A BIBLIOMETRIC STUDY ON THE MAIN MODELS IN PROJECT MANAGEMENT

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Abstract. *In this study we analyzed the scientific production concerning the management of projects through the most expressive models used to assess the maturity of an organization. The study is descriptive and also a research, and in it we conducted a bibliometric analysis of the existing bibliographic portfolio. The research was conducted over a period between 2010 and 2014, and involved the ISI publications in online databases: ScienceDirect, Springer Link and Web of Science. We did a quantitative analysis based on the most relevant papers and keywords. The data analysis was based on descriptive statistics and, as a result, we obtained a profile of publications.Throughout the study, we noted that the most common errors in choosing the research subject were: selecting an area rather than a research issue; attributing too long titles, which diversify the subject investigated and do not allow focus on a specific purpose; choosing a banal topic, for which research is not needed; the topic chosen does not fall into a sphere with enough information – sometimes there is no information whatever.*

Keywords: *Bibliometric, maturity models, project management, research, organization, research errors.*

1. INTRODUCTION

Using project management, regardless of the period of time, organizations want to achieve excellence in the projects conducted, yet this conditionnot is not sufficient to achieve excellence.The first steps in achieving excellence in project management are best described in the models of maturity in project management, which consist of descriptive stages expressing the difference between the levels of maturity in project management.

Rabechini Junior's view, in the paper entitled "Competencies and maturity in Project Management: A structural perspective", *"concern with maturity in Project Management appeared in organizations because projects are the best way to change a complex situation"* (Rabechini) [1].

The concept of maturity in a project is directly related to its potential success or failure.

Consequently, immature organizations will use improvisation in management, without establishing the necessary connections between different areas of knowledge.

In the paper published by the Institute of Project Management, which is entitled "Organizing Project Management – A Maturity Model", it is noted that: *A maturity model can be defined as a conceptual structure, with component parts, which defines the maturity of the area of interest and, in some cases, also describes the processes that the organization will need to develop in order to reach a desired future* [2]. This model highlights every step along this path and signals the gradual maturation of the organization.

Another definition, which appears in "Project Management: Best Practices", authored by H. Kerzner [3], presents maturity and development of systems and processes as being repetitive in nature, and defines a high probability for each of them to be successful, although the repetitivity of the processes and systems cannot guarantee success.

Another paper published by the Project Management Institute (PMI: 2009) [4] shows that development of maturity is a continuous process, and everything being done to achieve maturity quality depends on a concerted effort to develop, improve and promote communication between managers and project management professionals.

In achieving their strategic objectives, organizations use management project tools to measure the results and the level or degree of maturity of the organization in terms of using project management practices. Given the context mentioned, we decided to undertake a review of the scientific literature in terms of the use of models of maturity in project management, a review that drew on articles, journals, authors and keywords identified in the bibliography portfolio of existing ISI publications in the following online databases: ScienceDirect, Springer Link şi Web of Science.

The research objective we set was the analysis of the academic papers published between 2010 and 2014, where the most important models of maturity are approached, which are used in project management, drawing a comparison between them on five maturity levels, and highlighting the errors in selecting the subject dealt with – errors which would be highlighted and explained in detail.

The present study is divided into four parts, which successively develop issues relating to the most important models of maturity of an organization, specifically, the model CMMI (Capability Maturity Model Integrated) and OPM3 (Organizational Project Management Maturity Model), the methodological procedures used in research and highlighting errors in the choice of the research subject, which we found in the papers analyzed, bibliometric analysis and its results, and, finally, the conclusions that could be drawn from the research undertaken.

2. MODELS OF MATURITY AND ASSESSING THEIR LEVELS

As shown in the paper "A Guide to the Project Management Body of Knowledge" (PMI: 2013) [5], *a project represents temporary efforts undertaken to create a product, a service or a single result, it has its own targets or objectives, a defined outset and purpose, and ends when the objectives are completed*.

Maturity in project management is the position where the company or organization finds itself in terms of project management processes. In this way, maturity models try to quantify an organization's ability to manage projects successfully (Prado)[6].

An adequate level of maturity varies depending on the

resources available and the organization's needs.

The two main maturity models will show the degree that maturity reaches in the organization in question, in order to subsequently set the desired level to be achieved. As far as the Integrated Capability Maturity Model (CMMI) is concerned, the project is known to have been developed in 1986 by SEI (Software Engineering Institute) to integrate various capability maturity models. This model attempted to improve the processes of software development, and was published in 1993, focusing on the fields of systems and software engineering.

The aim of developing this model was to compare the processes in an organization with the best practices proven by the experts in that industry, in the government and in academia, providing ways of measuring progress towards the discovery of new areas that can be improved.

It would be important to note is that this model is meant to improve on the process, and it can be adopted to solve performance problems at every level of the organization by providing guidelines for improving internal discipline.

The Organizational Maturity Model of Project Management (OPM3) was created by PMI (Project Management Institute) between 1998 and 2003 (Zaguir, Martins)[7]. The model establishes the requirements and capacities to ensure and develop projects, programs and portfolios, so as to help organizations to achieve organizational strategies through projects.

OPM3 was developed in order to provide a way for organizations to understand project management, and to measure maturity in contrast with a comprehensive and extensive best practices in project management.

The OPM3 method of maturity, viewed from the angle of its progress, consists of dimensions, each of which leading to the capitalization of the best practices associated with the development stages of the processes, to the advance of the best practices associated with each of these areas: projects, programmes and portfolios.

A study by two Brazilian researchers from the Fluminense Federal University in Niterói city shows that[8] *a procedure in the OPM3 model is built based on the five groups of processes with three areas, interacting with the four stages of improvement. This interaction can be summarized in the following procedures: each process is required in all areas; execution of the processes depends on the adequate inputs, tools and techniques; control of variability in the processes and the maturity of each area depends on the progression of the steps in improving standardization, measurement and control, as well as the continuous improvement of processes controlul de variabilitate în cadrul proceselor.*

From the findings of two researchers one can conclude that the OPM3 model states that the organization should consider best practices and conduct a feasibility analysis and prioritization, establishing a plan composed of the best sequences devised for improvement, as well as appropriate actions for the situational conditions in order to achieve optimal maturity. Below we are going to draw a comparison of the two most important models of maturity in an organization, which we have presented above, as a result of exploratory research aimed to identify the main characteristics of the maturity models analyzed.

The model created by the Software Engineering Institute (SEI) was the pioneering model that served as a support for other specialists.

Table 1. Comparison of the maturity levels for models CMMI and OPM3

Level of maturity	Model of maturity	
	CMMI	OPM3
1	Initialization	Standardization
2	Management	Measurement
3	Quantitative definition	Control
4	Management	Continuous improvement
5	Optimization	-

Source: own processing

It can be noted that the maturity models analyzed are represented at their levels of maturity. The level of maturity consists in a certain ratio of practices connected to a predefined set of zones of processes that improved the overall performance of the organization. The CMMI model has five levels, each representing an essential layer in improving the evolution course of the processes, whereas the OPM3 model has only four levels. Compared to the first model of maturity, the OPM3 model considers that the organizations already adopt practices of documentation, so that the standardization process at level 1 (standardized) is, in most cases, included in maturity level 2 (measured).

The adoption of the improvement processes is identified in the progress of the maturity level, in both models analyzed.

In assessing maturity, the method used is the application of maturity questionnaires to determine the current state of maturity of the organization, and the goal of all the authors cited was a common, formulated the idea of improving the organization's processes that use these models of maturity.

3. METHODOLOGY PROCEDURES AND ERRORS IN SELECTING THE RESEARCH TOPICS

The method used is a quantitative and descriptive exploratory study (Gil)[9], because it provides information on the topic, on one hand, by researching the literature, while it descriptive nature (Guedes, Borshiver) [10], on the other hand, stands out by the fact it adopts the bibliometric approach, which consists of a combination of empirical laws and principles, representing the theoretical foundations of the sciences of informatics or computer technology, through a number of documents.

The bibliometric method is considered to be a statistical instrument capable of generating knowledge management indicators, in particular for information systems.

On the other hand, the bibliometric method is also a

quantitative instrument, which allows to minimize subjectivity in indexing information, while contributing to

In reaching the target aimed, the procedure used was searching articles in ScienceDirect, Springer Link and ISI/Web of Science in the online databases for a period of time ranging from 2010 to 2014. The process began with the collection of keywords that are related to the subject under investigation; three directions are used, the first with the keyword regarding the topic of the project management, the

decision-making in information management, second with the abbreviations of the main models of maturity, and the third highlighting the errors in choosing the research subject, which we could find in the papers analyzed. Searching for the keywords "Project" and the two models of maturity in the headlines, abstracts and databases, we obtained 198 such keywords, as shown in the table below.

Table 2. Number of keywords found in the databases researched

Keywords	Databases analyzed			Total
	Science Direct	Springer Link	ISI/Web of science	
"Project" and "CMMI"	152	2	10	164
"Project" and "OPM3"	22	2	10	34
TOTAL	174	4	20	198

Source: own processing

The technique used for searching and generating the words, which allowed us to visualize the words that appear with greater frequency in a given text consisted in typing the combination Ctrl+F for the sources listed above.

By analyzing the errors that occurred while choosing the research subject, we concluded that the most common errors were those shown in the following table.

Table 3. Errors in choosing the research subject

Errors found	Science Direct	Springer Link	ISI/Web of Science	Total
• Choosing a field rather than a research subject.	7	1	1	9
• Giving too long titls, which diversify the research subject and do not allow focusing for a precise aim.	6	1	1	8
• Choosing a trivial, banal subject for which research is no longer needed.	2	1	1	4
• The topic chosen does not belong to a sphere providing enough information – sometimes even none information whatever.	1	1	1	3
TOTAL	16	4	4	24

Source: own processing

The contributors that authored the papers analyzed presenting the errors in the table above are for the main part PhD candidates in medicine and civil building from China and Brazil.

4. BIBLIOMETRIC ANALYSIS AND ITS RESULTS

In this section we will present the results of the analysis concerning the data on project management maturity models;
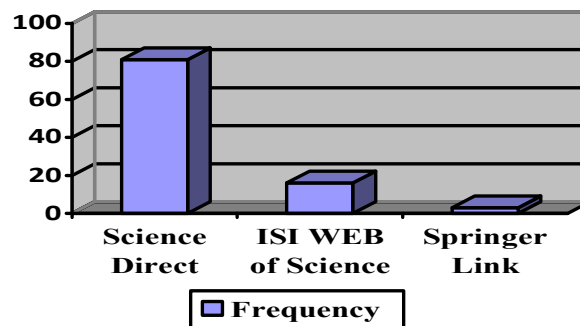
the areas of expertise of the institutions that use these models of maturity; the countries with the highest number of researches; and the statistics applied to these models, databases and subjects studied.The total number of 128 papers composed the bibliometric research collection, distributed over the three databases: ScienceDirect, Springer Link and ISI/Web of Science. The most papers, about 81%, were found in ScienceDirect, followed by 16% in ISI/Web of Science, and 2% in Springer link, as shown in Figure 1.

Fig. 1. Percentage distribution of the papers in the databases analyzed

Figure 2 below shows the amount of papers distributed over the time interval 2010 to 2014. It can be noted that the most papers were published in 2012 and 2013, and these

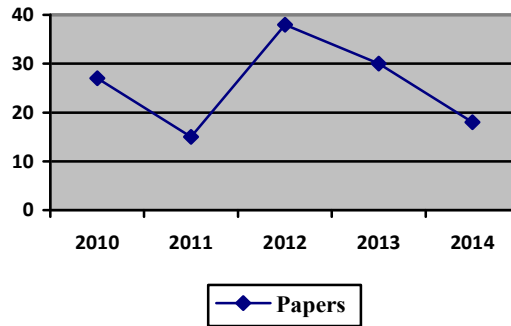contributed most to the study, with 38 and 30 papers, respectively.

3

Fig. 2. Evolution of the amount of papers analyzed by year

The bibliometric analysis continues with the data shown in Table 4, where the most influential countries in the group of papers investigated are presented. The table was compiled based on the frequency of the words in the texts analyzed.

Table 4. Number of papers analyzed by country

Country	Frequency	Country	Frequency
Brazil	21	Thailand	3
China	16	Spain	2
USA	12	Ireland	2
India	9	Russia	2
Italy	7	Germany	1
Japan	7	Bulgaria	1
Portugal	6	Croatia	1
South Korea	4	Denmark	1
Malaysia	4	France	1
Mexico	4	Indonesia	1
Turkey	4	New Zealand	1
Colombia	3	Swiss	1
Estonia	3	Sweden	1
Iran	3	Serbia	1
Pakistan	3	UK	1

Source: own processing

The table highlights the countries responsible for the papers making up the bibliography portfolio selected. Brazil and China are representative analysis, the present numbers 21 and 16 respectively articles. Based on this result, we can prove a growing concern from Brazilian (Nunes et al.)[11] and Chinese scientists in terms of production and publication of scientific articles.The next stage of the analysis consists in distributing articles in accordance with the maturity model analyzed. In terms of absolute frequency, which represents the number of times each model is studied, the papers that have to do with the CMMI maturity model were in number of 113, and the papers referring to the OPM3 maturity model were 15. The relative frequency of the two indicators, calculated as the ratio of the number of times each model occurs and the total of the series of observations, over the amount of the resulting papers, is 88% (CMMI) and 12% (OPM3), respectively.

In terms of the errors found in the selected papers in accordance with the two maturity models, their classification in keeping with their subject area is presented in Table 5.

Table 5. Errors in papers – by topic field

Topic field	Topic	Error found	Frequency of error
Building	OPM3	A*	1
		B*	2
Health and medicine	CMMI	A	8
		B	6
		C*	4
		D*	3
TOTAL			24

Source: own processing

Note*: A = Choosing a field rather than a research subject.
B = Giving too long titles, which diversify the research subject and do not allow focusing for a precise aim.
C = Choosing a trivial, banal subject for which research is no longer needed.
D = The topic chosen does not belong to a sphere providing enough information – sometimes even none information whatever.

Table 5 shows the frequency of errors found in relation to the maturity models (CMMI and OPM3) and the macro-divisions of the thematic field or area included in the articles studied.

On the other hand, as far as absolute frequency is concerned, there were 21 errors found in the articles that refer to the CMMI maturity model, and 3 errors found in the articles referring to the OPM3 maturity model.
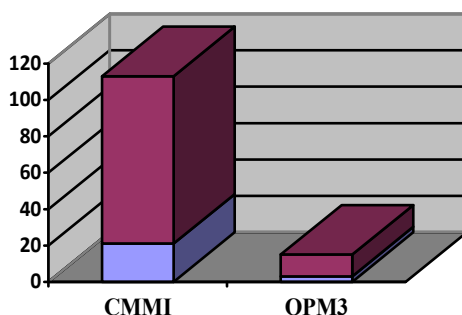

Fig. 3. Errors in the papers studied

The relative frequency of the papers containing errors, calculated as the ratio of the number of times a papers with erros is observed and all the series of observations, over the resulting amount of papers with errors, is 87% (CMMI), and 13% (OPM3).The bibliometric research in this study allowed the analysis of two key aspects concerning the use of maturity models in project management and the errors present in several articles that represented the basis for the analysis.

5. CONCLUSIONS

Comparing the two models of maturity used by organizations in project management, namely the CMMI model and the OPM3 model, was possible by conducting the bibliographical study which provided methodological support and led to identifying the characteristics of the two models, and to assessing the maturity levels specific to the most important models of maturity, and the result was five levels specific to the CMMI model and four levels specific to the OPM3 model.

Of the errors found on the occasion of the quantitative and descriptive study conducted, the majority were identified in the articles written by authors from Brazil and China on issues concerning the thematic area of health and medicine: topics were chosen whose scope was too broad to be able to focus on the two key topics (8 papers containing errors from the total 24); also, in the papers concerning topics from the area of building, the same type of error has been identified once.

The second type of error, i.e. choosing too long a title, which diversifies the researched theme, was detected in 8 articles, of which 6 dealth with health and medicine and 2 with building. The errors related to addressing a trivial topic, which cannot be subjected to serious research, were found in 4 papers on health issues; and the last type of errors, concerning the choice of the topic for which there is insufficient information, was found in 3 papers.

All four types of errors found were apparently caused by some PhD student authors' desire to publish as many papers as possible, which favoured quantity (i.e. numerous publications) to quality research.

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