Abstract - The research has the purpose of describing the structure of relationships (co-authorships) between researchers and institutions in service operations management from 1995 up to including 2008. Data was collected from the top three relevant operations journals identified by Barman et al. (2001). A search of the ABI/Inform Global (Proquest) database with the word “service” in the titles, abstracts or subjects, revealed a total of 341 documents: 128 in IJOPM, 115 in JOM and 98 in POM. Social Network Analysis was used and the unit of analysis was an entity that consisted of a collection of authors that published papers, a total of 579 authorships. It was possible to identify the centrality and prestige of actors and groups in the network, using measures such as degree centrality and betweenness centrality. In addition, it was analyzed the relationship between those measures and the service operations scientific production.

1. INTRODUCTION

The service sector has a relevant participation in the main worldwide economies. This sector can correspond from 70 to 85% of GDP (Growth Domestic Product) in many developed countries (JOHNSTON; MICHEL, 2008). Despite the size of the service economy, service operation seems to feature little in Production and Operations Management (POM) field.
The POM field has experienced substantial changes since the establishment of manufacturing products and processes in the nineteenth century, with occasional crises of identity (SPRAGUE, 2007). In recent decades, these changes have been intensified, with great impact on business as well as on teaching and research activities (GUPTA; VERMA; VICTORINO, 2006).

In this sense, Soteriou (1999) states that POM field was established as one of the key disciplines in most schools of business worldwide. This author highlights some fundamental changes observed in the business environment, such as the increase demand for quality, the emergence of new markets, the internationalization of production and time-based competition.

Thus, the development of POM as a critical area in Management Sciences has motivated researchers to identify and to establish a research agenda, indicating emerging issues and research methodologies (BUFFA, 1980; CHASE, 1980; MILLER; GRAHAM, 1981; AMOAKO-GYAMPAH; MEREDITH, 1989; MEREDITH et al., 1989; SWAMIDASS, 1996; PANNIRSELVAM et al., 1999). Other researchers have made efforts to conduct a review of field production in terms of topics and methods used to investigate the problems identified in the area (FILIPPINI, 1997; PANNIRSELVAM et al., 1999; PRASAD; BABBAR, 2000; BOYER et al., 2005; PILKINGTON; FITZGERALD, 2006; GUPTA et al., 2006). The latter have highlighted the importance of analyzing publication development and evolution, as well as trends and opportunities for future studies, which largely complements and verifies the research agenda proposed by the former.

In general, as seen in the POM field, the evaluation of scientific fields has the published paper as the unit of analysis. However, scientific knowledge, presented in
academic publications, is socially constructed through relationships developed by researchers (KUHN, 1978; POPPER, 1972).

With this premises, this paper attempts to analyze the development of the structure of relationships between researchers in Services Operations Management. Besides, this study aims to evaluate the structure of relationships between authors and their roles in the collaboration network, as well as to identify the most prolific researchers and institutions and the indicators of production and productivity of the scientific field.

The paper is divided into six sections, including the introduction. The next will discuss the theoretical background that supports research analysis. The third one, it is presented the methodological procedures chosen to achieve research objectives. After that, the data related to productivity and cooperation is discussed. The fifth section highlights the structure of researchers’ networks. In the final one conclusions and recommendations are made.

2. THEORETICAL BACKGROUND

2.1 THE PRODUCTION AND OPERATIONS MANAGEMENT RESEARCH

The POM research evolution was strongly linked to the business management evolution. Buffa (1980) suggests three steps of development in the POM field from the period after World War II. Throughout the 50s, when it was called the Industrial Management or Factory Management, the study area had a predominantly descriptive characteristic and the main research topics were related to studies of time and movements, the plant layout, production control and description of how production systems operate (BUFFA, 1980). According to Filippini (1997), studies made in this period implicitly assumed that (a) production systems were isolated from the
environment and strategically neutral, (b) the prevailing technical resources, and (c) that the ultimate goal was to maximize the productivity of labor.

During the 60’s and 70’s, Operations and Decision Science studies, in general, provided scientific methods that enabled researchers to develop scientific papers similar to the natural sciences, with the insertion of topics such as services management and others that have expanded the possibilities for research in the field (BUFA, 1980). From the analysis of 134 papers published between 1977 and 1979 in major journals, Chase (1980) identified that during the 70's, researchers have produced little empirical work, which culminated in little application to operation managers. Besides, it was the time of discussion around the continuity of the POM in the curriculum of schools of business (ANDREWS; JOHNSON, 1982), which generated a need for field legitimacy. In addition, researchers attempted to bring their concerns along with the demands of business, creating a greater focus on empirical work (EBERT, 1990; McCUTCHEON; MEREDITH, 1993).

Heineke and Davis (2007) mention that there was an initial research efforts in the 1960s and 1970s, although conducted by economists and focused primarily on health services. This fact started with an awareness of the need for business schools to develop courses and programs that addressed specific needs of managers in service companies. Researches concerned with the differences between manufacturing and services started to appear in the 1970s.

Buffa (1980) proposed a research agenda for operation management with an approach closer to the "practical world", with the purpose of results to be understandable and acceptable to practitioners. The author highlighted the continuation of research on strategic issues such as technology choice, capacity planning, analysis of plant location and issues related to planning and control. The author also stressed issues
such as positioning, capacity planning and quality control being important to address issues in services management.

Another research agenda to the field was proposed by Miller and Graham (1981). Unlike Buffa (1980), these authors focused on perception of researchers and professionals. They bring attention to four areas: policies, operations, production control, service management and productivity and technology. To study these issues, Miller and Graham (1981) recommended that researchers should use case studies and other empirical methods in order to expand the methods used by the field that was restricted to the use of simulation and modeling.

The discussions concerned with future directions revitalized the field. Cole (1998) identifies the resurgence of POM in the 80s as one of the main areas in Business Management with the emergence of issues related to quality (Quality Control Circle, Total Quality Management etc.).

The importance of this topic, in view of Slack et al. (2004), helped issues such as lean production, reengineering, supply chain management and e-business being associated with the operations field.

Pannirselvam et al. (1999) finds that the POM field has a low rate of exchange internationally and he explains its causes in three reasons. The first one is related to the pressure for publications in journals of prestige, which is an indicator of the universities status. This one covers the fact that researchers look at what is already legitimimized by the field and avoid bearing the risks associated with innovative themes and methodologies.

Another reason given by the authors is that there is some resistance on the part of publishers, and especially by auditors for new issues, especially for new and
unknown methods. Editors, sometimes, have difficulty in finding qualified auditors in new methodologies and the reviewers feel uncomfortable with them.

A third one is the high degree of sophistication that new methodologies must show in order to be acceptable. Most of the techniques, despite of new operations, are not new to researchers in other social sciences.

Another problematic aspect is discussed by Slack, Lewis and Bates (2004). Their research was based on the analysis of papers published in JOM and IJOPM during the period from 1990 to 2003. The authors reflects about the existence of two worlds between research and practice in the field of operations, which was a frequent topic since the 80's, as it was described in earlier section.

Slack, Lewis and Bates (2004) conclude their work emphasizing that from the moment that organizations make use of the POM to understand and improve their operational and strategic activities, the researchers of the field of operations will have a more comprehensive and representative environment to development of studies, which may increase their relevance and impact.

This section was dedicated to some aspects related to POM research over the last decades. It was possible to realize that, although some authors have reflected about field production, it was not identified authors discussing social dimension of the field, the purpose of the present research.

### 2.2 THE SCIENTIFIC SOCIAL DIMENSION AND SOCIAL ANALYSIS NETWORK CONTRIBUTIONS

The importance of scientific activity reflected in the scientific production relies on the fact that it is a formal means of legitimacy for actors in any scientific field (CARVALHO; GOULART; AMANTINO-DE-ANDRADE, 2005).
Bourdieu (1983) considers science field as a social field. The author states that logic would not be different in the scientific field, which is a social field like any other, with its relations of power and monopolies, their struggles and strategies, their interests and profits.

Thus, the concept of field implies the existence of a community of organizations that share common meanings and systems, in which participants interact more frequently among them than with actors outside the field (SCOTT, 2001). In this work the researchers of the field are seen in a network of social interaction, where they share, compete, share information and resources, where they are joined in schemes of cooperation, organize themselves in various forms for the research and create socially accepted parameters for assessing the recognition or rejection of ideas with pretense of knowledge in the field.

Thus, the analysis of social networks were used to assess the structure of the scientific field of Service Operations Management, from the experience of other fields (BARABASI et al., 2002; GUIMERA et al., 2005, LIU et al., 2005; MOODY, 2004; NEWMAN, 2001a, 2001b, 2001c, 2004; WAGNER; LEYDESDORFF, 2005).

Social networks analysis provides different alternatives to the visibility of knowledge in one area. It is not a formal theory or unit, but a comprehensive strategy of social research (EMIRBAYER; GOODWIN, 1994). With this type of analysis, it is rejected attempts to explain human behavior or the social process only in terms of attributes of the actors (EMIRBAYER; GOODWIN, 1994, SCOTT, 2000; WASSERMAN; FAUST, 1994; WELLMAN, 1988). As Wellman (1983) stated, social behavior is the result of both individual possession of attributes and rules, as the result of their involvement in the structure of social relations.
Thus, the inclusion of concepts and information about the relationship between units of analysis is the main difference between relational and non-relational methods of analysis (WASSERMAN, FAUST, 1994). Then, social networks are sets of contacts that connect various actors, in which such contacts may have different types, contents and structural properties.

Wasserman and Faust (1994) conceptualize that there are two different types of variables possible to be used in the analysis: (i) structural variables, which provide information about the links between pairs of actors, and (ii) composition variables, which consist on the attributes of actors, such as gender, age, and race. According them, the combination of both variables allows researchers to assess not only the relationships but also the effects of author attributes. The combination of variables was headed by White (1966) as CATNETS (categories and networks).

The following section will be dedicated to methodology, as well as the concepts and metrics related to the analysis of social networks.

3. METHODOLOGY

To achieve the stated objectives in this research paper, a descriptive and exploratory study was developed. It was based on documentary research with the use of scientific papers published in the top three most relevant operations journals (according to BARMAN et al., 2001) in the period from 1995 to 2008.

The journals analyzed were (i) IJOPM – International Journal of Production and Operations Management (ii) JOM – Journal of Operations Management and (iii) POM – Production and Operations Management. A search of the ABI/Inform Global (Proquest) database on the word “service” in the titles, abstracts and keywords of the journals (up
to 1995 and including 2008) as done by Johnston e Michel (2008) in order to identify scientific papers related to the issue in the year of 2006.

The level of research analysis is the researcher network in the POM field and the unit of analysis is each researcher individually. According to Wellman (1988), the level of relationships network is most appropriate for this type of analysis, therefore it is not limited to check intra and inter group relations.

From the selected papers, it was extracted the units of analysis, i.e. each author who, alone or jointly with other authors, published a scientific paper in the period of time being analyzed. It was analyzed 579 authors and 329 papers.

3.1 Data Analysis Categories

The data was analyzed using the software Microsoft Excel 2007, UCINET 6.0 (BORGATTA, EVERETT, FREEMAN, 2005) and PAJEK 1.10 (BATAGELJ; MRVAR, 2005). Microsoft Excel 2007 was used to tabulate the data, to generate dynamic reports measures of productivity and to generate the matrices in the UCINET 6.0. This, together with the PAJEK 1.10, were used to calculate the metrics of social networks of researchers and to draw them.

Density

Density is a parameter of the network, which expresses the ratio number of links in one group divided by the total number of possible links between the actors that comprise the network (KNOKE; KUKLINSKI, 1982). This structural indicator varies in an interval [0,1], which the closer to 0 is less connected to the network, the closer to 1, the closest is to be fully connected network.
This is an important parameter to assess the connectivity of a network. In environments of high density of relationships, its content becomes increasingly redundant (KOGUT; WALKER, 2001). Networks with low density have weak-ties. Thus, relationships established outside of the circle (i.e. weak-ties) allow access to other sources of information and resources, which can lead to new forms of knowledge.

Kuhn (1978) states that the cohesion between scientists may lead them to see new paradigms such as inconsistencies, particularly when they already have an old tradition in research, and they need to seek interaction with other researchers outside the group.

**Components**

A major effort in social networks is to find the various sub-groups together in the network can be divided (SCOTT, 2000). Component is the simplest of all concepts of sub-networks. Components are fully connected sub-networks (WASSERMAN, FAUST, 1994). In a component, all nodes are connected by links, but no link is made with an actor outside of the component (Scott, 2000).

**Centrality**

The centrality is configured as a property that measures how central is an actor in a network (SCOTT, 2000; WASSERMAN, FAUST, 1994). In analysis of social networks is common to identify the most central actors, as relates to this position on the importance of the network. To size the centrality of the actors, there are different measures, and two more used: Degree Centrality and Centrality (SCOTT, 2000; WASSERMAN, FAUST, 1994).
Degree Centrality: is the number of ties that an actor has with other actors in a network (WASSERMAN, FAUST, 1994). According to Scott (2000) as the degree of centrality takes into account only the adjacent relationships, this only shows the local centrality of actors.

Betweenness Centrality: the interaction between non-adjacent actors might depend on other actors, which may potentially have some control over the interactions between two actors not adjacent. In this sense, according to Freeman (1979) and Wasserman and Faust (1994), an actor is an agent if it binds several other actors that do not connect directly.

**Structure of Social Network**

This is in the relationship between social entities, their characteristics and implications for those involved (WASSERMAN, FAUST, 1994). This category was used by the analysis of the structural elements of the network (size, density and components) and the positions of researchers in the network (Degree and Betweenness centralities).

**Scientific Production**

The scientific production is the expression of scientific knowledge, in the form of papers, built from the practices of researchers in search of a scientific field. In this paper used the descriptive analysis of indicators of scientific output (papers published; Papers per Author, Author per Paper; Papers per Attribute; Papers per Institutions).
Dynamic Relationship between Researchers

This dynamic is related to the development of networks of relationships in a given period of time represented in the form of changes in the structure of relationships (MOODY, 2004; WASSERMAN, FAUST, 1994). In this study, this concept was based on longitudinal assessment of the structural indicators (size, density and components) and positioning of the researchers in the network (Degree and Betweenness centralities).

3.2 LIMITATIONS

As in any scientific work, it is possible to highlight some limitations. The first one is related to the type of relationship chosen for analysis because researchers do not cooperate only through publication of scientific papers. There are also informal relationships that can be analyzed. Another limitation is related to the delimitation of the research. The journals studied do not consist on the total possible means of publication. However, they are the POM top ones, and that fact makes the cut representative.

4. PRODUCTIVITY AND COOPERATION IN SERVICE OPERATIONS

This section discusses the development of indicators of production, productivity and cooperation in Service Operations.

Based on Table 1, it was found that 128 documents were published into service subject in IJOPM, 116 in JOM and 98 in POM. It represents 11.50%, 21.68% and 19.44% of total publications, respectively, in each of the journals. Moreover, they indicate that despite IJOPM has published the higher amount of articles on service operations, it was the JOM that had the higher percentual.
Table 1 – Scientific Production in Service Operations

<table>
<thead>
<tr>
<th></th>
<th>Period 1 (95-98)</th>
<th>Period 2 (99-03)</th>
<th>Period 3 (04-08)</th>
<th>Total (95-08)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IJOPM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>28</td>
<td>47</td>
<td>53</td>
<td>128</td>
</tr>
<tr>
<td>Total</td>
<td>330</td>
<td>429</td>
<td>354</td>
<td>1113</td>
</tr>
<tr>
<td>%</td>
<td>8.48%</td>
<td>10.96%</td>
<td>14.97%</td>
<td>11.50%</td>
</tr>
<tr>
<td><strong>JOM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>19</td>
<td>29</td>
<td>68</td>
<td>116</td>
</tr>
<tr>
<td>Total</td>
<td>127</td>
<td>161</td>
<td>247</td>
<td>535</td>
</tr>
<tr>
<td>%</td>
<td>14.96%</td>
<td>18.01%</td>
<td>27.53%</td>
<td>21.68%</td>
</tr>
<tr>
<td><strong>POM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>0</td>
<td>39</td>
<td>59</td>
<td>98</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>199</td>
<td>287</td>
<td>504</td>
</tr>
<tr>
<td>%</td>
<td>0.00%</td>
<td>19.60%</td>
<td>20.56%</td>
<td>19.44%</td>
</tr>
</tbody>
</table>

Source: research results.

It is perceived that there was an increase both in the amount of documents published and in their participation on the overall production, in the three journals. The growth of the number of publications into the subject represented, in IJOPM, 67.9% in the second period, and it consisted on the largest growth. JOM’s growth was 52.6%, while in POM, due to the fact that it had no publications into the subject in period 1, could not participate on the same comparison. Period 3 (when compared to period 2) has the largest growth in JOM, which represented 134%. The POM and IJOPM had growth equal to 51% and 13% respectively.

As only scientific papers were selected, the total database counted with 329 articles (126 in IJOPM; 276 in JOM and 207 in POM), representing 38.3% of the total in IJOPM, 35% in JOM and 26.7% in POM.

Table 2 – Service Operations’ Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>IJOPM</th>
<th>JOM</th>
<th>POM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papers</td>
<td>126</td>
<td>115</td>
<td>88</td>
<td>329</td>
</tr>
<tr>
<td>Authors</td>
<td>277</td>
<td>276</td>
<td>207</td>
<td>760</td>
</tr>
<tr>
<td>Institutions</td>
<td>253</td>
<td>217</td>
<td>179</td>
<td>579</td>
</tr>
<tr>
<td>Countries</td>
<td>141</td>
<td>129</td>
<td>101</td>
<td>285</td>
</tr>
<tr>
<td>Productivity</td>
<td>24</td>
<td>16</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Cooperation</td>
<td>1,09</td>
<td>1,27</td>
<td>1,16</td>
<td>1,31</td>
</tr>
</tbody>
</table>

Source: research results.
It was possible to identify the authors and co-authors, and it was identified 760 authors at the total (36.4% in IJOPM, 36.3% in JOM and 27.2% in POM). Thus, there is an average of 2.20 authors for each article in IJOPM, 2.40 in JOM and 2.35 in POM. In general, the same measure of cooperation (total authorship of articles in total) resulted in a value of 2.31, which means that on average 2.31 authors participated in the co-authorship of each article. The JOM therefore had the highest rate of cooperation among authors, which is higher than the average area of services operations as a whole.

In IJOPM, it was identified 126 papers, 277 authorships and 253 authors, and then only 24 authors (8.7% of total) published more than one article. Authors publishing in this journal were tied to the total of 141 institutions, located in 24 different countries.

In JOM, it was identified 115 papers, 276 authorships and 217 authors. Then, 59 authors (21.4% of total) published more than one article and authors publishing in this journal were tied to the total of 129 institutions, located in 16 different countries.

In POM, it was identified 88 papers, 207 authorships and 179 authors. 59 authors (13.5% of total) published more than one paper and authors publishing in this journal were tied to the total of 101 institutions, located in 13 different countries.

In general, we can conclude that with respect to productivity measure, each author published, on average, 1.09 papers in IJOPM, 1.27 in JOM and 1.16 in POM. On the database related to the area of services operations, therefore, the higher productivity and collaboration were found in JOM and the highest figures related papers, authors, authors, institutions and countries were found in IJOPM.

Service Operations publications grew considerably from 1995 to 2008. Table 3 shows the evolution of the number of papers, authors and authorship. These measures were used to calculate indicators of authors’ productivity and cooperation in the field.
The cooperation, which indicates the average number of authors per paper in each year, increased 12% from 1995 to 2008. The productivity, which reflects the average number of authorship for each author, also grew from the period 1 to period 2. The others variables also increased over the periods, showing that the research on the subject has evolved. There are more authors per paper, which indicates the tendency of researchers to have greater cooperation in the production of papers. In order to deep the analysis of field evolution, it seems interesting to get to know separately field publications and how they followed this development.

5. RESEARCHERS COOPERATION NETWORK IN SERVICE OPERATIONS

This section displays the results of longitudinal study of relationships between researchers in Service Operations Management. Thus, we tried to investigate how they are organized to cooperate in the scientific production in the period from 1995 to 2008.

The analysis was based on 329 papers and 579 authors in the period analyzed. Figure 1 presents a network of researchers throughout the analysis period (1995-2008). Different colors represent different components, which is a sub-network where the nodes are interconnected (DE NOOYI; MRVAR; BATAGELJ, 2005; WASSERMAN, FAUST, 1994). The nodes in pink are the main component, the largest fully interconnected network.
The existence of several groups of authors indicates fragmentation of the field. When in collaborative networks, researchers have greater probability of sharing ideas and one can influence the scientific activity of the other (MOODY, 2004).

Table 5 presents the descriptive statistics of the relationships between authors and their evolution in the periods analyzed. The columns for each analysis period (1995 to 1998, from 1999 to 2003, from 2004 to 2008) present data from the network of authors who published articles in their respective years. The last column shows the network data of relationships of authors who collaborated on at least one paper in the period studied.

<table>
<thead>
<tr>
<th>Table 5 - descriptive statistics of the Brazilian POM field network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 1</td>
</tr>
<tr>
<td>Articles</td>
</tr>
<tr>
<td>Author</td>
</tr>
<tr>
<td>Authorship</td>
</tr>
<tr>
<td>Average number of ties per author</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Isolated Authors</td>
</tr>
<tr>
<td>Number of Components</td>
</tr>
<tr>
<td>Number of authors in main component</td>
</tr>
</tbody>
</table>

Source: research results.
The number of articles grew 3 times from the first to the last period being the latter responsible for almost half volume of the total papers published over the fourteen years analyzed. The number of authors grew up in larger scale than the volume of articles, which indicates more authors per article and, consequently, greater relationship between the authors. This relationship can be seen in the average number of ties per author, which increased considerably, showing a structure of cooperation. Between 1999 and 2003, it was identified 1,954 ties, a number higher than in the first period. Between 2004 and 2008, it was identified 1,861 ties, a number lower than the previous period. De Nooyi, Mrvar and Batagelj (2005) propose that when the network stops to grow, there is indication of maturity of its structure. Analyzing the whole period, each author cooperated, on average, with 2 researches.

Also based on Table 5, the number of authors who published isolated felt and represented 5% of authors. The density of relationships in the global network was low in all periods analyzed. This measure indicates the percentage of possible ties in the network that are effectively achieved. In total, the network measure was 0.35% and it felt from first to last period with the network’s growth.

The components can be used to evaluate patterns of local cooperation. Over the years, the number of components increased significantly, in a smaller scale than the number of authors who work in the field. From 1995 to 1998, it was identified 34 components, 64 from 1999 to 2003 and 102 from 2004 to 2008. In other words, the number of researchers in a completely interconnected network increased, indicating that most local people were grouped with the advance of periods. In the fourteen-year network, the main component consists of 90 authors, equivalent to 15% of the authors of the field. According to Newman (2004), in the biology, physics and mathematics
fields, in an international context, the principal component represents 82% to 92%; in Computer Science field, this proportion was 57.2% (NEWMAN, 2001c).

This paper also identified the most central authors in Service Operations network. The centrality was discussed in terms of the number adjacent ties per researcher (Degree Centrality), as well as the ability of the researcher to be well positioned in the network, intermediating relations (Betweenness Centrality).

In studies of scientific fields, the identification of authors with greater ability to construct relationships can bring important conclusions about the field’s dynamics. This occurs because such researchers can be seen as agents with capacity to produce some effect on the structure of the field. While an agent cannot handle the entire field, he can cause important changes when his production is accepted by their peers.

In this sense, the first measure examined is the Degree Centrality of the authors, which can be understood as the number of direct ties (i.e. first-level) that a researcher has in the network (WASSERMAN; FAUST, 1994). Table 6 presents the authors with the greatest Degree Centrality in the period.

Another indicator of centrality measured was the Betweenness Centrality. This measure assesses the ability of the author to participate in different groups in the same network, controlling the information flow between members. Table 6 also shows the authors with greater capacity in Service Operations.
Table 6 – Authors Centrality

<table>
<thead>
<tr>
<th>Pesquisador</th>
<th>País</th>
<th>Centralidade de Grau</th>
<th>Pesquisador</th>
<th>País</th>
<th>Centralidade de Intermediação</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verma, Rohit</td>
<td>EUA</td>
<td>10</td>
<td>Roth, Aleda</td>
<td>EUA</td>
<td>2.190</td>
</tr>
<tr>
<td>Chase, Richard</td>
<td>EUA</td>
<td>9</td>
<td>Chase, Richard</td>
<td>EUA</td>
<td>1.944</td>
</tr>
<tr>
<td>Johnston, Robert</td>
<td>RU</td>
<td>8</td>
<td>Boyer, Kenneth</td>
<td>EUA</td>
<td>1.560</td>
</tr>
<tr>
<td>Bowen, David</td>
<td>EUA</td>
<td>8</td>
<td>Froehle, Craig</td>
<td>EUA</td>
<td>1.154</td>
</tr>
<tr>
<td>Goodale, John</td>
<td>EUA</td>
<td>8</td>
<td>Calantone, Roger</td>
<td>EUA</td>
<td>988</td>
</tr>
<tr>
<td>Boyer, Kenneth</td>
<td>EUA</td>
<td>8</td>
<td>Dasu, Sriram</td>
<td>EUA</td>
<td>720</td>
</tr>
<tr>
<td>Youngdahl, William</td>
<td>EUA</td>
<td>7</td>
<td>Rao, Jay</td>
<td>EUA</td>
<td>648</td>
</tr>
<tr>
<td>Froehle, Craig</td>
<td>EUA</td>
<td>7</td>
<td>Apte, Uday</td>
<td>EUA</td>
<td>592</td>
</tr>
<tr>
<td>Rabinovich, Elliot</td>
<td>EUA</td>
<td>7</td>
<td>Bowen, David</td>
<td>EUA</td>
<td>551</td>
</tr>
<tr>
<td>Apte, Uday</td>
<td>EUA</td>
<td>7</td>
<td>Verma, Rohit</td>
<td>EUA</td>
<td>549</td>
</tr>
</tbody>
</table>

Source: research results.

Some authors combine high Degree and Betweenness Centrality of intermediation. Others present a great ability to intermediate relationships in the network, but do not have much amount of direct ties. Based on the Degree Centrality data, the Figure 2 shows the Service Operations network main component.

![Figure 2 – Service Operations network main component - researchers](source: research results)

The institutions network is presented in Figure 3. It is possible to perceive the hegemony of North American universities in the Service Operations research. It was
identified that two British institutions (University of Warwick and University of London) were participants in the main component, but were not directly connected. Despite the geographical closeness, they have closer connection to North American Institutions.

![Service Operations network main component - institutions](image)

Source: research results.

6. CONCLUSIONS AND RECOMMENDATIONS

With the premises that scientific knowledge is socially constructed (Kuhn, 1978; Popper, 1972) and that researches networks are formed when preparing scientific papers, this paper analyzed the development of the structure of relationships between researchers in Service Operations. Besides, this study evaluated the structure of relationships between authors, their roles in the collaboration network, and to identify the most prolific researchers and institutions, as well as the indicators of production and productivity of the scientific field.

Over the period analyzed, it was observed a growth in the number of articles published in the field, specially the IJOPM that published the higher amount of Service
papers over the periods. Thus, more authors are publishing more papers. Most publications have a co-authorship structure, indicating growth of cooperation in the field.

The scientific production of the field was very stratified, concentrated in few researchers, institutions, and countries (mainly in USA and European countries). The identification of these institutions and researchers may increase the interaction between them. This type of information may be valuable to students who are selecting institutions to study in POM area and Service subject. Additionally, the identification of institutions, researchers and research groups can serve as guidance for publishers, colleges and companies in the search for institutions and scholars for the development of projects in the area are in teaching, research or extension.

Thus, this study identified relationships between the dynamics of networks of researchers and scientific production in Service Operations Management. Naturally, the subject is not exhausted and, thus, recommendations for future studies can be made. Other forms of relationships between researchers can be studied, in a qualitative way, seeking to understand how collaboration network are constructed.

7. REFERENCES


ARKADER, R. A pesquisa científica em gerência de operações no Brasil. 


BATAGELJ, Vladimir; MRVAR, Andrej. PAJEK - Program for Analysis and Visualization of Large Networks. Ljubljana, Slovenia: University of Ljubljana, 2005.


CARVALHO, Cristina Amélia; GOULART, Sueli; AMANTINO-DE-ANDRADE, Jackeline. Internacionalização Subordinada. É Possível Subverter as Regras


PILKINGTON, Alan; FITZGERALD, Robert. Operations management themes, concepts and relationships: a forward retrospective of IJOPM. International


