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THE PARADIGMA OF SUSTAINABILITY IN PRODUCTION ENGINEERING: A THEORICAL PERSPECTIVE

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1. Introduction

Production Engineering aims to plan, design, deploy and manage production systems to integrate and optimize production factors. It considers that managing production means having a competent management of issues relating to quality and productivity, using strategic methods and techniques to effectively operate production systems (SLACK, 2002; HAYES; UPTON, 1998).

However, there is not a plan for everything. Therefore, organizations need a strategic direction to decide what is more advantageous. A sequence of decisions over time allows a business to reach a framework and an infrastructure for manufacturing and a set of specific skills desired (SLACK, 2002).

In this context, any company that wants to expand, dominate the market and get good performance requires efficient management. For this, there must be an interaction between the various segments of the organization, since the objectives and strategies are dependent on the entire organizational structure (PORTER, 1980).

Within this perspective, the financial-economic model relies solely on profitability also to offer products and services that meet the expectations of customers that are increasingly concerned with issues related to sustainability. These initiatives, according to Porter (1980), support organizations over time, gain sustainable competitive advantage.

In this case, acquiring a competitive position requires improved productivity by the efficient use of resources, agility of the team to respond adequately to the constant fluctuations in demand and technology to systematize, facilitate and promote consistency in the operation of the company and its market, technological, financial and structural decisions.

For these reasons, there is an incresing concern about integrating the challenges to be solved within Production Engineering involving discussions on sustainability. Thus, topics that were not part of the agenda management challenges, became the target of small to large companies somehow trying to integrate economic issues performance criteria not purely financial, but also environmental and social (AMATO, *et al* ., 2008a). However, there is still not a consensus on the definition of sustainability. Some authors define it as a complex term because it encompasses three different dimensions: economic, social and environmental. However, the issues and conceptual bases so far are not consolidated, making it difficult to understand not only the relationship of these variables and their effects on the organizational development and behavior, but mainly to assess how sustainable development can and should be measured and, most importantly, to understand it as a systemic concept (SIENA, 2008; CLARO; CLARO; AMÂNCIO, 2008; AMATO, 2008b).

Thus, considering the new business demands and lack of consistent definitions, it is thought desirable to develop a research to identify the major works and authors that address sustainability in the operations management. In addition, through co-words analysis, to identify emerging areas that involve the sustainability concept. From this proposal, the results expected are to direct the content of publications to facilitate the understanding of the dynamics and internal structure of fields and subfields involving sustainability.

For this purpose, this study conducts a bibliometric and scientometric analysis from the database ISI Web of Science. An investigation was made to recover the major studies on operations management that involve the sustainability concept to evaluate the potential contribution of this approach to understanding the research in production engineering. Moreover, from a citations analysis in international papers, this study aims

to list the main highlights (authors and works) of theoretical analysis, along with the journals that support this research.

This article is structured into five parts, including this introduction. The second part represents the literature review, which are the main challenges faced by companies within production engineering and aspects related to concepts and topics on sustainability. Then is exposes the methodological framework of the study. In the fourth section, results are presented and analyzed. In the fifth and final section, the final considerations of the authors, the research limitations and recommendations for future work are presented.

2. Literature Review

2.1. Business challenges in the Production Engineering

Given the importance of spreading the sustainable development concept among the different business groups, to improve the efficiency of capacity and evaluation of the company before the market, perceive the interest of a restricted group of companies that invest or encourage management practices with sustainable prospects. Although the concepts are essentially related to human and organizational interaction with the environment, for Capra (2001) the term sustainable is a reflection of a complex organization pattern, the preferences of which should be based on: interdependence, recycling, partnership, flexibility and diversity.

Therefore, companies must devise strategies that focus on how business operations, strategic and environmental are structured. This disruption facilitates the identification of new business opportunities (Amato, 2008b) beyond improve the company image to customers and market.

In this case, the Sustainability Index (SI) created by the Brazilian Mercantile & Futures Exchange (BM&F) and the São Paulo Stock Exchange (BOVESPA) according

Mencarini and Amato (2008) can be used as a tool and an indicator of how companies evaluate the issues related to sustainability that, in the long run, directly reflect stock price. However, few companies are eligible for the selection process which rules out an perspective of sustainability index in companies that have shares traded in the stock market, for small and medium enterprises.

Thus, because there is still not a tool that allows managers to collect and analyze data to better anticipate and understand trends and market needs, their processes and productive resources, policies, responsibility towards society, some authors have developed researches seeking to fill this gap to improve the concept and applicability of the term sustainability (SIENA, 2008; GIANNETTI *et al*., 2007; BARELLA, ALMEIDA; GIANNETTI, 2005).

These models and methods are used not only to assess sustainable development through techniques to operationalize the concept, but can also help managers to monitor their productive resources and complementary models used for decision-making management.

2.2. Challenges of sustainability

The development and sprawl of large urban centers are aggravating global warming. These urban conglomerates increasingly demand energy resources such as water and energy in an environment where the infrastructure, in most cases, is not prepared to exploit their natural and productive resources efficiently. Thus, production costs caused by irrational organization of urban areas are outsourced and converted into social costs (RATTER, 2008).

Thus, within this context, enormous challenges are posed to companies and governmenst to serve also, through social programs, the inclusion of a representative portion of society. This social interface, the base of which is underpinned by principles

of Solidarity Economy (self-management, cooperation and solidarity) are some propositions make up that the concept of sustainability. These different approaches, according to Claro, Claro and Amâncio (2008) characterized as one the great difficulties of the companies involved speeches and practices management to complete interpretation of the definition of sustainability.

There are many differences about capitalist economy mainly because the production value differs radically from what the Classical Economic Theory suggests about profit and satisfaction/utility maximization. At the same time, issues discussed around organizational management are addressed in a similar manner in relation to both problems and solutions. Hence, the challenges in production and management, these different modes of production come up against the design of a model which aims to include economic, social and environmental issues. Even if Solidarity Economy is an idealization considered democratic, indirectly, capitalist firms have adjusted their models to maintain sustainable competitive advantage.

Clearly there is still a long way to go for the two groups. However, even the staff about sustainability being addressed at the global level, realizes that the concept needs to be better understood to be discussed (CLARO; CLARO; AMÂNCIO 2008). Another key issue discusses the product life cycle management and the importance of planning of the whole value chain to facilitate the measurement of the financial and environmental products and services (FENKER, 2007; JAPPUR *et al*., 2008).

The value chain analyses evaluate the efficiency of each member of the chain, and especially, identify the critical points of success for sustainable development. Thus, according to Jappur *et al*. (2008), strategic business management is no longer exclusively focused on the organization and shifts to business relations. Therefore,

competitiveness highlights the implementation of organizational and operational policies that maintain continuous improvement in the products and efficiency process.

Although the discussions on sustainable development emphasize the value of corporate restructuring to ensure greater integration depending not only the individual, but on collective efficiency, there is still a considerable percentage of specialists and people who do not have deep knowledge of the definitions involving value chain and sustainability (CLARO; CLARO; AMÂNCIO, 2008; JAPPUR *et al.*, 2008).

Hence, several theories, such as Filière's Analysis, Productive Chain e Supply Chain Management, seek to understand the forms of relationships between suppliers and buyers. Despite these concepts have premise identification and the stages of production or delivery of a product or service, have different perspectives:

- Filière's Analysis: its focus is directed to strategic planning. By identifying the sequence of operations in the value chain, bottlenecks, governmental and cooperative actions among agents are identified. These actions enable the transactions in various stages (MORVAN, 1988).
- Productive Chain: called value chain by some authors. The concept is defined from the steps of processing and, therefore, adding value to the product, in which the sequence of interdependent operations are intended to produce, modify and distribute a product (PORTER, 1980).
- Supply Chain Management: has represented a promising new boundary for companies interested in obtaining a competitive advantage not by indiscriminate competition, but through cooperative arrangements with companies that are part of the same production complex (CHOPRA; MENDEL, 2004; VOLLMANN; CORDON, 1996).

These concepts exposed in Table 1, promote synergies among the productive chain links. This indirectly causes organizations to have a sustainable behavior from different perspectives.

Productive Chain	Knowledge level (%) Not Know	Sustainability (dimension)	Knowledge level (%)	
			Know	Not Know
Filiere	25%	Social, Environmental and Economic	33%	2%
Cluster	6.50%	Economic	29%	
Supply Chain	12. 25%	Social	19%	
Networks of small and medium enterprises	0%	Environmental	6%	

Table 1 – Participants' knowledge level of the concepts of supply chain and sustainability
Adapted from Jappur *et a.* (2008)

Some authors who analyze the Third Sector Organizations pointed to the importance of partnerships between these entities and state. Highlight challenges of integration of this model within the capitalist configuration and propose ways of improving management to enable the spread of social policies focused on equity (FISHER; FALCONER, 1998). These models, as well as sustainable business models depend on high complexity and reliability throughout ensures acceptance. Even with successful practices that can be used as a basis of future projects that address both sustainability and self-management, it is difficult to avoid the ambiguities and complexities of the environment (SERVA, 1992).

Despite Third Sector Organizations and Solidarity Economic maintain social mechanisms promoters and inducers of sustainable practices, their management systems are characterized by social networks based trust between the members streamlines all financial and social transactions (JUNQUEIRA; ABRAMOVAY, 2005).

This structure by Serva (1992) depends in part on the environment, thus it will never be absolute; the increasing systems complexity leads to a paradoxical logic in which organization-environment interaction provides regularities and variations that directly and indirectly undermine the trajectory of the organization.

3. Metodology

The purpose of the study is to provide a technical evaluation of the literature on Sustainability which involves themes in the area of Operations Research and Management Science to better understand the lines of research on sustainability. Thus, the intent is to understand the themes and concepts used in this field of research.

Bibliometric analysis is a research method which permits the quantification, measurement and evaluation of scientific knowledge through statistical analyses (FONSECA, 1986; SPINAK, 1996). According to Castro (1997) bibliometric analysis allows researchers to evaluate publications on a given subject in greater depth and thus provide evaluations and judgments that make it easier to delineate future research. Moreover, the different fields of research use bibliometric to measure the productivity of authors, institutions, periodicals, and countries with a focus on identifying trends in research (CARDOSO *et al*., 2005; MOREL; MOREL, 1977). Thus, according to Rousseau (1998), bibliometric analysis constitutes a fundamental method for understanding scientific communication. Moreover, since the subject of study requires an analysis which combines different indicators using the principles of science metrics principles were used to make an analysis of co-words possible and thus to assess the development of areas and themes (VINKLER, 2006).

The study was done in three stages. In the first a bibliometric survey of scientific works in the area of operations management was undertaken focusing on sustainability. In the second stage, the most important works relevant to constructing the study were identified. In the third and final stage, using the same database as in stage two, co-words were analyzed to assess statistical aspects in order to identify the simultaneous occurrence of different words in a specific groups of publications.

3.1. Defining the method

In the first stage, a bibliometric survey was undertaken of the scientific works selected from the point of view of sustainability. The purpose of this stage is to analyze the evolution of this theory and for this purpose, the expectation was also to discover the main works, authors and periodicals to build a base of articles.

The search was restricted to the ISI Web of Science database® (2010) site seeking all publications that contained the word "sustainability". This stage identified a total of 25.057 publications directly related to sustainability in various areas of knowledge.

Given the range of the search, the study was refined according to the proposed objectives and criteria, described in Table 2. Based on this new refinement, 104 articles (Annex 1) were identified on sustainability which had been published in different periodicals that are related to some research topic in operations management.

Criteria	Definitions
Database	ISI Web of Science
Type document	Articles
Keyword	Sustainability
Core areas	Operations Research & Management Science
Period of publication	Unrestricted
Institutions	Unrestricted
Language	Unrestricted

Table 2 – Criteria for constructing the article base

Later, the data obtained in from the first and second stages were downloaded and imported using SITKIS software (Schildt, 2002) to construct a map of co-words.

3.1.2. Co-words Analysis

The third stage of the study consisted of analyzing co-words. In this case, the words and pairs of co-words are analyzed in order to facilitate an understanding of their connection with others through the network analysis method (BHATTCHARYA; BASU, 1998). For these authors, the value of this analysis lies basically in the identification of emerging areas, as well as facilitating an understanding of the dynamics and internal structure of important fields of research.

In this sense, for this analysis to be consistent with the research objectives, first criteria for the intensity of the relationship of key words were established aiming to identify important co-occurrences as seen in Table 3.

Range of intensity	Classification
Equal to 0%	Null
Greater than 0% and less than or equal to 33%	Weak
Greater than 33% and less than or equal to 66%	Average
Greater than 66% and less than or equal to 99%	Strong
Equal to 100%	Absolute

Table 3 – Criteria for intensity of the relationship of key words

These classification criteria allow us to identify the main lines of research in the area of management operations. This analysis is concerned with verifying the proximity and conceptual differences within the sustainability theme. In this case, only the words whose intensity classification are higher or equal to 66% were considered in building the co-word map. Moreover, some words were standardized so that results would not be compromised by words in the singular or plural and, only key words cited 3 or more times were included in the analysis. Figure 1 shows the results of standardizing these key words.

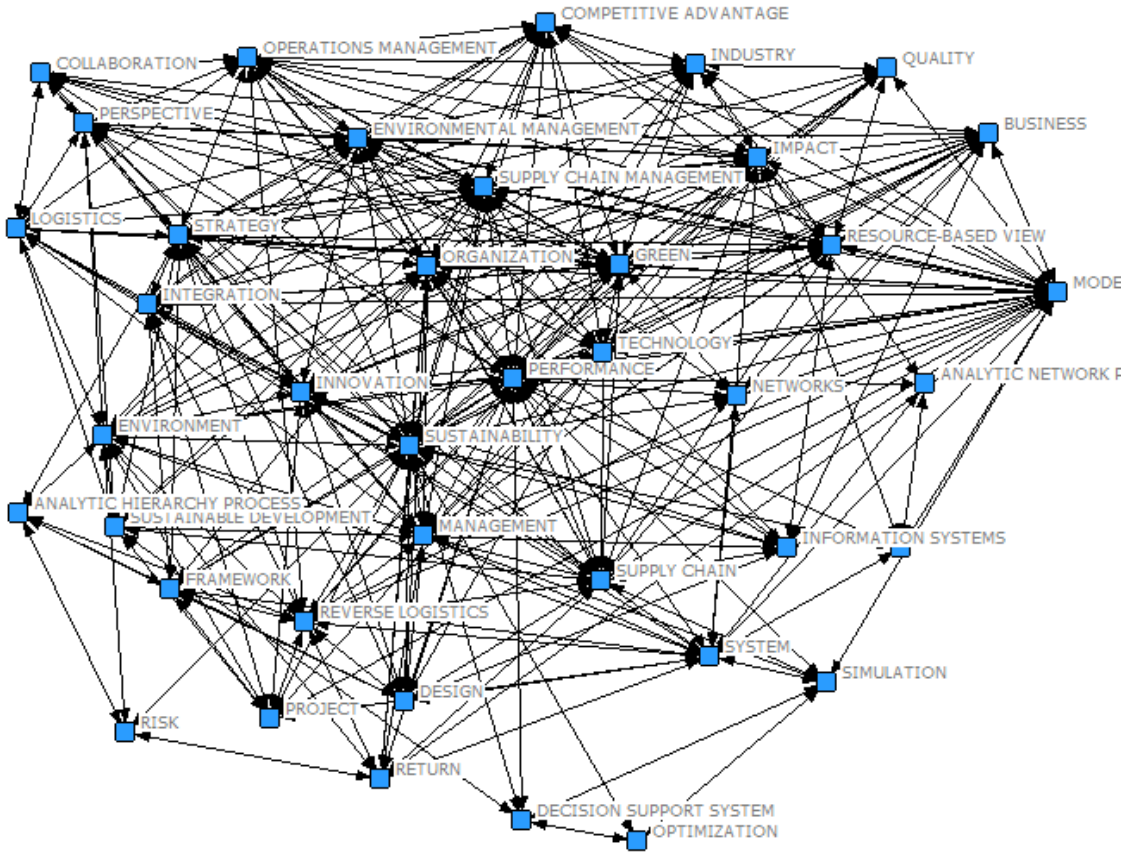

Figure 1 – Co-words map

4. Results

The first and second research stages of the study are characterized by a survey of the main highlights (authors and words) from the field of theory of research in operations management, in addition to identification of the principal periodicals. The 104 articles analyzed provide a set of date with 3328 references covering a relationship network of 170.178 co-citations.

Table 4 shows the most often referenced works. In addition, this analysis allows us to identify the most often cited authors: Robert Kassed (802 citations), Michael Porter (730), Craig Carter (643), Daniel Guide (526) and Charles Corbett (450). Of a total of 5074 authors cited, only 55, that is, 10% of the authors were cited over 200 times and

only 28 more than 150 times. Of the rest of the citations, 33% were cited from 50-149 times and 63% of the authors were cited from 1-49 times.

Author	Journal	Year	Citations
Porter, M.E.; Van De Linde, C.	Green and Competitive: ending the statement. Harvard Business Review, September–October.	1995	374
Russo, M.V.; Fouts, P.A.	A Resource-Based Perspective on Corporate Environmental Performance and Profitability. The Academy of Management Journal, Vol. 40, n. 3.	1997	318
Eisenhardt, K.M.	Making fast strategic decisions in high-velocity environments, Academy of Management Journal, Vol. 32.	1989	296
Hart, S.L.	Beyond greening: strategies for a sustainable world. Harvard Business Review, Vol. 75, n.1.	1997	294
Klassen, R.D.; Whybark, D.C.	The impact of environmental technologies on manufacturing performance. Academy of Management Journal, Vol. 42.	1999	262
Elkington, J.	Cannibals with forks: the triple bottom line of 21st Century business. New Society Publications: New York	1998	234
Hart, S.L.	A Natural-Resource-Based View of the Firm. The Academy of Management Review, Vol. 20, n. 4.	1995	228
Porter, M.E.	Toward a New Conception of the Environment-Competitiveness Relationship. The Journal of Economic Perspectives, Vol. 9, n.4.	1995	205
Carter, C.R.; Carter, J.R.	Interorganizational determinants of environmental purchasing: initial evidence from the consumer products industries. Decision Sciences, Vol.29, n.3.	1998	204
ClellanD,I.J.; Dean, T.J.; Douglas,T.J.	Stepping towards sustainable business: an evaluation of waste minimization practices in US manufacturing. Interfaces, Vol.30, n.3.	2000	196

Table 4 – Main works on sustainability

The data from the analysis of the referenced works reveals that 87% of the referenced works were cited only once. That is, there is still a small number of outstanding works and authors in this literature. This confirms the need to develop new studies on the theme of sustainability.

Figure 2 shows the historical perspective of publications on sustainability. The results reveal that publications from the last 3 years represent 56% of the total on the subject. This demonstrates a growing concern with the theme and thus, a large gap to be explored. Moreover, after the signing of the Kyoto Protocol in 1997, some industrialized nations committed to reduce pollutant emissions which culminated in

studies on themes connected to sustainability. This fact is confirmed by the year in which the studies are highlighted.

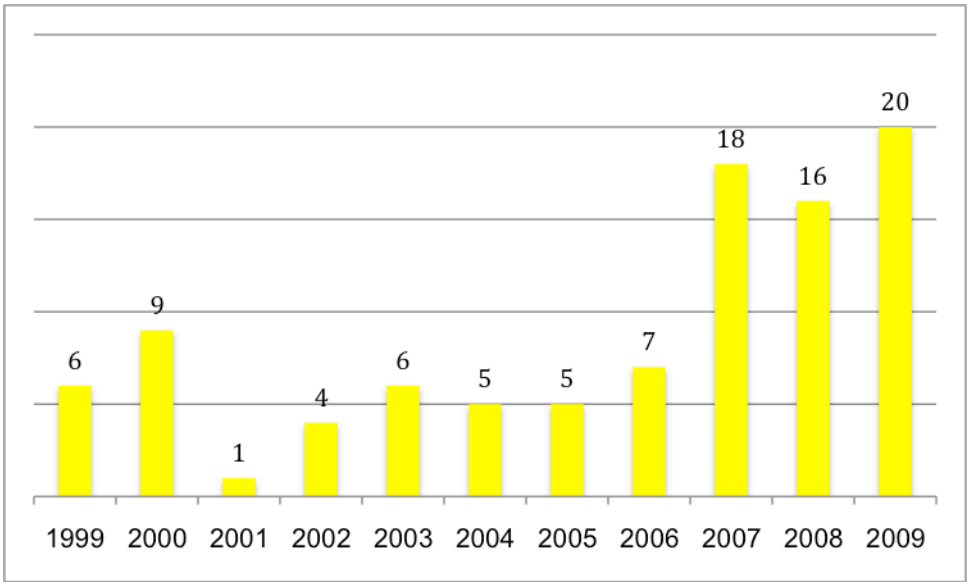

Figure 2 – Evolution of publications on sustainability

It can be said that in this context, sustainability has gradually gained space and importance inside the organizational model. This paradigmatic rupture directly interferes in the way an organization is structured and, therefore, encourages the development of new research and the process involves complexity and behavioral changes.

These topics are gradually being disseminated in operations management and the trend is toward an increase in the studies interested in developing theories and models for the theme of sustainability, since the companies tend to be judged increasingly on their ethical commitments and in a certain sense their later differentiation in the business environment (VERGARA; BRANCO, 2001).

Thus the importance of identifying the media that publicize the studies. Among the 104 articles encountered, 28 international periodicals are highlighted because they to make viable and encourage the publication of these studies (Table 5).

Periodical	Number of Publications
International Journal of Production Research	12
International Journal of Technology Management	11
European Journal of Operational Research	10
Interfaces	9
Technovation	7
Journal of the Operational Research Society	7
International Journal of Production Economics	7
Expert Systems With Applications	5
Production and Operations Management	4
Journal of Operations Management	4
Computers Environment and Urban Systems	4
Systems Engineering	3
Management Science	3
Decision Support Systems	3
Safety Science	2
Transportation Science	1
Reliability Engineering & System Safety	1
Quality Progress	1
Production Planning & Control	1
Or Spektrum	1
Optimal Control Applications & Methods	1
Omega-International Journal of Management Science	1
Military Operations Research	1
Logistics and Transportation Review	1
Journal Of Manufacturing Systems	1
Infor	1
Concurrent Engineering-Research And Applications	1
Annals Of Operations Research	1

Table 5 – Most Citations in Journals

Based on an analysis of citations and co-citations, those among them with most references were the *European Journal of Operational Research* (69 citations), *Production Operations Management* (58 citations), *Journal of Operations Management* (56 citations), *Strategic Management Review* (54 citations) and the *Academic Management Review* (52 citations), *Management Science* (51 citations) and the *Harvard Business Review* (50 citations).

Publications in these periodicals represent 20% of the total. This diversity in the means of publicity indicate how the field of research is scattered with little consensus and this proves to be a very immature theoretical line with excellent opportunities for research. Moreover, 81% of the total sample of periodicals analyzed was cited only once. This

fact also represents an important justification for the non-existence of a consensus on the concept of sustainability.

This fact coincides with the findings of several authors on research opportunities in approaches to sustainability. There are many insufficiencies pointed out and suggestions made in the literature. Even though there are government and non-governmental initiatives to encourage the expansion of sustainable development in a pyramid form, that is, an approach that contemplates all the foundations of sustainability, the capitalist market is not prepared for abrupt changes to its mode of production and capitalization. This diversity of publications vehicles indicates how the field of research is disperse with little consensus and proves to be a very immature theoretical line with excellent research opportunities.

Thus, these changes evolved according to the complexity and the stage of development of the companies in which basically the entire organizational structure is developed within an almost exclusively financial sphere. Within this field of knowledge, there are many issues and models to be studied in order to encourage the dissemination of the concept of sustainability and, especially, its applicability.

Thus in order to integrate knowledge, the CINET software as used (Borgatti *et al*., 1999) to create a network of co-words (Figure 3). The analysis of the network falls on groups of knowledge to which the works belong and contribute to the identification of lines of research in which they are concentrated. To make it possible not just to identify this network of key words, but especially their association with the main lines of research within Production Engineering, a new network of co-wards was created according to the criteria of intensity of relationships proposed earlier.

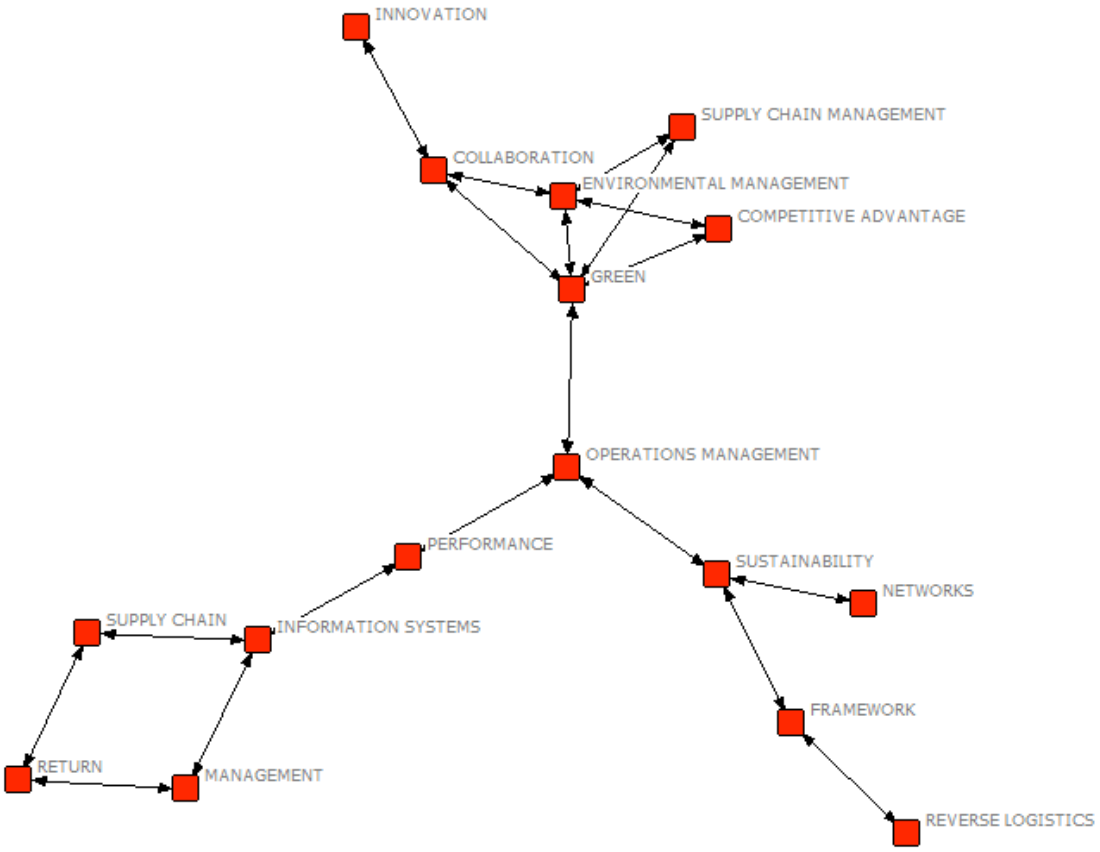

Figure 3- Co-words sustainability analysis

The result of the co-word map allows the identification of some key words that interconnect with the themes that Production Engineering develops such as: PERFORMANCE, SUSTAINABILITY, GREEN, ENVIRONMENTAL MANAGEMENT.

This result underlines that a significant part of the works are done in the field of sustainability, performance and environmental management, that is, the concern of the researchers is in developing works that assess the value chain and the product to produce more, while spending less. This optimization of resources aims to minimize environmental impact and turn these benefits into significant economic gain (HINZ, VALENTINA, FRANCO, 2007), that is, into competitive advantage.

.Another important issue is that the market, consumption, competition, individualism and maximum productivity continue to be the common denominator of the organizations. For this reason it is important that scientific themes focus on sustainability not just involving environmental issues, rather this transition needs also to include social issues so that it will be possible to create sustainable societies in the long term (LAYRARGUES, 2000).

Moreover, some works focus on themes linked to innovations since investing in technology that makes production clean makes the organization achieve better environmental management with global impact, that is, extended to all the members of the supply chain promoting competitive advantages and lesser environmental impact, also by reverse analysis of logistics and the product life cycle.

5. Final consideration

The contribution of this article to Production Engineering research is that it reveals the main works and authors, as well as identifying the most recent publications in the different fields of knowledge that involve operations management. This revelation offers researchers new opportunities for studies linked to both currents of thought, in addition to understanding the evolution of the line of research.

The study indicates a trend to development of studies involving issues linked to sustainability, performance, environmental issues and environmental management. Companies are increasingly concerned with understanding organization ruptures n order to promote practices with sustainable development goals and to encourage practices that improve performance in the supply chain as well as the production chain. Moreover, reverse logistics, together with innovation is an important tool for making cleaner production viable and for analyzing the life cycle of the product. These practices could offer sustainable competitive advantages over time.

The limitations of this study are based mainly in the database used (portal ISI Web of Science ® 2010), not due to inefficiency, but to the fact hat the study focused on journal articles on the international level, limiting the inferences from this study for other research universes, which do not include the source of the data used, such as annals of congresses, theses and dissertations, for example.

For future studies, it is suggested that an analysis of the main works and articles found in the database be undertaken in order to ratify or complement the results presented by this study. Considering the purposes of this study, it is hoped that by identifying the main works and authors, the limitations of the empirical research carried out up to the present will serve to inspire future research.

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ANNEX 1

Authors	Title	Source Title	Volume	Issue	Publication Year
Dierickx, I; Cool, K	Asset stock accumulation and sustainability of competitive advantage	Management Science	35	12	1989
Chuang, Sh	A resource-based perspective on knowledge management ability and competitive advantage: an empirical investigation	Expert Systems With Applications	27	3	2004
Mahadevan, B; Pyke, Df; Fleischmann, M	Periodic review, push inventory policies for remanufacturing	European Journal Of Operational Research	151	3	2003
Hung, Sc; Chu, Yy	Stimulating new industries from emerging technologies: challenges for the public sector	Technovation	26	1	2006
Mcgahan, Am; Porter, Me	What do we know about variance in accounting profitability?	Management Science	48	7	2002
Linton, Jd; Klassen, R; Jayaraman, V	Sustainable supply chains: an introduction	Journal Of Operations Management	25	6	2007
Vachon, S; Klassen, Rd	Environmental management and manufacturing performance: the role of collaboration in the supply chain	International Journal Of Production Economics	111	2	2008
Espinosa, A; Hamden, R; Walker, J	A complexity approach to sustainability - stafford beer revisited	European Journal Of Operational Research	187	2	2008
Sodhi, Ms; Reimer, B	Models for recycling electronics end-of-life products	Or Spektrum	23	1	2001
Kleindorfer, Pr; Singhal, K; Van Wassenhove, Ln	Sustainable operations management	Production And Operations Management	14	4	2005
Cox, S; Jones, B; Rycraft, H	Behavioural approaches to safety management within uk reactor plants	Safety Science	42	9	2004
Pujari, D	Eco-innovation and new product development: understanding the influences on market performance	Technovation	26	1	2006
Kassinis, Gi; Soteriou, Ac	Greening the service profit chain: the impact of environmental management practices	Production And Operations Management	12	3	2003
Lu, Lyy; Wu, Ch; Kuo, Tc	Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis	International Journal Of Production Research	45	18-19	2007
Nilsen, P; Timpka, T; Nordenfelt, L; Et Al.	Towards improved understanding of injury prevention program sustainability	Safety Science	43	10	2005
Lagace, D; Bourgault, M	Linking manufacturing improvement programs to the competitive priorities of canadian smes	Technovation	23	8	2003
Goodman, A	Implementing sustainability in service operations at scandic hotels	Interfaces	30	3	2000
Rapaport, A; Sraidi, S; Terreaux, Jp	Optimality of greedy and sustainable policies in the management of renewable resources	Optimal Control Applications & Methods	24	1	2003
Doukas, Hc; Andreas, Bm; Psarras, Je	Multi-criteria decision aid for the formulation of sustainable technological energy priorities using linguistic variables	European Journal Of Operational Research	182	2	2007
Maslennikova, I; Foley, D	Xerox's approach to sustainability	Interfaces	30	3	2000
Demaid, A; Quintas, P	Knowledge across cultures in the construction industry: sustainability, innovation and design	Technovation	26	05/Jun	2006
Clelland, Ij; Dean, Tj; Douglas, Tj	Stepping towards sustainable business: an evaluation of waste minimization practices in us manufacturing	Interfaces	30	3	2000
Guide, Vdr; Van Wassenhove, Ln	Closed-loop supply chains: an introduction to the feature issue (part 1)	Production And Operations Management	15	3	2006
Recio, B; Ibanez, J; Rubio, F; Et Al.	A decision support system for analysing the impact of water restriction policies	Decision Support Systems	39	3	2005
Pacheco-De-Almeida, G; Zemsky, P	The timing of resource development and sustainable competitive advantage	Management Science	53	4	2007
Dubose, Jr	Sustainability and performance at interface, inc.	Interfaces	30	3	2000
Farrow, Ph; Johnson, Rr; Larson, Al	Entrepreneurship, innovation, and sustainability strategies at walden paddlers, inc.	Interfaces	30	3	2000
White, L; Lee, Gj	Operational research and sustainable development: tackling the social dimension	European Journal Of Operational Research	193	3	2009
Zaccour, G	Time consistency in cooperative differential games: a tutorial	Infor	46	1	2008
Gerstlberger, W	Regional innovation systems and sustainability - selected examples of international discussion	Technovation	24	9	2004
Fogarty, Mj; Mayo, Rk; Obrien, L; Et Al.	Assessing uncertainty and risk in exploited marine populations	Reliability Engineering & System Safety	54	02/Mar	1996
Shapiro, Jf	On the connections among activity-based costing, mathematical programming models for analyzing strategic decisions, and the resource-based view of the firm	European Journal Of Operational Research	118	2	1999
Manson, S	Land use in the southern yucatan peninsular region of mexico: scenarios of population and institutional change	Computers Environment And Urban Systems	30	3	2006
Reinhardt, F	Sustainability and the firm	Interfaces	30	3	2000
Cooke, P	Economic globalisation and its future challenges for regional development	International Journal Of Technology Management	26	02/Abr	2003
Abreu, A; Camarinha-Matos, Lm	On the role of value systems to promote the sustainability of collaborative environments	International Journal Of Production Research	46	5	2008
Zhu, Q; Sarkis, J	The moderating effects of institutional pressures on emergent green supply chain practices and performance	International Journal Of Production Research	45	18-19	2007
Quak, Hj; De Koster, Mbm	Exploring retailers' sensitivity to local sustainability policies	Journal Of Operations Management	25	6	2007
Yada, K; Ip, E; Katoh, N	Is this brand ephemeral? A multivariate tree-based decision analysis of new product sustainability	Decision Support Systems	44	1	2007
Toh, Ktk; Nagel, P; Oakden, R	A business and ict architecture for a logistics city	International Journal Of Production Economics	122	1	2009
Watanabe, C; Lei, Sy; Ouchi, N	Fusing indigenous technology development and market learning for greater functionality development-an empirical analysis of the growth trajectory of canon printers	Technovation	29	4	2009
Lee, Ahi; Kang, Hy; Hsu, Cf; Et Al.	A green supplier selection model for high-tech industry	Expert Systems With Applications	36	4	2009
Azadivar, F; Truong, T; Jiao, Y	A decision support system for fisheries management using operations research and systems science approach	Expert Systems With Applications	36	2	2009
Smith, Hk; Harper, Pr; Potts, Cn; Et Al.	Planning sustainable community health schemes in rural areas of developing countries	European Journal Of Operational Research	193	3	2009
Ozener, Oo; Ergun, O	Allocating costs in a collaborative transportation procurement network	Transportation Science	42	2	2008
Yao, X	Where are public transit needed - examining potential demand for public transit for commuting trips	Computers Environment And Urban Systems	31	5	2007

Presley, A; Meade, L; Sarkis, J	A strategic sustainability justification methodology for organizational decisions: a reverse logistics illustration	International Journal Of Production Research	45	18-19	2007
Pagell, M; Krumwiede, Dw; Sheu, C	Efficacy of environmental and supplier relationship investments - moderating effects of external environment	International Journal Of Production Research	45	9	2007
Lopez- Baldovin, Mj; Gutierrez-Martin, C; Berbel, J	Multicriteria and multiperiod programming for scenario analysis in guadalquivir river irrigated farming	Journal Of The Operational Research Society	57	5	2006
Broman, G; Holmberg, J; Robert, Kh	Simplicity without reduction: thinking upstream towards the sustainable society	Interfaces	30	3	2000
De Ron, Aj	Sustainable production: the ultimate result of a continuous improvement	International Journal Of Production Economics	56-7		1998
Hofstede, Gj; Kramer, M; Meijer, S; Et Al.	A chain game for distributed trading and negotiation	Production Planning & Control	14	2	2003
Kleineidam, U; Lambert, Ajd; Blansjaar, J; Et Al.	Optimising product recycling chains by control theory	International Journal Of Production Economics	66	2	2000
Jain, R	Key constructs in successful is implementation: south-east asian experience	Omega-International Journal Of Management Science	25	3	1997
Bell, S; Morse, S	Problem structuring methods: theorizing the benefits of deconstructing sustainable development projects	Journal Of The Operational Research Society	58	5	2007
Biondi, V; Iraldo, F; Meredith, S	Achieving sustainability through environmental innovation: the role of smes	International Journal Of Technology Management	24	05/Jun	2002
Smith, Rk; Ahmed, Mu	International Collaboration For Technological Change In The 21st Century	International Journal Of Technology Management	18	03/Abr	1999
Schrady, D; Wadsworth, D	Naval combat logistics support system	Journal Of The Operational Research Society	42	11	1991
Yang, Cl; Sheu, C	Achieving supply chain environment management: an exploratory study	International Journal Of Technology Management	40	01/Mar	2007
Vachon, S; Klassen, Rd	Supply chain management and environmental technologies: the role of integration	International Journal Of Production Research	45	2	2007
Wisner, Ps; Stringfellow, A; Youngdahl, We; Et Al.	The service volunteer - loyalty chain: an exploratory study of charitable not-for-profit service organizations	Journal Of Operations Management	23	2	2005
Grutter, Aw; Field, Jm; Faull, Nhb	Work team performance over time: three case studies of south african manufacturers	Journal Of Operations Management	20	5	2002
Hasle, G; Haavardtun, J; Kloster, O; Et Al.	Interactive planning for sustainable forest management	Annals Of Operations Research	95		2000
Del Sol, P; Ghemawat, P	Strategic valuation of investment under competition	Interfaces	29	6	1999
Connell, L; Flynn, A	The environment, innovation and industry: a case study of south wales	International Journal Of Technology Management	17	5	1999
Reich-Weiser, C; Dornfeld, Da	A discussion of greenhouse gas emission tradeoffs and water scarcity within the supply chain	Journal Of Manufacturing Systems	28	1	2009
Tsai, Wh; Chou, Wc; Hsu, W	The sustainability balanced scorecard as a framework for selecting socially responsible investment: an effective mcdm model	Journal Of The Operational Research Society	60	10	2009
Chuang, Sw; Pan, Cy; Huang, Cy	A system-oriented analysis model to enhance patient safety in healthcare organizations	Systems Engineering	12	3	2009
Kemme, Mr; Westervelt, Jd	Identifying suitable dust-generating training/testing locations near residential areas	Military Operations Research	14	1	2009
Zhao, Kx; Xia, M; Shaw, Mj; Et Al.	The sustainability of b2b e-marketplaces: ownership structure, market competition, and prior buyer-seller connections	Decision Support Systems	47	2	2009
Fragkias, M; Seto, Kc	Evolving rank-size distributions of intra-metropolitan urban clusters in south china	Computers Environment And Urban Systems	33	3	2009
Pagell, M; Gobeli, D	How plant managers' experiences and attitudes toward sustainability relate to operational performance	Production And Operations Management	18	3	2009
Namen, Aa; Bornstein, Ct; Rosenhead, J	Robustness analysis for sustainable community development	Journal Of The Operational Research Society	60	5	2009
Wiek, A; Walter, Ai	A transdisciplinary approach for formalized integrated planning and decision-making in complex systems	European Journal Of Operational Research	197	1	2009
Elfkih, S; Feijoo, Ml; Romero, C	Agricultural sustainable management: a normative approach based on goal programming	Journal Of The Operational Research Society	60	4	2009
Juan, Yk	A hybrid approach using data envelopment analysis and case-based reasoning for housing refurbishment contractors selection and performance improvement	Expert Systems With Applications	36	3	2009
Garcia-Alonso, Cr; Guardiola, J; Hervas-Martinez, C	Logistic evolutionary product-unit neural networks: innovation capacity of poor guatemalan households	European Journal Of Operational Research	195	2	2009
Zellner, Ml; Theis, Tl; Karunanithi, At; Et Al.	A new framework for urban sustainability assessments: linking complexity, information and policy	Computers Environment And Urban Systems	32	6	2008
Munda, G	A conflict analysis approach for illuminating distributional issues in sustainability policy	European Journal Of Operational Research	194	1	2009
Grabner, C; Hahn, H; Leopold-Wildburger, U; Et Al.	Analyzing the sustainability of harvesting behavior and the relationship to personality traits in a simulated lotka-volterra biotope	European Journal Of Operational Research	193	3	2009
Van Iwaarden, J; Van Der Wiele, T; Dale, B; Et Al.	The six sigma improvement approach: a transnational comparison	International Journal Of Production Research	46	23	2008
Del Brio, Ja; Junquera, B; Ordiz, M	Human resources in advanced environmental approaches - a case analysis	International Journal Of Production Research	46	21	2008
Kouloura, Tc; Genikomsakis, Kn; Protopapas, Al	Energy management in buildings: a systems approach	Systems Engineering	11	3	2008
Haskins, C	A systems engineering framework for eco-industrial park formation	Systems Engineering	10	1	2007
Haigh, N; Griffiths, A	The environmental sustainability of information systems: considering the impact of operational strategies and practices	International Journal Of Technology Management	43	01/Mar	2008
De Brito, Mp; Carbone, V; Blanquart, Cm	Towards a sustainable fashion retail supply chain in europe: organisation and performance	International Journal Of Production Economics	114	2	2008
Tapiero, Cs; Kogan, K	Sustainable infrastructure investment with labor-only production	International Journal Of Production Economics	113	2	2008
Ciliberti, F; Pontrandolfo, P; Scozzi, B	Logistics social responsibility: standard adoption and practices in italian companies	International Journal Of Production Economics	113	1	2008
Calvo, R; Domingo, R; Sebastian, Ma	Systemic criterion of sustainability in agile manufacturing	International Journal Of Production Research	46	12	2008
Everingham, K; Polaski, G; Riedlin, F; Et Al.	Operations research enhances supply chain management at the us coast guard aircraft repair and supply center	Interfaces	38	1	2008
Chiaroni, D; Chiesa, V; De Massis, A; Et Al.	The knowledge-bridging role of technical and scientific services in knowledge-intensive industries	International Journal Of Technology Management	41	03/Abr	2008

Ijomah, Wl; Childez, Sj	A model of the operations concerned in remanufacture	International Journal Of Production Research	45	24	2007
Evans, S; Partidario, Pj; Lambert, J	Industrialization as a key element of sustainable product-service solutions	International Journal Of Production Research	45	18-19	2007
Lee, Hj; Kim, S	A study on the development methodology of the business model in ubiquitous technology	International Journal Of Technology Management	38	4	2007
Wang, L; Lin, L	A methodological framework for the triple bottom line accounting and management of industry enterprises	International Journal Of Production Research	45	5	2007
De Vos, D; Van Landeghem, H; Van Hoof, K	A knowledge discovery method to predict the economical sustainability of a company	Concurrent Engineering-Research And Applications	14	4	2006
Olaya, Y; Dyner, I	Modelling for policy assessment in the natural gas industry	Journal Of The Operational Research Society	56	10	2005
Bugliarello, G	Urban knowledge parks, knowledge cities and urban sustainability	International Journal Of Technology Management	28	03/Jun	2004
Shore, B; Cross, Bj	Maintaining funding in large-scale international science projects	International Journal Of Technology Management	27	4	2004
Hitchcock, D; Willard, M	Sustainability: enlarging quality's mission	Quality Progress	35	2	2002
Reece, Jd	From simple crops to complex ecosystems: agricultural research and the environmental imperative	Technovation	19	06/Jul	1999
Reis, D; Pati, N; Pena, L	Problems of modern technology	International Journal Of Technology Management	17	3	1999
Taplin, Jhe	Regulation, deregulation, and the sustainability of transport monopolies	Logistics And Transportation Review	19	1	1983
Zhou, P; Fan, Lw; Zhou, Dq	Data aggregation in constructing composite indicators: a perspective of information loss	Expert Systems With Applications	37	1	2010