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# A Framework for KNOWLEDGE MANAGEMENT IN PROJECT MANAGEMENT OFFICES

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ABSTRACT

Nowadays, knowledge management becomes a key challenge in modern organizations, especially project-based organizations. As a central unit in a project-based organization, a project management office (PMO) plays a pivotal role in projects' success and organizational performance. Consequently, PMOs need to build an effective knowledge management system that renders them more efficiency and effectively. This paper aims at proposing a conceptual framework for promoting knowledge management in PMOs. The paper begins with a review of the literature on knowledge management and activities in PMOs to provide a clear understanding of knowledge management in PMOs. Then the paper suggests an overall architecture of the knowledge infrastructure for PMOs. Finally, a framework is proposed for building an effective knowledge management system for PMOs based on the perspective of knowledge components that could help PMOs create more business value by classifying information formally and enabling its transformation into valuable knowledge assets.

## 1. Introduction

In the context of fierce competition organizations face nowadays, they need to build an effective knowledge management system in order to outperform their competitors *(Owen & Burstein, 2005)*. Knowledge is thus considered pivotal for managers in modern and networked organizations. Consequently, organizations require an effective knowledge management system that renders them more competitive. Inadequate knowledge management may cause loss of business opportunities and may affect various business fields in organizations, from product management to human-resource management *(Djordjevic-Boljanovic et al., 2013)*.

Besides, in order to meet the requirements of fast-changing markets, cross-functional business expertise and technological uncertainty, the project-based structure has become an ideal form of organization to manage increasing product and service complexity. To standardize patterns for managing knowledge in project-based organizations, the project management office *(PMO)* has been created as an organizational unit that aims at boosting project management *(PM)* efficiency, reducing costs, and improving project delivery in terms of time and budget *(Pande, 2012)*. Since the primary reason for project failures is the effect of an inadequate knowledge management and poor information sharing practices, one of the key objectives of a PMO is to promote organizational learning, which is the process of improving actions through better knowledge and understanding *(Desouza & Evaristo, 2006)*.

A PMO has the responsibilities of establishing and maintaining the standards of projects' activities within the organization so that project managers can understand and apply modern project management practices *(Pande, 2012)*. The main objectives of a PMO are to create a knowledge base by centralizing useful information in the organization and to promote the transformation of information into knowledge, and then from knowledge to understanding. Knowledge about projects needs to be shared among project management members, a process that is considered vital for project success *(Ismail et al., 2009)*. Playing a central role in organizations, PMOs need efficient knowledge management *(Aubry et al., 2010; Ismail et al., 2009)*. Indeed, knowledge management is proven to be pivotal to project success and efficiency. Effective knowledge management contributes to improvement in project management. In fact, knowledge management increases the capability of sharing and using available information and knowledge that help to reduce risks and to improve project quality. Knowledge management also enables project members to reduce reworking and compresses the time required for project planning. Further, effective use of a knowledge management system supports the control of a project throughout its life cycle.

However, recent studies showed that knowledge obtained from previous projects was rarely reused in current projects *(Newell et al., 2006)*. Some managers have a tendency to create a new knowledge system for a new project rather than use knowledge generated from previous projects *(Newell et al., 2006)*.

As a matter of fact, project-based organizations need effective knowledge managing and sharing in their PMOs to maintain their competitive edge *(Owen & Burstein, 2005)* and improve organizational performance *(Landaeta, 2008)*. There is a need for an approach to conciliate knowledge management and project management practices since project management is essentially based on information and knowledge *(Cope III et al., 2006)*.

For this reason, the main purpose of this study is to propose a framework for knowledge management in PMOs. The next section of this paper presents a literature review and suggests an overall architecture for a knowledge infrastructure in PMOs. Next, the framework for knowledge management in PMOs, called KM-PMO framework and based on knowledge components, is presented. Within a real-world example, the applicability of the framework is then checked and demonstrated. After a discussion on limitations and implications, the paper ends with conclusions and outlook.

## 2. Theoretical background

In this section, we present the concepts related to knowledge management and the roles of PMOs in organizations. Current studies on knowledge management for organizations in general and for PMOs specifically will be introduced.

### Knowledge and knowledge management

According to Plato *(Annas, 1981)*, knowledge is a subset of which is both true and believed. Truths are defined as everything we accept as true for ourselves from a cognitive point of view, meanwhile beliefs are concerned with what we believe. In the context of an organization, knowledge is dynamic, since it is created by social interactions among individuals and organizations, and is context-specific, as it depends on a particular time and space *(Nonaka et al., 2000)*.

Accordingly, there are different forms of knowledge, also called as knowledge components, such as know-what, know-how, know-why *(Garud, 1997)* and know-who *(Le Dinh et al., 2013)*. Know-what describes knowledge artefacts that are known and related to a phenomenon of interest. Know-how describes the understanding of the generative processes constituting phenomena. Know-why describes the understanding of principles of the underlying phenomena. Know-who refers to individuals, groups or organizations that may be responsible for the other forms of knowledge mentioned above.

There are two elements of knowledge: tacit knowledge and explicit knowledge *(Bergeron, 2003)*. Tacit knowledge is the knowledge gained from individuals' experience. Explicit knowledge is in the forms of words, symbols, expressions or specifications that can be transferred easily. Tacit knowledge rests in staff while explicit knowledge can be stored in information systems or content management systems *(Le Dinh et al., 2013)*.

Knowledge management is defined as a systematic method used within an organization to select, store, organize, share and develop information in various business areas to improve organizational performance and competitiveness *(Bergeron, 2003)*. Knowledge management is considered as the process of creating, confirming, representing, distributing and applying information in the organization *(Abzari et al., 2012)*. Organizations need a method called "knowledge management" to share and develop information and experiences, in order to ensure organizational success *(Ismail et al., 2009)*. Organizations build a knowledge management

strategy to create and store knowledge that is vital to organizational operations *(Owen & Burstein, 2005)*.

Knowledge management needs a method to encourage employees to share information *(Duffy, 2000)*. Knowledge conversion facilitates the transformation of knowledge and includes four processes: socialization, externalization, combination, and internalization *(Nonaka & Takeuchi, 1995)*. The socialization process transfers tacit knowledge from one person to another through social interaction. The externalization process turns tacit knowledge into explicit knowledge by creating knowledge sources such as documents and content. The combination process collects and processes relevant internal and external knowledge to make it more usable. The internalization process promotes the understanding and absorbing of explicit knowledge, which becomes tacit knowledge held by individuals.

In modern organizations such as project-based organizations, it is critical for managers to accept knowledge as the primary challenge in their business activities *(Djordjevic-Boljanovic et al., 2013)*. The roles of managers in knowledge management in organizations include *(1)* identifying knowledge management elements in organizations, *(2)* determining the problems of knowledge sharing failure and ineffective knowledge reuse, *(3)* maintaining knowledge exchange and sharing at different organizational levels, and *(4)* applying knowledge management to develop various business aspects, including customer relationship management, product and service quality, research and development, sales and marketing, and human-resource management. Knowledge needs to be considered as the key competitive edge and knowledge management strategy, as a way to obtain this advantage *(Djordjevic-Boljanovic et al., 2013)*.

Furthermore, knowledge management is a multifaceted concept that needs many stakeholders' involvement. Different stakeholders have different interests, so their participation in knowledge management may be limited, even though they recognize the benefits of knowledge sharing *(Chua & Goh, 2008)*. It is obvious that we need effective processes and procedures to motivate all stakeholders' involvement in knowledge management. Besides, knowledge management is not only internal, but external as well. Therefore, it is important for organizations to access and exploit external knowledge *(Chesbrough, 2003)*. Inter-organizational knowledge sharing and exchange have thus been the focus of certain recent studies *(Easterby-Smith et al., 2008)*.

Djordjevic-Boljanovic et al. *(2013)* introduced five key factors of a knowledge management project that include leadership skills, control of business processes, human-resource management, information technology, and corporate culture. Among these factors, corporate culture is determined as the main influencer of knowledge management and plays a pivotal part in knowledge reuse *(Owen & Burstein, 2005)*. Companies can organize structure, process, and procedures for knowledge management; however, they cannot reuse knowledge if they do not have an appropriate environment for knowledge cultivation *(Owen & Burstein, 2005)*. Organizations that do not have a culture that motivates knowledge sharing may fail in establishing an effective knowledge management strategy *(Nold, 2011)*. In other words, an effective knowledge management strategy should include a combination of networks and a culture of learning and sharing *(Owen & Burstein, 2005)*. Among various corporate culture elements, trust is demonstrated to be a key value for knowledge exchange and reuse *(Scarso & Bolisani, 2012)*. In a recent study, Nold *(2011)* concluded that trust is the most influential element for knowledge sharing. Trust between two parties is very important since information and knowledge transfer cannot be managed by contracts or agreements *(Scarso & Bolisani, 2012)*. Companies provide complex services to their clients, so they must share information to foster trust among them.

Finally, Cope III et al. *(2006)* suggested that effective knowledge management should be based on at least three principles. First, the lack of a knowledge management system should be a real business problem that all members recognize. Second, the knowledge management system needs to provide interesting information and motivate members to continuously build and share the information. Third, the system should be straightforward for all members in accessing the necessary information.

## Project management office and its activities

Nowadays, many organizations have acknowledged the necessity to build a project management office *(PMO)* as a center to manage projects' activities and performance *(Pande, 2012)*. PMOs have been established in many organizations to handle operation and strategy in project management *(Dai & Wells, 2004)*. In organizations, PMOs have increased responsibility, influence and acceptance as a strategic agent for organizational change and advancement *(Pande, 2012)*.

A PMO is defined as an organizational unit that has the function of managing, centralizing and coordinating projects in the organization *(Artto et al., 2011)*. A PMO can be a department or a group that has the responsibilities of establishing and maintaining the standards of projects' processes within the organization. The main purpose of a PMO is to create a knowledge base by centralizing information in the organization *(Desouza & Evaristo, 2006)*. The PMO assists project managers and related parties in the organization to understand and apply modern project management practices *(Pande, 2012)*. The PMO also helps to adapt and integrate organizational needs into the project management efforts. Thanks to PMOs, the use of innovation renders effectiveness in many organizations *(Dai & Wells, 2004)*.

The PMO has a variety of tasks and responsibilities to fulfill organizational needs *(Artto et al., 2011)*. Rad and Levin *(2002)* distinguish tasks that are project-focused from those that are enterprise-oriented. Those tasks include consultation, mentorship, and augmentation. The enterprise-oriented tasks include promotion, archiving, practice, and training. For his part, Letavec *(2006)* introduces three PMO tasks: *(1)* consultation *(2)* knowledge organization, and *(3)* standards organization. The responsibilities of the PMO can include supporting project management and directing project management *(Aubry et al., 2007)*. According to Hill *(2008)*, a PMO has five main tasks, including *(1)* practice management, *(2)* infrastructure management, *(3)* resource integration, *(4)* technical support and *(5)* business alignment. PMOs also have sub-tasks, including project management methodology, project tools, standards and metrics, project governance, assessment, organization and structure, facilities and equipment support, resource management, training and education, career development, team development, mentoring, project planning, project auditing and project recovery, project portfolio management, customer relationship management, vendor/contractor relationship management, and business performance management. Furthermore, Hobbs et al. *(2008)* suggest that PMOs can be different depending on their structure, their assumed roles and their perceived value.

A PMO may have one or more of the four following roles in an organization: consulting, knowledge managing, standard establishing, and implementation directing *(Desouza & Evaristo, 2006; Letavec, 2006)*. The PMO has various roles, so it has a wide range of configurations *(Singh et al., 2009)*. The PMO can have a minimum number of staff, and it does not directly control the management of individual projects *(Singh et al., 2009)*. In this configuration, the PMO only plays a supporting role by setting standards for project management. The PMO can have a large number of project managers and directly control individual projects. In this range, the PMO can play the pivotal role in the project outcomes.

Many organizations define PMOs as centralized-organizational units *(Aubry et al., 2010)*. More than playing a critical role in project management, the PMO has become a center for all organizational activities *(Aubry et al., 2010)*. With the central position they hold, PMOs are established as strategic units in organizational decision-making *(Pande, 2012)*.

## Knowledge management in PMOs

In order to succeed in project management and implementation, members of a PMO need various kinds of knowledge *(Ajmal & Koskinen, 2008)*. They need knowledge about the organization and environment in which they perform projects. They need project management knowledge related to procedures and methods to manage project implementation. They need knowledge specific to the project they implement. They also need technical knowledge about technology, work process, and specific areas within the project. Members also need status reports, analysis and changes in the plan, risk management documents, information on previous projects and a database of lessons learned *(Dai & Wells, 2004)*. Furthermore, the leader of a PMO needs knowledge about the organization and the business environment of the project team, while members of a PMO are mainly concerned about technical knowledge *(Muller, 2012)*.

Knowledge management is demonstrated to be fundamental to project success and efficiency *(Gannon & Banham, 2011)*. In fact, effective use of knowledge management positively affects performance and improvement in project management *(Al-Zayyat et al., 2010)*. More specifically, knowledge management increases the capability of sharing and using the available knowledge that helps to reduce project risks *(Al-Zayyat et al., 2010)*. Knowledge management enables members of a PMO to reduce reworking and compress the time needed to plan projects. Further, effective use of a knowledge management system supports the control of projects through the project life cycle *(Al-Zayyat et al., 2010)*.

### *Critical Success Factors of Knowledge Sharing in PMOs.*

Project work is based on the knowledge of each project member. Other project members can use this knowledge successfully if it is shared effectively *(Karlsen & Gottschalk, 2004)*. However, most of PMO members are freethinking, conservative, and autocratic *(Pemsel & Wiewiora, 2012)*. They mainly rely on their experience *(Ajmal & Koskinen, 2008)* and they do not want to learn and share knowledge with their coworkers *(Pemsel & Wiewiora, 2012)*. These behaviors may cause obstacles for knowledge sharing and management in PMOs *(De Nadae et al., 2015)*. Understanding how members of a PMO behave in knowledge management and how to motivate them to get positively involved in the system is important to gain effective knowledge management *(Artto et al., 2011; Ismail et al., 2009)*. Correspondingly, the mechanisms used to manage knowledge together with projects play a vital role in knowledge management for project-based organizations *(Loufrani-Fedida et al., 2014)*.

In general, critical success factors for KM are top management commitment, KM strategy, KM processes, KM infrastructure, and culture *(Alazmi & Zairi, 2003)*. A PMO is different from other departments, so KM in PMOs should be different. The project management environment is complex and the transfer of knowledge across projects is a challenge, while current project management techniques are insufficient *(Gannon & Banham, 2011)*. To improve effective knowledge management practices in PMOs, it is necessary to promote the process, to build the relationships among PMO members, and to facilitate the use of the knowledge management system *(Brochner et al., 2004; Hauschildt & Schewe, 2000; Walter & Gemunden, 2000)*. In addition, an effective knowledge management strategy in PMOs requires the connection among three elements: social networks, processes and corporate culture *(Owen et al., 2004)*. The success of many projects depends on systems, procedures and culture for knowledge sharing *(Karlsen & Gottschalk, 2004)*.

An incentive program to motivate PMO members to share knowledge was suggested in a recent study *(Ajmal et al., 2010)*. However, this factor was not supported by another

study *(Muller, 2012)* that stated that PMO members were willing to share knowledge and to learn from each other in the coordination and trust corporate culture *(Muller, 2012)*.

The success of projects is closely related to a corporate culture that supports effective knowledge management *(Karlsen & Gottschalk, 2004)*. Project-based organizations need to encourage a culture of accepting, adopting, and using knowledge sharing activities to develop an effective knowledge management strategy *(Ajmal & Koskinen, 2008)*. Knowledge management not only consists in building processes for knowledge sharing, it also needs a corporate culture that motivates the creation, sharing, and usage of knowledge *(Ajmal & Koskinen, 2008)*. Moreover, project management members need to combine organizational culture and professional culture in order to integrate a culture that encourages effective knowledge management *(Ajmal & Koskinen, 2008)*. The rate of project success may increase if PMO members know how to identify and cultivate the corporate core value of motivating knowledge sharing and integrate it in project management culture *(Ajmal & Koskinen, 2008)*.

Knowledge can be shared via both formal and informal means. The concept of knowledge management needs to be introduced formally in PMOs and knowledge is recommended to be managed in the structure of business processes that can be monitored in day-to-day activities *(Gannon & Banham, 2011)*. Besides the formal mean, the informal transfer and reuse of knowledge also play a critical role in knowledge management strategy *(Owen & Burstein, 2005)*. For example, knowledge can be collected and shared via social interaction *(Pemsel & Wiewiora, 2012)*. In fact, knowledge is only valuable if accessible when needed, making it necessary for members to develop systems and procedures *(Karlsen & Gottschalk, 2004)*. Furthermore, PMO members have to communicate what knowledge is worth exchanging; therefore, they need space and place for social interaction to share knowledge related to project management *(Karlsen & Gottschalk, 2004)*.

### *Recent studies on knowledge management in PMOs.*

Some studies were conducted to propose frameworks for KM in PMOs, but none included all of the elements mentioned above. Processes and networks were the main concerns, but corporate culture has not been strongly addressed.

Owen et al. *(2004)* studied an engineering project management company and proposed a model for knowledge reuse. The proposed model was based on the Observe, Orient, Decide, Act *(OODA)* loop and the Plan Do Study Act *(PDSA)* cycle. In the suggested model, the creation, transfer and reuse of explicit knowledge were applied. However, factors such as social networks and corporate culture were not addressed for the implementation of an effective knowledge management system.

Newell et al. *(2006)* reviewed the information and communication technology *(ICT)* based approach to manage knowledge in PMOs and found that this approach was not useful, even though it had been widely used. Findings from Newell et al.'s *(2006)* study showed that social networks were more effective than ICT. The authors suggested further research on the exchange between ICT systems and the development of virtual networks for employees in organizations.

Coakes et al. *(2005)* studied the case of KM in Taylor Woodrow Company. The technology field was the focus of this company in KM. Intranet and extranet were implemented to share and develop knowledge. It is demonstrated that technology was not the key driver in KM. Social communication and corporate culture may need to be considered in developing a KM strategy.

## 3. Research method

As mentioned above, the main purpose of this paper is to propose a framework for knowledge management in PMOs.

The research question is:

- "How can project management offices effectively capture, organize, share and use knowledge related to projects to continuously improve their organizational performance?"

To answer this research question, the paper uses design science research *(DSR)*, a popular research method for information system research that is particularly advantageous for creating and evaluating artefacts in order to solve organizational problems. Following the guidelines of design science research *(Hevner et al., 2004)*, this paper continues by presenting the overall architecture of a knowledge infrastructure for PMOs and the framework for knowledge management in PMOs.

According to design science research, the proposed framework consists of different types of artefacts, including a set of constructs, a model, a method, and a set of instantiations *(March & Smith, 1995)*. The constructs are different types of concepts related to knowledge produced and used in the knowledge infrastructure. The model is a set of statements expressing the relationships between knowledge concepts. The method is a set of activities that support the processes of knowledge development and management. The instantiations are best practices related to the operationalization of the framework.

In order to evaluate the artefacts of the framework, the analytical approach has been used to examine the structure of the artefacts and to explain how the proposed artefacts could be used in PMOs. In addition, an illustrated example is presented to demonstrate how the artefacts could be integrated into an IS architecture, e.g., with an open-source system.

## 4. Knowledge infrastructure for PMOs

Based on the review of the literature, an overall architecture of the enterprise knowledge infrastructure is suggested in **Figure 1**. The main purpose of a knowledge infrastructure is to enable an organization to learn in a natural and optimal way in order to reach its goals.

The architecture of the knowledge infrastructure is based on the three dimensions of an information system: management, organization and technology *(Laudon & Laudon, 2013)*.

### Management dimension

The management dimension aims at making sense out of many situations faced by the organization, at making decisions and at formulating action plans to overcome challenges *(Laudon & Laudon, 2013)*. As mentioned above, the strategic goals of a PMO are knowledge sharing, organization learning and innovation promoting.

Since the main purpose of a PMO is to create a knowledge base by centralizing information in the organization *(Desouza & Evaristo, 2006)*, one of the main functions of the management dimension is to build an organizational memory. Organizational memory is the accumulated body of data, information, and knowledge created in the course of an individual organization's existence *(Walsh & Ungson, 1991)*.

The second function aims at promoting organization learning to maintain knowledge exchange and sharing at different organizational levels. Organizational learning is the process of creating, retaining, and transferring knowledge within an organization so that it can improve over time by gaining more experience and creating new knowledge *(March, 1991)*. Moreover, the knowledge infrastructure needs to provide different learning styles such as learning-by-doing, learning-by-studying and learning-by-using.

The third function focuses on organizational decision-making and innovation promoting. The knowledge inside an organizational memory needs to be captured and organized conforming to the business strategy and corresponding types of innovation such as product, process and organizational innovation *(Boer, 2001)*.

### Organization dimension

The organization dimension is composed of different levels and specialties *(Laudon & Laudon, 2013)*. Their structure reveals a division of labor. PMO members are employed and trained for different functions of business processes. A knowledge culture is required to promote knowledge sharing, organization learning and innovation. For this reason, the organization needs a suitable policy to motivate members to share their knowledge within and between organizational units.

Firstly, PMOs need to build and develop a culture of promoting knowledge sharing in both formal and informal ways. Project team members have different cultural backgrounds, which may be a barrier to knowledge sharing. In this setting, trust plays a critical role in promoting knowledge sharing *(Sackmann & Friesl, 2007)*. Trust, communication and interaction are cultural values that foster knowledge sharing within and among project teams *(Muller, 2012)*.

Secondly, a suitable policy promoting social interaction in PMOs can be used to build relationships among PMO members in order to facilitate knowledge sharing. The dominant culture of a project team is called "clan culture" *(Fong & Kwok, 2009)*. This type of culture has the values of honesty, trust, respect, and collaboration. Further, Desouza and Evaristo *(2006)* suggested that effective PMOs work evolves in a culture of open communication and teamwork. According to Hanisch et al. *(2009)*, a culture of cooperation and risk-taking is a critical factor for successful knowledge management in project environments. Therefore, an effective framework for knowledge management in PMOs should be combined with a culture that supports trust, teamwork, collaboration and risk taking.

Thirdly, processes are needed for formal knowledge sharing, including internal and external knowledge. Knowledge can be shared at different organizational levels within an organization or between the organization and its stakeholders.

### Technology dimension

The technology dimension includes a set of systems and tools that support the business activities in order to achieve the organization's strategic goals. In the context of KM for PMOs, this dimension covers a set of KM tools and services as well as current enterprises systems used by the organization.

Web 2.0 or the "Social Web" has introduced new tools for social exchange *(Razmerita et al., 2009)* and should be used for knowledge management *(Levy, 2009; Paroutis et al.,*

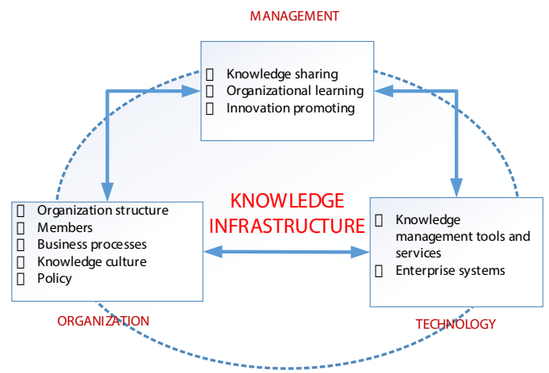


**FIGURE 1.** *Knowledge infrastructure for PMOs*

*2009)*. Various tools that are used in Web 2.0 to support knowledge management are blogs, wikis, discussion forums, and social networks *(Razmerita et al., 2009)*. Using Web 2.0 then goes along with the culture of trust and collaboration *(Levy, 2009; Paroutis et al., 2009)*.

Blog, an abbreviation of the term "Web-log", is a personal diary *(Levy, 2009)*. A blog is a good tool for sharing expert knowledge on different topics *(Razmerita et al., 2009)*. Blogs help to improve the diversity of available information and encourage members who want to share individual knowledge *(Yu et al., 2010)*. Sharing knowledge through blogs is more appropriate for individuals to share knowledge *(Shreves & Dunwoodie, 2011)* and trust is a key culture component related to sharing knowledge with blogs *(Chai & Kim, 2010)*.

Wiki is defined as a "freely expandable collection of interlinked webpages, a hypertext system for modifying and storing information, and a database where each page is easily editable by users" *(Grace, 2009)*. Wiki enables users to create knowledge together and share knowledge with each other *(Levy, 2009)*. The wiki tool allows users to delete, edit and add contents *(Grace, 2009)*. However, it needs collaborative editing supported by revision mechanisms that allow the monitoring of changes *(Razmerita et al., 2009)*. The usage of wikis may be impacted by the culture of risk-taking because users can delete and edit the contents freely *(Grace, 2009)*.

Discussion forums are used to present, analyze, assess and share knowledge *(Grace, 2009)*. The discussion forum tool enables discussions between multi-users *(Shreves & Dunwoodie, 2011)*. More specifically, it allows one person to post comments or questions and others to respond. The tool also provides a default menu option for the forum and the administration to manage it and control permissions for the users. A discussion forum is open and needs collaboration to facilitate social interaction *(Grace, 2009)*.

Social networks, such as Facebook, MySpace and LinkedIn, have gained a large number of users in the past years *(Razmerita et al., 2009)*. Social networks have become a central tool for sharing personal information and socializing. In fact, it attracts many users who share similar interests and create communities around centers of interests. However, in order to protect security and confidential information of project teams, only internal social networks should be used *(Razmerita et al., 2009)*.

The main objective of this paper is to propose a framework for building an effective knowledge management system for PMOs; therefore, our focus is on the technology dimension. However, the proposed framework is open and flexible so that it can be customized and adapted to be suitable to specific management and dimensions of different types of organizations. In the following section, the paper continues with the detailed description of the proposed framework.

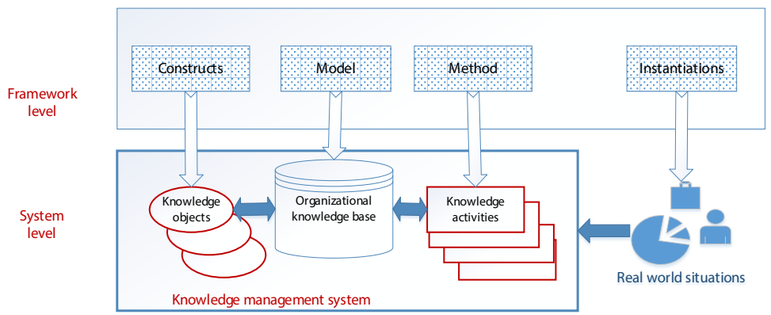


**FIGURE 2.** *Components of the KM-PMO framework*

# 5. Framework for knowledge management in PMOs

In this section, a framework for knowledge management in PMOs, hereafter called KM-PMO framework, is being presented and includes a set of constructs, a model, a method, and a set of instantiations *(March & Smith, 1995)*.

Knowledge management is the art of performing knowledge activities, such as organizing, blocking, filtering, storing, gathering, sharing, disseminating, and using knowledge objects, such as data, information, experiences, evaluations, insights, wisdom, and initiatives *(Sivan, 2000)*. To this end, the artefacts proposed by the KM-PMO framework must correspond to knowledge objects and knowledge activities (**Figure 2**). The constructs are different types of concepts related to knowledge objects produced and used in a PMO. The method is a set of activities that support the process of knowledge development. The model is a set of statements expressing the relationships between knowledge concepts at different levels in the organizational memory. The instantiations are best practices related to the operationalization of the framework.

## Constructs of the KM-PMO framework

The constructs of the KM-PMO framework are different types of concepts that represent knowledge objects, which are defined as a highly structured and interrelated set of data, information, knowledge, and wisdom concerning an organizational situation *(Bellenger, 2004)*. Each knowledge object has its own goal and a set of interrelated information as supporting materials. Depending on organizational strategies of innovation, knowledge objects could be more or less focused on a product, a process, or an organizational situation.

Correspondingly, the constructs of the KM-PMO framework deals with the semantics of the specification of a knowledge object that covers three aspects of knowledge: the static, the dynamic and the rule aspects *(Le Dinh et al., 2013)*. The static aspect of knowledge concerns the structure of knowledge and knowing, meanwhile the dynamic aspect of knowledge focuses on the transition of knowledge. The rule aspect is being defined based on the two previous concepts and concerns the governance of knowledge structure *(Le Dinh et al., 2013)*.

The structure of knowledge is represented by know-what, which describes knowledge artefacts that are known and related to a phenomenon of interest *(Garud, 1997)*. Know-what is often generated through "learning-by-using" and refers to project deliverables, which are often described in a work-break-down structure *(WBS)*.

The transition of knowledge is represented by know-how, which describes the understanding of the generative processes constituting phenomena *(Garud, 1997)*. Know-how is generated through "learning-by-doing" and refers to project activities, which are specified in the network diagram and earned value management system.

The governance of knowledge is represented by know-why, which describes the understanding of principles of the underlying phenomena *(Garud, 1997)*. Know-why is obtained through "learning-by-studying" or "learning-by-experiencing" and refers to the best practices, which can be specified in business rules or lessons learned. Business rules are put in place to help a PMO achieve its business goals, govern its information processing, and comply with laws and regulations. Know-why can apply to subsets of constructs related to know-what or know-how.

**Table 1** presents the main knowledge components that represent knowledge objects, the corresponding artefacts in PMOs, as well as PM knowledge areas *(PMBOK, 2015)*.

| Knowledge components | Artefacts | PM knowledge areas |
|---|---|---|
| Know-what | Project deliverables | Project Scope Management |
| Know-how | Project activities | Project Time Management<br>Project Cost Management |
| Know-why | Project risks and lessons learned | Project Risk Management<br>Project Integration Management |

**TABLE 1.** *Knowledge artefacts related to the constructs*

## Methods of KM-PMO framework

At the knowledge object level, the method of the proposed framework concentrates on the process of knowledge development based on the DIKW hierarchy *(Cleveland, 1982)*.

Indeed, a knowledge object may be at one of the following dynamic states: data, information, knowledge, or understanding (**Figure 3**). Data are captured and stored inside the organizational memory through research, creation, gathering, and discovery. Data are turned into information by adding semantics and organizing it so that we can easily draw conclusions. Knowledge has the complexity of experience, which comes about by seeing the object from different contexts. Wisdom is the ultimate level of understanding. In our approach, we use the term "understanding" instead of "wisdom" *(Rowley, 2007)* because our research still focuses on the first level of knowledge.

As seen in **Figure 3**, data can be captured and organized based on their semantics to become useful information and information can be processed and shared according to different contexts in order to become knowledge. Finally, understanding is the individual and collective experience of applying knowledge.

**Table 2** explains how the different knowledge activities support the knowledge development process using the components of the KM-PMO framework that correspond to the PM maturity phases *(Kwak & William, 2000)*.

As mentioned in **Table 2**, the constructs help to gather information objects *(data)* of knowledge objects, the model connects information objects *(information)* of a knowledge object, the method forms a knowledge object as a whole *(knowledge)*, and the instantiations form a network of knowledge objects by joining wholes *(understanding)*. Knowledge creation focuses on capturing tacit knowledge and creating new explicit knowledge in the form of data stored in the knowledge base. Knowledge organization focuses on transforming useful data into information by organizing these according to their semantics. Knowledge transfer is concerned with the collaboration context in which content is created and shared within an organization or a network. Knowledge

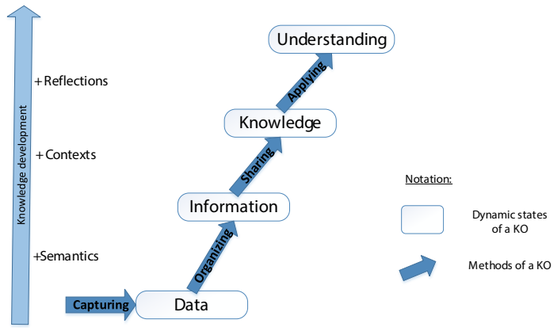


**FIGURE 3.** *Methods and dynamic states of a knowledge object*

application deals with the practices and applications related to the creation of intellectual capital *(Le Dinh et al., 2013)*.

### Models of KM-PMO framework

The objective of the model of the KM-PMO framework is to express the relationship between knowledge activities and knowledge objects.

The concept of zone of responsibilities *(ZoR)* in our approach represents the context of knowledge creation, which provides a basis for interpreting and transforming information into knowledge *(Le Dinh et al., 2013)*. A ZoR corresponds to a virtual and/or a real-world environment for knowledge creation *(i.e. know-what, know-how, know-why)* within a group of persons *(i.e. know-who)* at a specific time and space *(know-when, know-where)*.

The concept of ZoR is somewhat similar to the concepts of "ba" *(Nonaka et al., 2000)* and "community of practice" *(Kimble & Hildreth, 2005)*. The main difference between ZoR and other approaches is that ZoR corresponds to an integrated living and virtual space, while its boundary is evolutionary, and is defined by a set of responsibilities and interrelated know-what, know-how and know-why *(Le Dinh et al., 2013)*. In a PMO, a ZoR may associate with a project team or a program team.

### Instantiations of the KM-PMO framework

The objective of the instantiations of the KM-PMO framework is to map the generic constructs of the framework into the specific constructs that correspond to the domain knowledge of project management. **Table 3** explains how the specific constructs of the KM-PMO framework are extracted from the generic knowledge management framework *(Le Dinh, 2006)* and represents the different knowledge components.

The semantic relationship between the constructs is represented in **Figure 4** using simplified UML notation *(Rumbaugh et al., 1999)*. Concerning the specific constructs related to knowledge objects, know-what deals with the structure of knowledge that is represented by a deliverable. A deliverable has certain properties, tasks, and dynamic stages. Dynamic stages of the deliverable depict the levels of achievement of the associated work package or deliverable. Tasks are often used to perform transition from one level to another level of achievement.

| Knowledge activities | Dynamic states of a KO | Objectives | Framework components | Corresponding PM maturity phases |
|---|---|---|---|---|
| Knowledge creation | Data | Gathering of parts | Constructs | Basic knowledge |
| Knowledge organization | Information | Connection of parts | Model | Process definition |
| Knowledge transfer | Knowledge | Formation of a whole | Method | Process control |
| Knowledge application | Understanding | Joining of wholes | Instantiations | Process improvement |

**TABLE 2.** *Knowledge artefacts related to the method*

| Knowledge components | Generic constructs | Proposed specific constructs |
|---|---|---|
| Know-what | Class | Project deliverable (including work package) |
| | Attribute | Project property |
| | Method | Project task |
| Know-how | Process | Project activity |
| | Dynamic state | Project stage |
| Know-why | Integrity rule | Governance rule (including Lesson learned and Risk management) |
| | Risk | Risk control |
| Know-who | Zone of responsibilities | Project team |
| Know-when | Time | Creation time |
| Know-where | Space | Creation place |

**TABLE 3.** *Specific constructs of the KM-PMO framework*



A know-how concerns the transition of knowledge that is represented by a project activity. An activity in turn invokes a set of tasks and changes a set of dynamic stages of deliverables.

Finally, know-why concerns the coherence of knowledge that is represented by a governance rule, which may be extracted from a lesson learned or aims at managing a set of risks. Each risk is related to certain tasks and is involved in some properties of deliverables.

Concerning the specific constructs related to the context of knowledge creation, a knowledge object depicts a semantic context corresponding to the particular situation of an application of knowledge. In other words, a knowledge object includes a set of interconnected know-what about project deliverables, a set of know-how that uses certain tasks belonging to the deliverables, and a set of rules whose scope involves a set of properties of these deliverables.

A ZoR assumes a set of responsibilities related to knowledge management. In order to promote the creation of information products, a ZoR may provide different contexts of knowledge creation that involve a set of know-who, know-when and know-where.

Know-who is a knowledge component that refers to either groups or individuals who assume certain roles of a ZoR. For instance, there are popular roles, such as who-know-what, who-know-how and who-know-why.

Know-when is knowledge about the timing of events related to information products, meanwhile know-where is the knowledge required for navigating and finding the right information product. Correspondingly, each information product is organized and used based on its relevant know-where and know-when knowledge components.

## 6. Illustrative example

To evaluate the KM-PMO framework, we present an illustrative example of designing a knowledge infrastructure for a PMO. This example is inspired from a real-world situation in the PMO of a non-profit organization *(hereafter called the NF organization)* whose business objective is to find solutions to poverty around the world *(Makara, 2014)*. The purpose of the example is to propose a solution to build a knowledge infrastructure using the KM-PMO framework for the NF organization.

Since the priority of this organization is to better carry out its development projects and promote organizational learning, it concentrates on managing knowledge about projects, project processes, and project environment. Correspondingly, there are three types of knowledge objects in the organization's knowledge management solution: project, process and stakeholder. The NF organization is a project-based organization; therefore, managing knowledge related to projects and processes helps the organization to create a sustainable learning environment for PMO's members. Moreover, working with stakeholders, especially foreign partners in developing countries, is a real challenge for the NF organization. For this reason, managing knowledge related to stakeholders and their business environment helps the organization to improve stakeholders' satisfaction.

The proposed framework for the NF organization, including the constructs, the model, and the method, is described in the following.

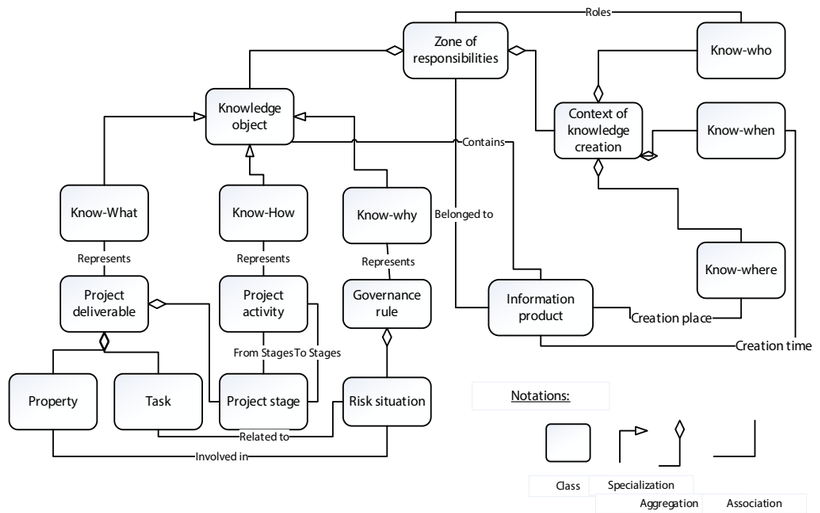


**FIGURE 4.** *Specific constructs of the KM-PMO framework*

*Constructs.*

First, the NF organization needs to determine the key knowledge components that help it in achieving its business goals, their corresponding constructs, and the methods and tools to specify these constructs. In order to become a highly project-oriented organization, it is recommended that the NF organization aims at working toward the Level 3 of the Project Management Maturity Model. This level focuses on the management of formal PM data, on the definition of formal PM processes, and on the identification of formal PM problems **[PMBOK, 2015]**. Consequently, the organization needs to concentrate on the following PM knowledge areas: project scope, project time, project cost, project risk and project human resource management.

**Table 1** presents the key knowledge components of the proposed framework for the NF organization that aims at capturing and managing knowledge about project deliverables as know-what, project activities as know-how, project risks as know-why and project stakeholders as know-who.

*Method.*

The NF organization has implemented a project management information system *(PMIS)* and an enterprise content management *(ECM)* system. For this reason, the knowledge infrastructure is based on the ECM system, and the instances of the constructs are imported from the PMIS. Each instance of the constructs becomes a tag of the ECM system which is defined as a non-hierarchical keyword assigned to a content object. Concerning the knowledge activities, the knowledge creation activity focuses on capturing tacit knowledge and creating new explicit knowledge in the form of content objects stored in the ECM system. Thus, the knowledge organization activity organizes data according to their semantics by adding the corresponding tags to existing content objects. The knowledge transfer may occur at different levels: between individuals within a team, between teams, and from teams to the organization. Content objects can be used to create information products. Each information product can belong to a member, be shared in a team, or be shared throughout the organization. The knowledge application activity aims at applying the organization's memory to a special purpose such as facilitating the enforcing directives, supporting organization routines and creating self-contained task teams *(Le Dinh et al., 2013)*.

*Model.*

Since the NF organization is a project-based organization, each zone of responsibilities corresponds to a project team and there is a virtual working space for each one of them. The content produced by the collaboration services used for daily activities of project members can be captured, selected and organized. Besides, documents related to project planning, execution and control *(such as the work breakdown structure, Gantt diagram, network diagrams, status reports, etc.)* should be entered in form of different types of content such as databases, wikis and discussion forums. These content objects can be tagged manually or automatically, thanks to intelligent tagging systems. Tags are stored in the taxonomy system which is the classification of the instances of constructs, including the principles of semantic relationship that underlie the classification specified by the model of the framework. Content objects can also be linked to other content objects based upon this relationship in order to create useful information products. Users of the knowledge infrastructure, such as stakeholders *(members, customers, suppliers or partners)*, can consult information products according to their roles.

*Instantiation.*

In order to achieve its organizational goals, the NF organization tried to use various tools from the Web 2.0 and the social Web. It used a popular and open ECM system to carry out its knowledge management initiative. This system is an open-source solution that allows an organization to easily publish, manage, organize, and customize a wide variety of contents at a low cost. At the beginning, the organization focused on identifying the types of content for capturing daily activities such as emails, video conferences, instant messages, blogs, virtual classes, and RSS. Thus, the types of content, which facilitate the process of knowledge sharing and transferring formally and informally, are identified as Web pages, forums, wikis, databases, glossaries and social networks integration. Users can use the tag cloud, or a particular information retrieval interface to explore contents according to knowledge components and their interrelations. Finally, a specific function supports case-based reasoning that helps to document a solution based on knowledge components and to find a solution based on solutions found for similar problems in the past.

| Knowledge components | Proposed specific constructs | Sources |
|---|---|---|
| Know-what | Project deliverable | Work Breakdown Structure (WBS) |
| | Project property | Project definition |
| | Project task | Network diagram |
| Know-how | Project activity | Network diagram |
| | Project stage | Network diagram and Earned Value Management System |
| Know-why | Governance rule | Risk Breakdown Structure (RBS)<br>Lesson learned |
| | Risk control | Risk control |
| Know-who | Stakeholders (including team members) | Organization Breakdown Structure (OBS) |
| Know-when | Creation time | Status report and Change management system |
| Know-where | Creation place | Status report and Change management system |

**TABLE 1.** *Specific constructs.*

# 7. Conclusion

Project management offices play a key role in the success of projects and organizations while knowledge management in this entity is a priority concern. A project management office is a special entity and knowledge management in PMOs is complex. Based on literature, a framework for knowledge management in PMOs *(called KM-PMO)* was proposed to effectively manage knowledge in PMOs. Besides process, social networks and organizational culture need to focus on successfully implement knowledge management in PMOs. This article may contribute to the literature on knowledge management, especially in a special environment like the one of PMOs.

Our approach is one of the first that focuses on knowledge infrastructure for PMOs by proposing a theoretical foundation for the classification and management of content objects and information products based on the perspective of knowledge components. The objectives of the framework are to add more business value to the activities of PMOs, promote knowledge development, and enhance intellectual capital. According to the DSR principles, we have designed and evaluated the KM-PMO framework, which consists of different artefacts with different levels of abstraction: constructs, model, method, and instantiations *(March & Smith, 1995; Hevner et al., 2004)*.

With regard to practical and theoretical implications, our approach aims at relating PMOs' activities to knowledge management. Due to the different perspectives of a PMO, we suggest that the artefacts of our framework could be adapted *(reduced or enhanced)* to several real-world scenarios in which each dimension of knowledge could be more or less important. When a PMO intends to implement a knowledge management system, the KM-PMO framework provides a starting point to classify and organize content objects and information products according to knowledge components, and to share these products within and among organizations conforming to their corporate culture.

The proposed framework is mainly based on the review of literature of knowledge management in different types of organizations, especially PMOs. Unlike previous studies, we propose to adaptable knowledge management tools to the specific environment of PMOs that motivate effective knowledge sharing and developing. Further research should be conducted to validate the completeness and to test the effectiveness of this framework.

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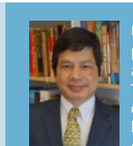

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