



SOCIAL NETWORK ANALYSIS ON LEAN PRODUCTION AND WORLD CLASS MANUFACTURING: HOW ARE ASSOCIATED IN THE LITERATURE?

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ABSTRACT

This paper aims to conduct a Systematic Literature Review (SLR) to identify how to configure the publications that relate WCM and Lean Production issues. Therefore, a search on the Brazilian metasearch portal called CAPES Periodicals was conducted focusing on articles of the last five years. They were identified after screening and filtering a total of 42 articles, which were analyzed. The construction of the network analysis has identified that the issues are still in an initial phase of association, with the characteristic part of decentralizes networks, with some points of greatest association. It was also identified that the theme Lean Production has greater representation between the two topics due its higher use by authors.

Keywords: Interrelation; Social networks; Systemic literature review.



1. INTRODUCTION

The global competitiveness, seeking increased profitability, has become the main objective of the companies in the current environment due to the expansion of segments in the same production chain. This aspect brings the constant need for improvement of organizational production system, boosting the use of administrative strategies which assist in the selection of appropriate techniques and tools to achieve a better industrial production, ensuring their stay in the market (BORGES; OLIVEIRA; OLIVEIRA, 2013). Every production process, no matter how good are their management, and their activities achieve controlled and planned tasks, it is still possible to identify points to be improved (GOETSCH; DAVIS, 2014).

In this sense, among many existing theories, the approach called World Class Manufacturing (WCM) shows to be efficient with regard to elimination of losses and has been able to enter into organizations that aim to achieve high levels of perfection in their production levels. In concomitant period the WCM approach was to rise the Lean philosophy, known in organizational environments such as Lean Production System and had to cradle the Toyota Production System, which has been studied and applied as a management model to inherit a strong culture that is characterized by the production control through perfect techniques, continuous improvement, and that has brought excellent results to organizations over the years (SMITH, 2011).

The reflection of great importance in the business world can be seen through the quantitative analysis of publications related to topics discussed here. Performing a matter of Lean Production in the Brazilian metasearch portal CAPES Periodicals (Higher Education Personnel Improvement Coordination) are identified 2.623 articles published in peer-reviewed journals over the past five years (2010-2015). Since the search for the subject WCM resulted in a total of 6.070 documents. However, although the large number of studies between these two topics in the literature, there are not available research that shows this interrelationship of WCM approach and the Lean Production System techniques, featuring this regard a research gap.

This way, before these two themes, the Systematic Literature Review (SLR) becomes all-important, as it can provide other researchers find study materials have been finalized and filtered. It also allows time and resources economy, provides mapping in which specific areas the studies are being developed and it is possible



and most relevant checking for gaps in the literature that can be explored by other researchers have not yet identified the lack of studies review (CONFORTO; AMARAL; SILVA, 2012). These factors, this research seeks to answer the problem checked: In what areas of study are concentrated scientific research involving topics Lean Production and World Class Manufacturing? In this context, this research has aimed at making a Systematic Literature Review (SLR) to identify how to configure the publications that relate WCM and Lean Production.

For development of the present study it was divided into sections, where the first part deals with the introduction, objectives, found problems, and the importance that justifies this production. The second section consists of literature review, which enabled the explanation and origin of the themes elucidated. The third topic contains the explanation of the adopted methodological concepts, from carrying out the procedures used to collect data as well as construction of the database. The fourth part shows the results. By the end, the fifth and final section reports the considerations of all developed production.

2. THEORETICAL FOUNDATION: WCM AND LEAN PRODUCTION

The World Class Manufacturing is among the strategies to enhance the production. Its techniques are based on "concept of zero waste, zero breakdown, zero defects and zero stock" (BORGES; OLIVEIRA; OLIVEIRA, 2013). This strategy becomes suitable for companies looking to minimize costs of its activities, increase its excellence and hence competitiveness across sectors (GAJDZIK, 2013; SOUZA; LIMA, 2003).

The origin of the concept of WCM took place in the 1980s through case studies of successful companies (BORGES; OLIVEIRA; OLIVEIRA, 2013). His term was coined by Hayes and Wheelwright (HAYES; WHEELWRIGHT, 1984) to describe the capabilities developed by Japanese and German companies, which had a higher level of production when compared to other industries. The excellent performance in global competition of these companies generated the term "World Class Manufacturing" (EID, 2009).

The WCM includes success against competitors and organizational profitability in a competitive international environment. His approach is related to the absolute competitive advantage and the best producers (HOSSEINIE; SHIRAZI;



ASHLOGHI; MEHR, 2012; PALUCHA, 2012) can define this as the best practice. Based on 10 interconnections, called pillars, which relate the manufacturing process and maintain and enable an organization to achieve world class (GAJDZIK, 2013; PALUCHA, 2012; ZIMWARA; GORIWONDO; MHLANGA; CHASARA; CHUMA, 2012). These pillars are divided in: safety, cost deployment, focused improvement, autonomous activities, professional maintenance, logistics, early management, people development and environment, and quality control (GAJDZIK, 2013; PALUCHA, 2012; ZIMWARA; GORIWONDO; MHLANGA; CHASARA; CHUMA, 2012).

Achieve the performance of a world-class organization involves important assignments, including: become a globally successful manufacturer; recognize the business environment and free competition, threats, opportunities and competitive advantages; and prepare and stay in this environment with industrial planning and manufacturing (HOSSEINIE; SHIRAZI; ASHLOGHI; MEHR; AN, 2012).

The competitive advantages pointed to an organization that achieves world-class are studied and listed in different ways by different authors that characterize points as improved profitability, training, product development, better quality, quick reaction against competitors, production programs, attention to customer needs, reasonable prices, delivery, flexibility, quality management, reducing the supply of goods, cost of production, innovation, strategy, systems and structures, accountability, performance measurement, values and fundamental objectives, culture and competitors (BORGES; OLIVEIRA; OLIVEIRA, 2013; CHIARINI; VAGNONI, VAGNONI, 2014; SCHONBERGER, 1996).

These different features that allow pointing to competitive advantage and classify the organization as a world class result in the attempt by the researchers to establish models to measure and classify an organization such as WCM (HOSSEINIE; SHIRAZI; ASHLOGHI; MEHR; AN, 2012; PALUCHA, 2012; NG; HUNG, 2001; ASKARI, 2004; MOTWANI; KUMAR; KATHAWALE; KATHAWALE; WCM, 1994). Other researches also aimed to identify the critical success factors for the implementation of WCM (XIE, 1995; SVENSSON; KLEFSJO, 2001).

Note, through these studies conducted in various research fronts, there is still need for further elucidate a topic considered again, and it lacks progress in its

theory. It is known (PALUCHA, 2012) that the adoption of a management organization, in accordance with the principles of WCM, is based on reliable methods, high quality tools, and extensive involvement of all employees and company managers. Also in the management aspect, Yamashina (2000) cited by (BORGES; OLIVEIRA; OLIVEIRA, 2013) complements the use of WCM is divided into four steps: identify the problem, identify the loss, define the method to be adopted for restoration and control the results.

The elucidated points that depict the WCM as the organizational pursuit of excellence through modern approaches, the use of techniques and tools and the elimination / minimization of losses in the process, brings a strong adherence to the principles of the philosophy of Lean Production System (PALUCHA, 2012).

The main appearance of the Lean Production system happened at the end of World War II, when the Japanese industry had to rethink their production model, appearing then the Toyota Production System (TPS), which due to the lack of productive resources, sought to produce lowest possible cost, especially fighting waste (OHNO, 1988).

The term Lean Production was set in the late 1980s in a research project at the Massachusetts Institute of Technology (MIT), who studied the global automotive industry, with the main focus on the Japanese model of Toyota, aiming to map best practices industry, through interviews with employees, union and government officials. The Lean Production System's philosophy identifying and minimizing or phasing out of waste sources, based on five fundamental principles: the definition of (i) value from the view of the customer and their needs, and then determined the necessary activities to offer the product to the customer at the lowest level waste through the definition of (ii) the value chain. Search is then manufacturing the product using a (iii) continuous flow; which is triggered only when the client makes the request. That is, using a (iv) Pull Production. From these four principles and the use of continuous improvement (*kaizen*) or radical improvements (*kaikaku*) is reached the fifth (v) fundamental principle that is the perfection of the system (CALARGE; PEREIRA; SATOLO; DIAZ, 2012). These waste minimization or elimination (*Muda* in Japanese) are crucial for companies to optimize their activities and to eliminate times and processes that do not add value and are classified into

seven types, namely: overproduction, waiting, transportation, motion, over processing, rework and inventory (VINODH; DEVADASAN; VIMAL; KUMAR, 2013).

When reviewing the implementation of Lean Production system in enterprises, it is noted that it can use various techniques and tools, which should take place in a coordinated and structured way (PETTERSEN, 2009; HUNTER, 2004) and assist in this process of minimization and / or elimination of waste, bringing results for the organization as reducing lead times, reduced costs, improved quality and increased productivity, making them agile and more competitive (WALTER; TUBINO, 2004; SAURIN; RIBEIRO; MARODING, 2010). Thus, the techniques and tools are a great help in improving a product or process in various kinds of organizations (FELD, 2001).

Within this context, there is a strong synergy between the World Class Manufacturing approach (WCM) to achieve competitiveness with global levels recommended by the great performance and reduce waste, and that can be implemented through the use of Lean philosophy, and the techniques and tools that support this system.

3. RESEARCH METHOD

This research can be considered theoretical because it was developed with bibliographical sources of information gathered through the metasearch portal of CAPES journals along the bases of the Production Engineering and Human and Social Sciences. In these bases were found 24 search sources, among which are cited as an example: Academic Search Premier - ASP (EBSCO), Cambridge Journals Online, Emerald Insight (Emerald), OECD iLibrary, Oxford Journals (Oxford University Press), SAGE Journals online, SciELO.org, ScienceDirect (Elsevier), SpringerLink, Wiley online Library, and others. These data were needed for the construction of bibliometric indicators of scientific production. However, this study is also an applied research, possessing quantitative and qualitative aspects (NEUMAN, 2009).

This research may also, as your goal, be classified as methodologically descriptive because in the search for information and characteristics of the particular subject seeking to know the factors involved, the objectives outlined, and the targeting of studies (MONSEN; HORN, 2007).



The technique employed to conduct the analysis of publications in this study is bibliometric. This type of survey is one of the methods developed for the systematic review of the literature on a subject or more proposed, having been worked by the Belgian Paul Otlet, which generated over a new field for the measurement of all aspects relating to the publication, reading books and documents, and thus has a characteristic of being methodical, transparent and replicable (ROUSSEAU, 2014; COOK; MULROW; HAYNES, 1997).

A literature review allows to assess with complete accuracy and reliability surveys conducted among specific topics, mapping where papers are published and allowing the researcher generates existing knowledge summaries of the results (CONFORTO; AMARAL; SILVA, 2012).

This research adopted the methodology created by Levy and Ellis (LEVY; ELLIS, 2006), (see Figure 1) which shows a SLR through a process consists of three steps that meet the criteria of this study. However, some modifications and adjustments were needed to comply with the standards defined herein to be achieved, which also reinforce and create the foundation for responding to problems and thus remain the goal.

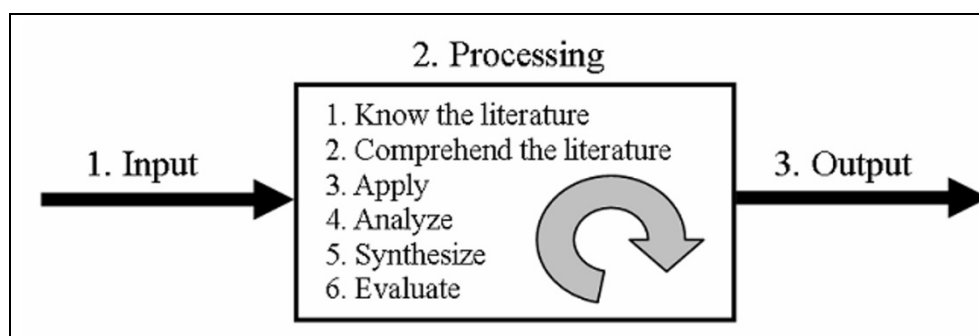


Figure 1. The three steps to conduct a Systematic Literature Review

Source: Levy and Ellis (2006)

The process as described, is divided into three stages, where the second stage is the highest concentration of business (LEVY; ELLIS, 2006):

Step 1: Input - its main point is to define the issue proposed connecting all the facts and the objective of which must be very well aligned so that there is clarity and are feasible (CRESWELL, 2013). Above all, here are initiated primary searches on pre-identified databases and stations as collection points, among so you need full attention and rigor in the collection, since this data will become a search of the database (CONFORTO; AMARAL; SILVA, 2012). For this study we performed a time

frame in the corresponding period of the last five years (2010 to 2015), where this way it was possible to raise a current database, with demonstration of the latest articles published.

Step 2: Processing - Concentrate the six data processing stages, which are the most important, being comprised as follows:

1st. Stage - To know the literature: identify publications and separate them based on goals;

2nd. Stage - Comprehend the literature: the detailing of information is essential to obtain and interpret what the authors of the research aimed and performed in their studies;

3rd. Stage - Apply: make revisions to search for possible errors in understanding and extracting the necessary parts to compose the survey. As a modification to this research was adopted string searches to refine again the publications of the base taken the first step. In that sense it is necessary to test the combinations adopting the words to the specificity sought thereby to can highlight the importance of carrying out a database for each survey (CONFORTO; AMARAL; SILVA 2012).

4th. Stage - Analyze: is understood in carrying out an analysis of the results to identify what factors include the research objectives through filters, which can perhaps incompatible delete reference to the purpose of the study, which began in the third stage;

5th. Stage - Synthesize: consists of assembling or creating clearly ways to expose the results. Among the ways: charts, tables, images can be built in helping to improve the outlook. From now on, this research was used for the assembly of the social networking Ucinet® software that interconnects with the NetDraw®, and the word cloud by Wordle®;

6th. Stage – Evaluate: describe the results achieved through the analysis and compilation of data, and by the end, to answer the problems found and make considerations about the whole study developed.

Step 3: Output - It is connected with the output of the whole process conducted where it can be disposed in the assessment base built for the research,



which in the process of remaking Step 2 as many times as necessary can be excluded by checking and finding that really. It does not belong to adopted people (LEVY; ELLIS, 2006).

A set of the desired information search strategies constituted by words or phrases applied with Boolean operators - which consist of informing the metasearch how to combine the necessary terms. Although the use of signs that can be closed is an expression, and separate the terms in cells (SCHNEIDER; EVANS, 2012). It used the Boolean operators AND and OR, as well as quotes in the truncation of words by objectified search. The AND function is to narrow the search by combining the terms making the intersection of joint research. Already the OR operator is the grouping of terms, expanding research, since many words have leads. The quotation marks have the function to search for exact grouping of words (BARKER; BARKER, 2013).

This way, for raising this study, the search strings were rethought so that the derivatives of words were also found being applied in isolation and later the crossing of the following: (i) "lean production" OR "lean manufacturing"; (ii) "world class manufacturing" OR "world-class" OR "word-class manufacturing"; (iii) "lean production" OR "lean manufacturing" AND "world class manufacturing" OR "world-class" OR "word-class manufacturing".

In this light, better elucidated in Figure 2, were found at the intersection of terms 98 publications where to apply the second stage adopted the methodological model has resulted in the delineation of 42 (AL-BAIK; MILLER,2014; ZULKIFFLI, 2010).

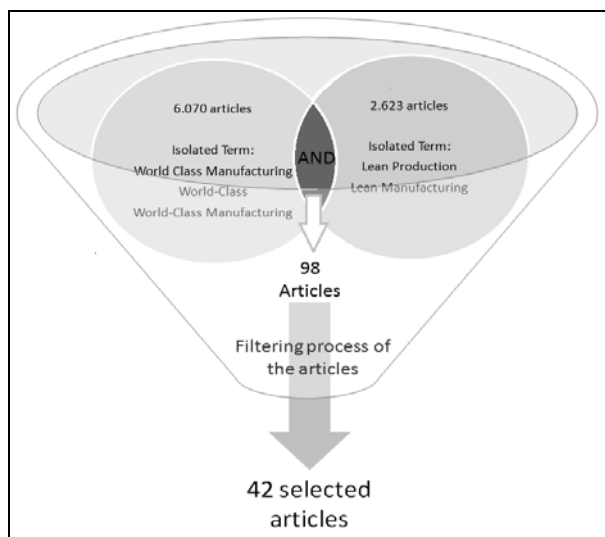


Figure 2: Results of search strings.

4. RESULTS

As noted in section 3, 42 articles that address the research themes were identified. Table 1 lists these articles. The column "Article Number" stands out as the basis for locating the articles in the figures related to the analysis of social networks. The authors, year of publication and the published periodical are presented along with this numbering.

Table 1: List of selected articles considered in current study

Article Number	Authors	Year	Periodical
1	GURUMURTHY; KODALI	2011	Journal of Manufacturing Technology Management
2	DEMETER; MATYUSZ	2011	International Journal of Production Economics
3	HEDELING; JACKSON	2011	Journal of Manufacturing Technology Management
4	TOHIDI	2012	Advances in environmental biology
5	FORRESTER; SHIMIZU; SORIANO-MEIER; GARZA-REYES; BASSO	2010	Journal of Manufacturing Technology Management
6	MEYBODI	2013	Advances in Competitiveness Research
7	PONG; MITCHELL	2012	The British Accounting Review
8	TANCO; SANTOS; RODRIGUEZ; REICH	2013	International Journal of Advanced Manufacturing Technology
9	ANGELIS; CONTI; COOPER; GILL	2011	Journal of Manufacturing Technology Management
10	VINODH; ARVIND; SOMANAATHAN	2010	Journal of Manufacturing Systems
11	CHOWDARY; GEORGE	2011	Journal of Manufacturing Technology Management
12	BOZICKOVIC; MARIC	2013	DAAAM international scientific book
13	RAHMAN; LAOSIRIHONGTHONG; SOHAL	2010	Journal of Manufacturing Technology Management
14	ALONY; CAPUTI; COLTMAN	2011	Issues in informing science & information technology
15	WANG; MING; KONG; LI; WANG	2011	Forest Products Journal
16	ESAN; KHAN ; QI; NAYLOR	2013	Journal of Manufacturing Technology Management
17	MONGE; CRUZ; LOPEZ	2013	Informacion Tecnologica
18	FURLAN; DAL PONT; VINELLI	2011	International Journal of Production Economics
19	PAIVA	2010	International Journal of Production Economics
20	WIENGARTEN; PAGELL	2012	International Journal of Production Economics
21	NAOR; LINDERMAN; SCHROEDER	2010	Journal of Operations Management
22	KISPERSKA-MORON; DE HAAN	2011	International Journal of Production Economics
23	BRANDT; THUN	2010	World Development
24	TYAGI; CHOUDHARY; CAI; YANG	2015	International Journal of Production Economics

25	BORTOLOTTI; BOSCARI; DANESE	2015	International Journal of Production Economics
26	VINODH; DEVADASAN; VIMAL; KUMAR	2013	Journal of Manufacturing Technology Management
27	SHAN; WANG; XIN; BI	2013	International Journal of Production Economics
28	BORADE; BANSOD	2010	Journal of Manufacturing Technology Management
29	THAKKAR; KANDA; DESHMUKH	2012	Journal of Manufacturing Technology Management
30	VIEIRA JUNIOR; LUCATO; VANALLE	2014	Journal of Manufacturing Technology Management
31	O'SULLIVAN; ANDREONI; LÓPEZ-GÓMEZ; GREGORY	2010	Oxford Review Of Economic Policy
32	GARBIE	2011	Journal of Service Science and Management
33	PENG; VERGHESE; SHAH; SCHROEDER	2013	Journal of Supply Chain Management
34	BACCHETTI, ANDREA; SACCANI, NICOLA	2012	Omega
35	SHAHIN; ATTARPOUR	2011	Modern Applied Science
36	AL-BAIK; MILLER	2014	Empirical Software Engineering
37	ZULKIFFLI	2010	International Journal of Business and Management Science
38	MEYBODI	2010	Advances in Competitiveness Research
39	KRISTENSEN; ISRAELSEN	2014	Management Accounting Research
40	CHOWDHURY	2014	Business Horizons
41	GONZALEZ; MARTINS	2014	Journal of Knowledge Management
42	CLOSS; SPEIER; MEACHAM	2011	Journal of the Academy of Marketing Science

A starting point to highlight is the variety of authors with publications throughout the period investigated. It can be observed that of the 42 publications in only four occur the repetition of authors, as in the case of Meybody (2010; 2013) and Vinodh et al. (2010) and Vinodh et al. (2013). This aspect demonstrates that the subject is still in a phase of exploration, and there are no researchers in the current period of research and among the bases researched, which stand out in terms of number of publications.

This fact does not occur when verifying the journals adopted by the researchers when presenting the society their researches. The 42 publications identified are published in 25 journals, of which two (Journal of Manufacturing Technology Management and International Journal of Production Economics) stand out by concentrating 45.2% of the publications.

In Figure 3 the quantitative representation of publications over the years was developed. Of these papers, 24% are published in 2011, showing that this way there was a drop in production over this period by the year 2015, as seen in Figure 3. This

can be caused by a variety of reasons, from the researchers' lack of interest in relating the issues to working on administrative strategies in isolation. It is also difficult to identify theoretical studies that indicate how theoretical convergence occurs between the two administrative strategies, and that in some articles that report practice in the business environment highlight the positive results achieved, but do not outline the way to tread for success.

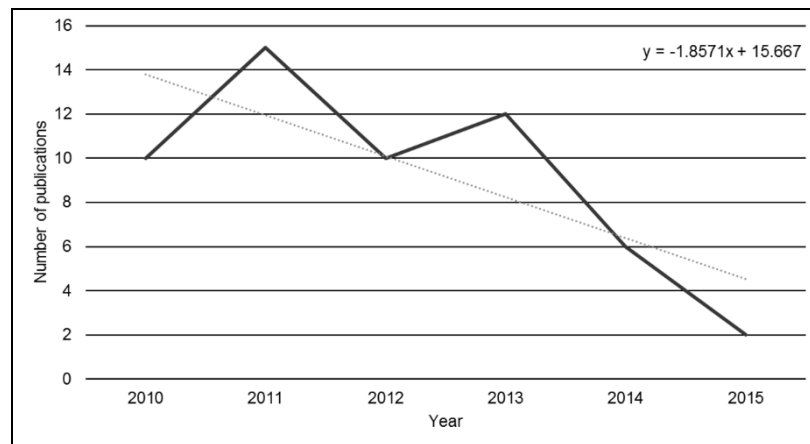


Figure 3: Number of publications in the year's survey.

Another analysis performed with regard to methodological questions of the research, which are divided into four aspects:

- (i) objective of the research that can be understood in three ways: (a) descriptive, when the process consists in the investigation, interpretation of historical facts to get understanding; (b) exploratory, when it is necessary to create a specific function to get results and; (c) explicative, in which it talks about these facts for a justification from a different point of view or to be the opposite, or even the need for a different point on the subject.
- (ii) The second aspect is related to how the research (ii) approach: characterized as (a) qualitative, when there is a focus on interpreting rather quantifying, orientation for the process and not for the result, preoccupation with context, in the sense that people's behavior and the situation bind closely in the formation of experience and; (b) quantitative, using structured procedures, formal data collection instruments under control conditions.

- (iii) The third refers to the (iii) types of research, It was identified the predominance of three: (a) case study, of empirical investigating a particular phenomenon, usually contemporary, within a real life context, when the boundaries between the phenomenon and the context in which it inserts are not clearly defined; (b) survey, comprising a data collection on a significant sample about a problem to be studied for, then by quantitative analysis, obtain them conclusions corresponding to the data collected and; (c) conceptual, which is connected to the study of existing theories and explanations of the concepts and techniques used.
- (iv) Ultimately, the latter deals with the (iv) analysis tools and data collections that understand: (a) documentary, which is employed by the survey documents that characterize the data and employment relationships with research and; (b) form, which aims at collecting and analyzing data through statistical procedures, it is their preconceived investigations by relationships of ideas (YIN, 2010; MIGUEL, 2011; CASSELL; SYMON, 1994; MARCONI; LAKATOS, 2002).

The Figure 4 summarizes this analysis and indicates that research using mostly of an exploratory methodology with a qualitative approach, it is developed by case studies and application forms.

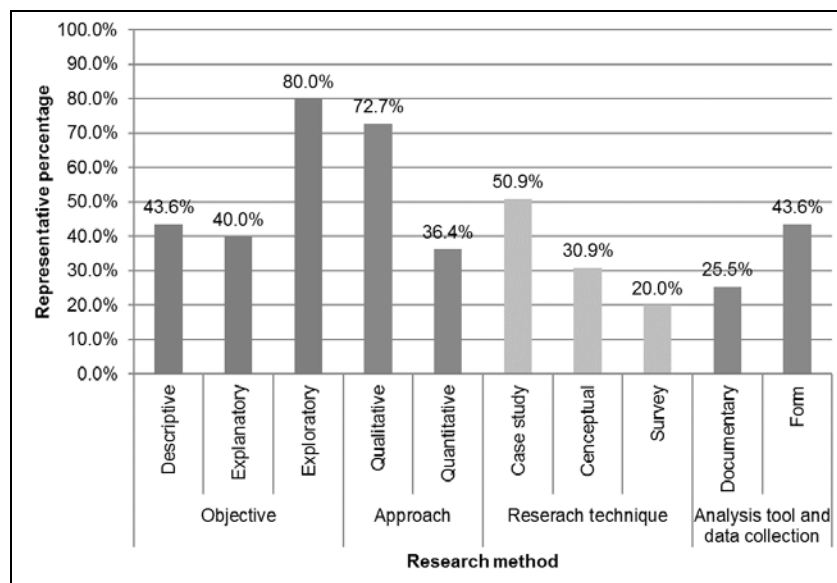


Figure 4: Percentage of employees questions about the purpose, approach, techniques, and methods for data collection.

This aspect can be explained by the term Lean Production concept is inherited from the Toyota Production System, which was born in the automotive sector (YAMASHINA, 2000). Large companies with high power and production technology that use such methods becoming search target for the development of studies and developments of theory. However, as is the quantitative approach is related to several different attempts at achieving measure processes in respect to construction of algorithms, or software.

This shows that the scientific productions inherent in the issues under study are in traditional sectors of transformation of industrial goods, and few studies conducted by the agro-industrial sector and services.

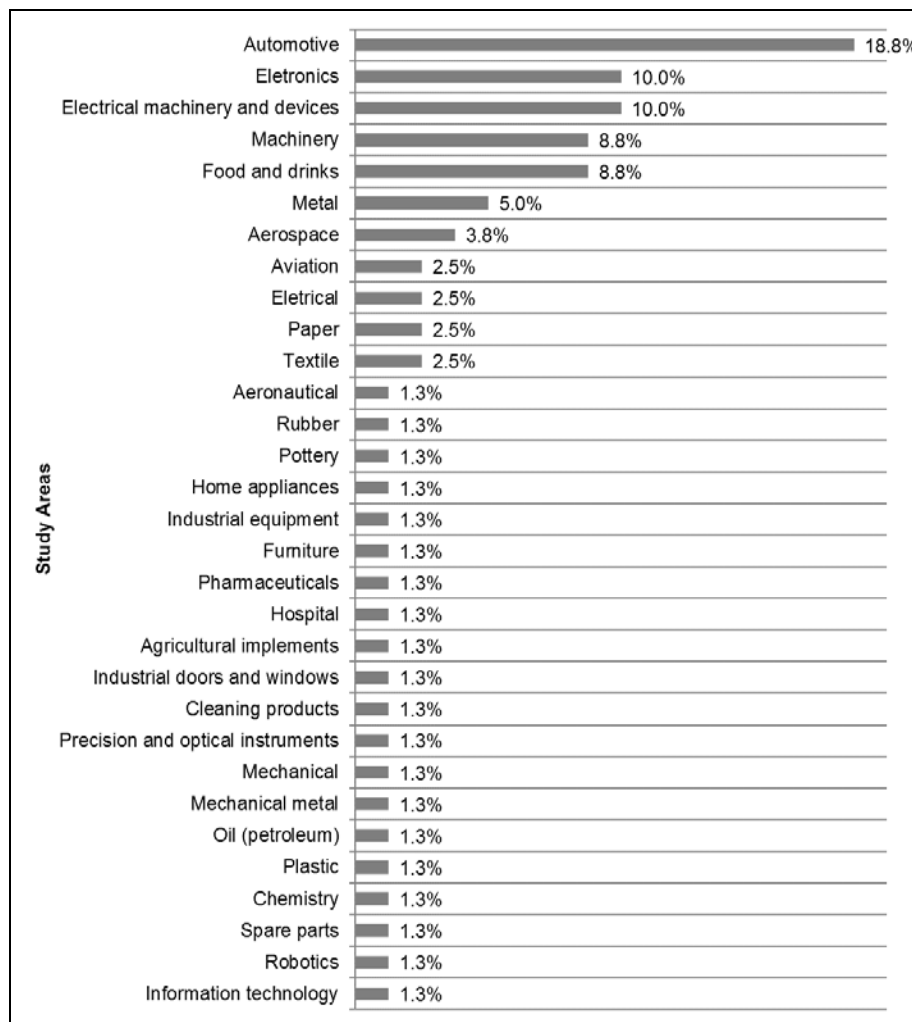


Figure 5: Percentage of concentration of research sectors.

The publications on the searched subjects have been conducted by researchers from different countries, highlighted in Figure 6. We identified 24 countries published in the period surveyed, involving 145 researchers. The United

States are the largest producer of research on the issues and have the majority of researchers, being 41 in total. The UK and India stand out with 22 and 15 researchers, respectively, followed by Brazil, Canada and China with 8 researchers each. These six main generators of knowledge countries concentrate 70% of the publications.

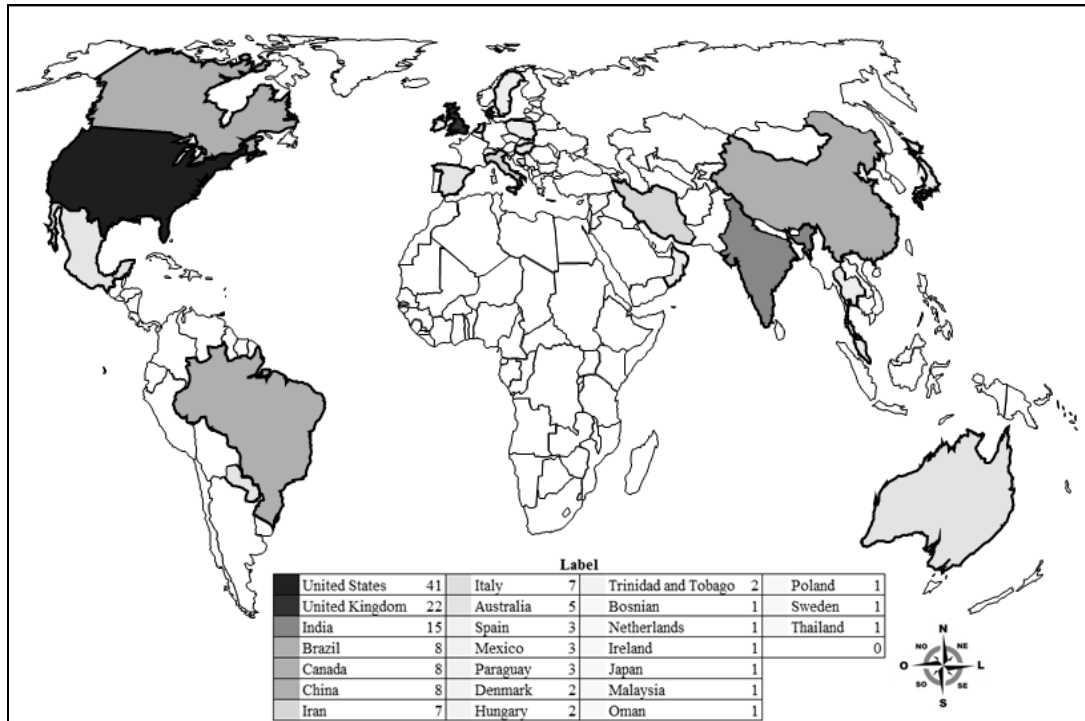


Figure 6: Number of researchers by countries.

The Figure 7 projects the social network of identified articles and their correlation with the keywords. This construction allows display as a set of actors that have correlation with each other, in which can be of different types present different contents as well as different structural properties (WORRELL; WASKO; JOHNSTON, 2013).

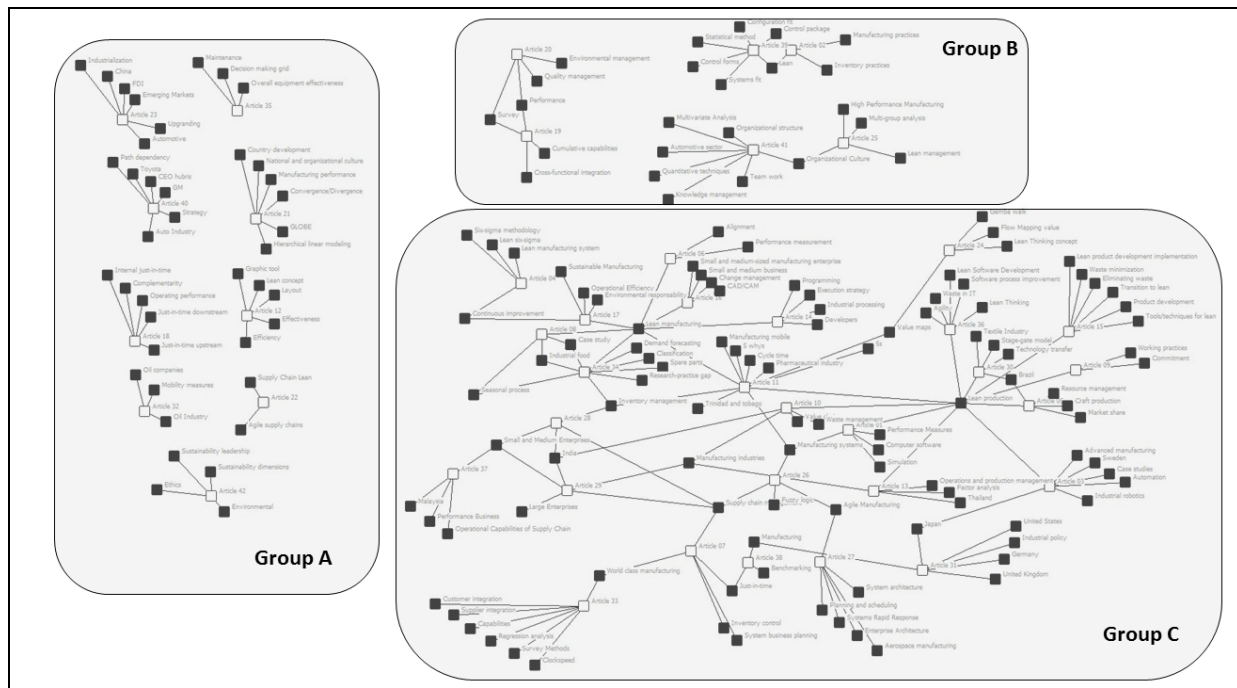


Figure 7: Number of network publications in the years survey.

In analyzing social networks, the most important aspect is to identify the most cohesive subgroups of actors (SCOTT, 2012). It is noted that this network of actors presents three main groups.

- Group A - Made up of 9 articles (BOZICKOVIC; MARIC,2013; BRANDT; THUN, 2010; CHOWDHURY,2014; CLOSS; SPEIER; MEACHAM; MEACHAM, 2011; FURLAN; DAL PONT; VINELLI, 2011; KISPERSKA-MORON; HAAN, 2011; NAOR; LINDERMAN; SCHROEDER, 2010; GARBIE, 2011; SHAHIN; ATTARPOUR, 2011), which are isolated and address issues isolated from other works identified.
- Group B - has 6 articles divided into two small groups of common themes, formed by Articles (DEMETER; MATYUSZ, 2011; KRISTENSEN; ISRAELSEN, 2014; PAIVA, 2010; WIENGARTEN; PAGELL, 2012; BORTOLOTTI; BOSCARI; DANESE, 2015; GONZALEZ; MARTINS, 2014).
- Group C - Group of greater concentration of research topics, formed by the 27 remaining articles, and that the main focus of relations issues. This network is displayed most prominently in Figure 8.

that each journal has dates for publication of their volumes, thus changing the result to the current year's end.

It was found that although distributed to publications, research has their researchers as a country of origin the United States showing greater contribution to the development of themes. However, denoted Japan, the country where it was inherited one of the subjects, with only one participant researcher will be shown.

Regarding the study of the network of actors, note that this is presented in an early stage to maturity, appearing for the most part as decentralized, but with actions to become distributed in some subjects, indicating that researchers. They begin to glimpse the association between topics.

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