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Bibliometric study on project portfolio management between 1994 and 2009

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Abstract: This article aims to underline the pattern of the academic literature on portfolio management through a review of the last 15 years using ISI Web of Science database. The methodological approach adopted encompasses bibliometric techniques of citation and co-citation analysis, using the concept of social networks, as well as the analysis of papers, themes, authors and the journals. The results show that the most relevant topics on portfolio management are the following: portfolio management frameworks and processes flow; risk and financial analysis of project portfolios; the decision making tools based on quantitative and qualitative information; and the impact of portfolio management in areas such as Research & Development, New Product Development, Information Technology and the pharmaceutical industry.

Key words: *project management; portfolio management; literature review.*

1. INTRODUCTION

There is a growing recognition that project portfolio management is important for a company to reach opportunities faster than the competitors. The importance of this theme relates to the necessity companies have to get an advantage with projects that meet the competitive strategy adopted by the organization while using limited human, financial and technological resources (ROZENFELD et al., 2006).

Project portfolio management can be defined as a series of models, procedures and processes which aim to manage a set of projects in a systemic way (CARVALHO; RABECHINI, 2008).

According to Archer and Gasemzadeh (1999), the process of project portfolio management requires the strategic evaluation of projects; clear criteria for a pre-assessment of projects; methods that do not generate overload of non relevant data; common parameters of assessment; flexible methods to allow stakeholders to use prioritizing tools with which they feel more comfortable, but allow the analysis of relevant data and decision-making; evaluation of the entire portfolio focusing on the interaction between projects and the sharing of resources; periodic assessment of the portfolio considering the impact of unforeseen changes, as well as allowing for the adjustment of the portfolio to changes in the company environment.

Considering the all aspects mentioned above and their relationship with project portfolio management, this study aims to underline the pattern of academic research.

This article is organized as follows: Section 2 presents the methodological approach, detailing the method of collection and processing of data. Section 3 outlines the research results. Section 4 summarizes the key learning of the work and the last section is a bibliographical reference.

2. RESEARCH METHODOLOGY

According to Prasad and Tata (2005), bibliometric research facilitates the discovery of patterns in literature. However, Neely (2005) argues that the same research can be made through the analyses of citations and co-citations, thus identifying the main researchers in the field of study.

Bibliometrics can be defined as a series of techniques that seek to quantify the process of written communication (IKPAAHINDI, 1985). The quantitative analysis of article citations can be performed by counting the number of citations of an individual text as well as by analyzing the bibliographic references used the articles cited more often.

The analysis of the number of citations allows us to identify the articles that cause greater impact on the field of knowledge thus enabling an assessment over time of the evolution relevant issues in the field and their interrelationship.

The analysis bibliographic references provides the identification of the bibliometric group phenomena, allowing for the identification of the significant relationships between two articles based on the number of references they have in common (Kessler, 1963), and co-citations, which, according Small (1999), identifies how strong the relationship between two items is by verifying the number of times they are mentioned together.

Sample and Procedure

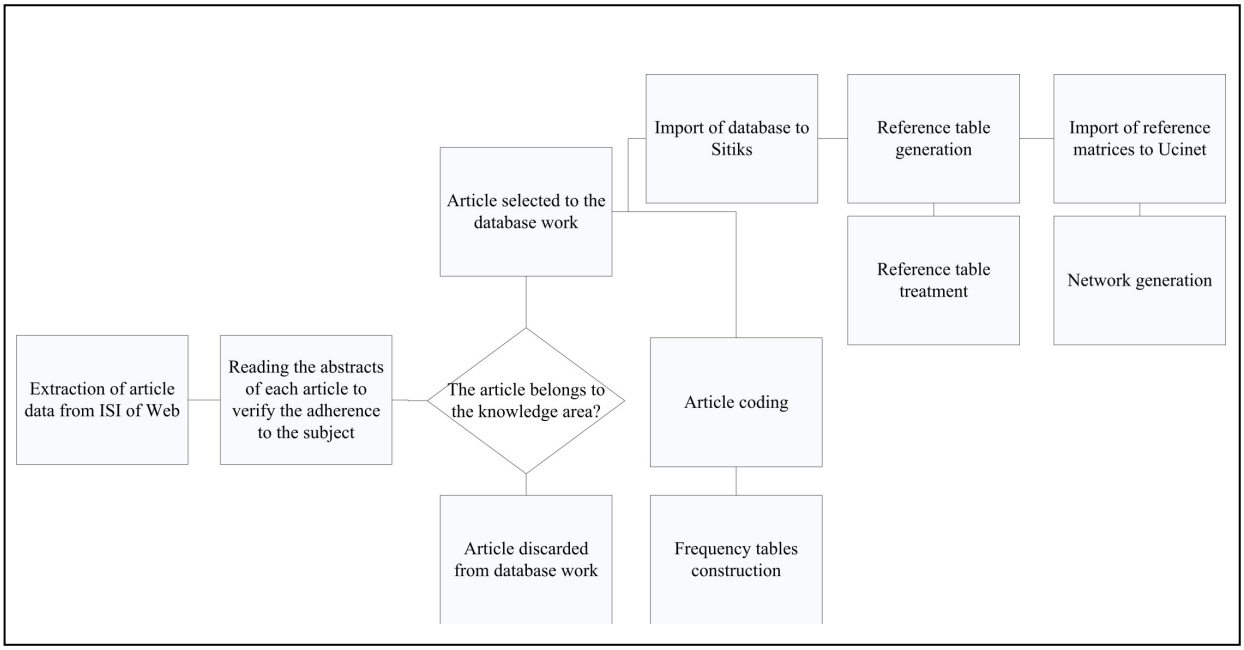
The authors analyzed 58 articles published between 1994 and 2009 in 39 journals in various fields of study, such as computing, technology, economy, engineering, manufacturing, telecommunications and pharmaceuticals among others.

The criterion used to select the articles was the combination of both "portfolio management" and "project management" topics in all databases.

After reading the abstracts, eight articles were eliminated because they do not belong to the subject of "portfolio management".

These articles were then treated according to the flow of the bibliometric review activities in Figure 1.

Figure 1: Workflow of the bibliometric review.



Articles Treatment

Table 1 shows the list of journals in the sample.

Table 1: List of journals.

AAPG Bulletin-American Association of Petroleum Geologists
British Telecommunications Engineering
Building Research and Information
Computers & Operations Research
Decision Support Systems
Drug Development Research
Drug Information Journal
Environment and Planning C-Government and Policy
IEEE Transactions on Engineerong Management
IEEE Transactions on Power Systems
Industrial & Engineering Chemistry Research
Industrial Management & Data Systems
Journal of Chemical Technology and Biotechnology
Journal of Economy Theory
Journal of Management in Engineering
Journal of Management Information Systems
Journal of Petroleum Science and Engineering
Journal of Product Innovation Management
Journal of Systems Science and Systems Engineering
Management Decision
Management Science
Omega International Journal of Management Science
Operations Research
Pharmaceutical Statistics
Pharmaeconomics
R&D Management
Research Technology Management
Science of Computer Programming
South African Journal of Industry Engineering
Technovation
Wirtschaftsinformatik

Source: Research Data.

Coding of articles and reviews

The abstracts of the 58 articles were read in order to make an initial selection, discarding articles that were not about portfolio management, and identifying key areas and issues addressed by the theme.

The other 50 articles were then coded in primary and secondary areas, namely: knowledge, new product development, efficiency, finance, integration, research and development, risk, information technology and decision making.

Once the articles had been coded, distinct forms of analysis are designed in order to better understand the information, as well as to construe perceptions and trends on the subject.

The first one was to sort publications by journal and year, so as to identify the journals with more influence and importance and analyzing the understanding of this information over time.

A second form was to analyze publications by the journal and field, characterizing the existence of the most cited and possibly more important fields, identifying possible clusters.

In a third moment, the authors analyzed the behavior of the fields over the years, and finally, the creation of a cross-tab with the primary with secondary areas.

Biblimetric tools

After analyzing of the tables, the authors felt compelled to evaluate the bibliographic references cited in the articles of greater impact selected for this article.

They have used the Sitkis software (SCHILDT, 2002) and Ucinet (BORGATTI, 2002) to treat their data, initially generated in the ISI. Through the software it was possible to work with the bibliographic references cited in the articles in search for further clarifications.

Tabulating the references generated by Sitkis, it was possible perform a descriptive statistical analysis which, just as with the selected articles, allowed for the analysis of

citations over time and the most cited references, as well as an assessment of the number of times a citation was quoted in the body of each article, allowing for the creation of descriptive tables and graphics.

Furthermore, once the data from Sitks was imported to Ucinet, the networks of co-citations were built thus enabling the identification of references that are often mentioned together, indicating related themes; cross-citation networks impart, within the set articles, what authors work on related themes; building networks of key words, indicating the key words that are more often mentioned together, demonstrating how project portfolio management themes interconnect.

3. RESEARCH RESULTS

Publications by journal and year

Table 2 shows the number of publications by journal between 1994 and 2009. Twenty-three journals published only one article, four published two, while a single one published three, two published four articles and finally one published eight.

Table 2: Publications by journal and year.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
AAPG Bulletin-American Association of Petroleum Geologists			1														1
British Telecommunications Engineering						1											1
Building Research and Information									1								1
Computers & Operations Research														1			1
Decision Support Systems											1						1
Drug Development Research													1				1
Drug Information Journal					2					1				1			4
Environment and Planning C-Government and Policy								1									1
IEEE Transactions on Engineerong Management								1							1	1	3
IEEE Transactions on Power Systems							1										1
Industrial & Engineering Chemistry Research									1								1
Industrial Management & Data Systems															1		1
Journal of Chemical Technology and Biotechnology													1				1
Journal of Economy Theory														1			1
Journal of Management in Engineering	1																1
Journal of Management Information Systems											1						1
Journal of Petroleum Science and Engineering											1						1
Journal of Product Innovation Management						1				1	1		1				4
Journal of Systems Science and Systems Engineering															1		1
Management Decision														1			1
Management Science														1			1
Omega International Journal of Management Science														1			1
Operations Research												1					1
Pharmaceutical Statistics										1							1
Pharmaeconomics												1					1
R&D Management								1							1		2
Research Technology Management						1	2		1	1	1		2				8
Science of Computer Programming															2		2
South African Journal of Industry Engineering														1			1
Technovation								1				1					2
Wirtschaftsinformatik												1	1				2
Total	1	0	1	0	2	3	3	4	3	4	5	4	6	7	6	1	50

Source: Research Data.

In this step we verify the existence of four major journals:

- IEEE Transactions on Engineering Management: a nonprofit organization, the world leader in professional association for the advancement of technology in areas such as aerospace systems, computers, telecommunications and biomedical engineering. Considered a source of technical and professional information, resources and services.

- Drug Information Journal: journal dedicated to disseminate information for drug research, promoting the communication between academy, industry and government. It also seeks better methods of presenting the research data in chemical, toxicological, pharmacological and clinical studies.

- Journal of Product Innovation Management: this journal combines the academic theory of innovation with the effective practice of management. Promotes incentive and innovative thinking to the academic and corporate world.

- Research Technology Management: an important journal that promotes technological innovation through research and development of new products. It is considered a source of knowledge and best practices in innovation management.

Publications by journal and field

Table 3 shows the classification of articles by journal and field of study.

Table 3: Publications by journal and field.

	Knowledge	New product development	Efficiency	Finance	Integration	Research and development	Risk	Information Technology	Decision making
AAPG Bulletin-American Association of Petroleum Geologists							1		1
British Telecommunications Engineering						1			1
Building Research and Information			1	1					
Computers & Operations Research			1					1	
Decision Support Systems			1						1
Drug Development Research			1			1			
Drug Information Journal			3	1	1	1	1		1
Environment and Planning C-Government and Policy			1			1			
IEEE Transactions on Engineerong Management		1	1			2	1		1
IEEE Transactions on Power Systems							1		1
Industrial & Engineering Chemistry Research						1			1
Industrial Management & Data Systems	1		1						
Journal of Chemical Technology and Biotechnology						1	1		
Journal of Economy Theory			1						1
Journal of Management in Engineering	1		1						
Journal of Management Information Systems								1	1
Journal of Petroleum Science and Engineering							1		1
Journal of Product Innovation Management	1	3	1	2			1		
Journal of Systems Science and Systems Engineering								1	1
Management Decision		1							1
Management Science		1			1				
Omega International Journal of Management Science						1	1		
Operations Research				1		1			
Pharmaceutical Statistics				1					1
Pharmaeconomics		1							1
R&D Management	1					1	2		
Research Technology Management		4	4			2	3		3
Science of Computer Programming							2	2	
South African Journal of Industry Engineering			1						1
Technovation				1		2	1		
Wirtschaftsinformatik							2	2	
Total	4	11	18	7	2	15	18	7	18

Source: Research Data.

Summarizing how each field is presented in the studied articles:

- Knowledge: knowledge here refers mainly to the environment. Knowing the environment to face threats and deal with the opportunities; effectively working with a

sustainable development of skills; making the best decisions regarding the choice of projects and the allocation of financial and human resources.

- New product development: especially technology research and product innovation. A proper development of the product can not only generate financial gain, but also prevent waste and grant the company a better position in the industry.

- Efficiency: one of the most mentioned. Increasing efficiency is undoubtedly one of the main goals of those who devote to portfolio management. How to get better results, performance improvement and a steady growth.

- Finance: clear focus on the need for conscious and precise allocation of financial resources. Which project do the companies invest in? When do they have to block a project in progress?

- Integration: appears only discreetly in the articles despite its great importance, especially in what regards the integration of projects and of the people involved in them.

- Research and development: ever present, especially in medical, chemical, engineering and technology research.

- Risk: another field vastly explored in this study. The majority of companies which seek portfolio management in order to minimize the risk of inadequate investment, wrong choice of projects or misallocation of financial and human resources.

- Information technology: this field presents itself with a strong link to projects, and therefore, to the need for efficient portfolio management.

- Decision making: it encompasses one of the major concerns of all businesses. Decision making involves knowledge, experience, dynamism and flexibility.

Publications by field and year

It is possible to analyze the behavior of publications by field of study between 1994 and 2009 in Table 4.

Table 4: Publications by field and year.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Knowledge	1					1									2		4
New product development								1	1	2	2	1	2	2			11
Efficiency	1				1	1	1	1	1	2	2		2	4	2		18
Finance									1	3		2	1				7
Integration														2			2
Research and development					1	2	1	3	1			2	2	1	1	1	15
Risk			1		1		2	2			2	1	4	1	3	1	18
Information Technology											1	1	1	1	3		7
Decision making			1		1	2	2	1	2	1	3	1		3	1		18
Total	2	0	2	0	4	6	6	8	6	8	10	8	12	14	12	2	100

Source: Research Data.

Frequency of publication

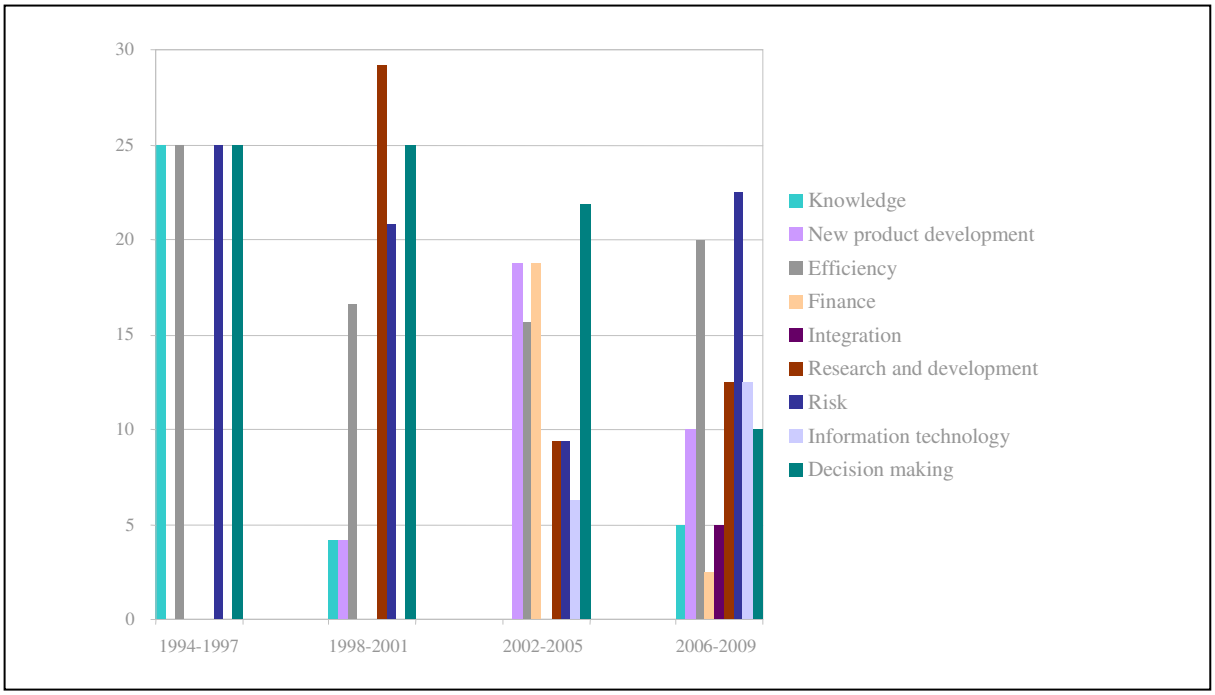
Table 5 shows the analysis of each field every 4 years.

Table 5: Frequency of publication.

	1994 - 1997		1998 - 2001		2002 - 2005		2006 - 2009	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Knowledge	1	25	1	4			2	5
New product development			1	4	6	19	4	10
Efficiency	1	25	4	17	5	16	8	20
Finance					6	19	1	3
Integration							2	5
Research and development			7	29	3	9	5	13
Risk	1	25	5	21	3	9	9	23
Information Technology					2	6	5	13
Decision making	1	25	6	25	7	22	4	10
Total	4	100	24	100	32	100	40	100

Source: Research Data.

Figure 2. Pattern of field publications every four years.



Source: Data Research.

The analysis shows that, between 1994 and 1997, portfolio management was little sought after, although some studies had been conducted. The first movements occurred between 1998 and 2001, indicating the need and interest for portfolio management, and encompassing other areas in besides knowledge, efficiency, risk and decision making. There was also a noticeable growing interest in research and development and new product development.

Between 2002 and 2005, the first impressions of portfolio management growth are confirmed; it is now less focused on knowledge, but rather in the financial area. From 2005 until 2009, the subject of project portfolio management sustained a major growth of interest; companies are now more concerned with area of risk, followed by efficiency, information technology and research and development.

Clusters of primary and secondary areas

Table 6 shows the intersection of the primary and secondary areas.

Table 6: Cross-tabulation of the primary area with the secondary.

	Knowledge	New product development	Efficiency	Finance	Integration	Research and development	Risk	Information Technology	Decision making
Knowledge			3						
New product development			2	2	1		3		3
Efficiency									
Finance			2						
Integration			2						
Research and development			4	2			6		3
Risk	1		1						2
Information Technology			1				4		2
Decision making		1	4	1			2		

Source: Research Data.

As previously mentioned, the interest in knowledge and efficiency walked side by side in the first stages of the research on portfolio management. The ever present concern with all sorts of risk mingled with several other areas. However, it was only together with research and development that it received more emphasis, followed by information technology and new product development.

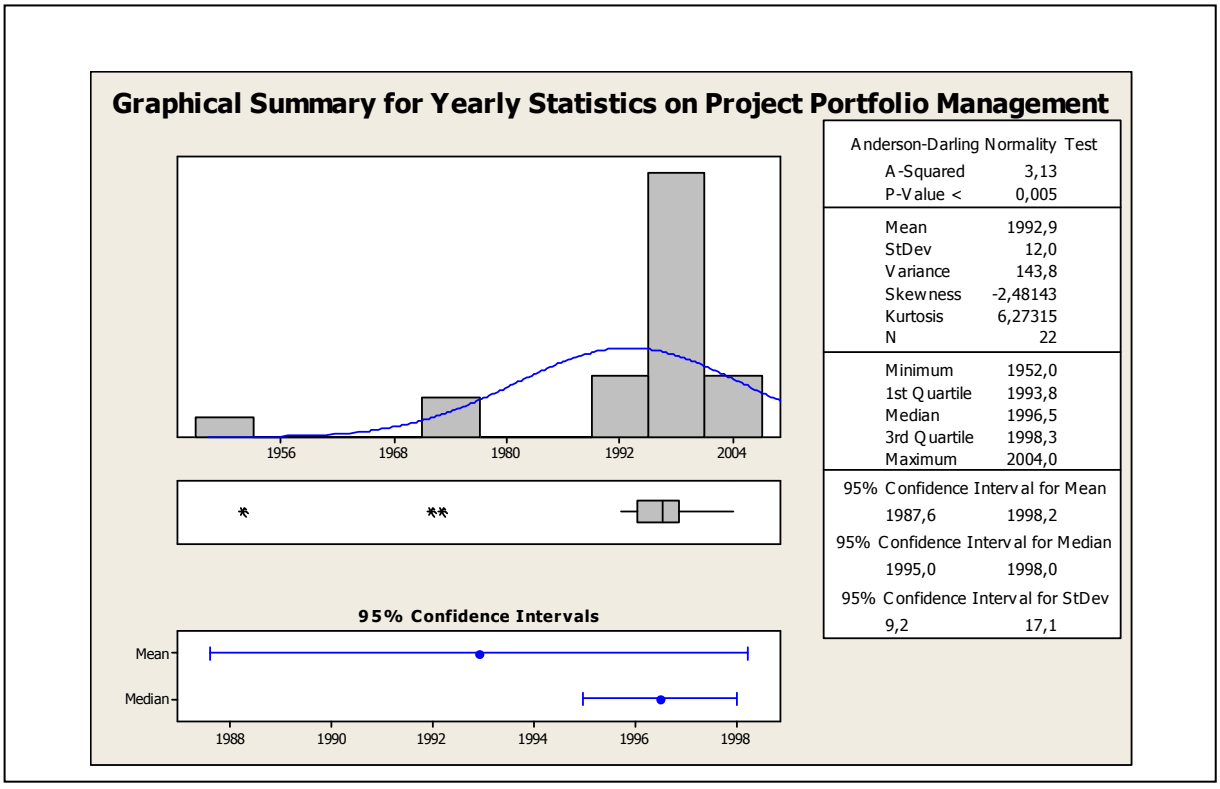
Efficiency not only was present throughout the evolution and growth of portfolio management, but was also the main area, joining mainly decision-making, research and development and knowledge.

Publications with more than four citations

Figures 3, 4 and 5 represent the works with more than 4 citations in the total of articles examined, with their respective citations in the period between 1994 and 2009.

It is possible to see in Figure 3 that out of the 22 papers referenced, 11 were published after 1996, concentrating mostly between 1995 and 2001, although there is work with a volume of references in the 50's and 70's.

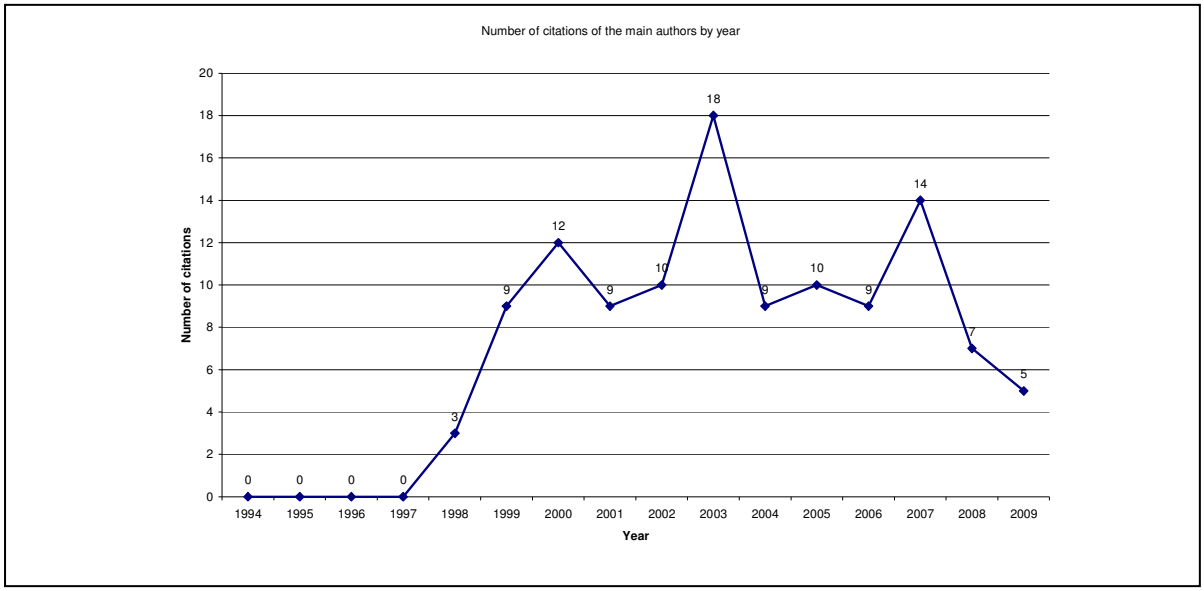
Figure 3. Frequency of repetition of the year of origin on the most commonly used references.



Source: Sitkis.

Looking at figure 4 we notice that there are no citations of these authors earlier than 1997, and the peak of citations are dated between 2000 and 2007, which indicates a rather recent field of knowledge. In 2008 and 2009 there is a drop in the number of citations from this group.

Figure 4. Yearly number of citations considering the group of references more often cited from 1994 to 2009.



Source: Sitkis.

Analyzing the work individually, it can be seen in Table 7 that a large proportion of the volume of citations shown in Figure 3 belongs to Cooper, and among the 22 references that appear in more than four citations, 10 come from the same author. Other important authors are Hernriksen, Montoya-Weiss and Verhoef.

Table 7: Most cited references.

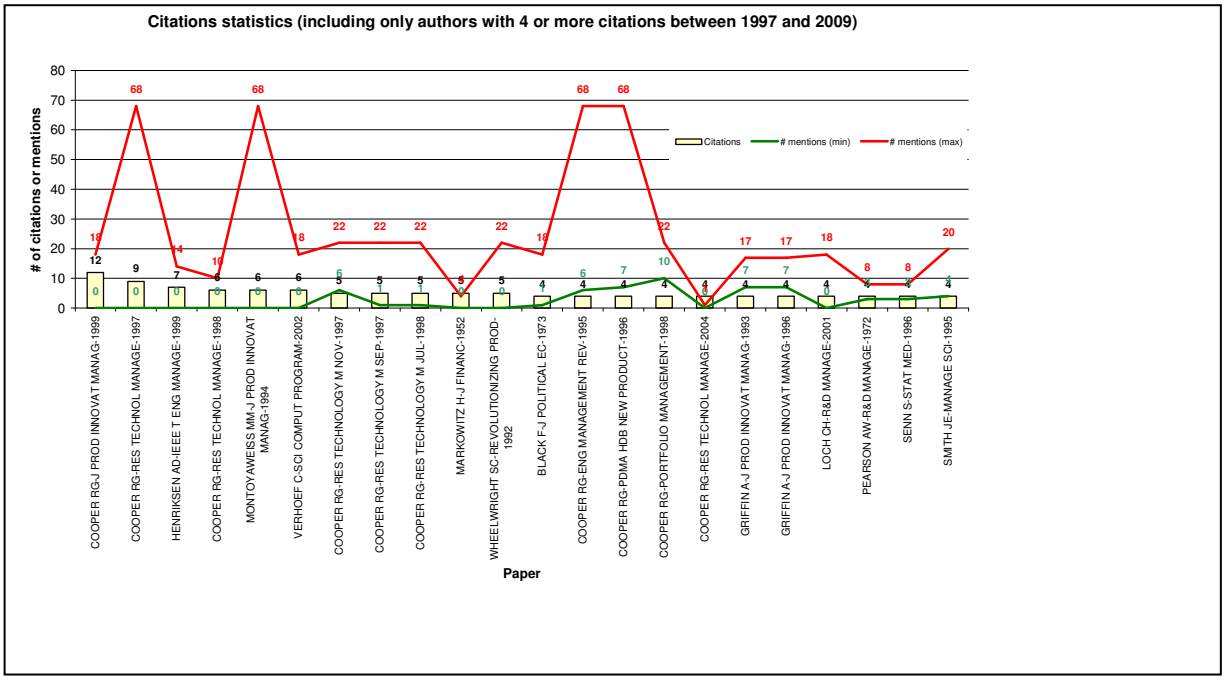
Author	Journal	Year	Citations
COOPER, R.G.	Journal of Product Innovation Management	1999	12
COOPER, R.G.	Research Technology Management	1997	10
COOPER, R.G.	Journal of Product Innovation Management	1997	9
HENRIKSEN, A.D.	IEEE Transactions on Engineerong Management	1999	7
COOPER, R.G.	Research Technology Management	1998	6
MONTOYA, M.M.	Journal of Product Innovation Management	1994	6
VERHOEF, C.	Science of Computer Programming	2002	6
COOPER, R.G.	Research Technology Management	1998	5
MARKOWITZ, H.M.	The Journal of Finance	1952	5
WHEELWRIGHT, S.C.	The Free Press (Livro)	1992	5
BLACK, F.	Journal of Political Economy	1973	4
COOPER, R.G.	Journal of Product Innovation Management	1995	4
COOPER, R.G.	Industrial Marketing Management	1996	4
COOPER, R.G.	Addison Wesley (Livro)	1998	4
COOPER, R.G.	Research Technology Management	2004	4
GRIFFIN, A.	Journal of Product Innovation Management	1993	4
GRIFFIN, A.	Journal of Product Innovation Management	1997	4
LOCH, C.H.	R&D Management	2001	4
PEARSON, A.W.	R&D Management	1972	4
SENN, S.	Statistics in Medicine	1996	4
SMITH, J.E.	Management Science	1995	4

Source: Research Data.

Analyzing figure 6 we can see not only the citation count, but also the number of times that the articles are mentioned in the text. We can notice that twelve texts of Cooper, Black, Griffin, Pearson, Sean and Smith are mentioned in all selected articles, while the other 10 references do not appear in all the studied articles.

We can also notice that only one reference was mentioned a single time. Most references are mentioned from 10 up to 25 times in each article and some of Cooper's texts have been mentioned up to 68 times in each article, as shown in figure 6.

Figure 6. Number of citations and references in the studied articles according to the main references.

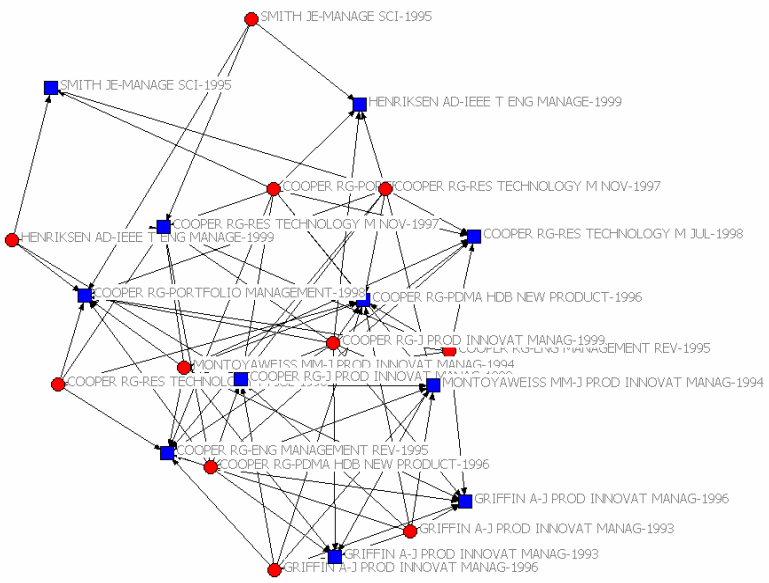


Source: Sitkis.

Complementing the previous observations, that consider an individual approach on each reference, we built a few social networks that allow us to visualize the behavior of the whole set of references, identifying the similarities amongst the work groups.

In the network represented by figure 7, we have the results of the co-citation networks, which measure the similarity between academic works by identifying the volume of articles which refer to those works together. On this network, we can notice that the main relationships found include the citation all of Cooper's texts as a single set — just as expected given the huge volume of citations on those papers. We also found the relation of this author's papers with the work of Griffin, Montoya-Weiss and Henriksen, but these, however, are on the edge of the network, meaning they are less cited together.

Figure 7. Network of co-citation for references with at least 4 citations on the articles cited at least 4 times as measured by MDS.



Source: Sitkis.

4. CONCLUSIONS

It was possible to describe the academic research on project portfolio management through the results found on this study.

The subject is fairly recent as a field of knowledge given that the volume of citations has become more significant from 1997 on.

The journals that presented the greater number of publications were *IEEE Transactions on Engineering Management*, *Drug Information***,** *Journal of Product Innovation Management* and *Research Technology*.

Between the years of 1994 and 1997, knowledge and efficiency presented the main interest of companies. Between 1998 and 2001, the main signs of interest on portfolio management process come to light encompassing also NPD and R&D. From 2002 on the interest on project portfolio management process increased consistently, on the ratio of one article per year.

Risk and efficiency were the recurring themes throughout due to the need companies have of evaluating consistently the relationship between investment and benefit of the projects on the portfolio, which will be affected by unidentified and untreated uncertainties, as well as the proper use of the resources in the projects.

Among the references, the main themes developed were the building and refinement of project portfolio management process frameworks, criteria to evaluate the project portfolio, the role of management and leadership on the process and the decision making models.

It was possible to identify Cooper's framework (Stage-Gate) as the prevailing model on academic literature regarding the project portfolio management process.

Many authors, such as Rogers, Lin and Wang, discuss decision support systems for project evaluation, many of which computer based. These systems aim to support the use of quantitative data on financial, risk and strategic variables, which are usually treated by project portfolio management, but often on a qualitative view.

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