 2010; Ventola 2014), is a novel manufacturing process used for fabricating objects by depositing materials in layers from digital models. The models can be generated either through computer aided design (CAD) software or image acquisition methods, such as computerised tomography (CT) scans, magnetic resonance imaging (MRI) or 3D scanning. AM has many advantages over traditional manufacturing, such as reducing material waste, minimising manufacturing cost for complex parts and manufacturing unconventional, personalised shapes (Banks 2013; Basiliere and Shanler 2015; Davey et al. 2011; Espalin et al. 2010; Paterson et al. 2010; Schubert et al. 2014; Ventola 2014). This increases the attractiveness of AM technology. It is a very versatile technology that has the potential to fabricate personalised medical devices, such as prostheses or orthoses.

2. METHODOLOGY

The scientometric tools of bibliographic occurrence and bibliographic coupling, as well as network map analysis, were used within the competitive and technology intelligence (CTI) methodology of Rodríguez-Salvador et al. (2017), with the aim of determining the most active and most influential author and understanding the level of collaboration (co-authoring) between institutions working on the fabrication of hand orthoses using AM.

The process began with the determination of the most suitable keywords with which to build a search query for both scientific and patent databases. This stage included a review of publications on rehabilitation, therapy and orthopaedics (García-García et al. 2018). The terms obtained were then assessed by experts on hand therapy who asked to remain anonymous. Four main keyword categories were determined as follows: anatomy (e.g., hand, finger, phalangeal), technology (e.g., 3D printing, AM), application (e.g. rehabilitation for stroke) and medical devices (e.g. orthosis, splint). Figure 1 shows a Venn diagram of the keyword groups. These keywords were used to build a general search query in which Boolean operators, proximity terms, truncators and wild cards were applied. A set of 100 searches was performed before arriving at a final search query approach. The general query used was based on the following:

TITLE-ABSTRACT-KEYWORD(((("3D print*") OR ("rapid prototyp*") OR ("additive manufact*") OR ("solid free form fabric*") OR ("fuse deposit* model*") OR ("selective Laser sinter*") OR (stereolithography) OR (photopolymeri?ation) OR "reverse engineering") AND ((hand OR wrist OR finger OR "upper limb") W/5 ("static progressive splint*" OR "serial static splint*" OR "casting motion to mobile stiffness" OR orthos?s OR orthotic* OR orthop?edic OR splint* OR brace* OR cast* OR rehabili* OR aid OR paresis OR "post-stroke")) OR ((dynamic W/10 orthos?s) AND ("prototype")) OR (dynamic W/10 splint*) OR (exoskeleton))

Where W/# indicates a search within a specified number of words. This general query was then modified according to each of the databases consulted.

Patseer, an online patent platform that covers more than 104 leading patent authorities, was used to collect and analyse patents (Sinha and Pandurangi 2016). To

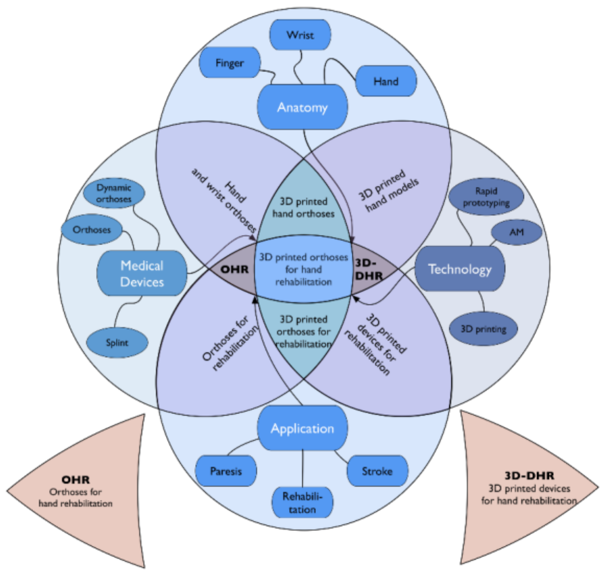

Figure 1 Main terminology categories. Keywords grouped by anatomy, technology, applications and medical devices.

search for scientific documents, Scopus and the WoS were utilized (García-García et al. 2018).

Scopus, at the time of the search, contained information from more than 20,000 journals (Elsevier 2016), while the WoS covered information from more than 13,000 journals (Thomson Reuters 2011). The time frame to be searched was defined as 1980 to 2016 (2016 was the year in which the information gathering for this study concluded). The year 1980 was chosen because the first reported works on 3D printing technology were published in the 1980s (Dormehl 2018).

The next step in the methodology was the cleaning process, in which those publications not related to the topic of interest were discarded. During this step, publication titles and the names of authors and institutions were homogenised and the data deduplicated, eliminating repeated items from the data set.

Then, a bibliographic network map of the publications was generated to identify the most cited authors on the subject. This was achieved through bibliographic coupling, determining the betweenness centrality and finding the indegree and outdegree parameters. A collaboration analysis was also carried out using network mapping to find partnerships between the main affiliations advancing the fabrication of hand orthoses using AM.

3. RESULTS

The overall number of publications obtained from the searches of the three databases (Scopus, WoS and Patseer) was lower than expected. Only 15 published patent families were identified in Patseer, while a total of 46 publications were obtained from Scopus and 33 from the WoS. A further cleaning process homogenised the titles of patents and articles, the names of the authors and inventors and the titles of affiliations or institutions. The cleaning process also eliminated duplicates and those patents and articles that, despite containing the terms of the query, were not related to the topic. After this process, a total of 9 published patent families were obtained from Patseer and 34 research articles were obtained from Scopus and the WoS. Figure 2 shows the number of publications per year, from 2006 to 2016 (1980 was considered initially, however no information was detected), for each database.

The patent families are listed in reverse chronological order in Table 1. Seven patents were published between 2014 and 2016, one patent in 2010, and the remaining one in 2007.

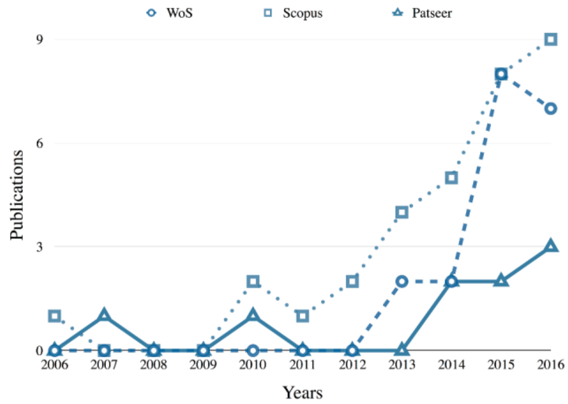

Figure 2 Publications and patents per year for the WoS, Scopus, and Patseer.

The analysis also showed that the United States has five patents published, making it the most prolific country in the field. From the patents retrieved, only two were closely related to orthoses: 'Methods for integrating sensors and effectors in custom three-dimensional orthosis' from Turkey and 'Systems and methods for generating orthotic device models by surface mapping and extrusion' from the United States. Only one author published more than one patent: James Schroeder, whose patents were published in 2007 and 2010 and are related to the customization of implants, prostheses, and surgical instruments and methods of manufacture.

Of the 34 research articles from Scopus and the WoS, 24 were about developing dynamic orthoses or exoskeletons for rehabilitation, and only ten were related to static orthoses. As a preliminary result, it was observed that the article with the most citations was A. M. J. Paterson's, published in 2010 (Paterson et al. 2010): 'A review of existing anatomical data capture methods to support the mass customisation of wrist splints.' A further bibliographic network map (Figure 3) was generated to visualize the connection between the publications and their references, and to carry out bibliographic coupling. The map was plotted in Gephi™, using the Force Atlas Algorithm. This algorithm is commonly used to emphasise complementarities and to spatialise networks with a small amount of data (Bastian et al. 2009; Jacomy et al. 2014). Figure 3 shows the network map of the documents and their references, where the size of the nodes is proportional to the indegree parameter, which displays the number of citations each document has (Gmür 2003) and thus identifies highly cited publications. On the other hand, the outdegree parameter is proportional to the number of references contained in each document.

Table 1 Patent families gathered from the patent search in Patseer.

Patent No (Pub. Date)	Title	Assignee	Inventor	Priority Country
BR102014029649A2 (31 May 2016)	Manufacturing process articulated prostheses from a combination of rigid and flexible material in one piece (Gomes da Fonsêca et al. 2016.)	Fundaçao Universidade de Brasilía	Gabriela Freitas Gomes da Fonsêca,Jeferson Andris Lima Lopes, Jorge Ribeiro Cunha da Silva, Lucas Coelho de Almeida, Marcelino Monteiro De Andrade	Brazil
WO2016071773A2 (12 May 2016)	Methods for integrating sensors and effectors in custom three-dimensional orthosis (Karasahin 2016)	Deniz Karasahin	Deniz Karasahin	Turkey
US2016101571A1 (14 Apr 2016)	Systems and methods for generating orthotic device models by surface mapping and extrusion (Schouwenburg et al. 2016)	Sols Systems Inc.	Kegan L. Schouwenburg, Daniel Bersak, Jeff Smith, Ciaran N. Murphy	United States
US2015328840A1 (19 Nov 2015)	Use of additive manufacturing processes in the manufacture of custom wearable and/or implantable medical devices (Zachariasen and Cropper 2015)	Joseph T. Zachariasen Dean E. Cropper	Joseph T. Zachariasen, Dean E. Cropper	United States
WO2015095459A1 (25 June 2015)	Robotic finger exoskeleton (Deshpande and Agarwal 2015)	Board of Regents, The U. of Texas System	Ashish Deshpande, Priyanshu Agarwal	United States
JP2014533975A (18 Dec 2014)	Customisable embedded sensors (Ranky and Mavroidis 2014)	Northeastern University Richard Ranky Constantinos Mavroidis	Richard Ranky, Constantinos Mavroidis	Japan
CN203935304U (12 Nov 2014)	Novel bionic exoskeleton artificial limb controlled by cable wires (Xiogjiao et al. 2014)	Xing Xiongjiao Yuan Ning Zheng Haolin	Xing Xiongjiao, Yuan Ning, Zheng Haolin	China
WO2010120990A1 (21 Oct 2010)	Personalized fit and functional designed medical prostheses and surgical instruments and methods for making (Schroeder 2010)	James Schroeder	James Schroeder	United States
WO2007045000A2 (19 Apr 2007)	Personal fit medical implants and orthopaedic surgical instruments and methods for making (Goodman et al. 2007)	Steven L. Goodman, Kyujung Kim James Schroeder Vantus Technology Corp.	Steven L. Goodman, Kyujung, James Schroeder, Vantus Technology Corp.	United States

These categories have the highest frequency of occurrence. Patents, letters, notes and standards were also cited in the documents obtained, but so infrequently that they are barely visible on the map.

The higher numbers of nodes are for publications related to dynamic hand orthoses, as seen in Figure 3. However, the analysis showed that bibliographic information related to AM of dynamic hand orthoses came mostly from conference papers (80 percent), and the majority did not have citations up to 31 December 2016. The documents related to static orthoses were mostly journal articles,

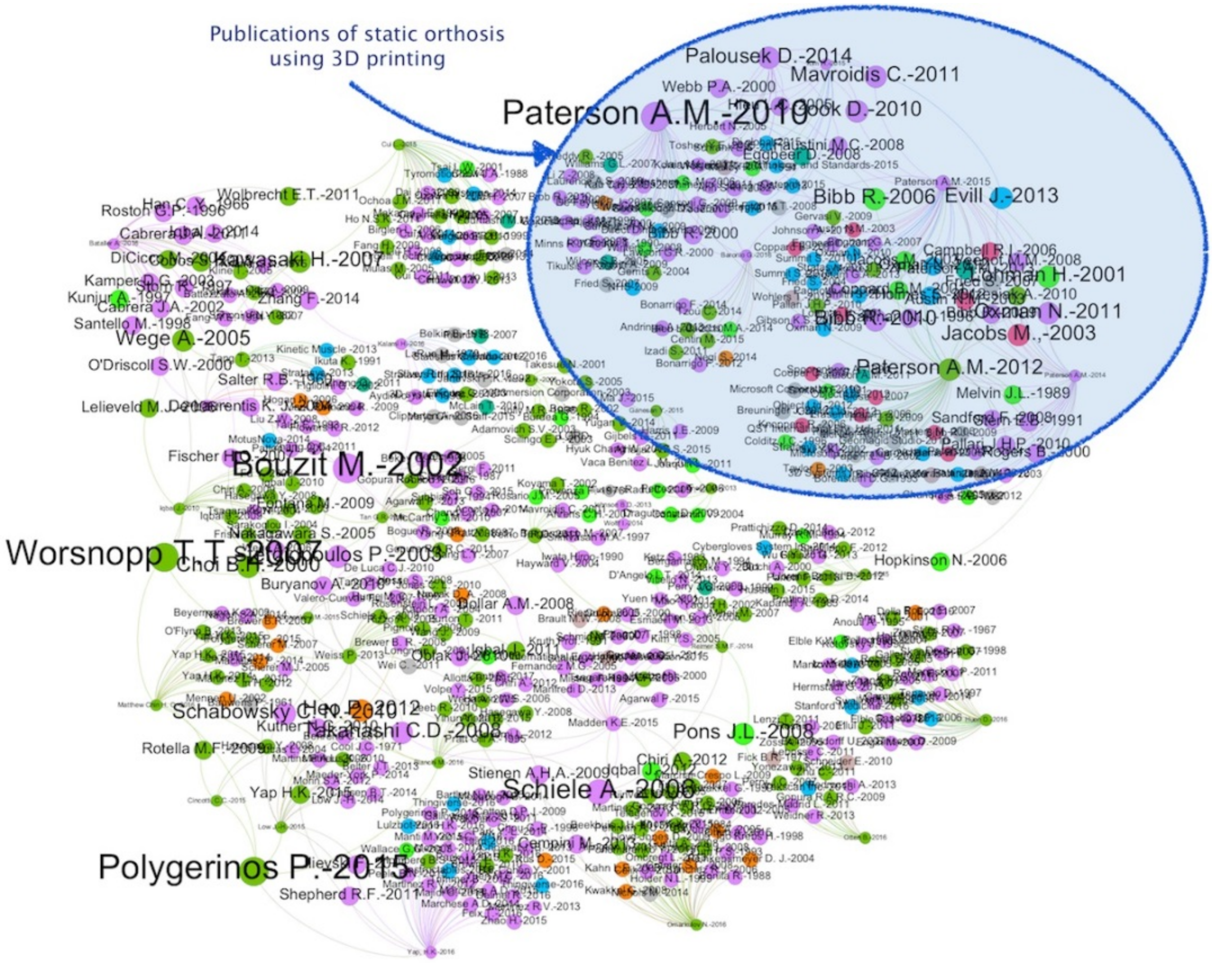

Figure 3 Bibliographic network map based on the indegree parameter and kind of document. The colours indicate document type. Magenta = papers, dark green = conference papers, blue = websites, grey = manuals, orange = reviews, light green = books, turquoise = theses. The size of the nodes are proportional to their indegree parameters.

and only ten percent were conference papers. These documents and their references are circled in Figure 3.

The lack of interaction between publications related to dynamic orthoses and those for static orthoses can also be seen in Figure 3. Only one such connection can be noted: 'Hopkinson (2006)' (Hopkinson et al. 2005), which is shown in light green, on the far-right side in the middle of the map. This single connection was cited by Paterson et al. (2014) from the set of static orthoses and by Madden and Deshpande (2015) from dynamic orthoses.

The most cited author from the analysed documents was Paterson, who published four pieces across a six-year period: Paterson et al. (2010), Paterson et al. 2012), Paterson et al. (2014) and Paterson et al. (2015). These publications discussed methods for image capturing and fabricating orthoses using 3D printing.

Additionally, the betweenness centrality was estimated to identify the authors with more influence on the topic. This parameter is often used to grade nodes on network maps according to their spatial position, based on the number of shortest paths between two nodes that pass through a particular node (Brandes 2001). For instance, a node has a high betweenness centrality if it connects different parts of the network to each other, like a train station—different trains from different places running through one centralized station. From the information retrieved, only eight nodes had a betweenness centrality value (Table 2), while the value for the other nodes was zero. These eight nodes have an actual betweenness centrality value because they connect, not only to nodes of references, but also to some of the different publications retrieved. It should be noticed that Paterson is displayed three times in this list—with values of 189.0, 130.0 and 34.5—which shows the notable influence of the author on the flow of the knowledge network.

Table 2 Weighted indegree, weighted outdegree, and betweenness centrality of the eight nodes with a betweenness centrality value. Times cited = times cited in retrieved documents only.

Publication Label	Weighted Indegree	Weighted Outdegree	Times Cited	Betweenness Centrality
Paterson (2010) (Paterson et al. 2010)	5.0	33.0	5	189.0
Paterson (2012) (Paterson et al. 2012)	3.0	41.0	3	130.0
Madden (2015) (Madden and Deshpande 2015)	1.0	27.0	1	44.0
Weiss (2013) (Weiss et al. 2013)	1.0	23.0	1	41.0
Palousek (2014) (Palousek et al. 2014)	3.0	15.0	3	34.5
Paterson (2015) (Paterson et al. 2015)	1.0	44.0	1	34.5
Velho (2011) (Velho and Zavaglia 2011)	1.0	11.0	1	11.0
Tang (2013) (Tang et al. 2013)	1.0	12.0	1	8.0

Figure 4 shows the map of the bibliographic coupling carried out among the publications about static hand orthoses, while Figure 5 shows the map of bibliographic coupling for dynamic hand orthoses. In both figures, the size and colour of the nodes are proportional to their indegree parameters; the higher the value, the bigger and darker the node. Similarly, the citations received by each node are represented by incoming arrows, while the outgoing arrows are connected to the citing documents.

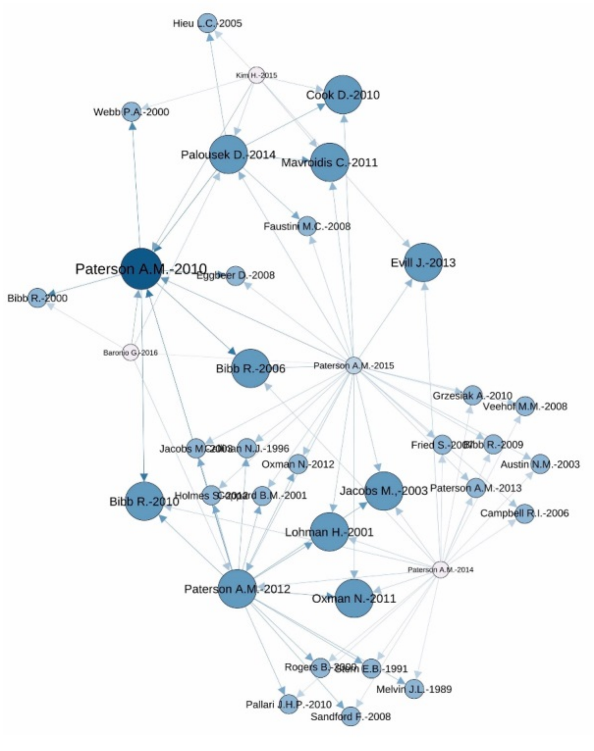

Figure 4 Bibliographic coupling for publications in static orthoses for the hand.

The bibliographic coupling analysis observed that the highest number of coupled cites was 12, between Paterson et al. (2014), shown on the right side of the map in Figure 4, and Paterson et al., (2015), located in the map's upper corner. However, though the number of shared references was high, these sources were selected by the same author and were, thus, negated for our research purposes. The second set of documents coupled were Paterson et al. (2015) and Palousek et al. (2014), with four citations in common (namely, Faustini et al. (2008), Cook et al. (2010), Mavroidis et al. (2011) and Paterson et al. (2010)), as in Figure 4. Both Paterson (2015) and Palousek (2014) described methods for designing customised splints using 3D printing, while the cited papers from Faustini (2008), Cook (2010), and Mavroidis (2011) dealt with the use of AM for foot orthoses, serving as referents for

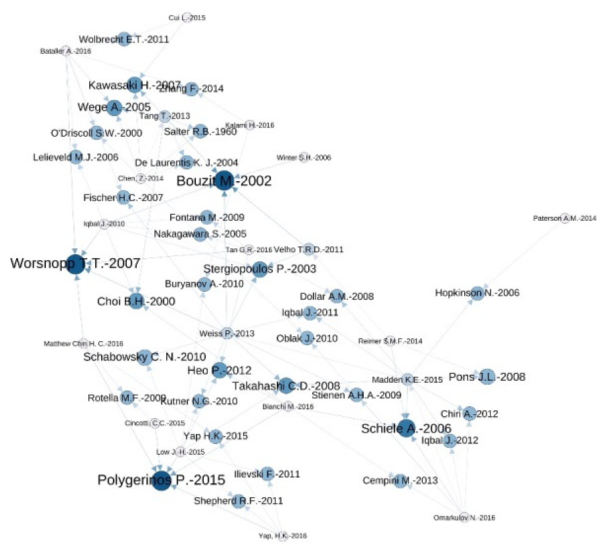

Figure 5 Bibliographic coupling for publications in dynamic orthoses for the hand.

researching methods applicable to personalised hand orthoses. For dynamic orthoses, there was a reduced number of papers coupled with their references. This was because there were no documents sharing more than two resources. As this resulted in a bibliographic coupling of less impact, the most cited documents were listed instead.

Table 3 lists the documents with more citations (4-5). From the documents listed in Table 3, Paterson et al. (2010) was the only one from the set of static hand orthoses, and this document was published by the institution with the most articles on the subject, Loughborough University.

The number of institutions with most publications was found to be limited. Despite this, Loughborough University had the most publications (four papers), followed by the National University of Singapore and Shanghai Jiao Tong University, with two articles each.

4. DISCUSSION

This study applied the scientometric tools of bibliographic occurrence, bibliographic coupling and collaboration network analysis to identify the institutions working on the development of hand orthoses using AM. Results revealed that the implementation of AM for developing personalised hand orthoses is not present in a high number of publications and collaboration between different institutions to publish jointly is rare.

From the 34 scientific publications detected, a total of 42 affiliations were identified. A network map analysis was carried out using Gephi™, in which only the affiliations with documents cited at least once were considered. This resulted in 20 affiliations. The highest number of affiliations working collaboratively was three: Loughborough University co-authored with the University of Manchester (Paterson et al. 2015) and the Royal Derby Hospital (Paterson et al., 2014). This was considered an important collaboration, not only for the number of affiliations involved, but because one of them is a medical institution. A second collaboration with a medical affiliation was found in Australia, where Curtin University's School of Physiotherapy and Exercise Science partnered with the Mechanical Engineering Department. These, however, were the only multidisciplinary collaborations the analysis discovered.

The limitations of this study lie in the novelty of applying AM to medical devices. While the first searches did not produce results when using terms related to dynamic orthoses, this changed after adding exoskeleton terms. Exoskeletons provide enormous advantages as, in many cases, they include sensors and electronic systems to improve rehabilitation (Iqbal et al. 2010; Worsnopp et al. 2007).

For this research, a co-citation analysis could not be carried out because of the small number of citations of the documents retrieved. Further analyses might embrace a higher number of publications as the application of AM in the development of orthopaedic devices is growing quickly.

Table 3 Publications with four or more citations.

Reference (Number of citations)	**Title**	**Cited by:**
Paterson et al. 2010 (5)	A review of existing anatomical data capture methods to support the mass customisation of wrist splints	(Paterson et al. 2012), (Palousek et al. 2014), (Kim and Jeong 2015), (Paterson et al. 2015), (Baronio et al. 2016)
Polygerinos et al. 2014 (5)	Soft robotic glove for combined assistance and at-home rehabilitation	(Cincotti et al. 2015), (Low et al. 2015), (Chin et al. 2016), (Yap et al. 2016), (Bianchi and Buonamici 2016)
Worsnopp et al. 2007 (5)	An actuated finger exoskeleton for hand rehabilitation following stroke	(Iqbal et al. 2010), (Weiss et al. 2013), (Tan and Robson 2016), (Chin et al. 2016), (Bataller et al. 2016)
Bouzit et al. 2002 (4)	The Rutgers Master II: new design force-feedback glove	(Winter and Bouzit 2006), (Iqbal et al. 2010), (Velho and Zavaglia 2011), (Weiss et al. 2013), (Tang et al. 2013)
Schiele and Van Der Helm 2006 (4)	Kinematic design to improve ergonomics in human machine interaction	(Reimer et al. 2014), (Madden and Deshpande 2015), (Omarkulov et al. 2016), (Bianchi and Buonamici 2016)

5. CONCLUSION

The scientific documents and patents involved in the personalisation of hand orthoses using AM were tracked back to 2006 through an enhanced CTI analysis using scientometric and network map analysis tools. The main knowledge area involved in this technology was found to be engineering. This information was corroborated in the collaboration analysis, which also disclosed that there has been minor participation of medical affiliations.

The analysis uncovered that the relevance of the information retrieved depends highly on the search strategy, which was carried out through the building and testing of different queries that were later validated by experts. Despite the low number of publications and patents obtained, the tools used to perform the analysis were useful for identifying main authors, institutions, and collaboration networks. Bibliographic occurrence and bibliographic coupling also constituted a valuable resource to understand knowledge diffusion through citations and to determine the dynamic of the research in a specific field. Furthermore, network map analyses enabled identification of publishing collaborations among affiliations. The methodology presented in this paper can be implemented to obtain a more complete analysis of the institution's research dynamics, particularly of emerging technologies. The tools used in this research can be applied over a wide range of areas to better understand the interaction between authors and affiliations, and to identify those most influential in their fields.

The proposed method would require future improvement by comparing results with opinions of experts to validate the main outcomes.

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7. CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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Characterizing business intelligence tasks, use and users in the workplace

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ABSTRACT This paper investigates business intelligence (BI) tasks, use and users in a workplace setting. The study reports on a mixed methods study of users in three different types of organisations employing BI. 1052 respondents answered a survey and 15 individual and 3 group interviews were conducted to elaborate on the survey results. The study finds that the majority of public BI users are employees, and fewer managers and students, that are handling a variety of tasks. Although they can experience challenges learning and using the BI system, they are still satisfied with it from different perspectives.

KEYWORDS Business intelligence, information system use, workplace studies

1. INTRODUCTION

In 2017, Gartner performed a worldwide survey of IT spending among 2500 chief information officers (CIOs). Business intelligence (BI) was one of the top technology priorities they identified ("Gartner Survey of More Than 2,500 CIOs Charts the Rise of the Digital Ecosystem," n.d.). One of the reasons for this focus on BI can be attributed to the increasing importance of BI systems. BI can be defined as "a broad category of technologies, applications, and processes for gathering, storing, accessing, and analysing data to help its users make better decisions" (Wixom & Watson, 2010, p. 13). In recent years, BI technologies have received considerable attention from both industry and the public sector (Chen et al. 2012). BI is an interesting technology because several studies have shown that there is a relationship between computer-driven decisions and organisational performance (Brynjolfsson, Hitt, & Kim, 2011). However, achieving BI success depends on both organization and staff characteristics (Worley et al. 2005; Salmasi et al. 2016). Salmasi et al. (2016) previously conducted a study of organisational level competences in achieving success with BI. However, García and Pinzón (2017) found that amongst others, the human perspective along with learning and skills are highly important to success. Therefore, we will focus on the individual perspective and focus on the users in this paper.

At the same time as the development of government processes, organisations and technologies are expected to change government employees' tasks. Before the emergence of e-government, governments' information technology and data management tasks were largely related to employment (see Kraemer & Dedrick, 1997). Today, changes in work tasks are an expected consequence of governments' digitising efforts. In particular, e-government is expected to affect the composition of public employees' tasks (Dörfler, 2003; Snellen, 2002). Jürgensen (2012) documented employees' expectations within the framework of administrative grants and found that specific, routine tasks had fallen from employees' daily tasks while the proportion of challenging applications had risen. Others note similar findings regarding tax department employees.

The present paper is concerned with characterising the tasks users solve with BI. Thus, to achieve success with BI at the user level, there is a relationship between task characteristics and success (Petter et al. 2013). Furthermore, we examine BI systems' ability to underpin the tasks their users solve with BI in a Danish e-government setting. The use of BI in e-government has spread worldwide in the latest decade. By improving access to BI among employees, governments are aiming to improve their decision-making processes, resource use, increase quality of the services delivered or even reduce costs.

The paper is structured as follows: In the following section, we review existing studies of task characteristics and present the theoretical framework for the data collection process. The next section is a presentation of the research methods applied in the study: a survey questionnaire, 12 semi-structured interviews and three group interviews. The subsequent section presents our findings with regard to the research question. The paper concludes with closing remarks and suggestions for further research.

2. THEORETICAL BACKGROUND

2.1 The concept of a task

A task is what individuals engage in to keep their work or life continuing (Li & Belkin, 2008), and the concept of 'tasks' is important in human–computer interaction. A task (whether work- or leisure-related) may trigger information-oriented activities (Byström Katriina & Hansen Preben, 2005). On this basis, the task becomes a central element of any user's context, as it arises from an incident external to the user that first triggers an information need, followed by a searching activity (Ingwersen & Järvelin, 2005). Being external to the user, the task, as such, will be easier to observe and measure, from a research perspective, if compared to information needs that are inherent to the user.

Tasks have been analysed in human–computer interactions from many different perspectives. Historically, the focus on tasks went from a technical (ergonomic) perspective, to a conceptual (information processing) perspective and then to work-process (contextual) models (Crystal & Ellington, 2004).

Different approaches can be followed to gain insight into tasks in specific contexts. Hierarchical task analysis breaks generic tasks into smaller sub tasks with related sub goals. (Stanton, 2006). The purpose is to become able to map goals, and sub goals in particular, with technologies or information systems to ensure successful solutions for the users' tasks.

A different way of perceiving tasks is to model them according to Li and Belkin's (Li & Belkin, 2008) taxonomy of task characteristics. Departing from a literature review, the taxonomy defines tasks on the basis of generic facets and common attributes, thus representing a top-down perspective on the task concept.

The different approaches to understanding and operationalising tasks emphasises the importance of the concept in human–computer interaction. We have not identified any papers to date within the BI systems field that have attempted to identify and characterise the specific tasks users carry out. The purpose of the current paper is to address this gap in the research in a public organisation context.

2.2 DeLone & McLean: The IS Success Model

DeLone and McLean's IS success model (DeLone & McLean, 1992) is used to frame the study. The model represents a framework for understanding influential factors on information systems' success. The identified variables in the model include system quality, information quality, use, user satisfaction, individual impact and organisational impact. We use the model to frame the quantitative data collection below, as it represents a consolidated theoretical model (eg. Iivari, 2005), providing both an organisational *and* system-based perspective on the notion of tasks.

3. RESEARCH DESIGN AND METHOD

In this study, we used a multiphase 'mixed methods' research design. The research design consists of two main phases, namely a questionnaire and interviews. The mixed methods approach represents a form of triangulation; the quantitative approach provides a broader view, while the qualitative approach provides greater depth. Together, the approaches yield results from which more accurate inferences can be made (Seddon et al. 1999).

3.1 Quantitative method

We chose a questionnaire to research users' perceptions of different task characteristics.

Data were collected via an online survey available for a specific period during the spring of 2017. All respondents were BI end-users who had access rights to their organisation's BI system. The users accessed the BI web client through a browser, meaning that BI can be implemented across an entire organisation without having to install software on each machine. All BI users from three public organisations were invited to complete the survey. The three organisations were a municipality using Business Objects, a public healthcare organisation (among 12 hospitals) using Tableau and a university using QlikView.

Initially, we conducted a pilot study before distributing the survey to all invitees. The survey was based on a literature review, and three researchers in the field evaluated the questions. Afterwards, BI users with differing levels of BI experience evaluated the questionnaire using a think-aloud test (Nielsen, 1994). Minor refinements were made based on these results. The final part of the pilot study called for testing the survey on 24 BI users. After evaluating those results, the questionnaire was distributed by email to 4901 invitees. Participants accessed the questionnaire via a personal invitation email with a unique link to the online survey. Each respondent received an adapted questionnaire depending on whether he or she had previously used or never used the BI in question. Participation in the survey was voluntary, and two reminders were sent. In total, 1741 people completed the survey, resulting in a response rate of 35.52%. Among these, 1052 were used for the statistical analysis, as 689 respondents indicated that they did not use BI. All data were analysed in SPSS version 24.0.

3.2 Qualitative method

The next step in our research design was interviewing BI users. In addition to the questionnaire, we used interviews for three reasons: qualitative data can explain the complexity of the users' tasks identified in the survey, data from interviews helps us to grasp the users' contexts and interviews make it possible to check for potential additional elements of BI systems' successes or failures (Driscoll et al. 2007).

We conducted 15 interviews as part of the qualitative study, and three group interviews with a total of seven participants were arranged for the three organisations. The results from the survey were presented to the groups, and the participants in the group interviews commented on the survey results. Afterwards, we formulated a semi-structured interview. The semi-structured interviews had an average length of 45 minutes.

All interviews were transcribed and analysed in NVivo version 11.0. We used a deductive method to categorise the different tasks' descriptions. The different categories were adapted from earlier work. We will use the interviews to exemplify quantitative findings in the analysis.

4. RESULTS

The results of the study are presented in three sections: end users' characteristics, task characteristics and the users' assessments of BI success.

4.1 End user characteristics

In the survey, the respondents were asked about their gender, age (Table 1), education, organisational role and experience.

Table 1 Respondents' ages.

Age	N	%
20–29 years	66	4
30–39 years	225	22
40–49 years	345	33
50–59 years	325	31
60–69 years	91	9
Total	105 2	100

Table 2 Organizational roles.

Role	N	%
Employees	758	72
Managers	223	22
Students	65	6
Missing	6	0
Total	1052	100

Most of the respondents were women (73%). As shown in Table 1, the majority of respondents were 40–49 years old.

Their educational levels varied; most commonly, the respondents either held a master's degree (35%) or a vocational degree (30%) (see Figure 1).

The respondents' organisational roles were distributed among employees (72%), managers

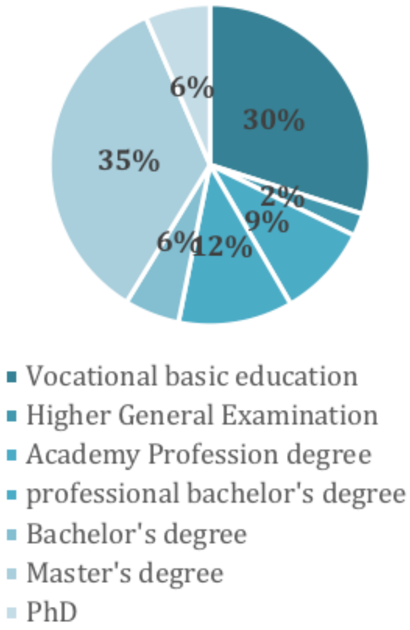

Figure 1 Respondents' educational levels.

(21%) and students (6%) (see Table 2). For the sake of comparison, Negash & Gray (2008) found that BI is mainly used by managers and highly educated employees.

Finally, we can characterise the respondents in terms of their BI experience. The distribution appears in Figure 2. The question asked the respondents to assess their BI experience on a scale from 1 to 5, where 1 is 'little experience' and 5 is 'great experience'.

More than three-fourths (76%) of the respondents rated their BI experience at 3 or below, indicating that they were not highly experienced users. Here, it should be noted that two of the three organisations under investigation had used BI for a number of years, while one implemented BI about two years ago (in 2016). This difference of time spent with BI may explain some of the differences in experience assessments among the organisations. In related studies, technology experience has been found to be a critical factor for system success (Dishaw & Strong, 2003; Marshall et al. 2000; Thompson et al. 1994). Corresponding explanations were found in the interviews. One interview participant explained:

"…the more experience you get with the system, the more you think: 'Well, this is fine and really easy to understand'. But then when you get out and have to explain it – for instance at meetings in our controller group, if I have prepared something and ask 'What do you think about this?', then they are like, 'We don't understand that', and I think, 'Well, that is easy to understand'. But you easily get into an understanding of what you think is easy to understandable" (2017).

Apart from confirming the importance of experience, the quote above also illustrates the difference between system users (users interacting with the system) and information users (employees using the information from BI).

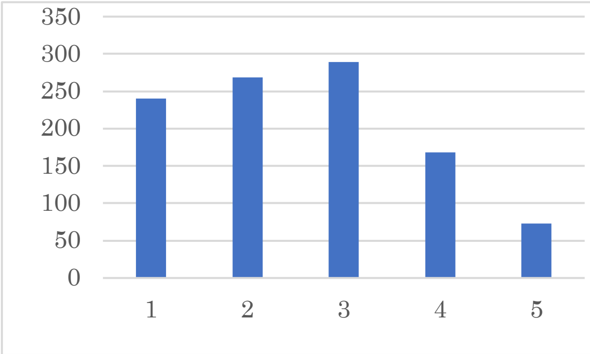

Figure 2 Respondents' assessments of their BI experience

4.2 Characteristics of BI tasks

We identified BI tasks from several different dimensions in the study. At an overall level, the respondents were asked what BI was primarily used for. The distribution of their answers is shown in Figure 3. More than half (56%) reported their main use is for data extraction, 29.8% point to reporting and the last 14.2% mentioned ad-hoc analysis as their most frequent use of the system.

The respondents were also asked what specific BI functionalities they use. The results appear in Figure 4. As shown, the most-used function by far was data filtering, followed by compiling data in a table and visualisation. Less common functionalities included drilling down, layout formatting, calculations (e.g., numeration) and merging (e.g., linking data together from different sources).

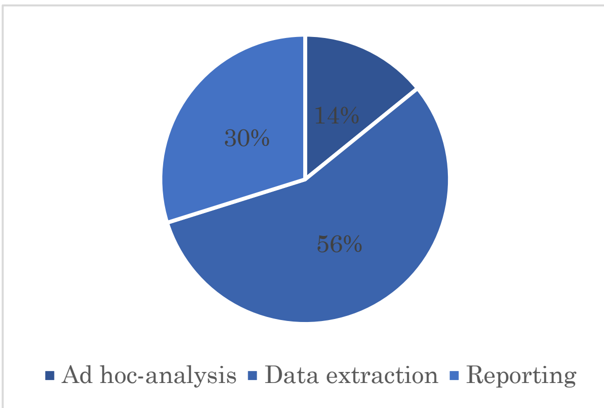

Figure 3 What is BI primarily used for?

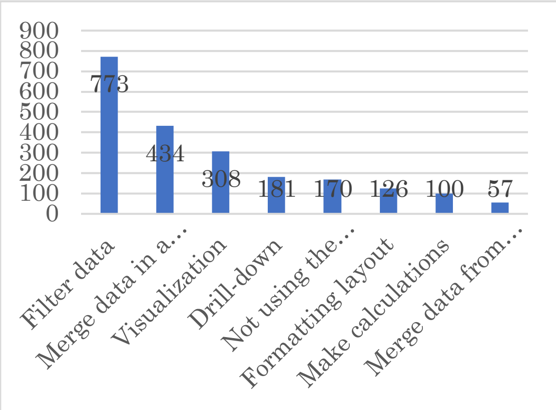

Figure 4 Functionalities used in BI

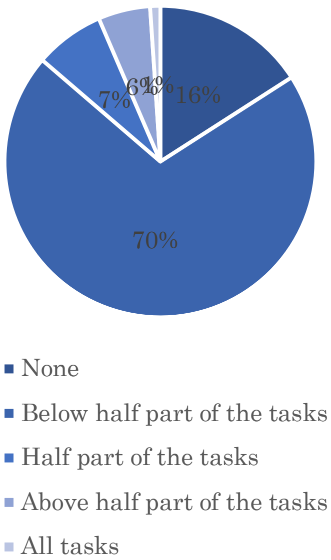

Figure 5 The amount of work tasks in which BI is used

Figure 5 presents the share of tasks that BI represents among the total tasks handled by the respondents. As is evident from the figure, the majority use BI less than half of the time, or not at all. Thus, BI use represents a minor part of the total number of tasks respondents handled. However, based on interview data, it appears that, despite these minor use patterns, users still consider BI to be an important tool in their everyday work practice.

All statements in the survey were rated on a 5-point scale, with 1 being *highly disagree* and 5 being *highly agree*. As shown in Table 3, the mean response rating is above 3, indicating that the respondents more or less agree with the statement.

The statement with the lowest rating addresses the amount of data in the system and the relation with the respondents' tasks. In the interviews, more participants claimed that they think the amount of data is appropriate. One comment may explain some of the lower rating of the statement. The participant states:

"As regards the report module, I can create the things I would like to, but it is less appropriate in terms of publication and dissemination. It comes in short in terms of saying 'We would like to continue here, but we can't with this tool, so we need new technology to move on'" (2017).

Table 3 Univariate statistics on 'Task compatibility'

Reply	Min	Max	Mean	SD
This information is useful for my work	1	5	3.86	0.974
This information is complete for my needs	1	5	3.28	0.976
This information is sufficiently up-to-date for my work	1	5	3.46	1.04
This information is relevant to our work	1	5	3.45	0.943

Table 4 Univariate statistics on 'Task significance'

Statement	Min	Max	Mean	SD
The tasks I complete in BI are an important part of my tasks.	1	5	3.44	1.180
I make decisions on the basis of the tasks I complete in BI.	1	5	3.32	1.284
My tasks completed in BI are important to other employees in the organisation.	1	5	3.50	1.176
Other people make decisions based on the tasks I complete in BI.	1	5	3.45	1.234
My tasks in BI are important for collaborators outside the organisation.	1	5	2.28	1.273

Error! Reference source not found. shows the distribution of responses as regards 'Task significance'. In all statements, except for the last one, the mean value is between 3 and 4. In general, the respondents consider their BI tasks to be important, and they or others make decisions on these tasks. The respondents do not consider the tasks to be important for collaboration outside of their organisation, so the BI is instead used as an internal tool. The following quotes from the interviews illustrate the significance of BI tasks:

"The tasks are pivotal, because we need to touch upon the economy so much. We need to file reports very, very much" (2018).

"I think it is quite important, at least in relation to many of the requests we get. We get a lot of requests that are used politically, or […]

So, if we didn't have the option […]. Usually, it is with a very short time frame, where a politician asks, 'We need this for our…' Or it can be on the same day that you are in a meeting and they go, 'We need this…' and that would then be within an hour" (2017).

The quotes illustrate why BI is important to the users. One thing is that they need to file reports within their organisations. The other is that several users receive requests from others regarding facts that are being drawn from the BI system.

Table 5 Univariate statistics on 'Task interdependence'.

Statement	Min	Max	Mean	SD
If I do not complete my tasks in BI, one or more employees in the organisation cannot complete their tasks.	1	5	2.49	1.346
In BI, I can only do tasks if one or more employees have completed another task first.	1	5	2.61	1.378
I am independent of other employees to prepare tasks in BI.	1	5	2.94	1.339

Task interdependence reflects the users' dependencies in relation to the system; this can be in terms of a user's dependence on something, or another's dependence on the user. These assessments are presented in Table 5. Here, we can see that, across all three organisations, the users do not depend on anything to use BI themselves. It is assumed that the BI system is available, updated and so on. Further, the respondents disagree that their tasks depend on colleagues' completion of other tasks first. Although the ratings for task interdependence are low, the interviews revealed dependencies, typically in the participants' ability to deliver information to other employees, such as managers. To illustrate:

> "Well, the closest managers" (2017).

> "The department management, and then our doctors. They are the ones using me for this" (2017).

> "That would typically be our political committees or the management of our administration" (2017).

A partial explanation for the dependencies reported of the respondents may be found in this quote from the interviews:

> "Everyone can go in and get data. It is just not everyone [who] know[s] how to use it. The benefit of asking me is that I know data better than most people, and by that I also know how to use data and how to do this. That's how it works" (2017).

In sum, one of the barriers to employees' access to the BI system is a lack of knowledge of the underlying data models.

The respondents were also asked about the difficulty of the tasks solved by the BI system. The assessments appear in **Error! Reference source not found.**.

Table 6 Univariate statistics on 'Task difficulty'.

Statement	Min	Max	Mean	SD
BI makes it possible to complete complicated tasks.	1	5	3.12	0.984
The tasks I complete in BI require specialised knowledge.	1	5	3.05	1.127
The tasks I solve in BI are ones I have never faced before.	1	5	2.55	1.207

The assessments of the two first statements in Table 6 signal a neutral attitude. The latter statement, concerning the novelty of the tasks, demonstrates that the users, to some extent, consider BI tasks to be routine. Despite their ratings of the statements, the interviews reveal nuances of task difficulty. Thus, the interviews demonstrate examples of both routine and more complex tasks. To illustrate routine tasks, consider:

> "Well, if I have to do a monthly follow-up, then I need to define and follow up on every cost centre and see the transactions, if they are okay. That is like a routine task" (2017).

> "That is when I make a list of the patients we had for the last five years with a specific diagnosis. Super easy task, because the template was developed for that purpose. Some BI people have been thinking big thoughts, and there are very good headings for what you should go and look for in the system, so it is just a matter of going in and typing your filters" (2017).

However, the interviews also reveal examples of more complex tasks. For instance:

> "We had some where we should combine the kind of medicine they got, which is a standard extract in BI, with how long they were hospitalised. So, they should have had both a certain kind of medicine and be hospitalised for more than five days, for instance" (2017).

Here, the complexity consists of combining different data types. Another kind of complexity is when the underlying data models are complex. For example:

> "Yes, you need to know your data and which… You could believe that you have the right data and then there is really something you didn't take into account. I think I have tried that quite often, at least in the first couple of years I was working with this. That you think that you had everything under consideration and then there is some kind of twist of it" (2017).

The last cluster of statements, regarding the users' tasks, concerns the specificity of these tasks. The assessments appear in Table 7. The respondents' assessments are average when rating to what extent the tasks are defined before they start solving them. There is a general agreement that the tasks can be solved in different ways. Again, the table indicates some extent of the routine tasks in the low rating of the repeatability of the tasks in the last statement.

Table 7 Univariate statistics on 'Task specificity'.

Statement	Min	Max	Mean	SD
My tasks are always defined before I complete them in BI.	1	5	3.03	1.061
The tasks I complete in BI can be done in more than one way.	1	5	3.29	0.935
Normally, I do not complete the same kinds of tasks in BI.	1	5	2.03	1.117

4.3 Users' assessments of BI success

In addition to the respondents' background characteristics and the characteristics of their BI tasks, the survey also considered system and information quality as independent variables that influence the success of the BI system. The assessments of system quality appear in Table 8. In that table, all statements have mean ratings below 3, meaning that the users find the system difficult to learn, use and understand. The challenges are expressed in the interviews:

> "It requires quite a lot to learn how to use BI" (2017).

> "I would say that, about using the front end part of it, if you haven't used it a lot, then it can be quite difficult to find out how to present it" (2017).

Table 8 Univariate statistics on 'System quality'

Statement	Min	Max	Mean	SD
BI is easy to learn.	1	5	2.62	1.098
BI is easy to use.	1	5	2.74	1.094
The information in BI is easy to understand.	1	5	2.89	1.009

When the users have difficulties using the BI system, they report two strategies for the appropriation of the technology (Dourish, 2003). One is asking a colleague for help, which is considered an example of the employee aiming to adopt the technology. The other exemplifies adaptation. Here, the users import the data into Excel:

> "At times, I import it into Excel. I might as well admit it: I love Excel, including the graphical part. I like working with that" (2017).

Table 9 Univariate statistics on 'Information quality'.

Statement	Min	Max	Mean	SD
Data are displayed in a consistent format in BI.	1	5	3.11	0.948
The data in BI have high validity.	1	5	3.20	0.955
Other employees in the organisation also think the data in BI have a high degree of validity.	1	5	3.04	0.871

Information quality is another aspect that influences the users' assessment of BI success. Three statements are included in the construct. The assessments appear in Table 9. Overall, the users have a neutral assessment of the three statements with a mean slightly above 3.

Thus, the users believe the consistency of the data to be reasonable. The data validity is rated slightly higher, while the users' impressions of other employees' impressions receive the lowest, but also most neutral, assessment. Regarding users' satisfaction with the BI system (see Table 10), they do not think that the system's functions and capabilities are as expected (rated at a mean of 2.82). However, they would still recommend the system to colleagues (rated at a mean of 3.21). The overall rating of satisfaction has a mean of 3.07.

Table 10 Univariate statistics on 'User satisfaction'.

Statement	Min	Max	Mean	SD
BI has all the functions and capabilities I expect it to have.	1	5	2.82	1.067
If a colleague asked, I would recommend BI.	1	5	3.21	1.161
Overall, how satisfied are you with BI?	1	5	3.07	1.014

The interviews revealed some of the issues the users experience with the system. In some cases, the users prefer to report in Excel. For instance:

> "It is not like it is working in the same way as a spread sheet with formulas and the like. It is a little more complicated and heavy to work with" (2017).

The users' individual impact is lower, when asked if they can make reports in BI effectively (mean of 2.98) and quickly (mean of 2.73). Completing the reports in BI is rated higher (mean of 3.04), suggesting that, although it may not be effective or fast, the users do finish their reports in the system (see Table 11).

Table 11 Univariate statistics on 'Individual impact'.

Statement	Min	Max	Mean	SD
I can effectively make my reports using BI.	1	5	2.98	1.105
I can complete my reports quickly using BI.	1	5	2.73	1.240
I can complete my reports using BI.	1	5	3.04	1.111

5. DISCUSSION

The data analysis has shown that the majority of respondents and active users of BI are employees, and not managers as found in other studies. To most respondents, BI was not playing a dominant role in their work life, which may also explain their assessment of their own experience as being limited. However, the users handle routine tasks and more difficult tasks in the system. The most important task handled in the BI system was data extraction and more specifically filtering data and merging them into tables. The most important use of BI is internally in the organisations. The users do not think it is very easy to learn how to use the system, but they do experience consistency and validity of the data in the system, and they would recommend it to colleagues.

The results of the study can be used to indicate how implementation can be approached to take into account the strengths and challenges users experience in using BI as a part of their work practice. The results demonstrate that the users still can experience challenges in using the system, although the system has been implemented for some time in all three case organisations.

This paper used DeLone & McLean (1992) for guiding the data collection. That enables comparison across diverse organisations for a general picture of BI use and users in the public domain. However, if the aim is a more detailed understanding of the BI tasks and related use in subdomains within this domain, more task-oriented theories as presented in the theory section could generate a more detailed understanding of task characteristics and the system use generated on that basis.

6. CONCLUSION

This paper has provided a picture of the characteristics of BI users and their tasks carried out by means of a BI system in different parts of the public sector. The analysis has not investigated differences between domains, but merely presents a cross sector perspective. Future research should aim to investigate further the differences between sub domains, the types of tasks generated, and the system success found as a consequence. This could provide useful inputs for the implementation of BI systems in the public sector.

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A competitive intelligence model based on information literacy: organizational competitiveness in the context of the 4th Industrial Revolution

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ABSTRACT This paper investigated how information literacy and competitive intelligence are connected in business management and information science fields. It demonstrates the contribution of information literacy in the phases of the competitive intelligence process. This paper is relevant, since the model supports creativity and collaborative innovation in small businesses in the context of Industry 4.0. Furthermore, it contributed to connect the information science and business management fields, so it is multidisciplinary. It also proposes a theoretical model of information literacy and competitive intelligence in the context of Industry 4.0, which can be used for applied research. The methodology was developed based on a systematic literature review (SLR) of information literature and competitive intelligence. These concepts contribute to the development of a framework and a conceptual model in which the three themes are interconnected and demonstrate that information literacy can efficiently contribute to the competitive intelligence process, especially in the context of the Fourth Industrial Revolution.

KEYWORDS Competitive intelligence; Industry 4.0; information literacy; systematic literature review

1. INTRODUCTION

Information literacy is understood as lifelong learning (Belluzzo and Feres, 2015; Bruce, 1999; Lloyd, 2017) and it is useful to competitive organizations. Information literacy enables organizational individuals to better understand information and convert it into knowledge. The knowledge constructed during the professional life contributes to the densification of critical thinking about the consulted information, so individuals can understand their backgrounds (Lloyd, 2017).

Competitive intelligence (CI) is based on scanning and monitoring information that significantly influences the market. In this perspective, the development of CI tools provides organizational individuals with more adequate conditions to face challenges. CI generates analyzed data and information that can be integrated into the organizational business (Tisluk et al., 2015). It also provides insights from external contexts, supports decision-making, and contributes to medium- and long-term strategies. CI reduces uncertainties about the competitive environment (Valentim and Souza, 2013).

The competitive environment became more complex in the context of Industry 4.0, which refers to the 4th Industrial Revolution. Industry 4.0 is related to the digital transformation and many technological drivers that allow organizations to create and innovate their products, services, and processes, whose differentials will be key to remaining in the marketplace (Anderl and Fleischer, 2015; Schwab, 2016). An increased amount of data generated by different technologies becomes available for individuals, but the value creation coming from the usage of data needs more investigation (Bordeleau, et al., 2018). Moreover, individuals who are involved in this revolution need to know how to intelligently access, evaluate, and use data and information in the CI process in order to improve decision making and better orient business strategy.

Information literacy is a significant predictor of online information search competencies (Çoklar et al., 2016), which is important to access information. However, having information access offers no guarantee that the information will be well evaluated and used by individuals. Librarians pointed out the relevance of effective instructions in order to fill gaps in the curriculum and prepare students to improve their skills to get and use valuable information (Howard and Stonebraker, 2018).

Considering information literacy is a critical competency in digital age, it can help managers to identify relevant information for decision making in business management. This paper has three purposes: the first one is to investigate how information literacy and CI are connected in the business management and information science fields. The second one is to demonstrate the contribution of information literacy in the phases of the CI process, which supports creativity and collaborative innovation in small businesses in the context of Industry 4.0. The third purpose is to propose a theoretical model of information literacy and CI in the context of industry 4.0, which can be used for applied research.

In the context of Industry 4.0 and digital transformation, a large amount of data and information is generated in all digital activities. Managers and employees need to know how to search and use information to construct meaningful knowledge. They can construct knowledge through information literacy. This process also happens with CI professionals because they also need to access external information (Ottonicar, 2016). Information literacy and CI are relevant elements to Industry 4.0 since they allow individuals to access different information sources.

This paper is organized as follows. The next section discusses the concepts of information literacy, CI and Industry 4.0. The subsequent section explains the methodology and shows some results of the SLR. The discussions and results section show the inter-relation between information literacy and CI in the context of Industry 4.0. Furthermore, it demonstrates a conceptual model that can be applied in business as future research. The conclusions highlight the directions for further research, the limitations of the paper and its relevance to businesses management and information science.

2. THEORETICAL REFERENCES

2.1 Information literacy

The information literacy concept emerged parallel to social changes, which resulted from the renewal of means of production. These changes influenced educational systems and libraries, since they are both traditional environments of information storage and dissemination (Gomes and Dumond, 2016). Furthermore, information literacy is fundamental to citizens and to their social integration. This literacy helps people to access, choose, manage and evaluate information (Belluzzo and Feres, 2015).

Information literacy is present in different organizations. It is related to individuals' capabilities and behaviors which were developed in their lives (Ottonicar et al., 2016).

Information literacy is studied in the field of information science, which is interdisciplinary. Because of that, information literacy is related to the political, technological, educational and organizational context (Ottonicar et al., 2016). Furthermore, this literacy is connected to individuals' experiences, since it shows how they seek, evaluate and create information (Demasson et al., 2016).

Information literacy has become more than individuals' abilities and skills. Bruce et al. (ACRL, 2014) demonstrated that information literacy is also relational. It depends on the context studied and described in a complex information environment. The advantage of this approach is the creation of many information literacy models in different fields.

According to ALA (2016, 3) information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning. It is also understood as "the ability to think critically and make balanced judgements about any information we find and use. It empowers us as citizens to develop informed views and to engage fully with society" (CILIP, 2018).

In the context of the workplace, information literacy contributes to employability, and it helps individuals to develop work analysis, solve problems (CILIP, 2018) and support efficient decision making (Ottonicar, 2016; Yafushi, 2015). These studies demonstrate that information literacy research is increasing in the field of business and management (Rader, 2002).

According to Sproles et al. (2013, 409) "information literacy has become an integral part of the library literature and has been adopted and implemented outside the traditional venues of reference and instruction services". Information literacy is fundamental for business processes within organizations (Jinadu and Kiran, 2014, 2016). Strategic, tactical and operational levels can benefit from identifying and using critical knowledge. This knowledge inspires creativity, innovation and competitiveness (Ottonicar, 2016).

2.2 Competitive intelligence

The term competitive intelligence (CI) was coined in 1980 and its purpose was to monitor the external environment. This process allows the integration of information and data in real time and influences decisions that are useful, considering time and speed in data generation nowadays (Souza, 2016). Information and data are different. Data is understood as facts, measurements and statistics. Information is defined as the action of informing, and knowledge involves the development of experience through learning. Intelligence is the ability to understand and use knowledge practically (Bouthillier and Shearer, 2003).

The main purpose of CI is to access, interpret, evaluate and disseminate information. This information is gathered in the external context of the organization. The analysis of external information is fundamental to the process, since intelligent information contributes to product and service innovation. Furthermore, it influences innovation speed and the quality of the final products (Hassani and Mosconi, 2017).

CI is a continuous process, since it has no beginning, middle or end. That process works in a business environment continuously (Valentim, 2004). It allows the explanation of data through graphics, charts and tables, so individuals can construct knowledge from that information (Teixeira, 2014). Other professionals such as business managers also need to understand the opportunities and threats that influence organizations (Hoffmann and Chemalle, 2006).

Innovative technologies contribute to CI since a professional can use potential information available in social media and in emergent technologies that are catalyzers of the 4th Industrial Revolution (Hassani and Mosconi, 2018). In the past few years, only formal information sources were analyzed, but it is not enough anymore (Tisluk et al., 2015; Cubillo, 1997). According to Jin and Ju (2014) the complexity of the task influences the professional to access more information sources, making information literacy fundamental to guide individuals to analyze the quality of these sources.

Calof (2016, p. 48) explains that: "Competitive intelligence assists organizations in developing a proactive approach that identifies and responds to changes in the competitive environmental, helping organizations (companies, governments, universities, associations and others) thrive in turbulent times". This intelligence is useful for many kinds of organizations.

CI has many concepts in both the business management and information science fields. In this paper, CI is understood as a process that is the result of individuals' actions. Professionals need to access and evaluate data to transform it into information. The use of that information allows for knowledge construction, decision making, problem solving and innovation.

2.3 Industry 4.0

The first Industrial Revolution occurred through steam engines in 1784. The second one started in 1870 because the machines worked with electrical power. The third Industrial Revolution started in 1969 with the arrival of electronics and information technology. This technology evolved and connected to cyber-physical systems (CPS), so those connected technologies became more complex. It includes the Internet of Things (IoT) of objects and services. (Kagermann et al., 2013).

Therefore, Industry 4.0 is an ongoing process (Kagermann et al., 2013). Xu et al. (2018, 2942) agree with Kagermann et al. (2013), since they emphasize: "During the Fourth Industrial Revolution, the use of cyber-physical systems (CPS) has triggered a paradigm shift in industries, in particular the manufacturing sector" (Xu et al. 2018, 2942). Industry 4.0 is a current phenomenon and it will influence the production of society. CPS are a fuel that encourages that revolution. CPS are objects with software and computer skills, so the products are smart. The objects are based on connectivity and self-management (Almada-Lobo, 2015).

Mass production is disappearing; there are more and more customized products based on clients' needs. The production chain is becoming transparent and its elements are becoming integrated, since the physical fluxes are controlled by digital platforms (Almada-Lobo, 2015). Because of that, Industry 4.0 will influence business in a positive way, and it can be used in developing countries (Silva et al. 2018).

In this paper, the IoT is not understood as a synonym of Industry 4.0, because it involves objects and biological technology. The IoT is part of the Industry 4.0 processes. The IoT allows the dissemination of electronic information between objects. Therefore, the family, logistics and public management will be affected by those changes (Dutton, 2014). Industry 4.0 is transforming individuals' lives (Schwab, 2016), and furthermore, it encourages competitiveness and process improvement (Anderl and Fleischer, 2015).

3. METHODOLOGY

This methodology was developed based on a systematic literature review (SLR) of information literacy and CI (Sampaio and Mancini, 2007; Cook and Mulrow, 1998). The primary study is the first step of the SLR, in which we analyzed the title and the keywords of papers. They were "information literacy" AND "competitive intelligence". Table 1 shows the protocol of the SLR followed by the authors to get the results.

Table 1 – **The connection between information literacy, competitive intelligence and Industry 4.0.** The information on literacy standards, indicators and expected results developed by Belluzzo (2007), the steps of competitive intelligence based on concepts and results of Industry 4.0 to business and society. This table allowed to connect these three themes, and also demonstrate the importance of competitive intelligence based on information literacy. Therefore, information literacy can help in every step of competitive intelligence, so information can be gathered in a more effective way. Information literacy contribute to competitive intelligence because it helps individuals to find quality information and evaluate the information source critically.

The context of Industry 4.0	CI Steps	Information literacy standards, indicators and expected results
The context provides a lot of information	Identify the niches of external and internal intelligence.	**S1** Individuals identify the nature and extent of the information need. **I. 1.1** Define and recognise information need; **I. 1.2** Identify a variety of formats and potential information sources; **I. 1.3** Consider the costs and benefits of information acquisition;
Smart and connected technology emergence, such as smart factory	Prospect, access and gather data, information and knowledge in the internal and external context of the organization.	**S2** Individuals access needed information effectively; **I. 2.1** Select the appropriate research methods or information systems; **I. 2.2** Construct and implement search strategies established effectively; **I. 2.3** Seek information electronically or with people. Use a variety of methods; **I. 2.4** Rework and improves the search strategy when it is needed; **I. 2.5** Extract, register and manage information and its sources.
The information sources are humans, technology, biological and digital elements	Select and filter data, information and knowledge relevant to people and organizations	**S3** Individuals evaluate information and its sources critically; **I. 3.1** Demonstrate knowledge about the information gathered; **I. 3.2** Apply evaluation criteria to information and its sources;
The smart technology transforms data in information adding value to the information	Treat and add value to data, information and knowledge	**I. 3.3** Compare the new knowledge of the previous knowledge to determine the value added, contradictions, or other characteristics of information;
New systems of information storage in groups of technology in real time	Store data, information and knowledge through technology focusing on quality and safety	**S4** Individuals use information effectively to reach a goal or a result individually or in a group; **I. 4.1** Individuals are capable of synthesising information to complete a project, activity or task;
The smart technology and factory share information in a massive way	Disseminate data, information and knowledge through services and high value-added products	**R. 4.1.2** Understand how to use an author's citations, paraphrases or texts to support ideas and arguments. This item is used for writing activities, reports, documents and manuals; **I. 4.2** Communicate the results of the projects, activities or work effectively; **R. 4.2.1** Use documentation norms and formats properly to develop a project, activity or work task.
The smart technology and factory bring new issues to be debated. For example, the disappearing of some professions and unemployment	Create mechanisms of feedback to generate new data, information and knowledge	**S5** Individuals understand economic, legal and social issues of information use. Also, they access and use information ethically and legally. **I. 5.1** Understand the legal, ethical and socioeconomic issues which involve information, communication and technology; **I. 5.2** Respect laws, rules, institutional policies and guidelines related to information access and information source use. **I. 5.3** Indicate the information source in the communication of results;

The downloaded papers fulfilled the inclusion and exclusion criteria described in Table 1. The search terms constructed used the keywords described in Table 1. After the transcription of keywords in search mechanisms, we read the title and keywords to apply the inclusion and exclusion criteria. Extracted information referred to contributions of information science and business management in the competitive context. The information search was performed in five databases: SCOPUS, Web of Science, Proquest Library and Information Science Abstracts (LISA), Proquest Central and EBSCO Library, and Information Science and Technology Abstracts (LISTA).

Table 2 **Results of RSL.** The quantitative results of the systematic literature review. The papers were found in 4 data bases: SCOPUS, Web of Science, Proquest Library and Information Science Abstracts (LISA), Proquest Central and EBSCO Library, Information Science and Technology Abstracts (LISTA). The first column shows the names of the data bases, and the second one shows the numbers of papers found. After an analysis of the title and key words, we showed the quantitative results. After, the authors read the abstract and selected the papers that studied both information literacy and competitive intelligence in a multidisciplinary perspective.

	Articles		
Database	**Total found**	**Chosen (based on title, keywords)**	**Total (after abstract review)**
SCOPUS	42	10	3
Web of Science	0	0	0
Proquest (LISA)	161	58	2
Proquest Central	39	16	0
EBSCO (LISTA)	65	3	2

In the second phase of the SLR we analyzed the content of the abstract to identify information literacy and CI in a business context. Most papers that were selected referred to libraries and students, and only a few focused on business or innovation. The SLR found a total of 7 articles related to the theme published in academic journals. In the end, there were only 4 articles, because three of them were duplicated. The SLR shows that information literacy and CI are not studied very often by researchers. There is a gap of knowledge about the theme, especially in the context of Industry 4.0.

4. RESULTS AND DISCUSSION

The connection between CI and information literacy is fundamental to competitive businesses (Ottonicar, 2016; Silva et al. 2016, Ottonicar et al., 2018). This happens because information literacy guides the CI process (Teixeira, 2014) and focuses on quality information and its sources. The CI process contributes to organizational survival in the market (Tarapanoff et al. 2016; Souza, 2016; Teixeira, 2014).

Companies are essential to the economy of a country (Porter, 1998), since they create wealth and employ people. Small businesses need to develop processes to add value to products and services, so they can use CI (Hassani and Mosconi, 2016; Hoffmann and Chemalle, 2006) based on information literacy (Silva et al. 2016; Ottonicar et al, 2018) to achieve competitiveness, as well as larger companies.

The paper "How information literate are you?" is a self-assessment by students enrolled in a CI elective authored by Barbie E. Keiser. The text was published in the Journal of Business and Finance Librarianship in 2016. This paper studied students' information literacy in a CI course. The results demonstrated the use of information literacy to learn and develop skills influenced by the information behavior of students (Keiser, 2016).

The paper was focused on the field of education, but it was considered in the SLR because the appropriate information literacy can be used by individuals who work with CI processes. Furthermore, the paper values the librarian profession as fundamental to information access, especially in companies. The paper also pointed out that students have difficulties to learn which information can help them to face challenges (Keiser, 2016).

The second paper perceived environmental uncertainty, information literacy and environmental scanning towards a refined framework focuses on the context of businesses and uses the term environmental scanning, which is also understood as CI. It was written by Zhang et al. and it was published by Information Research in 2012 (Zhang et al., 2012). Forty-two travel agents in Singapore answered the questionnaire. The authors found out that information literacy is fundamental to the steps of CI. Furthermore, they showed that information quality is not related to information quantity. The quality of information is based on the process, organization, dissemination and evaluation in an effective way (Zhang et al., 2012).

These same authors also published another two papers that are based on information literacy in the context of businesses and environmental scanning. The first paper, entitled The Role of Information Literacy in Environmental Scanning as a Strategic Information System - A Study of Singapore SMEs, was published in 2010. Zhang et al. (2010) explained the importance of information literacy to business management in a practical context.

In that paper, environmental scanning is understood as a strategic information system and they discuss information literacy in small and medium-size companies. They researched SMEs in Singapore thorough a questionnaire which guided the quantitative analysis and an interview which contributed to a qualitative analysis (Zhang et al, 2010).

Another paper was published in 2010 in the Journal of Information Science with the title Environmental scanning: An application of information literacy skills at the workplace. The authors studied information literacy to monitor the external environment of organizations to achieve a competitive advantage (Zhang et al. 2010).

There are only a few researches that connect the scan of external context and information literacy. Furthermore, few researches have studied information literacy as a tool to achieve businesses competitiveness. The authors applied information literacy in every step of environmental scanning. They concluded that scanning can be used by every organizational level, it is not limited by the strategic one (Zhang et al., 2010).

The SLR showed that there are no researchers who focus on CI and information literacy in an interdisciplinary perspective. Because of that, this study is fundamental, since it aims to use concepts from information science and business management. We strongly recommend that those fields should work together in order to share knowledge and apply research through research groups and researchers.

Information literacy needs to be incorporated in the business management field, since studies have demonstrated its relevance to improve processes and competitive advantage (Yafushi, 2015; Ottonicar, 2016; Santos, 2014). Other researches have emphasized the applicability of information literacy for decision-making (Yafushi, 2015) and for creativity and innovation (Ottonicar, 2016; Ottonicar et al., 2018). We would like to emphasize the importance of Zhang et al.'s work (2012, 2010, 2010) as an international parameter to connect information literacy and CI to others researchers in the field.

Furthermore, this paper developed an interdisciplinary connection between information literacy and CI to help business in the context of Industry 4.0. The results were based on Valentim's (2002) CI steps, since it explains seven main actions developed in this process. Belluzzo's (2007) information literacy standards and indicators were chosen, since it was based on international standards from the International Federation of Library Associations and Institutions (IFLA).

According to Valentim (2002), CI has the following steps:

- Identify the niches of internal and external intelligence;
- Prospect, access and gather data, information and knowledge;
- Select and filter data, information and knowledge which are relevant to people and organizations;
- Treat and add value to data, information and knowledge which are mapped and filtered in order to seek interactions language of users and systems;
- Store data, information and knowledge in information technology focusing on quality and safety;
- Disseminate and transfer data, information and knowledge through services and high-value-added products. The goal is to develop people and organizations;
- Create mechanisms of feedback in order to generate new data, information and knowledge to feed back to the system.

The information literacy standards and indicators can be used as a tool to evaluate the process. They serve as a guide of the activities developed during the process.

The context of the Fourth Industrial Revolution allows physical and biological technology to produce data and information in real time (Schwab, 2016). During the CI process, the professional must understand information needs to identify the 'niche' of external and internal intelligence (Valentim, 2002). Therefore, professionals can develop a strategy to define a research topic or information. They verify the value and potential information sources, and they seek information in several formats through a checklist (Belluzzo, 2007; Ottonicar, 2016).

After that, there is information access (Ottonicar, 2016). In Industry 4.0, access occurs through smart and connected technology. That technology is capable of producing information and disseminating it to other platforms (Almada-Lobo, 2015). The CI professional needs to prospect and monitor internal and external data (Valentim, 2002) which are shared by IoT and other tools. The professional selects information systems that are available, observes the type of information in smart technology, creates keywords based on specific vocabulary and uses people, services and other media to access information (Belluzzo, 2007; Ottonicar, 2016).

It is fundamental to be attentive to the information source, because information sources are people, objects and biological technology in the context of Industry 4.0. Because of that, the professional selects and filters data to create smart information and to contribute to competitiveness (Valentim, 2002). The information needs to be created based on the quality of sources. Individuals need to read and learn from gathered information, develop criteria to evaluate information sources, observe the hidden intentions and understand the factors that influence information sources such as culture, geography and history (Belluzzo, 2007; Ottonicar, 2016).

There is the information treatment and addition of value in CI (Valentim, 2002). Therefore, professionals can aggregate their previous knowledge and new information during information seeking (Belluzzo, 2007; Ottonicar, 2016). They need to understand the language used between the user and system (Valentim, 2002), and furthermore, they understand the information dissemination through smart technology. They compare the knowledge constructed with other information, which is a result of different sources to learn a new perspective (Belluzzo, 2007).

In the context of Industry 4.0, systems are integrated and store information together. Because of that, professionals understand how to store data securely (Valentim, 2002). They synthesize and organize information and also understand smart technology to adjust it based on its structure (Belluzzo, 2007; Ottonicar, 2016).

The convergence of smart technology allows the systems to share information in real time and make people's lives easier. The CI professional uses those technologies to share smart information in order to contribute to organization members' decisions (Valentim, 2002). Therefore, individuals need to understand the ideas developed based on reports, manuals and documents. Furthermore, they need to communicate intelligent information through systems and technology. They respect the rules of documentation in businesses (Belluzzo, 2007; Ottonicar, 2016).

The CI professional must know the legal and ethical issues of information use (Belluzzo, 2007; Ottonicar, 2016). They create new mechanisms of feedback to retrieve smart and ethical information in the future (Valentim, 2002). After the professional understands the context, he or she can realize the impacts of actions on competitiveness, innovation and creativity. In Industry 4.0, technology has been replacing some jobs, especially the ones that can be replaced by smart machines. An individual who works with CI understands the impact of the profession on society. Therefore, information must be made available in an ethical and legal way.

The connection shown in Figure 1 allowed the construction of a theoretical model to demonstrate how information literacy can contribute to every step of competitive intelligence in the context of Industry 4.0.

Information literacy is present in every step of the CI process, so it can contribute and guide this process during the new changes resulting from IoT and other technologies of Industry 4.0.

The first phase of the CI process is to identify the 'niche' of internal and external intelligence. That is equivalent to the 'information need' phase of information literacy. Professionals need to observe the information they need to explain the context of the organization and competitors in terms of production, services and competitiveness. In the context of Industry 4.0 there is a lot of information available through technology, so the challenge is to identify information needs.

The next step is the storage of accessed information in physical and biological technology. The purpose is to know how to access technology and use strategy to find information. The most useful information is

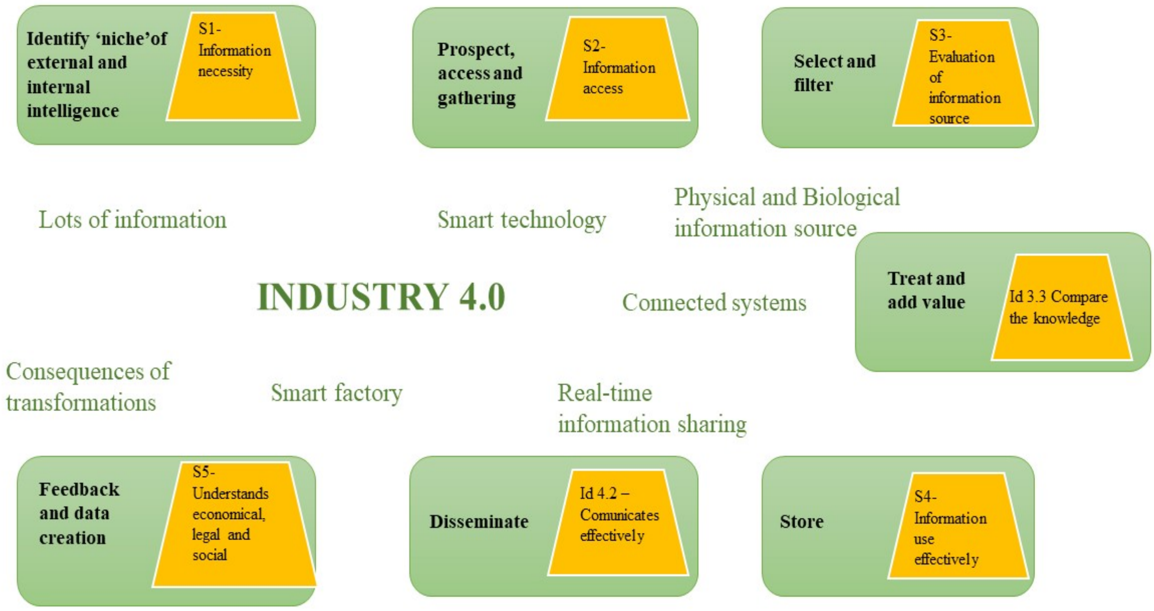

Figure 1 **Competitive intelligence and information literacy in Industry 4.0.** Information literacy is represented by the standards and indicators in yellow, and the steps of CI are demonstrated in green. This shows a conceptual model that can be used by business and competitive intelligence professionals to guide the information seeking process about competitors. There are 7 green rectangles that represent competitive intelligence. The yellow contains information literacy standards, indicators and results based on the table 3 (third column). Industry 4.0 is represented as the context in which firms operate nowadays. The words around Industry 4.0 represent keywords extracted from the first column of the table 3. These words can be connected to a technology, a process of the consequences of transformation to society.

chosen and filtered. This process is based on information quality through the evaluation of the source. After that, information is treated and new knowledge is added to it to add value. In that moment, the organization and information systems are connected in every organizational level. The goal of this process is to use information efficiently through creativity, innovation, problem solving and decision making.

Smart information also needs to be used by other people, so it is disseminated through communication. Professionals share information with people and smart systems, following documentation rules. They evaluate the performance of the process and create mechanisms of feedback in order to criticize the CI process. Therefore, individuals need to understand the economic, social and legal results of that process to smart organizations.

5. CONCLUSIONS

The SLR showed that information literacy and CI need the development of interdisciplinary studies between information science and business management. The concept of information literacy should be studied in the business management field in order to develop practical studies. This literature review showed that the theme is emergent, so both fields can improve their body of knowledge.

The information literacy standards and indicators can be useful in the CI steps, especially in the context of Industry 4.0. In that context, biological and physical technology are the main sources of information to understand the demands and variations of the market, as well as the main channels of communication and dissemination of their products and services. Businesses that use information literacy and CI can find market opportunities in the 4th Industrial Revolution.

The model of information literacy and CI in the context of Industry 4.0 can guide both small and large businesses to have better information quality. Information quality is essential to solve problems and take decisions in an effective way. Managers may work based on information literacy concepts and standards, especially when monitoring competitors. Therefore, reliable information can contribute to decision making, problem solving and innovation.

Future research may use the model as a guide to develop a practical study, for example, creating a CI process based on information literacy to encourage innovation and creativity. Furthermore, academics may investigate if the technology of CI will be capable of analysing the information source. Researchers may analyze this gap of information literacy. Artificial intelligence modernized some technologies, so maybe it will be capable of doing CI.

Also, managers can use information literacy models and adapt them into their context, especially in developing countries. Future studies could address this aspect and adapt tools such as TRAILS 9 (Syazillah et al., 2018), which guides the translation and adaption of information literacy models.

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