

# The evolution of the relationship between project management and knowledge management: a bibliometric study

## *A evolução da relação entre a gestão de projetos e a gestão do conhecimento: um estudo bibliométrico*

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**Abstract:** The objective of this work is to investigate the relationship between project management and knowledge management. To understand the intersection between these two fields of research, the methodological approach selected was a systematic literature review. The multi-stages approach was adopted, starting with bibliometric analysis with descriptive statistical analysis of the population of papers studied, followed by a co-citation and network analysis, and finally a content analysis in order to identify trends and research gaps. The results show that the project management and knowledge management are related to issues involving the skills of project managers and of the organization, governance of knowledge between projects through the area of Project Management Office, and aspects related to factors critical to success and success itself of a project. As a trend, studies aimed at the formation of virtual teams formed by distributed organizations stand out, and as a gap, the importance of knowledge for projects involving sustainability issues, as few studies were identified about this subject. It was possible to notice that these constructs are essential to organizational performance, and that together they have a synergy that may contribute to enable companies to differentiate themselves from their competitors and achieve competitive advantage.

**Keywords:** Project management; Knowledge management; Bibliometric study.

**Resumo:** O presente estudo teve como objetivo investigar a relação entre gestão de projetos e gestão do conhecimento. Para compreender a intersecção entre esses dois campos de pesquisa, a abordagem metodológica selecionada foi a de revisão sistemática da literatura. A abordagem multiestágios foi adotada, iniciando-se por análises bibliométricas, com análise estatística descritiva da população de artigos estudados, seguida de uma análise de cocitação e, por fim, por uma análise de conteúdo, buscando-se identificar tendências e lacunas de pesquisa. Os resultados apontam que a gestão de projetos e a gestão do conhecimento estão relacionadas com questões que envolvem as competências de gestores de projetos e da organização, a governança do conhecimento entre projetos por meio da área de Project Management Office, e com aspectos relacionados a fatores críticos de sucesso e sucesso de um projeto. Como tendência, destacam-se estudos voltados para a formação de times virtuais em ambientes formados por organizações distribuídas e, como um gap, a importância do conhecimento para projetos que envolvem questões de sustentabilidade, visto que foram identificados poucos estudos sobre esse assunto. Foi possível notar que esses construtos são essenciais para o desempenho organizacional e que, juntos, possuem uma sinergia que pode contribuir para que as empresas possam se diferenciar de seus concorrentes e alcançar vantagem competitiva.

**Palavras-chave:** Gestão de projetos; Gestão do conhecimento; Estudo bibliométrico.

## 1 Introduction

Project management has a fundamental role for organizations. Carvalho & Rabechini (2015a) justify the interest in project management due to the fact that in the knowledge age the project activities are the ones that add more value to the products / services, and not the routine activities.

Furthermore, the project management literature has awakened to the fact that not only the hard project management (PM) approaches, exemplified by the reference guides, are relevant, but efforts should also be invested in soft PM aspects (Carvalho & Rabechini, 2015b).

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In this context, an important construct that must be taken into account and which may have a positive impact on project management is the knowledge management (KM) that has been shown to be important for organizations to differentiate themselves from their competitors. Lindner & Wald (2011) showed that knowledge is an important resource in advanced economies, and that for many organizations the effectiveness of knowledge management is one of the main factors of an organization success.

Easterby-Smith & Prieto (2008) justify that knowledge management has become important due to the increasing awareness of the importance of knowledge for the prosperity of the organization and their survival, and a contributing factor were the information technologies that allowed the storage, distribution and management of knowledge in general. The KM theme has raised interest from academics in the PM area, but there are still few studies relating these areas, which emphasize the relationship between KM and project management offices (Aubry et al., 2008; Aubry & Hobbs, 2011; Aubry et al., 2011; Müller et al., 2013; Nadae et al., 2015), the process of project decision-making (Johansson et al., 2011), in the practices (Tukel et al., 2010; Gasik, 2011) and the management of networks in projects (Alin et al., 2011). For Park & Lee (2014) knowledge sharing is a valuable activity as it encourages project participants to maintain social capital, sustain high performance and promote innovation.

Knowledge management is an area that has synergy with several others, and in this way the resource knowledge must be considered a very valuable asset for an organization. The efficient and effective management of this asset is important because the organizations may discover new ways of differentiating themselves, through the integration of this asset with the other areas that move an organization.

To contribute to the literature, the objective of this work is to investigate the relationship between project management and knowledge management, exploring the intersection between these two fields of research. The methodological approach selected was to systematically review the literature (SRL), seeking to understand the main forms of relationship between the two constructs. In order to achieve this objective, a methodological approach was adopted, based on a bibliometric study, which in recent years has been widely used due to the new tools that allow for a more in-depth study of literature.

This paper is structured as follows: section 2 presents the research method, involving the selection criteria of the papers sampled and the techniques of analysis used in the study; section 3 contains the presentation and discussion of the results; finally, section 4 presents the main conclusions of the study.

## 2 Research methods

According to Ramos-Rodríguez & Ruiz-Navarro (2004), bibliometric analysis has traditionally been divided into two categories: production of activity indicators and of relationship indicators. The first is related to the influence of the study, and the last is related to the interactions between different researchers and research fields. In this context, Diodato (1994) explains that the word bibliometric is used to refer to mathematical analyzes and statistics of patterns that appear in publications.

### 2.1 Data search

In order to carry on a bibliometric study, a database was selected to extract the papers to be analyzed for the study. The selected database was ISI Web of Knowledge (Web of Science), because the extracted data have a high compatibility with softwares that allow the analysis of a greater set of data from the papers. In addition, this database accesses in its search procedure all journals with impact index calculated by the Journal Citation Report (JCR) (Carvalho et al., 2013).

The set of keywords used for the ISI base search was “Project Management” and “Knowledge Management”, in addition to the filter to select only papers. After this initial search, 135 papers were identified, forming an initial sample. No temporal or area filters were used. Therefore, the sample treated in the bibliometric process was 135 papers for the descriptive statistical analyzes, to analyze the main keywords and for the social network analysis, while for content analysis we opted to reduce this universe, as will be explained in the next section.

### 2.2 Data analysis

A set of descriptive statistical analyzes was performed on the sample of 135 papers using the *Excel* tool. This type of analysis allowed the study of the following aspects: the evolution of the quantity of publications throughout the year, in order to identify the evolution of the studies on the theme over time; the distribution of papers by author within the sample by periods of time, with the purpose of allowing the identification of the main authors within the period; the distribution of papers by country within the sample for periods, with the objective of identifying the main poles in relation to project management; the classification of the main key words of the studies of this initial sample, in order to identify the main topics related to the field of this study.

Specifically for conducting the keywords analysis, a treatment was performed to identify the main terms

involved with the two constructs chosen in the study. The set of keywords found was standardized in a common word that represented them, for example, the words *project risk*, *corporate risk maturity*, *risk analysis*, *risk identification* and others were grouped in the word *risk*.

In addition, a co-citation analysis, or social network analysis, was performed on this sample, which consisted in verifying how the authors mentioned in these papers are related, so it is possible to form clusters with the intention of grouping the authors that are quoted together with a higher frequency and determine the main theme of the studies conducted by them. CiteSpace software (Chen, 2006) was used for cluster and network analysis of both papers and keywords. This software adopts the hard clustering procedure, seeking to divide the sample into a number of non-overlapping clusters (Chen et al., 2010).

Finally, a content analysis was carried out, and to this purpose it was chosen to classify the papers by means of a weight indicator of the paper, calculated as inspired by Carvalho et al. (2013), but replacing the total number of citations by the average number of citations, according to Equation 1, based on the average number of citations and the Journal Citation Report (JCR) impact factor, to reduce the number of papers to be read with the objective of separating the most relevant papers in the literature.

$$Weight\ Indicator(IP) = (1 + JCR\ Impact\ Factor) \times \frac{Average\ number\ of\ citations}{of\ citations} \quad (1)$$

After calculating the weight indicator, the boxplot was performed on the weight indicators of all papers from the initial sample. In order to reduce the scope for the content analysis of the selected papers, it was chosen to select the papers that were found above the 75th percentile, that is, we selected papers with a weight indicator higher than 4.4864 according to Figure 1. This filter resulted in 34 papers that were used in content analysis. The detailed data for this sample are in Appendix A.

The content analysis was performed through its interaction with the keyword analysis and with the co-citation network analysis, which allowed to verify whether there is convergence between these analysis with the most relevant papers that were selected.

### 3 Presentation and discussion of results

The objective of this section is to present the results obtained from three types of analysis: publications analysis (descriptive statistics), analysis of social networks (co-citation) and content analysis.

### 3.1 Review of publications

The first analysis of the publications has the objective of understanding the trends of growth or decrease on the interest of the researchers in relation to the studied subject, involving project management and knowledge management. The Figure 2 shows this evolution over the years. It is possible to notice that the first publication involving the two constructs occurred in 1991, and that in recent years there is a certain stability in the number of publications with little difference between them.

It is possible to notice that the year with the highest peak was 2008 and that the studies carried out that year are mainly related to the performance of the project. The main areas that appear in these studies are focused on the area of information technology and development of new products.

The second analysis was performed to identify the main authors, the countries of origin of the publications and the main journals involved. Most of the papers were from the United States followed by England and Taiwan. On the publications from the United States it was possible to identify a concentration of papers in the year 2008, as from the 31 publications 7 occurred that year. The papers are related to the performance of

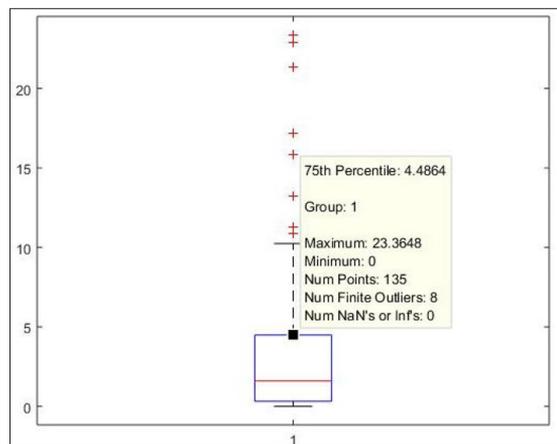


Figure 1. Boxplot on the weight indicators of papers.

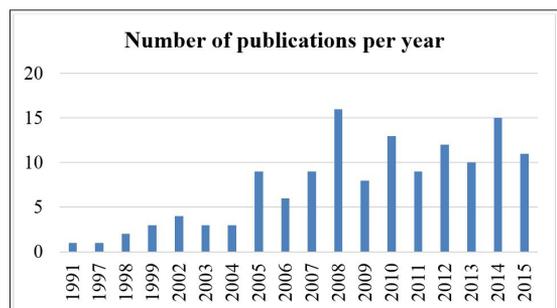


Figure 2. Evolution of sampled publications over time.

the projects associated with the areas of information technology and the development of new products, and the reuse of experience between projects in terms of knowledge transfer between projects.

There is a considerable dispersion in relation to the publications by authors, 21 authors with more than one publication were identified, which shows that there is no concentration that could indicate authors of relevance in the field of project management and knowledge management. It is important to emphasize that it is not enough for an author to publish many papers to be considered of relevance in the field of study, as his studies must be published in well-qualified journals, with a high impact factor, besides being quoted in other papers.

In relation to the number of publications per journal, it is possible to highlight the International Journal of Project Management (IJPM), which has a JCR impact factor for the year of 2014 equal to 2.436 and corresponds to 11.11% of the sample of papers selected for the analysis of publications, and which in the field of project management is one of the most relevant journals in the international context. In addition, it was possible to identify other journals such as the Journal of Knowledge Management (JKM) and Project Management Journal (PMJ), which are like other journals that focus on one of the two constructs under analysis: knowledge management, in the case of JKM, or project management, in the case of PMJ.

### 3.2 Social network analysis

The social network analysis consisted in verifying how the authors, mentioned in the papers of the selected sample, are related, so it was possible to form clusters with the intention of grouping the authors that are quoted together with a higher frequency and determine the main theme of the studies carried out by these authors.

Figure 3 shows the co-citation network with the main clusters found and their respective subjects after the application of the *CiteSpace* software. The names of the clusters were defined through the main themes that unite the papers of the sample, and this is generated by the software that does the aggregation through its similarity, and the way they are quoted together.

The main study groups, that are quoted together in the papers in the initial sample, are related to the following aspects: knowledge-based approach and project success; new product development and leadership; success factors and project management office (PMO); knowledge sharing and team performance; perspective of knowledge integration and project management performance; and knowledge design and management.

Figure 3 shows that knowledge management, in terms of knowledge integration and sharing, may influence the performance of project management, so that the knowledge-based approach may contribute

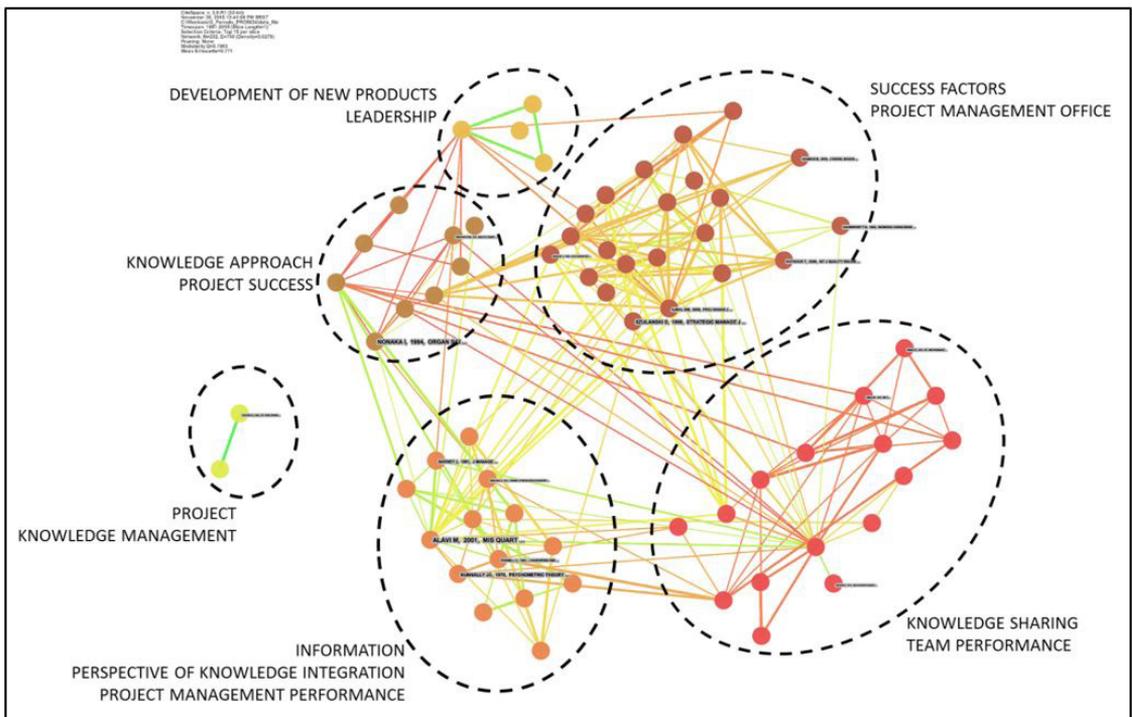


Figure 3. Co-citation network generated by CiteSpace.

to the projects success. Functional areas that play an important role in the integration and dissemination of knowledge are PMOs, which are considered as one of the factors for the success of a project. In addition, KM is present in new product development projects and in the way leadership functions in managing a project.

The high density of the co-citation network shows that several themes are quoted together in the papers that were selected in the initial sample. Some identified themes are in line with those found through the survey of the main keywords of the papers studied, and are presented in Figure 4 in the next section.

### 3.3 Content analysis

After adequate treatment, the key words with the highest representativeness in the sample chosen, constituted by 135 papers, were: performance, success, risk, learning, innovation, information technology / information systems, leadership, new products development, governance and project management office (PMO).

Through this analysis, it is possible to notice that in the papers, the constructs *project management* and *knowledge management* are related to the following themes:

- Functional area of project management: governance and project management office (PMO);
- Specific projects in some areas: information technology and new products development;
- Tools: information technology / information systems;

- Impact on project management and knowledge management: performance and success;
- Knowledge area: innovation and human resources (leadership and learning).

The main concepts involved in the relation between constructs *project management* and *knowledge management*, are shown in Figure 4.

In addition, it is possible to notice that the association of the two constructs has impacts on the project results related to performance or the success/failure of the project. This fact may be characteristic of areas that have an important role on the management of projects such as the area of governance and the project management office.

The areas of knowledge that are most closely related to the association of the two constructs are innovation and human resources. This fact makes sense because knowledge is an important resource to implement an innovation and for organizational learning in relation to the projects already carried out by its employees, as well as being a fundamental element for the use by a good project manager.

Finally, information technology has a fundamental role in order to permit managing the knowledge about the projects already carried out, and those that will be carried out, so it has been inserted as a tool to integrate the two constructs.

The content analysis was performed on the sample of papers selected using the boxplot, having as proxy of selection the impact of the paper through the average citations of the work and the impact of the journal in which it was published. Initially, the titles and abstracts of each paper were read to classify

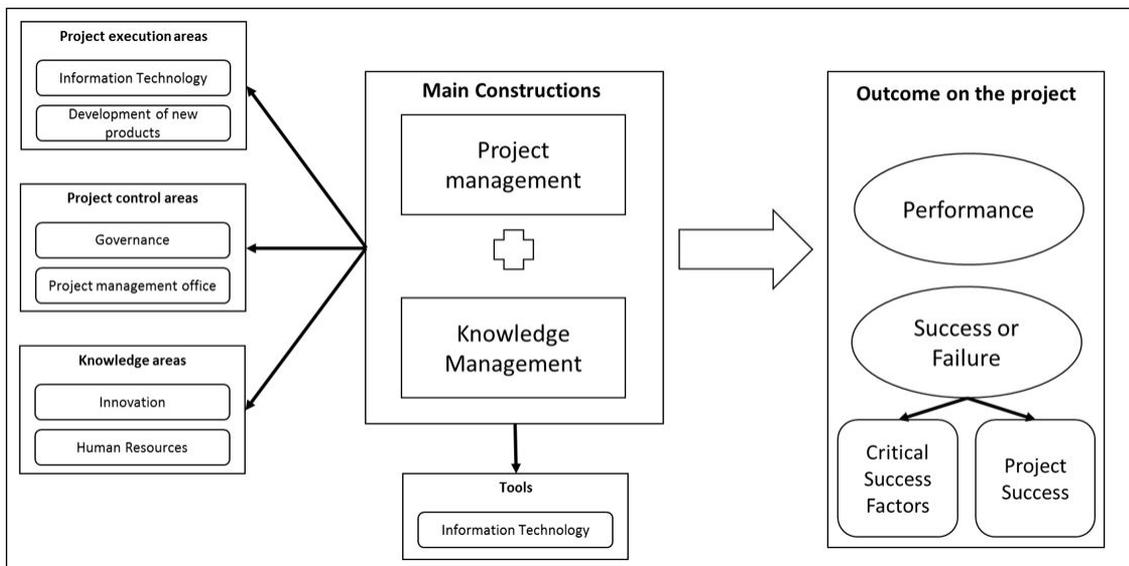


Figure 4. Theoretical chart of Systematic Review of Literature (SRL) synthesis.

them in thematic areas. The following 13 themes were identified: Project Management Office (PMO), Skills, Strategic Communities, Project Performance, Success Factors, Managers Projects, Innovation, Project Teams, Complex Projects, Decision Criteria, Measurement of Knowledge Management, Risk and Business Value.

#### 4 Project Management Office (PMO)

One of the functions of PMOs is to create and disseminate a PM methodology that synthesizes best practices (Nadae et al., 2015). According to Pemsel & Wiewióra (2013), the roles of PMOs must have different capacities in the process of knowledge sharing, such as the capacity to promote the strategic development of the relationships between project managers and stakeholders; the ability to manage, control and support project managers to ensure efficient knowledge flow, adopt coaching, negotiation and role-building, to ensure the development of competencies of project managers - to mediate knowledge to support and meet the need of knowledge sharing among project managers. Therefore, a PMO has a relevant role in organizing communities of practice in project management in the organization (Aubry et al., 2011), fostering networks and flows of knowledge project managers (Müller et al., 2013; Pemsel & Wiewióra, 2013).

Desouza & Evaristo (2006) carried out a study with the objective of delineating the nature and characteristics of PMOs, classify and derive the PMO typology, concluding that the main objective of a PMO is to centralize information to create a knowledge base, and that an effective PMO may be an important step towards a greater success of the organization. Other authors, such as Denford & Chan (2011), Rose (2011) and Unger et al. (2012), also corroborate this view, in which PMOs centralize the knowledge acquired during the project life cycle, bringing together the lessons learned and converting the accumulated knowledge into new practices, procedures and processes. Desouza & Evaristo (2006) generated a typology which differentiates administrative PMOs, that should generally document and disseminate project reports, lessons learned and best practices, but tacit knowledge of projects is difficult to capture in their paper; knowledge-intensive PMOs create collaborative communities for project managers to share knowledge and learning that may be difficult to capture and document through conventional mechanisms.

Thus, it is possible to notice that PMOs have a direct role in knowledge management. This association creates a structure that allows the sharing of project knowledge and lessons learned, as well as the diffusion of ideas throughout different projects

with the PMO as a tool focused on the governance of these processes.

#### 4.1 Competence

The development of competencies related to project management is fundamental, it is important to understand the competences as capabilities that an organization have, and that may determine the success in terms of the companies competitiveness. According to Suikki et al. (2006) the ability to understand problems cyclically due to changes in environmental conditions that are frequent, may affect the performance of a project.

Anbari et al. (2008) emphasize the post-project review as a key competence of project management, which is related to the success of future projects and the improvement of organizational performance. The process of collecting lessons learned, store and use in subsequent projects is a critical element to the project success and consequently to organizational competitiveness. This database allows the assemblage of a comprehensive project plan that covers all areas of expertise, and allows project managers to identify the specific skills needs of the team, the specific recruiters, the customer profile and the operational environment, which may have impacts on the success/failure of the project.

In the context of an environment involving technological aspects, Palacios-Marqués et al. (2013) carried out a study seeking to understand the knowledge skills that a project manager must develop to work in web 2.0 environments. The authors point out that project managers should modify already existing competences - competences involved with managerial, technical and social aspects - to develop new skills based on knowledge management to manage e-learning projects in the web platform. Those skills are divided into two levels; in the first level the skills required by a project manager may be grouped mainly in the pedagogical scope and in the management, coordination and structuring of contents and project evaluation. With the emergence of IT, a second level emerges, in which the project manager must adapt to a technological environment where communication happens through a virtual platform eliminating the triple dimension: space, time and activity. In this way, other skills must be developed and must play a crucial role in the development of e-learning projects: technological and social skills.

Regarding competences, it is possible to notice that their association with the project management function, such as post-project review, or even project management itself, is considered a competence in a given context. The development of existing skills and new skills is important in a market with constant dynamics.

## 4.2 Strategic communities

Kodama (2005a) analyzed the characteristics of strategic communities networks, as a trigger that allows the knowledge to be spread through the distributed individual limits. This is possible due to the following aspects: involvement and immersion in collaboration, and the resonance of values in which these communities are formed. The author defines strategic communities as a shared space that allows emerging relationships that contribute to the process of knowledge creation. It is highlighted that one of the key factors for innovation production in a knowledge-based society is how organizations may organically and innovatively form different knowledge networks created from the formation of a variety of strategic communities inside and outside the organization, and acquire the capacity for synthesis through dialectical leadership.

In another work, Kodama (2005b) seeks to provide a new view on new product development management, a high-tech area that requires the fusion and integration of different knowledge technologies. In this context, it is argued that the formation of a network of strategic communities plays a fundamental role in the creation of new knowledge. The result of the study highlights that the formation of strategic communities may continuously generate innovation through the capacities of individual community leaders, the number of community leaders at each level of management, and the skills of those leaders to exercise their competencies, along with those strategic communities network.

The formation of strategic communities must involve stakeholders who are in some way related to the project, so that knowledge may be shared to improve project performance and consequently promote a competitive advantage for organizations.

## 4.3 Project performance

Park & Lee (2014) understand that sharing knowledge is a valuable activity, as it encourages project participants to maintain social capital, sustain high performance and promote innovation. The authors propose a model that has been validated through a survey research, taking into account two dependent variables (dependency and trust) that depend on the complexity of the environment, the expertise, the similarity of project value and the frequency of communication. These two dependent variables affect the knowledge sharing variable that consequently affects project performance.

Patnayakuni et al. (2007) point out that knowledge integration in the process of system development improves development performance, and consequently there is a performance increase on IS projects, due

to the formal and informal integrative practices used to facilitate this integration of knowledge.

Parolia et al. (2007) carried out the work with the objective of understanding the impacts on the performance of the information systems project, through coordination (horizontal and vertical) marked by aspects of leadership, transfer of knowledge, and a clear mission statement with its goals. Horizontal coordination mechanisms involve tools to increase communication and decision making across organizational boundaries. Vertical coordination occurs through managerial control, and may help set objectives and make clear the individual roles of each project team member. Horizontal coordination influences mission and objectives creation more clearly, as does vertical coordination that has a meaningful relationship through managerial control that may set goals and clarify roles. Regarding the commitment and autonomy of leadership, only horizontal coordination has a significant positive relation. The authors emphasize that a high degree of knowledge transfer is more difficult in organizations with a very rigid hierarchy, because in this scenario, horizontal coordination leads to a positive result in relation to project performance.

In the context of human resources, Anantamula (2008) seeks to identify a set of factors related to people that may influence the success of the project, and to understand how these factors relate to each other. The author concludes that information technology plays an important role in assisting the project manager in the management of project teams in terms of improving the communication process and establishing trust, and consequently contributes to the success of the project. Furthermore, technology integration may help reduce the lifecycle of project management.

Still in the context involving information technology, the work by Gemino et al. (2007) proposes and tests a temporal model of performance of information technology projects. In this model, the performance may be understood by separating into previous risk factors and emerging risk factors, and presents the influence of the former on the latter. The project performance, the dependent variable, is measured considering both processes (budget and schedule) and components (result) of the product. The authors conclude that a separation and classification of risk factors into a priori and emerging risks reveals previously unrecognized interactions; a priori risks affect emerging risks, which shows that project management has a differential effect on risk categories; emerging risks have direct effects on performance, so the effects of risk cannot be completely modeled through project management mediation.

Han & Park (2009) present a work intending to propose a model of knowledge-centered processes,

and to develop a knowledge management system for knowledge creation and retrieval. The authors conclude that when knowledge is separated from the context of the business process, it cannot contribute to the performance objectives, because knowledge is used and created during the execution of business processes.

Regarding civil construction environment, Ping Tserng & Lin (2004) carried out a work that addresses the application of knowledge management in construction projects, and propose the concept of knowledge management based on construction activity. The authors conclude from a case study that knowledge management system based on construction activities assists in the task of mapping valuable information and knowledge into units of activity during the construction phase of a project. The content of the knowledge database in the system not only provides solutions to specific problems, but also includes all domain knowledge and experiences gained in projects, which contributes to the performance of future projects.

The performance of the project depends of numerous factors due the high frequency that events occur. As may be noticed, knowledge sharing, factors related to coordination and collaboration, are the main highlights when it comes to the management of knowledge related to project management, regarding project performance.

#### 4.4 Success factors

Lindner & Wald (2011) conducted a work to identify the success factors for knowledge management in temporary project-focused organizations. The model presented by the authors takes into account factors related to culture and leadership (informal networks, tolerance to errors, project culture and management commitment), organization and processes (control of knowledge management activities, maturity of projects management methodologies) and information and communication technology systems. The authors conclude that project knowledge management is an important factor in project success, and is associated with dedicated project management practices and activities, which are essential to improve organizational learning.

Ajmal et al. (2010) conducted a work with the objective of identifying and analyzing several factors that influence the success or failure of knowledge management initiatives in project-based companies. After the survey, the authors conclude that lack of incentives and lack of an adequate information system are the most significant barriers to successful knowledge management initiatives in projects.

In the context of information systems projects, Liu (2011) examined the critical success factors of

Enterprise Resource Planning (ERP) implementation associated with knowledge management, and analyzed the influence of these critical success factors on overall management of the organization, focused on Taiwanese industries. The survey conducted determined that among all the critical factors, the support of senior managers, corporate vision, reengineering of corporate flows and project management, selection of consulting firms and adequate software vendors, the identification of suitable employees to participate in the introduction of ERP and adequate training and education programs have a positive influence from performance management.

To understand knowledge management as a success factor in project management from the perspective of different organizational levels, Gasik (2011) carried out a work that presents a complete and coherent theoretical model of projects knowledge management. The proposed model shows how to systematically combine processes performed at all organizational levels. It demonstrates how project knowledge is processed at a lower individual level and how this process cooperates with other processes at other organizational levels. In this context, knowledge is conveyed along a vertical organization axis, but the knowledge needed for a project may be generated at the project level or at another level. The highest level is responsible to document and distribute the knowledge to its end users.

The work associated with the success of knowledge management was carried out by Hanisch et al. (2009) showing how knowledge management in temporary organizations is an increasingly important factor in many industries. This work aimed to analyze the knowledge management within and between projects, and from a case study the authors reached the conclusion that the success of project knowledge management is determined mainly by cultural factors, considering that the technical aspects, as information systems and project management methods are only support factors.

It may be noticed that when it comes to the construct success factor, it has associated with the success of knowledge management initiatives in project-oriented organizations.

#### 4.5 Project managers

Petter & Vaishnavi (2008) present a model to facilitate the reuse of knowledge among software project managers, focusing specifically on their experiences. The authors point out that the experience exchange model offers an easy-to-use approach to share, apply and subsequently reuse knowledge developed based on design principles identified from the literature on knowledge reuse. In addition, the main challenge in managing software projects is related to the fact

that not all project managers have the experience to handle this type of project.

Savolainen & Ahonen (2015) carried out a work that highlights the loss of knowledge due to the challenges of changing the project manager between the sales process and the implementation process in software projects. The authors point out that the knowledge acquired during the sales phase of a software development project is very important for the supplier companies. However, the knowledge that a project manager acquires prior to the start of the project, and during the sales phase, is not necessarily available when the project is starting. Through a case study, the authors conclude that almost all project managers have a participation in the sales process, but there is no evidence that the same managers are selected to manage the project.

Project managers play an important role especially when it comes to the knowledge issue, since it is important that they have the ability to reuse and share knowledge more efficiently, avoiding its loss.

#### 4.6 Innovation

Tarafdar & Gordon (2007) intended to understand how specific information system skills influence the ability of the organization to conceive, develop and implement innovation processes. The competence in project management was responsible to encourage the interaction of project team members as well as of project teams, which contributed to strengthening other competences such as collaboration. In addition, knowledge management was also considered an IS competence that involves five aspects: disseminate project information, share project plans within project team, share project files, store knowledge and disseminate information about innovation processes. It was identified that this competence has an important role to develop parameters and structure for the new innovation processes.

Hall & Andriani (2003) studied a project funded by a United Kingdom government institution. The project was concerned with the operationalization of concepts of knowledge management in the context of interorganizational innovation. The authors emphasize that at the strategic level it is expected that senior management must be able to solve problems in relation to the five fundamental processes of knowledge management: externalization, education, internalization, socialization and radical transformations.

Knowledge management has an important role to play in improving innovation processes together with project management, which allows better coordination of project teams, creating a collaborative environment. However, it is necessary a support from the strategic level so that the objectives related to innovation may be achieved.

#### 4.7 Project teams

Dustdar (2004) presents a coordination model on virtual teamwork. The author specifically analyzes the relevant criteria for system metaphors for collaboration in conscious processes; the models and constructions for organizational structures of the virtual teams, as well as the processes of collaboration and ad hoc tasks; the design requirements and problems of implementing an integrated system of conscious process collaboration for virtual teams on the Internet. The author concludes that the information system used - "Caramba" - supports virtual teams in their ad hoc collaboration processes by allowing links between artifacts (eg documents and database objects), business processes (activities) and resources (organizational objects, people, and skills).

Akgün et al. (2008) investigated the effect of team knowledge on new products development. After the data analysis, the authors concluded that team knowledge influences the creativity and success of new products, the knowledge database of the team (declarative and procedural knowledge), functional diversification, and the use of IT influences the intelligence of project team.

Chinowsky et al. (2010) emphasize the balance of a traditional project management emphasis directed to communications efficiency with a focus on the social factors that move the project team from efficiency to effectiveness. The authors conducted a survey and worked on the social networks model, which is an innovative approach to increase the performance of project teams. A significant relationship between trust, communication and knowledge transfer was identified, in addition to highlighting the need for project-oriented organizations to expand their focus from efficiency to a broader emphasis on effectiveness.

Finally, Evaristo et al. (2004) look for understanding the real meaning of the word "distributed" when discussing project management, a problem largely hidden in relevant literature. The case study carried out suggests a theoretical model composed by the following dimensions: trust, level of dispersion, type of stakeholders, type of project, complexity, culture, methodologies and the existence of standards and policies.

The beginning of the theme about virtual teams may be noticed, due to the necessity of forms in which knowledge is passed on in order to create a collaborative environment. In addition, information technology appears to play an important role in the intelligence of the project team.

#### 4.8 Complex projects

The work of Ahern et al. (2014) examines some of the key conceptual and practical implications for the traditional project management literature associated

with the two important empirical insights about the complexity of project management, the knowledge of pre-determined incomplete knowledge, and the coordination of emerging knowledge. The authors conclude that the complexity of project management is a way of solving complex organizational problems, where a complex project is one that is unable to be completely specified in advance except in sketch or in part.

Several organizations have projects that involve high complexity, and it is up to them to develop their resources so that they may have a better understanding.

#### 4.9 Decision criteria

The work by Sell et al. (2006) presents and discusses the results of an exploratory survey research that was directed to groups of European and Latin Amerimay market actors in order to understand their decision criteria for engaging in tropical forest projects aimed at providing environmental services. The results suggest that Latin Amerimay actors focus more on issues related to markets and information management, while European actors emphasize social and environmental benefits and sustainability.

It is important to understand the decision criteria in relation to the involvement or realization of a project, since this may vary between the stakeholders involved, and also according to the contingency factors.

#### 4.10 Measurement of knowledge management

Chua & Goh (2008) conducted a work associated with thematic measurement of knowledge management that aimed to elucidate the nebulous nature of knowledge management initiatives, discover the motivation behind measuring knowledge management and identify the various elements of a knowledge management initiative that may be measured. From the analysis carried out, the authors emphasize that the main drivers of measurement of knowledge management were project management and the need to quantify and communicate the value of knowledge management initiatives. In addition, a combination of indicators was used to measure various aspects of the initiatives, as the activities, the stock of knowledge assets created or improved, the impact on the organizational processes and the benefits from business carried out.

#### 4.11 Risk

In relation to the risk theme, Jafari et al. (2011) present a risk management model of knowledge loss in a project-based organization in Iran. From a case study, the results show that after one year of applying the model, jobs facing loss of knowledge

were reduced by 88 percent. This demonstrates that the concern of a project-oriented organization to have a robust model for risk management associated with loss of knowledge may provide a good performance of their projects.

#### 4.12 Business value

On the business value theme, Reich et al. (2012) investigate how IT-enabled business projects may be managed to contribute with a greater value to the organization customer. The authors present a model to identify the relationship between the dimensions of knowledge management, and the creation and alignment of knowledge-based projects. They conclude that the artifacts containing the three dimensions (knowledge stock, favorable environment and knowledge practices) produced in information technology projects have to be created and then maintained in alignment. It is highlighted that a high level of project management positively influences the creation and the alignment of these knowledge artifacts.

### 5 Conclusions

This work contributed to expand the literature at the intersection between knowledge management and project management. It was possible to notice that these constructs are essential for organizational performance, and together have a synergy that may help companies to differentiate themselves from their competitors and achieve competitive advantage. It was possible to arrive at a theoretical framework (see Figure 4) that may contribute to future research on the topic. This framework also has implications for practice, as it may help the PMO coordinator to better organize his knowledge management processes.

In this framework it was possible to notice a synergy of the main keywords with the co-citation network, which directed to the creation of some content analysis themes, such as PMOs, project performance and success factors. Six major clusters were identified through co-citation analysis and it is possible to make an association with the analysis of keywords (see Figure 4) and content analysis as described next.

First, the cluster that deserves to be highlighted is one that presents precisely the two constructs that are the focus of the study: project management (in the word "project") and knowledge management, which demonstrates that the two constructs are related in some way. This fact fits the purpose of the study - to understand the intersection between knowledge management and project management.

Regarding the cluster that presents the leadership issue, it is possible to notice its association with the

roles of project managers, through their competencies that must be developed in order to achieve the success of the project. In addition, skills must also be developed at the organizational level, related to project management.

An area of governance over projects knowledge is necessary, and this area and the PMO have a key role in the aspects related to knowledge management in projects. This theme is present in the cluster that contains the PMO associated with success factors.

Regarding the team performance, it is possible to highlight its association with issues that involve mainly project teams, and in this context there is a strong orientation towards the need to create a collaborative environment between these teams. It is the type of environment that allows knowledge sharing without friction. Here we present the topics that make up the cluster of team performance and knowledge sharing.

On the cluster that involves project management performance and knowledge integration, it may be highlighted that the performance of project management depends on the many factors that are addressed in the section associated to the performance of projects. It is necessary that studies about this subject consider the contingency aspects in its analysis. In relation to the issue of knowledge integration, factors related to coordination and collaboration between project teams are highlighted.

Finally, the last cluster involves the word project success and knowledge-based approach. On these topics, the importance of knowledge management in project-oriented organizations is highlighted in some works as a factor that may bring several benefits to the success of the projects.

As a possible gap for future work with the context of the current period, it is possible to think on the relationship between project management and knowledge management focused on the issue of sustainability – as it was mentioned only in the study by Sell et al. (2006) –, and as a possible trend for future works, the formation of virtual teams to be feasible by the use of information technologies, especially nowadays, when society is experiencing distributed organizations. These are some of the themes that may bring great contributions in the field of project management. In addition, the part that is involved with the governance of this knowledge is also a very strong theme.

As a limitation of the work, it is possible to highlight the use of only a single database. Perhaps the use of more databases could provide for a more robust and reliable sample to be used in the study. Regarding content analysis, papers that are more recent become less prominent, because the chance of having a high number of citations is low.

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Appendix A. Sample for content analysis.

Authors/ Year	Journal	Title	$\mu_{\text{citation}}$	JCR	IP
Lindner, F., & Wald, A. (2011)	International Journal of Project Management	Success factors of knowledge management in temporary organizations	6.80	2.436	23.365
Pemsel, S., & Wiewióra, A. (2013)	International Journal of Project Management	Project management office a knowledge broker in project-based organisations	6.67	2.436	22.918
Tarafdar, M., & Gordon, S. R. (2007)	Journal of Strategic Information Systems	Understanding the influence of information systems competencies on process innovation: a resource-based view	5.78	2.692	21.340
Park, J. G., & Lee, J. (2014)	International Journal of Project Management	Knowledge sharing in information systems development projects: explicating the role of dependence and trust	5.00	2.436	17.180
Kodama, M. (2005a)	Long Range Planning	Knowledge creation through networked strategic communities - case studies on new product development in Japanese companies	4.27	2.718	15.876
Petter, S., & Vaishnavi, V. (2008)	Information Sciences	Facilitating experience reuse among software project managers	2.62	4.038	13.200
Wright, A., Ash, J. S., Erickson, J. L., Wasserman, J., Bunce, A., Stanescu, A., St Hilaire, D., Panzenhagen, M., Gebhardt, E., McMullen, C., Middleton, B., & Sittig, D. F. (2014).	Journal of the American Medical Association	A qualitative study of the activities performed by people involved in clinical decision support: recommended practices for success	2.50	3.504	11.260
Hall, R., & Andriani, P. (2003)	Journal of Business Research	Managing knowledge associated with innovation	4.38	1.480	10.862
Dustdar, S. (2004)	Distributed and Parallel Databases	Caramba - A process-aware collaboration system supporting ad hoc and collaborative processes in virtual teams	4.75	1.156	10.241
Jafari, M., Rezaeeneour, J., Mazdeh, M., & Hooshmandi, A. (2011)	Management Decision	Development and evaluation of a knowledge risk management model for project-based organizations A multi-stage study	4.20	1.429	10.202
Ajmal, M., Helo, P., & Kekale, T. (2010)	Journal of Knowledge Management	Critical factors for knowledge management in project business	3.83	1.586	9.904
Han, K. H., & Park, J. W. (2009)	Expert Systems with Applications	Process-centered knowledge model and enterprise ontology for the development of knowledge management system	2.86	2.240	9.266

Appendix A. Continued...	Authors/Year	Journal	Title	$\mu_{\text{citation}}$	JCR	IP
	Anbari, F. T., Carayannis, E. G., & Voetsch, R. J. (2008)	Technovation	Post-project reviews as a key project management competence	2.12	2.526	7.475
	Patnayakuni, R., Rai, A., & Tiwana, A. (2007)	Ieee Transactions on Engineering Management	Systems development process improvement: A knowledge integration perspective	3.44	1.103	7.234
	Suikki, R., Tromstedt, R., & Haapasalo, H. (2006)	Technovation	Project management competence development framework in turbulent business environment	2.00	2.526	7.052
	Ping Tserng, H., & Lin, Y. C. (2004)	Automation in Construction	Developing an activity-based knowledge management system for contractors	2.50	1.812	7.030
	Ahern, T., Leavy, B., & Byrne, P. J. (2014)	International Journal of Project Management	Complex project management as complex problem solving: A distributed knowledge management perspective	2.00	2.436	6.872
	Savolainen, P., & Ahonen, J. J. (2015)	International Journal of Project Management	Knowledge lost: Challenges in changing project manager between sales and implementation in software projects	2.00	2.436	6.872
	Akgün, A. E., Dayan, M., & Di Benedetto, A. (2008)	Information & Management	New product development team intelligence: antecedents and consequences	2.25	1.865	6.446
	Parolia, N., Goodman, S., Li, Y., & Jiang, J. J. (2007)	Information & Management	Mediators between coordination and IS project performance	2.22	1.865	6.360
	Hanisch, B., Lindner, F., Mueller, A., & Wald, A. (2009)	Journal of Knowledge Management	Knowledge management in project environments	2.43	1.586	6.284
	Kodama, M. (2005b)	Technovation	New knowledge creation through leadership-based strategic community - a case of new product development in IT and multimedia business fields	1.73	2.526	6.100
	Reich, B. H., Gemino, A., & Sauer, C. (2012)	International Journal of Project Management	Knowledge management and project-based knowledge in it projects: A model and preliminary empirical results	1.75	2.436	6.013
	Ur-Rahman, N., & Harding, J. A. (2012)	Expert Systems with Applications	Textual data mining for industrial knowledge management and text classification: a business oriented approach	1.75	2.240	5.670
	Chua, A. Y. K., & Goh, D. H. (2008)	Journal of Information Science	Untying the knot of knowledge management measurement: a study of six public service agencies in Singapore	1.12	4.038	5.643
	Sell, J., Koellner, T., Weber, O., Pedroni, L., & Scholz, R. W. (2006)	Ecological Economics	Decision criteria of European and Latin American market actors for tropical forestry projects providing environmental services	1.50	2.720	5.580

Authors/ Year	Journal	Title	$\mu_{\text{citation}}$	JCR	IP
Chinowsky, P., Diekmann, J., & O'Brien, J. (2010)	Journal of Construction Engineering and Management - Asce	Project Organizations as Social Networks	3.00	0.842	5.526
Anantatmula, V. S. (2008)	Project Management Journal	The Role of Technology in the Project Manager Performance Model	2.50	1.143	5.358
Desouza, K. C., & Evaristo, J. R. (2006)	International Journal of Information Management	Project Management Offices: A case of knowledge-based archetypes	2.10	1.550	5.355
Evaristo, J. R., Scudder, R., Desouza, K. C., & Sato, O. (2004)	Journal of Engineering and Technology Management	A dimensional analysis of geographically distributed project teams: a case study	1.67	2.060	5.110
Gemino, A., Reich, B. H., & Sauer, C. (2007)	Journal of Management Information Systems	A temporal model of information technology project performance	1.56	2.062	4.777
Gasik, S. (2011)	Project Management Journal	A Model of Project Knowledge Management	2.20	1.143	4.715
Palacios-Marqués, D., Cortés-Grao, R., & Lobato Carral, C. (2013)	International Journal of Project Management	Outstanding knowledge competences and web 2.0 practices for developing successful e-learning project management	1.33	2.436	4.570
Liu, P. L. (2011)	Expert Systems with Applications	Empirical study on influence of critical success factors on ERP knowledge management on management performance in high-tech industries in Taiwan	1.40	2.240	4.536

Appendix A. Continued...