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Assessment of Maturity in Project Management: A Bibliometric Study of Main Models

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Abstract

This article aims to examine scientific production about project management regarding the most expressive maturity evaluation models in organizations. The present study is descriptive and exploratory, and has adopted a bibliometric analysis of the existing bibliographical portfolio. The research was carried out in ISI/Web of Science, Scopus and Scielo databases in order to find data for the period from 2010 to 2014. Articles including the most relevant key-words were analyzed quantitatively. The analysis of the data was based on descriptive statictics and, as a result, a profile of the publications was obtained.

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Keywords: Project Management; Maturity Models; Bibliometric

1. Introduction

Every organization wants to achieve excellence in projects. Using project management, even if for an extended period of time, is not a sufficient condition for reaching excellence. The basis for achieving excellence in project management is best described by Maturity Models in Project Management [1], which are composed of stages that describe the difference in levels of maturity in project management.

According to Rabechini Junior [2], "the concern with maturity in project management has arisen in organizations because projects represent the best way to change a complex situation". The concept of project maturity is closely linked to their potential for success/failure. Immature organizations are characterized by improvisation in management, without establishing the required connections between the various knowledge areas.

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A maturity model can be defined as a conceptual structure, with constituent 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 to reach a desired future [3]. The model acknowledges each step taken on this journey, signaling the progressive maturation of the organization. Another definition presents maturity as the development of systems and processes that are repetitive by nature, setting a high probability that each one of them is successful. However, repetitive processes and systems are not by themselves a guarantee of success. They only increases its likelihood [1].

Developing maturity is a continuous process. Improvements in maturity depend on a concentrated effort to develop, improve and foster communication between executives and professionals in project management [4].

To achieve the outlined strategic objectives, organizations use project management tools to measure results and the level or degree of maturity that the organization finds itself in regarding the use of project management practices.

Experience has shown that organizations work best when they focus their efforts on the improvement of processes in a number of controlled areas that require an increasingly sophisticated effort as the organization improves. A level of maturity consists of specific and generic practices related to a predefined set of process areas that improve the overall performance of the organization [5].

In this context, we decided to carry out a review of the scientific literature on the use of maturity models in project management. This review was based on articles, journals, authors and keywords identified from the chosen bibliographical portfolio.

The research objective is to map the academic production between 2010 and 2014 that addresses the use of the main maturity models in project management. This gives rise to the following research question: How are the main maturity models in project management produced in academic terms?

This paper was divided into five sections: The introduction, where a contextualization is carried out and the research objective is presented. In the second section, the literature review on the subject is carried out. The third section is devoted to the methodological procedures. The fourth presents the study's findings. And in the last section the concluding remarks on the subject are laid out.

2. Maturity Models

According to the Project Management Body of Knowledge (PMBOK) guide [6], a project is a temporary endeavor undertaken to create a unique product, service or outcome, which has goals, a defined beginning and end, and which is concluded when the objectives are completed.

For Vargas [7], a project is defined as a non-repetitive enterprise that is characterized by a clear and logical sequence of events, with a beginning, middle and end, intended to achieve a clear objective and conducted within predefined parameters.

Maturity in project management is the position in which the company finds itself regarding the project management processes. Based on this, maturity models seek to quantify the ability of a company to manage projects successfully [8].

The appropriate level of maturity may vary depending on the available resources and the organizational needs. First, it is necessary to define which type of maturity assessment should be adopted. The models will present the degree of maturity in which the organization finds itself for the subsequent establishment of the level it wants to achieve.

2.1. Capability Maturity Model Integration (CMMI)

The Capability Maturity Model Integration (CMMI) project was developed in 1986 by SEI in order to integrate the various CMM models. CMMI, which sought to improve software development processes, was published in 1993, focusing on the fields of systems and software engineering.

CMMI was developed to compare the existing processes in an organization with the proven best practices developed by members of industry, government and academia. And to provide ways to measure progress so as to reveal potential areas for improvement [9].

The CMMI model was not developed for software development only, but to assist software and services organizations in the alignment of process improvements with business objectives, engineering costs, schedules, productivity, quality and customer satisfaction. It is a process improvement model that can be adapted to solve performance problems at any level of the organization or industry by providing guidelines for improvement in the various disciplines of the organization.

2.2. Organizational Project Management Maturity Model (OPM3)

The Organizational Project Management Maturity Model (OPM3) was created by the PMI between 1998 and 2003 [10]. It sets forth requirements to ensure and develop capabilities in projects, programs and portfolios so as to assist organizations in accomplishing organizational strategies through projects.

OPM3 was developed with the purpose of providing a way for organizations to understand project management, and for measuring the maturity in contrast to a comprehensive and wide-ranging set of best practices in project management.

The progress of maturity in OPM3 consists of several dimensions. One of these dimensions involves the valuing of best practices associated with the development stages of processes (Standardization, Measurement, Control, and Continuous Improvement), which represent, respectively, the improvement processes of projects, the implementation analysis of projects, the assessment of practices and their improvement. Another dimension corresponds to the progression of best practices associated with each one of these domains: Projects, Programs and Portfolios. Each progression represents a continuity along the organizational aspirations towards improvement.

A process in the OPM3 model is built based on the five process groups with the three domains, interacting with the four stages of improvement. This interaction can be summarized by the following procedures: Every process is necessary in all domains; the execution of the processes depends on the appropriate inputs, tools and techniques; control of variability within the processes; and the maturity of each domain depends on the progression of the improvement stages of Standardization, Measurement, Control, and Continuous Improvement processes.

At the last stage, the OPM3 model provides that the organization should consider the list of best practice and perform a feasibility and prioritization analysis, establishing a plan made up of the best sequence of improvement actions appropriate for its situational conditions in order to achieve greater maturity.

2.3. Kerzner Project Management Maturity Model (KPMMM)

The Kerzner Project Management Maturity Model (KPMMM) presents itself as an extension of the CMMI model, focused on the field of project management. According to Rabechini Júnior [11], KPMMM is made up of five levels of maturity combined with the area structure of PMBOK.

When dealing with maturity, there is a common heresy that all work must be carried out sequentially, but that the levels could overlap. Because the magnitude of the overlap is based on the amount of risk that the organization is able to tolerate [12].

The model proposed by Harold Kerzner distinguishes itself from the others by presenting methods to assess each level of maturity. The objective is to verify the degree of the organization's adherence at every level. It is worth mentioning that the adoption of a project management methodology is a necessary, but not a sufficient condition for obtaining organizational success [12].

2.4. Project Management Maturity Model (PMMM)

The Project Management Maturity Model (PMMM) is a formal tool developed by PM Solutions that seeks to measure the maturity in project management of an organization. Once the initial level of maturity and the areas for improvement have been identified, PMMM provides a roadmap, defining the necessary measures to be taken towards maturity in project management [13]. PMMM was first published in book form in 2002 and its second edition was released in 2007. It provides for five levels of evolutionary maturity and examines the development in ten knowledge areas of PMI's PMBOK guide.

The objective of the PMMM methodology is to allow any organization to systematically and efficiently develop its project management capabilities [14].

2.5. Project Management Maturity Model – Darci Prado (MMGP)

The MMGP model was created to assist the project management team of the *Instituto de Desenvolvimento Gerencial* (Management Development Institute, INDG), currently *Falconi Consultores de Resultado*, in the assessment of the maturity stage of the organizations that hire it.

According to Prado [15], there is a consensus on the part of project management professionals that a maturity model should consider the following areas: Strategy, Processes, People and Technology. MMGP was developed in six dimensions linked to the five levels of maturity.

Prado [15] states that the MMGP model should be applied separately in each sector within the organization, given that the same organization may harbor different levels of maturity.

2.6. Main Characteristics of Maturity Models

This section seeks to present the results of the exploratory research, identifying the main characteristics of the analyzed maturity models and making comparisons between the levels of maturity. A comparative analysis between the models is essential to show that there is complementarity between the existing models [16]. The model created by SEI was the pioneering model that served as support for the others, which are listed in Table 1.

Table 1. Comparison of the Maturity Levels

Levels	MATURITY MODELS				
	CMMI	OPM3	KPMMM	PMMM	MMGP
1	Initial	Standardization	Common Language	Initial Process	Initial
2	Managed	Measurement	Common Processes	Structured Processes	Known
3	Defined	Control	Singular Methodology	Organizational Standards	Standardized
4	Quantitatively Managed	Continuous Improvement	Benchmarking	Managed Process	Managed
5	Optimized	-	Continuous Development	Optimized Process	Optimized

Source: Developed by the authors

The analyzed maturity models are represented in levels of maturity. The level of maturity consists of a specific report of practices related to a predefined set of process areas that improve the overall performance of the organization. The model has five levels, each representing a layer of the improvement base of the ongoing processes [17].

One can see that the analyzed models feature five levels of maturity in project management, with the exception of OPM3, which has only four stages. This characteristic is a result of the fact that OPM3 considers that organizations already adopt documentation and process standardization practices in level 1 (Standardized), which, in most cases, is only included in maturity level 2.

In the analyzed models, the adoption of improvement processes for the progression in maturity levels can be identified. The method employed to assess maturity is the application of questionnaires to determine the

organization's current stage of maturity.

Despite the fact that the analyzed models were created by different authors, all have the same objective: improve the maturity of the organizations that use them, improving their processes.

3. Methodological Procedures

The methodological procedure aims to outline the path to be taken by the researcher. A method can be seen as the set of systematic and rational activities that allow you to reach your goal - valid and true knowledge, with more security and less cost, tracing the path to be followed, detecting errors and helping the researcher in decision-making [18].

Based on this principle, the chosen method was an exploratory and descriptive study with a quantitative approach [19], because this will provide information about the subject on hand through a research of the literature that can serve as an aid to further studies. It stands out by its descriptive nature in view of the adoption of a bibliometric approach, which consists in a combination of the empirical laws and principles that constitute the theoretical foundations of Information Science, by means of a document count [20].

Still according to the previously mentioned authors, the bibliometric method is considered to be a statistical tool that is able to map and generate indicators for knowledge management, especially in management and information systems. As such, it is also a quantitative tool that enables you to minimize subjectivity in the indexation of information, and that contributes to the decision-making in information management.

In order to achieve the proposed objective, the keyword construction process was adopted in order to look up the publications and knowledge generated by the scientific community in the search engines. A data analysis was then performed with the Zotero® software, which is able to organize the references by date, author and title, and allows you to retrieve the metadata automatically, and with Excel® using a structured roadmap in a spreadsheet.

The procedure used was the search of articles in the Scopus, Scielo and ISI/Web of Science databases in a time period from 2010 to 2014. The study was carried out in November/2014 and considered the content analysis of articles for the construction of the bibliometric research. The collected data was submitted to statistical treatment, which classifies the study as quantitative in nature [19].

The process began with the selection of keywords that are related to the research subject. Two axes were used, the first one with the keyword regarding the project management theme, and the second with the abbreviations of the main maturity models.

9 steps were completed to realize the bibliometric research, as described in Table 2.

Table 2. Research Steps

1. Definition of keywords	6. Export of Articles to the Zotero® software
2. Establishment of the Boolean Search Strategy	**7.** Reading of Selected Articles
3. Definition of the Criteria for the Selection of Articles	**8.** Entering of the Data in the Excel Software®
4. Search for Articles on the web sites: www.scielo.org / www.scopus.com / www.isiknowledge.com	**9.** Descriptive Data Analysis
5. Selection of Articles	-

Source: Developed by the authors

The keywords selected provided the combinations shown in Table 3. These words were used to search for articles in the selected databases.

Table 3. Combinations of Selected Keywords

Axis 1 - Project Management	Boolean Operator	Axis 2 - Maturity Models
"Project"	AND	"PMMM"
"Project"	AND	"OPM3"

"Project"	AND	"MMGP"
"Project"	AND	"CMMI"
"Project"	AND	"KPMMM"

Source: Developed by the authors

With these keyword combinations, a search was carried out in the titles, abstracts and keywords of the selected databases. As a result, 217 articles were obtained, as shown in Table 4.

Table 4. Quantity of Articles Found in the Databases

KEYWORDS	DATABASES			TOTAL
	SCOPUS	SCIELO	ISI/Web of Science	
"Project" AND "PMMM"	11	0	6	17
"Project" AND "OPM3"	22	2	10	34
"Project" AND "MMGP"	1	0	1	2
"Project" AND "CMMI"	152	2	10	164
"Project" AND "KPMMM"	0	0	0	0
TOTAL	186	4	27	217

Source: Developed by the authors

In the gross database of articles, a verification was performed of the adherence with the subject and repeated articles were identified by analyzing the titles, keywords, abstracts and body text of articles. After this verification, 135 articles remained, which then became the bibliographical portfolio of the study.

In addition, the word cloud generation technique was used with the Wordle tool, which allows you to visualize highlights of words that occur with greater frequency in a given text [21-22].

4. Analyses and Results

In this section, the result of the data analysis regarding the maturity models in project management; the area of expertise of the institutions that use these maturity models; the countries with the highest number of research; and the statistics applied to the models, databases and topics under study, are presented.

A total of 135 articles composed the collection of the bibliometric research, distributed over three databases: Scopus, Scielo and ISI/Web of Science. Most articles, approximately 81%, were found in Scopus, followed by 16% in ISI/Web of Science, and 2% in Scielo, as shown in Figure 1.

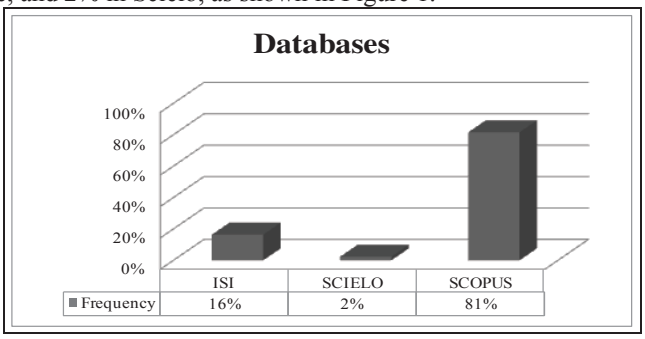

Fig. 1. Distribution of Articles by Database

Figure 2 shows the quantity of articles distributed in the time range from 2010 to 2014. One can see that the years 2012 and 2013 were the ones that most contributed to the study, with 38 and 30 articles, respectively. It is important to note that since the article search was carried out on November/2014, it was not possible to

accommodate the collection of the year 2014 in its entirety.

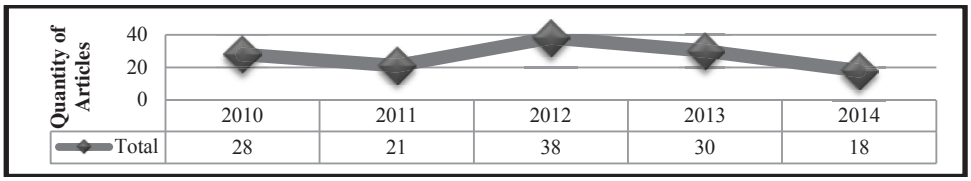

Fig. 2. Distribution of Articles by Year

In Figure 3 the most influential countries in the collection of articles can be seen. The frequency of country names for the generation of the word cloud with the Wordle software (Wordle.net), which highlights the most frequently appearing words in the text, was considered.

PAÍS	Frequência	PAÍS	Frequência
China	24	Thailand	3
Brazil	22	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	United Kingdom	1
Estonia	3	Serbia	1
Iran	3	Sweden	1
Pakistan	3	Switzerland	1
TOTAL		135	

Fig. 3. Number of Articles by Country

The countries responsible for the articles of the selected bibliographic portfolio were analyzed. China and Brazil can be highlighted as the most representative countries in the analysis with 24 and 22 articles, respectively. This is due to a growing concern on the part of Brazilian scientists regarding the academic production and publication of articles [23].

In table 5 the distribution of articles according to maturity model is analyzed. where *fi* refers to absolute frequency (Number of times that each model is studied), *Fi* reflects the accumulated absolute frequency, *fri(%)* represents the relative frequency (ratio between the number of times that each model is observed and the total number of observations) and *Fri*(%) is the accumulated relative frequency. One can see that the total number of observations of models is greater than the number of articles. This is a result of two of the studied articles addressing more than one maturity model for the evaluation of project management maturity.

Table 5. Articles by Maturity Model

MODEL	(fi)	Fi	fri(%)	Fri(%)

CMMI	113	113	82%	82%
OPM3	15	128	11%	93%
KPMMM	2	130	1%	95%
PMMM	6	136	4%	99%
MMGP	1	137	1%	100%
TOTAL	137	-	100%	-

Source: Developed by the authors

In table 5 one can see that the CMMI model concentrates most of the academic production studied, with 82% of the articles. Already the Brazilian model, MMGP, accounted for 1% of the analyzed articles.

Another analysis considered was to identify which countries are responsible for the greatest production of articles by the maturity models of the study. As a result, Figure 4 shows the most influential countries in academic production by each maturity model.

Fig. 4. Most Influential Countries in the Use of Maturity Models

According to Figure 4, Brazil was responsible for the largest academic production on the CMMI and MMGP models, with 17% of articles on the CMMI model and 100% on the MMGP model. China contributed with the largest amount of articles referring to the OPM3 (7%), KPMMM (50%) and PMMM (67%) models. We chose to consider the percentage of participation of each country in this analysis and one can see that both China and Turkey produced the same amount of articles on the KPMMM model.

Aspects regarding the areas under study in the articles are worth noting. As such, an analysis was performed of the most frequently mentioned words in order to identify which were the recurring themes.

In addition, Table 6 was compiled based on the data found. In it, the words were grouped and macro divisions were performed to define in which thematic category the project management maturity studies fitted.

Table 6. Macro Divisões dos Artigos por Área Macro Divisions of the Articles by Area

AREAS	Frequency	AREAS	Frequency	AREAS	Frequency
1. Information Technology (IT)	101	8. Gas and Energy	2	15. Production Planning and Capacity	1
2. Construction	6	9. Offshore	2	16. Portfolios in general	1
3. Airline	4	10. Banking	1	17. Projects in general	1
4. Engineering	4	11. Supply Chain	1	18. Telecommunications	1
5. Research and Development	4	12. Education	1	19. Small and Medium-sized Enterprises	1
6. Development of a New Maturity Model	3	13. Automotive Industry	1	-	
7. Health Care	3	14. Naval	1	TOTAL	139

Source: Developed by the authors

Some of the 135 articles analyzed focused on more than one theme, which amounted in a total of 139 articles in 19 macro divisions. Information Technology (IT) is the area on which project management maturity studies are most focused, with 102 articles. Among the IT articles, most addressed software development processes, software quality management, and systems engineering, as shown in Table 3 above. It should be noted that three

of the articles sought to use traditional maturity models as a foundation to develop a new maturity model, namely: one article based on PMMM (Project Management Maturity Model) and two articles based on OPM3 (Organizational Project Management Maturity Model). Table 7 shows the relationship of maturity models with the macro divisions of the areas contained in the articles.

Table 7. Articles by Maturity Model

AREAS	MODELS	Frequency	AREAS	MODELS	Frequency
Airline	CMMI	3	Offshore	CMMI	2
	PMMM	1	Small and Medium-sized Enterprises	OPM3 and CMMI	1
Banking	CMMI	1	Research and Development	CMMI	3
Supply Chain	CMMI	1		MMGP	1
Construction	OPM3	5	Production Planning and Capacity	OPM3	1
	PMMM	1	Portfolio	OPM3	1
Development of a New Maturity Model	OPM3	2	Projects	OPM3	1
	PMMM	1	Health Care	CMMI	2
Education	KPMMM	1		OPM3	1
Engineering	CMMI	3	Information Technology	CMMI	96
	CMMI and OPM3	1		KPMMM	1
Gas and Energy	OPM3	2		OPM3	2
Automotive Industry	CMMI	1		PMMM	3
Naval	CMMI	1	Telecommunications	CMMI	1
Grand Total			139		

Fonte: Elaborado pelos autores

Table 7 shows that the airline industry has opted for the use of two models, mostly CMMI, as is the case for the Engineering, Health Care and Information Technology industries. The OPM3 model was more used in the Construction industry and as a basis for the development of a new maturity model. Other macro divisions used a maturity model among those that are the object of this study.

This bibliometric study has enabled the analysis of important aspects related to the use of maturity models in project management. With the field survey, the greater quantity of articles related to the area of Information Technology and a majority use of the CMMI model could be verified, which allows for the inference that the technology area is the most influential in academia regarding the publication of articles related to maturity models.

5. Conclusions and Suggestions for Further Research

The bibliographical study has provided methodological support and assisted in the assessment of the main project management maturity models. As such, it was possible to make comparisons between the peculiarities of each model.

The relevance of the theme in scientific production could therefore be highlighted, since mature organizations will be better positioned to attain success in projects. For with planning and detailed specifications, waste and failures can be avoided and the lessons learned in the past can be maintained for future projects, contributing to the acquisition of capabilities over time, which entail the acquisition of organizational maturity.

The theme that grouped the largest number of articles was Information Technology. As a result, a large concentration of studies on the CMMI model could be observed, given that the focus of this model lies on technology and related areas.

A significant number of the observed studies were carried out in Brazil, representing 16% of the articles used in this work. China also stood out in the amount of publications, with 18% of the total number of articles.

The distribution of articles in macro divisions for a better identification of the subject areas under study in the selected bibliographic portfolio should be highlighted. This revealed that the area of Information Technology

represented the largest share of articles of the bibliographic portfolio under study. In the same way, CMMI came out as the most frequently used maturity model by researchers, with an expressive share in the field of Information Technology.

As a suggestion for future work, there is a need for more in-depth studies on the maturity models and on their similarities and differences. Even so, it is important to assessment of project management maturity in organizations, aiming at performing a comparison with the research already done. In addition, it is suggested that other databases be included to search for articles, using a qualitative approach for the publications through a historical account and a measurement of the prospects for the development of the maturity in projects.

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