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**Brazilian International Publications in Production and Operations Management from 1980-2007: A Review of the Literature and Directions for Future Research**

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## **Abstract**

This research reviews and analyzes the publications of Brazilian authors in the main journals of Production and Operations Management (POM) between 1980 and 2007. The research objective is to investigate the participation and contribution of Brazilian authors in the evolution of the POM field. The methodology is grounded in the selection of articles available in four electronic data base: Business Source Premier, Emerald Intelligente, ABI/Inform e Science Direct. A criterions scanning selected 161 articles, through the key-word "Brazil". After the classifications, the research proceeded with social network analysis, through the use of the software UCINET 6.0. The main results show the concentration of articles related to operations strategy and competitiveness (27%), 40% of the articles collected data in companies located in Brazil and co-authorship are polarized in 5 clusters of authors with little inter-institutional relation.

**Key Words:** Brazil, Production and Operations Management Field, Literature Review, Social Network Structures.

### **1. Introduction**

Previous works have called attention to the relevance of knowing the history of scientific publication and research in an area of knowledge as a way of identifying the main theoretical development in the field as well as to propose paths for future research.

Through a review of the articles published in the International Journal of Operations & Production Management (IJOPM), Pilkington & Fitzgerald (2006) identified the main themes of POM and the emergence of new topics in the field. These authors have also identified the main authors of the field, based on citation and co-citations analysis. Gupta, Verma & Victorino (2006), based on a review of the literature published from 1992 to 2005 in the Production and Operations Management Journal, investigate

the scientific production with empirical content in the POM area based on the following variables: main topics, type of contribution, data source and main authors,

In Brazil, Arkader (2003) makes a thorough analysis of the emergence of POM concepts in Brazil based on a selection of articles published in the main national Management Journals and Conferences. The authors, who write the most in the field were identified, and also their institutions.

Another research was made in Brazil, however in a different area of knowledge. Farias (2005) discusses the process of publishing articles in journals and conferences in the area of marketing. The main purpose of his research is to study the key aspects of having an article accepted in refereed national and international Journals. The author also presents Brazilian scientific production in the Marketing as compared to the world scientific exporter of marketing concepts.

This research aims to investigate the participation and contribution of Brazilian authors in the evolution of the POM field based on the analyses of the articles published by Brazilian authors in the main International POM Journals, written in English, between 1980 and 2007.

Some important questions drive this research: what are the issues of major incidence? What is the importance of foreign co-authorship? What is the historical behavior of the Brazilian scientific production in these journals? Do the topics of interest follow any international trends? What is the main type of contribution to the POM field? What are the main sources of data used? Data collection is done in organizations located in Brazil or abroad?

The main assumption of this work is the essentiality of looking careful to previous development in an area of knowledge in order to understand and contribute to its future evolution. This research intends to contribute to evolution of POM field.

The world today is in the midst of an economic crisis and most companies face a global and fierce competition. The emergence of new economies such as Brazil, Russia, India and China, the so-called BRICs is bringing some new challenges for business competing in such a globalized world. Some believe that in less than 40 years BRICs could become the major forces in the world economy surpassing even the

G6, comprising the United States, Japan, Italy, United Kingdom, France and Italy (Building Better Global Economic BRICs, 2001).

At the 2005 meeting of the WTO, led by Brazil and India, the strength of these new and strong economies in the world stage could be perceived by their ability to negotiate withdrawal of government subsidies in the European Union and the United States and import tariffs reduction and trade in the same countries (STOCK, 2005).

Brazil is becoming an important and strong economy. Due mainly to its natural vocation and increasing development in agricultural, renewable fuels such ethanol and biodiesel, his strong position as a supplier of raw materials like oil, steel and aluminum, a huge diversity of its flora and fauna and abundant water (GOLDMAN SACHS, 2007).

The further development of these areas and activities in Brazil will bring additional challenges to business and require improvements in every management area, especially in production and operations management. Although it appears to have a promising future, the country still lacks an efficient logistics system, for example, (LIMA, 2009). We cannot forget the important role of industry in this development process as a producer of capital goods (machinery and equipment), agricultural products, trucks and so on.

## **2. Methodology**

The first phase was a review of everything that had been published following the initial goals of the research, as well as the literature about research methodologies, development of the POM field, area concepts and knowledge about the possible use of concepts and network analysis for this research. In the next step, given the definition of the thematic focus for the research, which was originally defined only as "Research in production and operations associated with Brazil (1980 to 2007): a literature review and directions for future research", covering both national and international papers. Set the international focus for this research and the selection limited to articles that contained at least one researcher connected to a Brazilian institution, we defined the objectives of the research and its contribution to the POM field of

knowledge. The articles selection was restricted to academic journals available in four electronic databases: Business Source Premier, Emerald Intelligente, ABI / Inform and Science Direct. A first scan, by using the keyword "Brazil", reached the sum of 180 articles. However, further analysis showed that only 161 met the required criteria (author researcher should be linked to a Brazilian institution, and the article should be published in English in a journal of POM from 1980 to 2007), whereas some of selected articles cited only the keyword "Brazil", but separated from the authorship of articles. In other cases the articles were not related directly to the field of POM or were outside the period described above. At a later stage, we proceeded with the homogenization of data mined with regard to the names of authors and institutions link declared in the articles. This homogenization was required because of the different nomenclature used among the various international journals.

The next steps were based in the classification of articles by topic of interest, type of contribution and source of data, from reading all the articles mapped (the classification was based at least in the reading of the abstract, introduction and conclusion of each article). Next, the research proceeded with the network analysis related to the relationship among authors, institutions, international journals and topics of interest, using the software UCINET 6.0 (BORGATTI, EVERETT, FREEMAN, 2005). Microsoft Excel 2007 was used to tabulate the data, generate dynamic reports of productivity measures and to generate the two-mode networks that feed the UCINET 6.0. The one-mode networks (relationship between authors and institutions) didn't use the PivotTables of Microsoft Excel 2007. In a last step, there was a final report containing the analysis of mapped data, the interpretations of network maps, the research findings and their limitations.

## **2.1 Topic of Interest**

The first dimension, topic of interest, aims to identify the main topics of interest of research in Production and Operations Management related to Brazil. The topics were adapted from a list of topics of Production and Operations Management Society (POMS). For articles that addressed more than one topic in the research, just the one with more importance in the article will be considered. The eight topics that the

articles can be classified are: Operations Strategy and Competitiveness; Services and Product Design; Process Analysis of Manufacturing; Total Quality Management; Inventory Management; Operations Schedule; Environmental Management; and Supply Chain Management and Logistics.

## **2.2 Type of Contribution**

The second dimension, the type of contribution, aims to assess the contribution of the article to the development of the area of knowledge of Production and Operations. Three dimensions were selected to identify the main contributions of each article:

**(1) Describe / Introduce / Explain concepts in POM (D / I / E):** In this topic we included all articles that do not declare to have collected data and done case studies in Brazilian organizations, but that somehow developed a concept, refuted a theory or sought to exploit it in a different perspective. Note that if data were collected data from outside organizations, the articles were classified in this topic.

**(2) Application of POM theories in organizations located in Brazil (APL):** This category includes articles that seek to investigate the reproduction and the success rate of POM theory developed in environments of developed countries or not in Brazilian organizations. The use of established practice in POM is one of the main concerns of local organizations in seeking a competitive advantage in production (Hayes et al, 2005). This part includes articles that say they have put into practice some POM theory in any Brazilian company.

**(3) Detection of problems and practices, data collection and case study of companies located in Brazil, but without practical application of theory (DET):** Brazil is not for beginners. Its complexity has led to casualties among both local businesses and among foreign inefficient unaware. Building competitive businesses in Brazil means learning how to move in a maze of unfavorable conditions and unstable (Wood Jr. and Caldas, 2007). Some theories and technologies of production and operations are characteristic of Brazilian business environment. In this category are items that portray POM practices or

business models developed by executives and/or Brazilian researchers. This is a local contribution to the development of topics POM.

### **2.3 Data Source**

The third dimension, data source, aims to evaluate how the research data were obtained. The level of availability of data reveals the degree of openness and ease of carrying out empirical research related to POM in Brazilian organizations. It also reveals the degree of maturity and academic rigor of research conducted in the region. Four categories were used to classify the studies:

(1) No data: no data were collected in the survey

(2) Questionnaire: A questionnaire was used as a tool for data collection

(3) Case Study: Data were obtained from data provided by the organization studied.

(4) Secondary data - The research used secondary data source, such as reports from government agencies and reports of industries.

### **2.4 Period**

The fourth and final dimension is the record time of publication. The objective was to investigate the evolution and research trends in production and operations related to Brazil in the last 27 years. The political and economic environments of Brazil have changed dramatically since 1980.

**Period I - 1980 to 1994** - During this period, Brazil had an unstable economic policy environment, the rate of inflation was high, low participation in the international market and domestic market closed to international trade.

**Period II - 1994 to 1999** - During this period, Brazil began its economic reform and promoted a drastic reduction of inflation. The country has attracted many foreign investments, but also faced severe international economic crises.

**Period III - 1999 to 2007** - Period of continued political and economic stability. Greater involvement in the international market and implementation of social programs that had increased the income of the poor population.

### **3. Analysis and main Results**

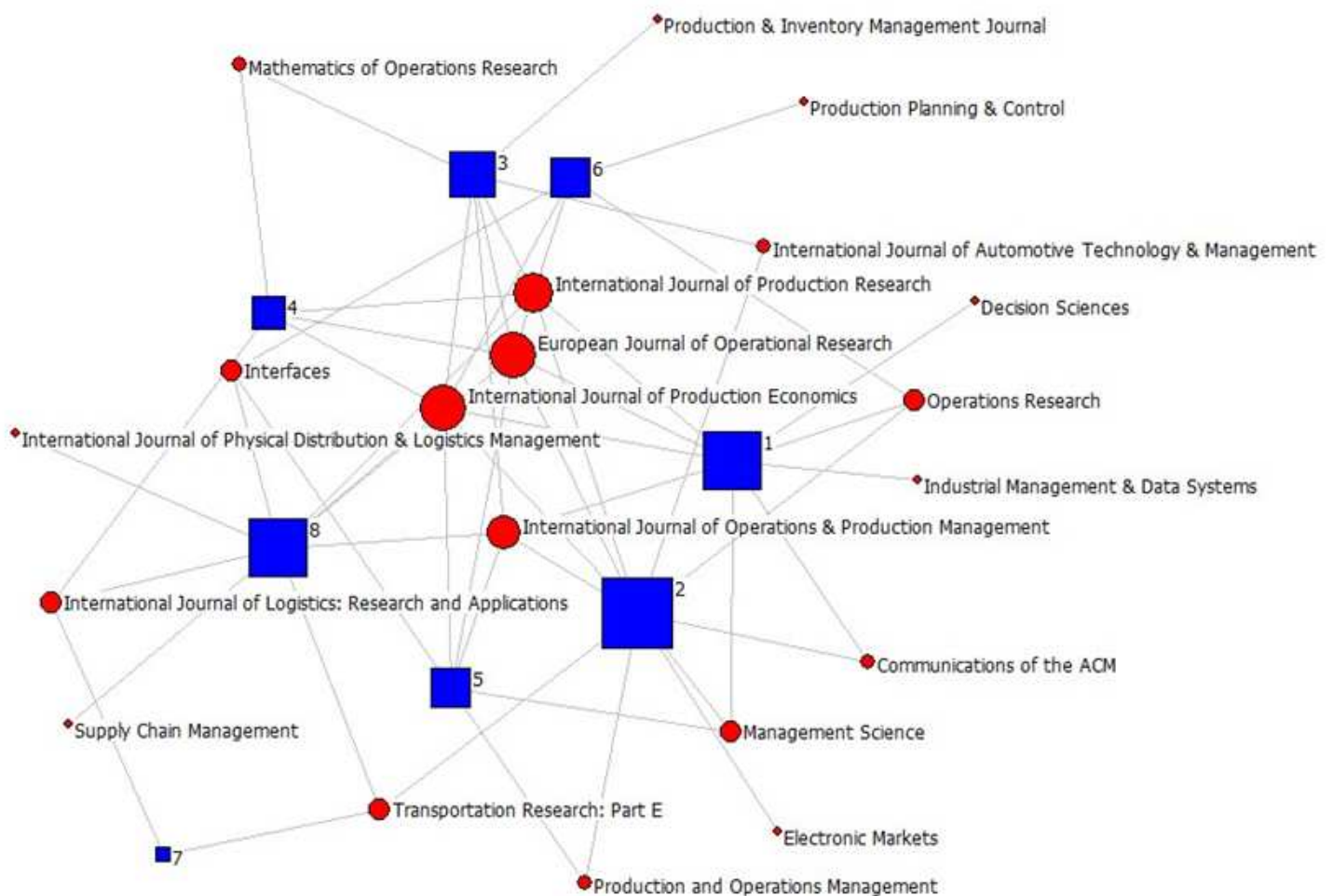
#### **3.1 Analysis of the Concentration of Articles per Journal**

Reviewing the international journals that have articles published by national authors, we can see three different concentrations: the European Journal of Operational Research - EJOR - (39% of articles), the International Journal of Operations and Production Management - IJOPM-(13% Articles) and the International Journal of Production Economics - IJPE-(12% of articles). Although very relevant in the POM field, the journals listed above are not among the top ten English language journals in the classification of (OSLON, 2005, that ranks the major Journals in the areas of production and operations.

The European Journal of Operational Research is in 13th place in terms of operations and 15th in production, on the other hand the International Journal of Operations & Production Management is in 28th place in terms of operation and in 29 of the production and the International Journal of Production Economics reaches the 25th position in the ranking of operations and the 29th in production. There are few articles published in Journals ranked among the top ten. Only 7% of all articles are screened in this situation, having been published in Management Science, Mathematics of Operations Research and Operations Research Journal.

A network analysis of topics of interest and Journals is shown in structure 1. Red nodes in the center of the network indicate the journals with the highest network centrality, or that relate to many topics of interest, establishing more ties (not articles). Blue squares represent the topics of interest addressed by Brazilian researchers who published in international journals. The bigger and more central is the square, the greater is the centrality of the network and number of ties formed with their journals. This analysis serves to illustrate the diversity of issues addressed by the following Journals: International Journal of Production Research (covers six topics), European Journal of Operational Research (addresses seven topics), International Journal of Operations & Production Management (5 topics) and the International Journal of Production Economics (7 topics). It is worth noting the strong correlation between the number of items mapped and number of topics of interest addressed by each journal. The most recurrent theme for

Journals is the design of products and services (11 Journals), followed by SCM and Logistics (9 Journals) and the operations strategy and competitiveness (11 Journals). Thus, it appears that even the topic of operations strategy and competitiveness being one with the greatest number of items mapped, this is not the topic most acceptable to the international journals of the English language among articles published by Brazilian researchers.



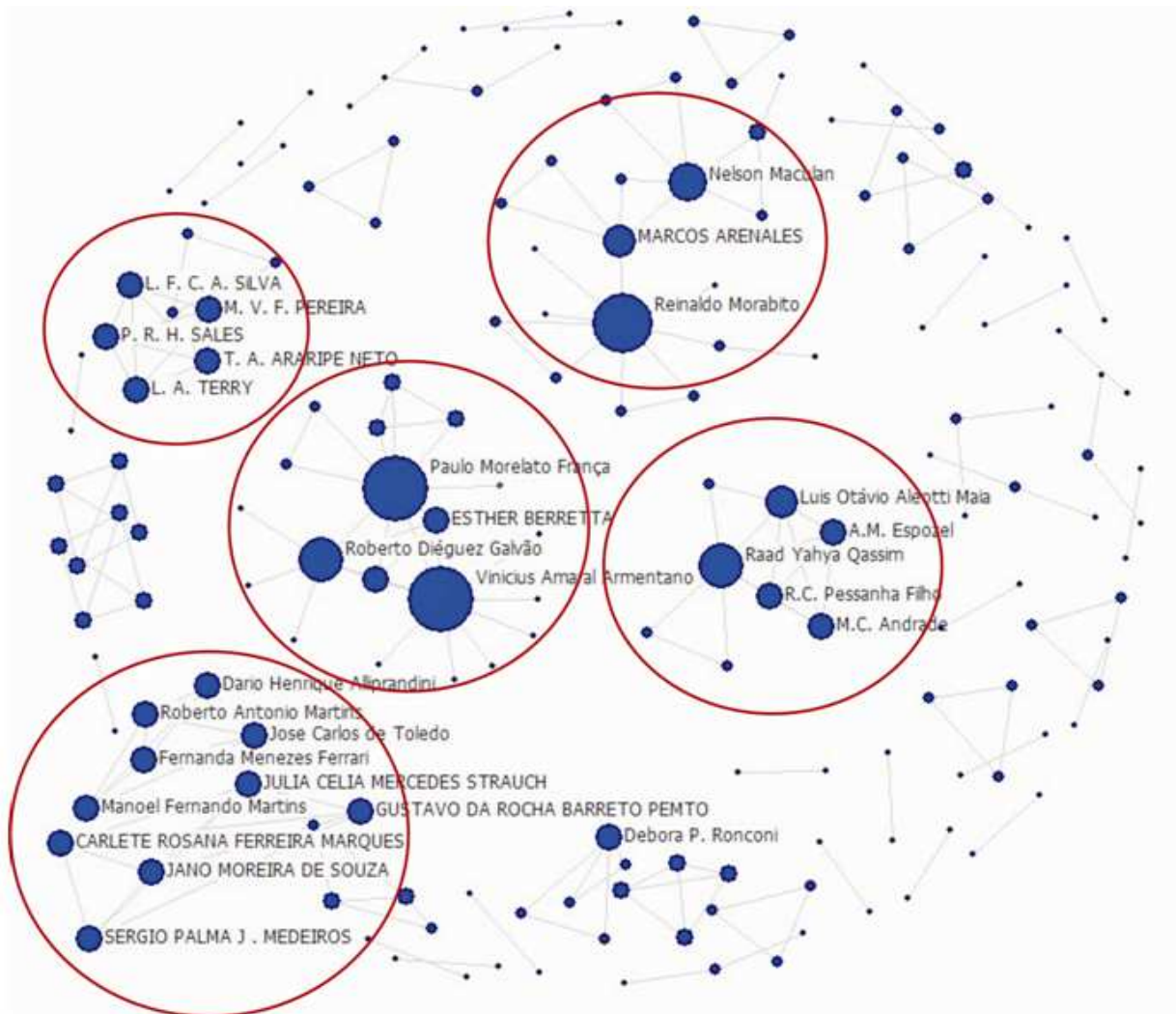
- 1- Operations Strategy and Competitiveness
- 2- Services and Product Design
- 3- Process Analysis of Manufacturing
- 4- Total Quality Management
- 5- Inventory Management
- 6- Operations Schedule
- 7- Environmental Management
- 8- Supply Chain Management and Logistics

Source: prepared by the author

#### NETWORK STRUCTURE 1: ANALYSIS OF AUTHORS AND TOPICS OF INTEREST

### **3.2 Analysis of the authors networking**

When analyzing the relationship between authors, one can see the formation of 5 major groups (clusters of authors), but with different degrees of centrality among its players. It should be remembered that the groups are not necessarily composed by authors from the same institution and the importance of the authors in the network does not concern the number of published articles, but the number of links established with other authors. Authors with more links are located in the center of the network and have larger node (colored ball). Ties are defined as a connection established between a pair of authors (Wasserman and Faust, 1994). In this analysis, a tie means an exchange of knowledge and formal relationship between two authors, through the joint development of a scientific paper published in an international journal written in English in the area of POM. The group most central, or one that has the largest absolute number of ties is formed by 20 authors, is not related to other groups and is headed by the following authors: Paulo Morelato França (UNICAMP), Vinícius Amaral Armentano (UNICAMP) and Roberto Diéguez Galvão (UFRJ), in descending order of number of links established. The second group is more centralized and formed by 20 authors, who are not related to the other groups and is led by the author Reinaldo Morabito (UFSCar), Marcos Arenales (USP), Nelson Maculan (UFRJ), listed in descending order of number of ties established. The third most central group is formed by 8 authors that do not relate to other groups, is headed by Raad Yahya Qassim (UFRJ) and formed exclusively by authors from UFRJ. The other two groups are peripheral because of the lower number of links between the authors and do not have authors with different degree of centrality. One is centered by authors connected to Eletrobras and the Centro de Pesquisas em Energia Elétrica. The network structure 2 illustrates the relationship between authors.



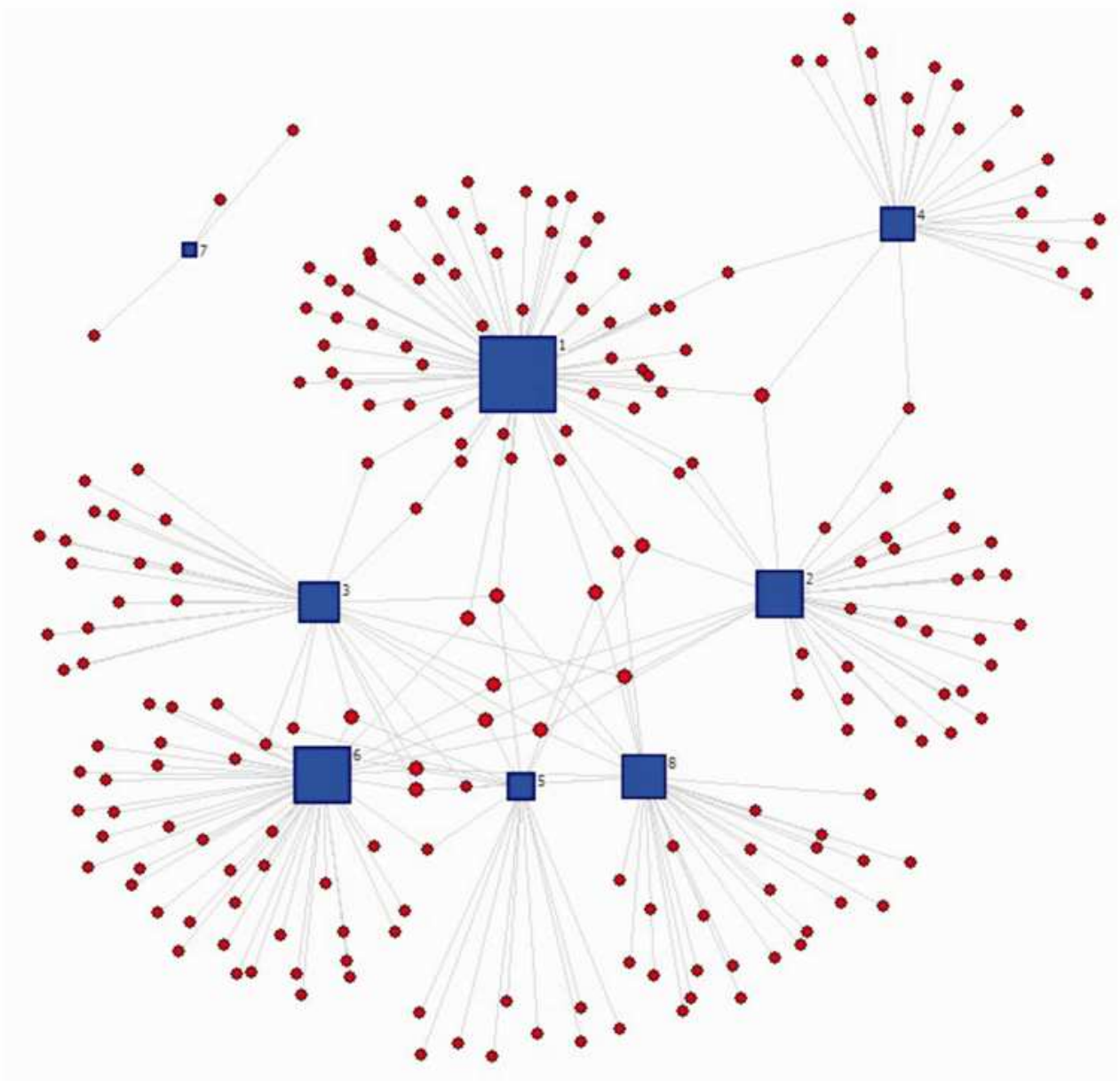
Source: Prepared by the author

NETWORK STRUCTURE 2: RELATIONSHIP BETWEEN AUTHORS

### 3.3 Analysis of authors and topics of interest

The analysis of networks from the perspective of the topics of interest published by the authors concludes that there are few authors who write in different fields in the area of POM. Of the 213 authors mapped, 89% are restricted to write within a field of knowledge, 5% within two topics of interest, 4% within three and only 1% on four topics. The network structure 3 explains the centrality authors-topics of interest. The red nodes marginalized and without links represent the authors that only address a topic of interest in your articles. At the center of the network, is possible to identify those who write in different fields and create links between the themes. There is a strong correlation between the centrality of the author's relationship network of authors and number of topics of interest addressed by the authors in their articles. Among the

authors who address more than 3 themes are Marcos Arenales, Nelson Maculan, Reinaldo Morabito, RaadYahya Qassim, Roberto Diéguez Galvao and Vinicius Amaral Armentano, authors that have greater centrality of relationship.



- 1- Operations Strategy and Competitiveness
- 2- Services and Product Design
- 3- Process Analysis of Manufacturing
- 4- Total Quality Management
- 5- Inventory Management
- 6- Operations Schedule
- 7- Environmental Management
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Source: Prepared by the author

**NETWORK STRUCTURE 3: ANALYSIS OF AUTHORS AND TOPICS OF INTEREST**

### **3.4 Analysis of foreign co-authorship**

Of the 161 articles mapped, 37% have at least one foreign co-authorship, 94 in total, divided into 59 articles. We can see large concentrations of co-authorship in English speaking countries like the United States (42%), Canada (14%) and United Kingdom (12%). While calculating the aggregate of three periods (I, II, III) shows that 37% of the articles have at least one foreign co-authors, it should be noted that this proportion has fallen over the period. In the period I, 53% of the articles had foreign co-authorship, reaching 42% in period II and 34% in the period III. This analysis may indicate two possibilities: either the Brazilian researchers are connecting less with foreign and losing in the exchange of information and experience between countries, which is bad, or Brazilian researchers are becoming more independent and less in need of aid or influence foreign researchers to have their articles published in international journals in the POM area.

### **3.5 Analysis of Articles by period and topic of interest**

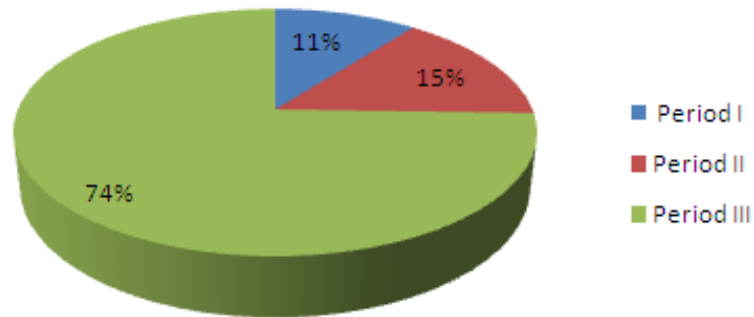
By analyzing the division of the articles tracked in the three periods, we see a large concentration of articles in the so-called period III (1999-2007), i.e. the period of continued economic and political stability in Brazil, with greater participation of the country in the international market and implementation social programs that have increased the income of the poor population. During this period were found 74% of the articles mapped, while in periods I (1980 to 1994) and II (1994 to 1999) were located 11% and 15% of the articles, respectively. A detailed analysis of the articles and their topics of interest revealed that the publication of articles in foreign journals do not follow the conceptual national trends viewed in this study. In several cases we have articles published in the period I on a particular topic, which had not yet arrived, or even become popular in Brazil. To this end, we analyzed the years of publication of the two first articles that were published in each of the eight areas of interest of POM and

compared with the theoretical of this research. The reason for this lack of congruence between the emergence of theories in Brazil and publishing articles abroad by Brazilian researchers may be linked to the large number of foreign co-authorship in the period I and decreased gradually in subsequent periods. As shown in Figures 3 and 4, between 1980 and 1994, period of emergence of most of the concepts of POM, 53% of the articles had foreign co-authors, revealing the strong influence of foreign authors in preparing articles. Another fact that proves that international influence is the fact that only 35% of the articles of the time I declared to have collected data on organizations located in Brazil. On the other hand in the follow period is possible to notice the decrease of outside influence as there is a reduction in the number of foreign co-authors: 42% of articles in period II and 34% of the articles in the III and increasing participation of the articles that declare to have collected data in Brazilian organizations (54% of the articles of the period II). One suggestion for future research would be to analyze the influence of the growing number of doctoral programs in Brazil over the periods analyzed. The concentration of articles in period III is related to the growth and proliferation of doctoral courses in the late 90? Were the articles of periods I and II doctoral theses developed abroad? Graphs 1 and 2 show the distribution of articles during the 3 periods and the 27 years.



Source: Prepared by the author

**GRAPH 1: NUMBER OF ARTICLES PER YEAR**



Source: Prepared by the author

**GRAPH 2: NUMBER OF ARTICLES PER PERIOD**

### **3.6 Analysis of the number of authorships per institution**

A total of 52 Brazilian organizations have been declared by the authors as the main institution bond. Of these, 41 are institutions of education and /or research, are 9 companies, 1 is a labor class and 1 is a public agency. There is, however, high concentration of articles in the following educational institutions: Universidade de São Paulo (USP), Universidade Federal do Rio de Janeiro (UFRJ), Universidade Estadual de Campinas (UNICAMP), Universidade Federal do Rio Grande do Sul (UFRS ), Universidade Federal de São Carlos (UFSCar) and Universidade Federal de Minas Gerais (UFMG). In the case of USP, 38 articles have at least one author with ties to this institution declared, but there are 56 authorships in total linked to this institution. There is a concentration of authorship in topics related to the area of operations strategy and competitiveness, 27% of the total, almost half of authorship related to the European Journal of Operational Research. When analyzing the type of contribution of articles related to USP, 40% say they have collected data in Brazilian organizations, but only 11% have practical application of theory in the organizational context. Concerning the data source of articles, 52% of the authors declare that they haven't collected data. It should be noted that although the topic of operations strategy and competitiveness is the most discussed, the articles are well divided among the other topics. This is probably because of the wide variety of colleges and institutes that are linked to the authors, such

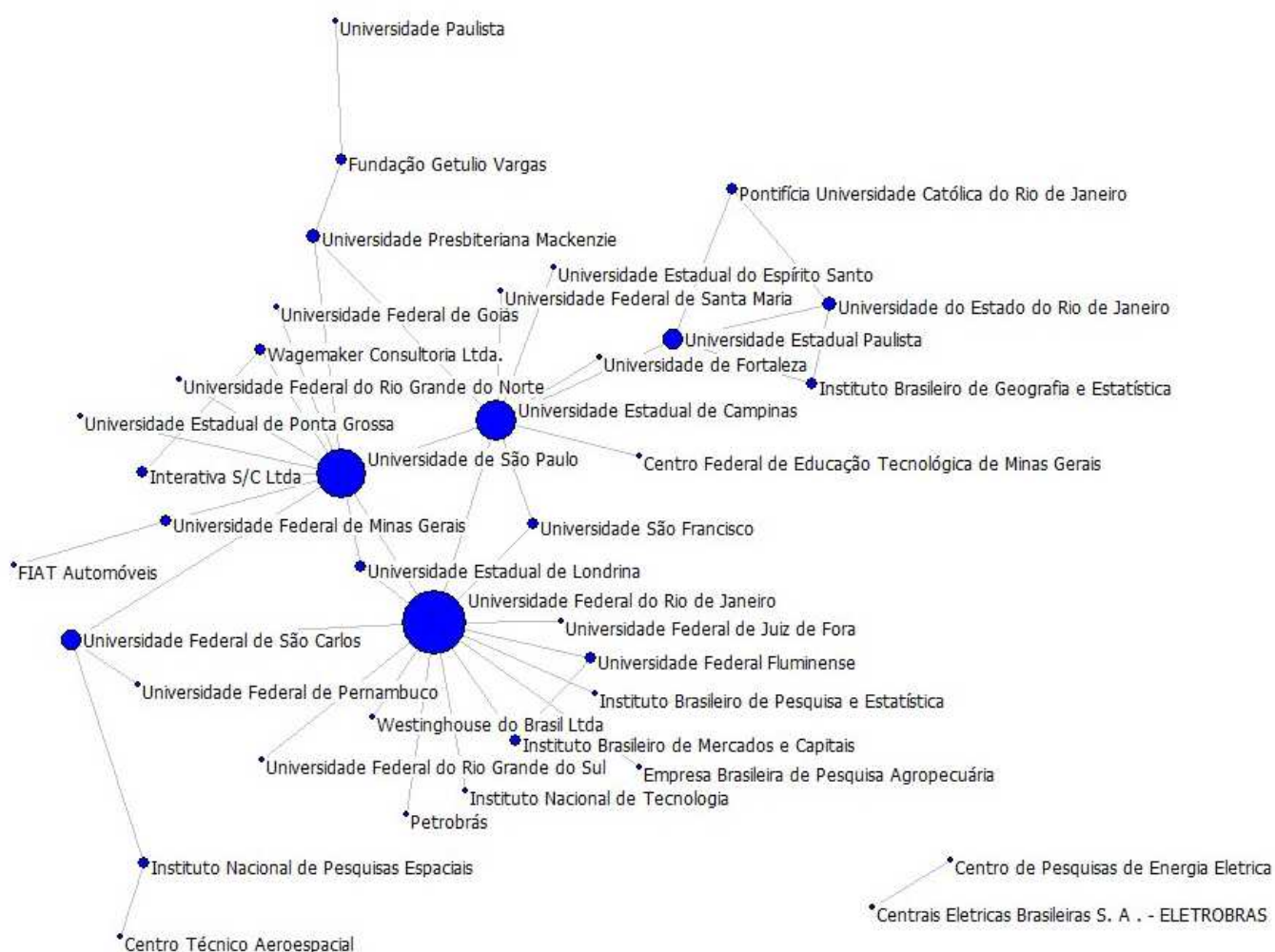
as the Polytechnic School (POLI), the Faculty of Economics and Business Administration (FEA), the Institute of Mathematics and Statistics (IME) and the School of Engineering of São Carlos, those with the higher incidence. Altogether there are 32 papers with at least one author working with the UFRJ, 57 is the total number of authorships, concentrated mainly on the topic of operations strategy and competitiveness (40% of authorships). Regarding the type of contribution, although 42% of articles aim to introduce and/or explain concepts in the POM area, it can be seen an above-average participation in the categories of application of the theory in Brazilian organizations (26%) and detection of problems, data collection and / or case study in Brazilian organizations (32%). In the case of UFRJ, more than half of authorship (58%) say they have collected data in Brazilian organizations, a very important notice to explain the importance given by the authors of this institution to use, in some way, the Brazilian experience in the preparation of their articles. About 46% of authors used case studies as a data source. In the case of UNICAMP, 22 articles are mapped with at least one author with ties with this institution, but there are, in total, 37 authorships. Unlike the institutions mentioned above, the authorships of UNICAMP are focused on the topic of interest operations schedule (62%) and inventory management (16%). Regarding the type of contribution, 86% of the authors are focused on introducing and/or explain concepts related to area of POM, and only 14% of the authors collected data or applied theories in Brazilian organizations. Concerning the sources of data, 84% of the authors declare that they have collected external data, ie, they use the simple construction of theories and mathematical computed simulations. Probably because of the high concentration of articles in the areas above, using computer simulations and algorithmic methods, is the large number of authors that belong to the Institute of Computing and School of Electrical Engineering and Computing at the State University of Campinas. When analyzing articles related to UFRS, one sees a large concentration of authorships (67%) interest in the topic of operations strategy and competitiveness, following the overall average. Altogether there are 11 papers with at least one author with the institution and 15 authorships, in total. An interesting aspect is the absence of articles related to the areas of inventory management, scheduling of operations, environmental management, SCM and Logistics. Moreover, great importance is given to empirical research, whereas 67% of the authors made use of the practical application of his theories in Brazilian organizations. The principal methodology

employed was the case study, present in 80% of authorships related to this institution. Probably the focus given to the area of operations strategy and competitiveness is given by the link of the vast majority of authors to the Faculty of Administration of UFRS. In the case of UFSCAR major focus is given to research related to the design of products and services (56% of authorships), followed by thematic analysis of manufacturing processes (25% of authorships). One cause of this concentration is probably the amount of teachers and researchers of the Department of Production Engineering of the University. A total of 8 articles were mapped with at least one author on the institution and 16 authorships, in total. Regarding the type of contribution in the case of UFSCAR, 69% of authorships are aimed at detecting problems, data collection and / or a case study in Brazilian organizations, which shows the importance given to the Brazilian experience in the POM, and questionnaires and case studies are the main methodologies used. Altogether there are 8 articles with at least one author on the UFMG, 12 is the total number of authorships and major focus was given to the area of operations strategy and competitiveness (50% of authorships). The main type of contribution of its articles is the introduction or explanation of concepts related to area of POM (83% of authorships). Moreover, 58% of the authors declare that they have collected external data. Is possible to see the formation of clusters of institutions when analyzing the topics of interest to POM. The university that has most of its authors related to their departments and colleges of engineering, the articles are focused on technical areas of POM, such as process analysis, programming, operations and design of products and services, as the case of UFSCAR and UNICAMP, for example. Another group is formed by the other institutions mentioned above and is focused (to varying degrees) the topic of operations strategy and competitiveness, largely motivated by the connection of their teachers and researchers to the business and economics schools.

The network structure 4 analyzes the networks formed by the institutions of the authors link. The larger the size of the node (blue sphere) as well as its centrality, the greater the number of ties that the institution establishes with other institutions. At the center of the network can realize the large number of ties generated by the Universidade de São Paulo, Universidade Federal do Rio de Janeiro and Universidade Estadual de Campinas. Not always an institution with a large number of articles published is able to develop relationships with other institutions, such as the Universidade Federal do Rio Grande do Sul that

is in 5th place in terms of articles, but has a very low network centrality, because it exclusively publishes articles with authors from USP, being in the same situation as institutions that have only one article, when analyzing the importance of the network. Isolate data were excluded from the network.

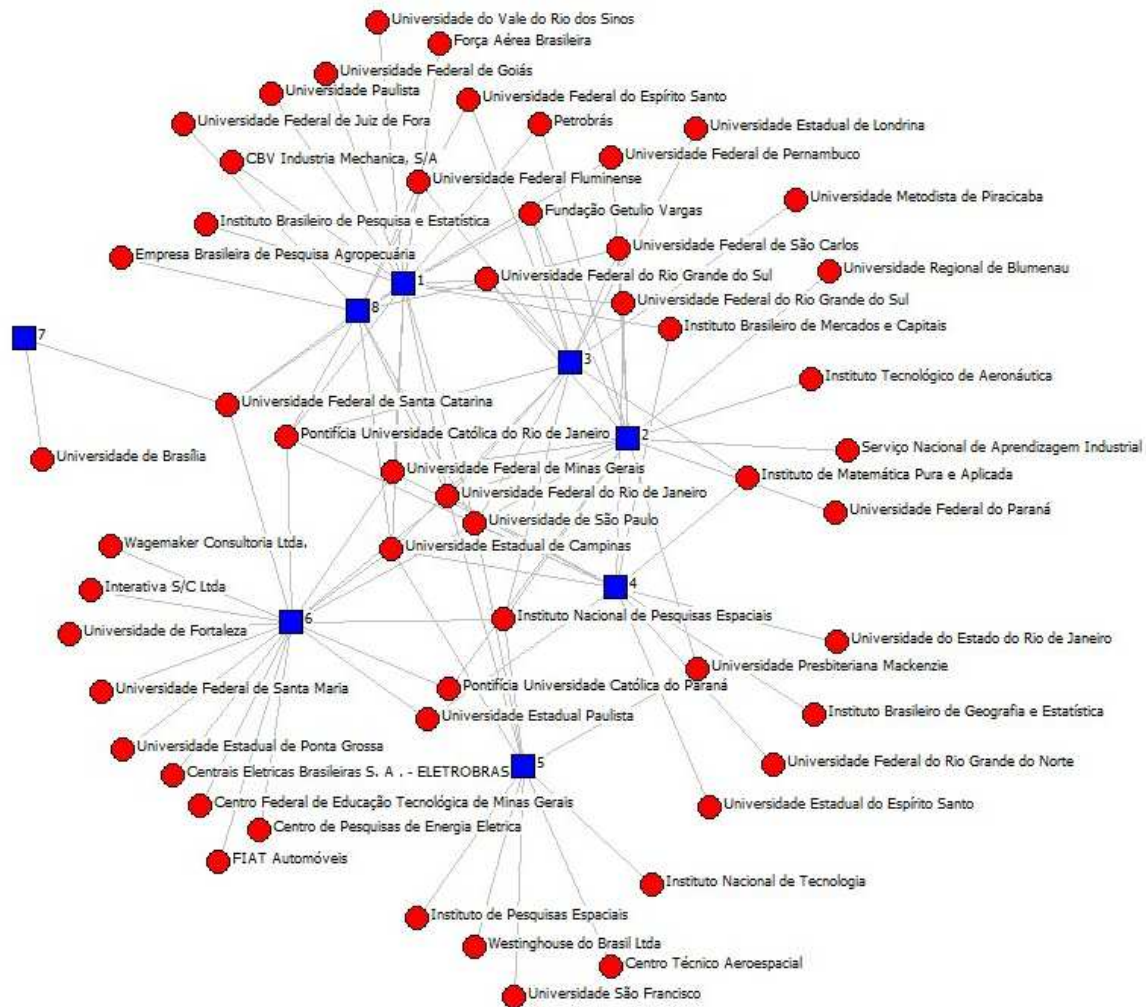
Another important aspect concerns the number of topics of interest addressed by each institution. Most institutions (62%) have just published articles on a topic of interest, with a tendency to specialization or research lines well defined. The institutions with the highest number of articles eventually relate to various topics of interest, as is the case of UNICAMP (6 topics), USP, UFRJ (7 topics each). Network analysis between the topics of interest and institutions is explained in the structure 5. In it, we can see that the institutions most central to the network are those that establish more ties with the topics of interest (regardless of the number of published articles. A single article on that topic of interest is enough to generate a tie). The blue squares represent the topics of interest in the POM area. The more the center is



Source: Prepared by the author

NETWORK STRUCTURE 4: RELATIONSHIP BETWEEN INSTITUTIONS OF AUTHORS LINK

located the square the more is the number of ties generated with the institutions. Among the institutions with the highest degree of centrality are: USP, UFRJ, UNICAMP, UFMG and PUC-RJ. Two universities have a significant number of articles published while a low degree of centrality. They are UFRJ and UFSCAR. Therefore, not necessarily institutions with the largest number of articles published establish more ties with the topics of interest.



- 1- Operations Strategy and Competitiveness
- 2- Services and Product Design
- 3- Process Analysis of Manufacturing
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Source: prepared by the author

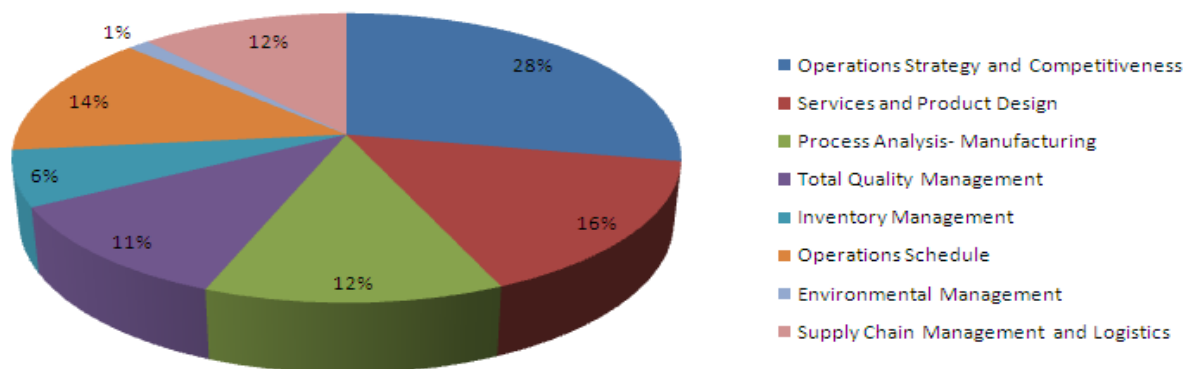
**NETWORK STRUCTURE 5: ANALYSIS OF INSTITUTIONS AND TOPICS OF INTEREST**

### 3.7 Analysis of topics of interest

The topic of operations strategy and competitiveness addresses the following topics: development of the POM's field; vision systems with open and closed corporate strategy, analysis of the core business, administration and science competitiveness of operations, focused factory, strategies overall cost, quality, speed of delivery and flexibility, trade-offs, establishing priorities, measures of productivity, location of plants and offices; Human Resources practices, learning curves, among others. The focus of articles dealing with the topic of interest is to study the scope of POM or business activity from the perspective of the whole, thinking in the gain of the overall competitiveness of the operations. Of the 161 articles, 28% were classified in this topic of interest. The main topics addressed were: creation of models for decision-making, plant location, retail outlets, service facilities, cultural challenges faced and specificities of the Brazilian market. In this section the main data source were the case studies (51%) and the main type of contribution is the explanation or the introduction of concepts in POM's field (44%), and 55% of the articles declare to have collected data from Brazilian organizations, including Petrobras, Embrapa, Organizações Globo, Bunge and Correios. The topic of interest on the Design of Products and Services covers the following topics: industrial design, process of generating ideas, technical characteristics of the product or service, high or low degree of contact with the customer service delivery; variability and tangible service provided; package of services, technical assistance, service blueprint, service poka-yoke; generation of value to the consumer, among others. The focus of the articles mapped dedicated to this topic of interest was design of e-commerce services, design of computer networks, technical assistance and maintenance, creation of cutting patterns and industrial design, and satisfaction surveys (to proof a concept when creating a product). Of the total articles, 16% were classified in this topic, 40% of them said they had collected external data and the main contribution was to explain or introduce concepts from the fields of POM (60%). It is worth mentioning that 40% of the articles declared to have collected data in Brazilian organizations. Within the topic of interest of manufacturing processes, the following topics are discussed: conversion of the product cycle; manufacturing process, assembly line, testing process, process flows; array of products and processes; break-even analysis; layout processes, cellular manufacturing, fixed layout, flexible assembly lines, line balancing, theory of constraints, among others. Among the 161

articles mapped, 12% were classified in this topic, 60% of these papers said they had not collected external data, only 20% of data were collected in Brazilian organizations and the main contribution is to explain or introduce concepts from the fields of POM. Among the main issues addressed by the authors are: cutting processes with the use of guillotines, packaging process, layout, manufacturing and theory of constraints. The first article of this topic appeared in 1992, two years after the opening of the Brazilian economy by the President Fernando Collor and when the discussion on new production processes that provide greater efficiency for companies to compete in the international market becomes intense. In regard to the topic of quality management can be said that the key issues are: reduction of defects; matrix of Quality Function Deployment (QFD); costs of managing the quality control; Kaisen; PDCA cycle- plan, do, check and action , ISO 9000, Six Sigma Lean, quality circles, among others. Among the articles mapped, 11% were classified in this topic of interest, and 66% did not take external data and only 22% based their research in Brazilian organizations. The main issues addressed by the authors of these articles were: methods for the identification of errors, statistical process control and Markov chain. The first article of this topic deals with the detection of flaws in the production process and was published in 1986, the year that appeared the first quality standards in the POM, ISO 9000, which in Brazil is now called NB 9000 (ABNT) and NBR 9000 (INMETRO) and the first circles of quality control in the country. The second article appeared only in 1997. Therefore, one can see that the debate on quality management starts in the mid-80s, but its institutionalization in companies takes place only in the late 90's when they start to recognize the reduction of failures as a way to gain competitiveness and increase profitability, hence the high concentration of articles in the Period III. The topic of interest on the inventory management relates to the following themes: Just-in-time; Japanese manufacturing, kanban, inventory costs, safety stocks, Material Requirements Planning I and II (MRP I and II); Enterprise Resource Planning (ERP); Two / One-bin system, among others. Of the 161 articles mapped, 6% were classified in this topic, and 70% said they had not collected data for research, only 20% of data were collected in Brazilian organizations, and explain or introduce concepts from the fields of POM was the main contribution of this topic . Among the main issues addressed by authors mapped in this topic are the sizing of production and minimize inventory. The first articles appeared in the mid-80 (1980, 1982 and 1984) and deal with the sizing of

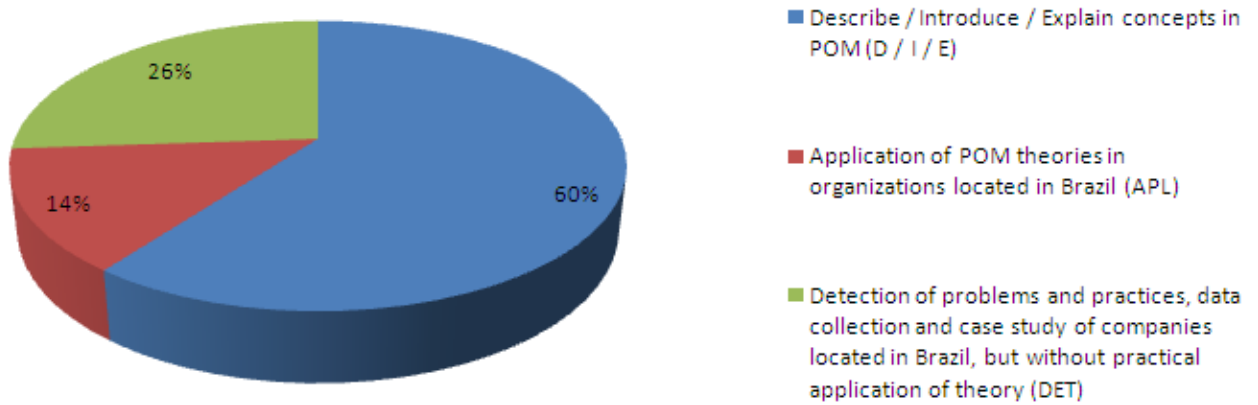
production, on the other hand the articles related to minimize inventory and just-in-time had focus on the period III, when debates about reduction of inventory costs become more intense. Within the topic of interest operations schedule, the main topics are: linear programming, overtime, setup time, production techniques of aggregate demand management, sales forecasting, economies of scale and scope, rate of men by machines, seasonal production, among others. Of the articles mapped, 14% were mapped in this topic, and in 77% of cases the main contribution was to introduce or explain concepts in the POM's area. Moreover, 23% say they have based their research in Brazilian organizations. Among the main issues addressed by the articles mapped in this topic are: the reduction of setup time and delays in the production process. The topic of interest with fewer incidences among the articles was environmental management (only 2 articles were classified in this topic). In both cases the research was based on case study of Brazilian organizations and deal with the minimization of waste through recycling and sustainable development of logistics operations in the Amazon region. The two articles date from 2007. In regard to the topic supply chain management and logistics, we can say that the key issues are: a supply chain, locating distribution centers, route optimization, models for making decisions concerning logistics, logistics costs, port, airport, road and multimodal management. 12% of the 161 articles mapped were classified in this topic of interest, and the detection of problems, data collection and / or a case study in Brazilian organizations was the main type of contribution (47% of cases), with similar division between sources of data collected: secondary data, case studies and data collection without external (26% each). It is worth mentioning that in 68% of the articles collected data in Brazilian organizations. The Graph 3 shows the distribution of the articles among the topics of interest.



Source: Prepared by the author

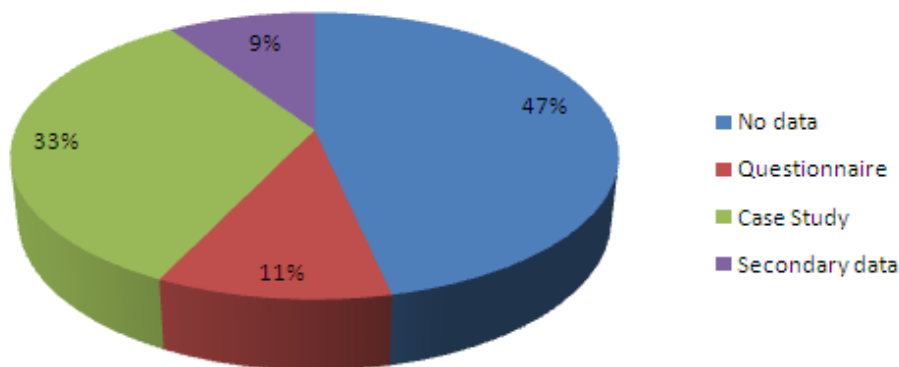
GRAPH 3: ARTICLES PER TOPIC OF INTEREST

### 3.8 Type of Contribution and Data Source



Source: Prepared by the author

GRAPH 4: ARTICLES PER TYPE OF CONTRIBUTION



Source: Prepared by the author

GRAPH 5: ARTICLES PER DATA SOURCE

## 4. Conclusion, Research Limitations and Directions for Future Research

From the above analysis we can conclude that the articles published by Brazilian researchers abroad are not present in a representative way in the top ten international journals in the area of classification of POM (OSLON, 2005). Only 7% of the articles are in this situation. There is great concentration of articles in European Journal of Operational Research (39%), which is only the 13th in the ranking of operations. Should be considered, however, that 13% of the articles published are not among the top 30 journals in

the area. The three main institutions link of the authors are USP, UNICAMP UFRJ, UFMG, UFRS and UFSCAR. It is also noticed the formation of two clusters when analyzed the topics of interest to POM. The university that has most of its authors related to their departments and colleges of engineering have most articles focused on technical areas of POM, as process analysis, programming, operations and design of products and services, such as the UFSCAR and UNICAMP, for example. Another group is formed by the other institutions mentioned above and is focused (to varying degrees) in the topic of operations strategy and competitiveness, largely motivated by the connection of their teachers and researchers at business and economics schools. From the analysis of networks of relationships between authors, one can see the formation of 5 groups of authors internally heterogeneous when analyzed their institutional bonds. Moreover, is possible to conclude that the vast majority of authors (89%) are restricted to write within a single topic of interest. There is a concentration of 74% of articles in the period III (1999-2007), ie the period of continued economic and political stability in Brazil, with greater participation of the country in the international market. It is evident that the publication of articles by Brazilian authors in journals followed international trends, especially in the period I. One reason is the strong participation of foreign authors in the articles of this period. Gradually the number was decreasing and the international influence in the articles as well. This can be verified as there was a significant increase in data collection in Brazilian organizations over the periods. Therefore, one can infer that Brazil is increasing its influence in the field of POM and contributing with their experience in a world that wants as much information related to developing countries as possible. We should also consider that the years mentioned in this report refer to the years of publication and not preparing articles, which may represent a limitation of the analysis of this research, given the time between submission and publication of articles. In general, evaluating the three periods, it appears that only 37% of the articles have at least one foreign co-authors, revealing the strength of national authors to publish articles abroad. Moreover, this participation is decreasing over the period. The topic of interest most tackled in articles was operations strategy and competitiveness, followed by design of products and services and programming operations. The main type of contribution of articles mapped was "introduce or explain a concept in the area of POM" (60% of cases). It can be concluded that 40% of the articles collected in some way, data on

companies located in Brazil. As the source of the data collected, most of the articles (47%) stated that it had collected external data, followed by case studies and use of questionnaires. In general, we can state that the initial questions have been addressed and attended to their research purposes. Some of the proposed directions for future research are: addressing issues currently underused and take advantage of the Brazilian experience, as with the topics of environmental management and inventory. Brazil has the opportunity to show the world if its operations are environmentally and socially sustainable or not. It may also show that despite having difficulties with respect to logistics and distribution, is possible to minimize inventory and operations just-in-time can create competitive advantage in countries like Brazil. Thus, there is opportunity to further explore topics related to inventory management, Just-in-time and social and environmental sustainability of operations. Questions like these are essential for attracting international investments and important tools to break paradigms and conceptual barriers. Another recommendation is the further elaboration of empirical research, using the Brazilian experience through the collection of data in organizations in the country. It is seen that 60% of the articles do not address the Brazilian experience, applying a theory or practice and detecting problems in Brazilian organizations. An opportunity would be greater incentives for research in the areas of POM by institutions located outside the south-southeast axis, showing their local experiences and bring different contributions to this field of knowledge. Currently 97% of authorship are linked to institutions in south and southeast. Among the main limitations of the research is the subjectivity in the classification of articles by the author of this research. Although utilized a solid conceptual grounding, careful attention to the reading of articles and tools to search for keywords, the classification could lead to different interpretations. Another problem stems from the fact that in some cases the same article was composed of up to 5 authors from the same institution which had become biased by the data analyzed, when analyzing number of authorships. Still, few such cases and the overall objectives of the research were not affected. This work is the result of hard work and dedication over 12 months, that were only possible because of the support from some people and important institutions.

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