



Article

Knowledge Management Maturity Contributes to Project-Based Companies in an Open Innovation Era

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Abstract: Knowledge is a crucial asset for any organization nowadays. Despite the temporary nature of projects, proper knowledge management can improve outcomes and benefit future endeavors. However, an effective knowledge management system has to be tailored to each organization. Therefore, it is extremely important to assess the stage of knowledge management (KM) maturity of an organization. The present study analyzed the general maturity level of European project-based organizations. The analysis was performed to understand the maturity of the knowledge management cycle's phases and it was possible to distinguish which phases were more developed and what are the main steps to create effective organizational learning in a project-based organization. Overall, European-based project-oriented organizations are halfway through the implementation of KM systems. While the need for a proper system has already been acknowledged, the infrastructure to support it still needs to be developed so proper measures can be put in practice.

Keywords: knowledge management; project management; maturity models; organization learning; open innovation



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1. Introduction

In this increasingly competitive world, organizations need to distinguish themselves. Knowledge is currently seen as a key organizational asset that allows companies to achieve the innovation necessary to thrive in today's challenging environment [1,2]. Even though the importance of knowledge management (KM) has been widely acknowledged, when it comes to project-based organizations there is still a lot to be learnt [3]. Projects are temporary by nature; however, it is important to retain the knowledge created or acquired during the project lifetime in order to save resources and improve future projects [4]. There is not a recipe for KM initiatives so they need to be tailored to each organization [5], their success depending on the organization's characteristics and on the KM maturity stage the organization is presently at [6]. Therefore, it is extremely important to know which maturity stage a company is at before planning KM measures.

This study aims to understand the general level of KM maturity of European project-based organizations. As such, the research was divided in two steps. First, the goal was to find out which phases of the KM cycle had been implemented and to what extent. Then, looking at each phase individually, the goal was to recognize if they were consistent or if there were traits underdeveloped compared to the whole phase.

This paper is structured as follows. First, the literature review presents an overview on KM, its cycle, maturity models and project application. The following chapter describes how the data were gathered and how the KM cycle was divided. The results are described

and consequently examined in the Data analysis and Discussion chapters, respectively. The main contributions of this study are emphasized in the Conclusion, and its limitations addressed in the last chapter together with guidance for future work.

2. Literature Review

KM handles the processes related to the organization's intellectual capital. KM is not a new topic—the questions of how organizations create and process knowledge were already researched in the 1990s [7]—however, it became increasingly popular from the beginning of 2000 [8]. Although information technology adds value through infrastructure, KM is a socio-technical system composed of precise business procedures [9]. Knowledge, unlike information, is about meaning, action and highly dependent on the individual [10], and thus, on human resources [1]. Mueller [11] also found that corporate culture and knowledge processes are mutually dependent.

The knowledge management cycle (KMC) has been widely researched [12–14]. Most models identify phases such as capture or acquisition; creation; sharing, distribution or transfer; storage or compilation; use or application; learn, and refine or update. For the purpose of this study, KM was analyzed using the cycle model of Evans et al. [15]: identify/create, store, share, apply, learn and improve, that although not new it is still relevant [16].

KM research has been mainly focused on creation or sharing/transfer of knowledge [17]. It has been shown that knowledge sharing can effectively improve the organization's performance [18,19] and how social media and HR practices influence communication [20–22]. Social networks have been facilitating information sharing not only within the organization but also with suppliers, customers and external markets, creating opportunities for an open innovation environment [23]. Nevertheless, Donnelly [24] found that knowledge-sharing behaviors are also sustained by extrinsic motivators, which confirms Asrar-ul-Haq and Anwar's [25] work that identified trust, organizational structure and the reward system as main promoters of knowledge transfer. Adaileh et al. [26] found that knowledge application has the greatest impact on performance, regardless of firm size, and that knowledge capture can only be linked to performance improvements in medium-size firms. Recent studies have tried to measure knowledge [27], analyzing the importance of leadership and its role in promoting the creation, storage and sharing of knowledge [28,29] and emphasizing the relevance of big data in KM [30].

Nonetheless, many organizations have trouble implementing and maintaining prosperous KM systems, mainly due to the lack of standardization of KM procedures [31]. This lack of normalization also makes KM outcomes hard to measure, impairing the assessment of an organization's maturity regarding its KM routines. According to Escrivão and Da Silva [32], the KM maturity level portrays the different stages of growth of KM procedures that an organization has already achieved. The authors also defend that a KM maturity model (KMMM) is needed to assess KM initiatives from several perspectives in order to obtain a complete picture. Most KMMMs can be divided into five stages: the starting point, where employees recognize the concept of KM but there are no procedures in place; a second stage where there is consciousness of KM's importance and relevance to the organization; third, the organization has put in place some basic infrastructure; fourth, KM practices are systematically supported, are part of the organizational culture and are monitored and measured; finally, these practices are continually improved and are integrated in the external network [32–36].

When it comes to project-based organizations, there seems to be a contradiction between the short-term project goal and the long-term organizational learning which makes KM a more pressing matter. Due to the transient nature of projects it is easy to let critical knowledge assets get lost once the project is over and the team is reassigned, which leads to the continuous "reinvention of the wheel" and duplication of errors [37]. Furthermore, due to the tight schedule and budget that projects are run on, there is no time or space to capture, store and share knowledge, much less for reflective learning

among the teams. All the same, KM has been applied in project-based organizations and its drivers and consequences have been studied. Ajmal et al. [3] found that KM initiatives in project-based companies need incentives, an appropriate system and interdepartmental coordination to succeed. Moreover, Wingate et al. [4] present Project Vita as a tool for KM in projects, which would support communication, evaluation and management of knowledge created during projects. On the other hand, projects have the perfect setup to make the best of open innovation, since there is already a lot of cooperation between the developing team and the client. KM processes should be slightly adapted to accommodate these knowledge fluxes between the organization and the outside, be it either by internalizing external knowledge in their research and development teams or by delivering new ideas to the market that can help other organizations [38,39].

However, when it comes to KMMM in project-based environments, there is still a gap to be addressed. Sokhanvar et al. [6] identified knowledge creation and capturing the most important processes for project-based organizations at the lowest level of KM maturity, while highlighting the need for more research on KMMM in project-based companies. Akhavan and Philsoophian [36] also present some effective procedures for the first stage of maturity found in non-profit organizations. More recently, Hartono et al. [40] found a significant link between KM maturity and organizational performance. The different stages of the models identified can be seen in Table 1.

Table 1. Knowledge management maturity models.

Stage	References			
	[32]	[36]	[33]	[34]
1		Undeveloped	Chaotic Knowledge	Initial
2	Consciousness	Underdeveloped (knowledge management mechanisms planned)	Conscientious Knowledge (starts to nurture technical environment for KM)	Aware (there is intention to implement KM initiatives)
3	Formalization (infrastructure and strategy for KM)	Developing (knowledge management mechanisms partially deployed)	KM (promoted through culture and regulation)	Defined (basic infrastructure in place)
4	Institutionalization (control, monitoring and measure)	Developed (knowledge management mechanisms in place)	Advanced KM (organization can qualify and quantify KM performance)	Managed (initiatives are well established)
5	External network integration	Highly developed	KM integration (part of the culture, supported by technical infrastructure)	Optimizing (part of the culture, constant review and improvement)

Overall, although a lot of research has been done on KM, it has focused mainly on its cycles, or the importance of isolated phases. The relevance of KM for project-based organizations has already been highlighted; however, it is hard to effectively implement it. KMMM can be the solution to improve the efficacy of KM initiatives, and although developed for KM in general, project-oriented organizations have specificities that call for additional research.

3. Research Methodology

The goal of this paper is to identify the KM’s maturity stage of a specific sector in order to propose efficient initiatives to improve the KM system. To do so, a survey was given to 170 people from different sectors and hierarchical positions, all from European or European-based project-focused companies. This survey consisted of 32 questions concerning not only the overall KM recognition but also the different KM phases (Table 2). The questions used a Likert scale with 4 levels: from totally disagree to completely agree

(1 to 4), in order to “force” respondents to take a position and not be able to “hide” in the middle level.

Table 2. Survey questions by KM phase.

Phase	Questions	Code
Recognize	“Management and transfer of knowledge in project management” is a current topic in my organization.	R1
	Knowledge is a valuable asset in project development in my organization.	R2
Identify/Create	I identify the project team’s knowledge and redirect it to each project type.	C1
	I take part in constant brainstorming meetings within the scope of each project.	C2
	In my organization, team meetings allow the development of new ideas that once filtered and analyzed may help to solve project problems.	C3
	I identify the information extracted from knowledge to solve problems or make decisions during the project lifetime.	C4
	In my organization, the quality and relevance of the information gathered from knowledge contributes to project development.	C5
Store	The storage of acquired knowledge is crucial to my organization.	S1
	In my organization knowledge is recorded on paper or in digital format.	S2
	In my organization knowledge is well recorded, organized, structured, evaluated and filtered so that information can be applied to future projects.	S3
	I record knowledge in databases as organizational history to be used in future projects.	S4
	I record and store knowledge transferred by all stakeholders.	S5
	My organization has a record of knowledge that can be consulted.	S6
Share	My organization has a network of knowledge sharing between departments to enrich project development.	T1
	I share and transfer knowledge between manager and team.	T2
	My organization promotes and rewards knowledge sharing between co-workers.	T3
	In my organization, project managers are receptive to knowledge transfer to help a project succeed.	T4
	My organization commonly identifies knowledge to be transferred and shared.	T5
	My organization commonly captures knowledge to be transferred and shared.	T6
	In my organization, knowledge is commonly shared between departments, teams and project managers.	T7
	In my organization, transferred knowledge is used for projects’ advantage.	T8
	My organization evaluates the benefit of transferred knowledge for project success.	T9

Table 2. Cont.

Phase	Questions	Code
Apply	In my organization, knowledge is used to solve problems and make informed decisions on projects.	A1
	In my organization, knowledge is used to improve competencies of managers and project teams.	A2
Learn	In my organization, after being shared and used, knowledge is analyzed and improved to benefit future projects.	L1
	In my organization, learnt knowledge improves worker performance and professional maturity.	L2
	In my organization, learning improves managers’ and project teams’ knowledge, which benefits future projects.	L3
	In the project management section of my organization, when knowledge is insufficient and immature, knowledge identification and capture will be restarted.	L4
Improve	In my organization, all gathered and refined knowledge is improved and recorded to be used in future projects.	I1
	The improvement of knowledge gathered during project management is an asset to my organization.	I2
	In my organization, lessons learnt are recorded so positive aspects can be improved and negative ones minimized or eliminated.	I3
	In my organization, there are tools to register all lessons learnt from project management.	I4

The results of the survey were combined and the average of each question and phase calculated. The second averages (phases) allowed us to evaluate the relative importance or development of each phase while the first were used to understand which steps of each phase were less developed and needed to be addressed.

4. Data Analysis

From all answers collected, only 51 were complete. There were answers from big (47%), medium (31%) and small (27%) companies. The survey was answered by middle managers (49%), project managers (35%) and top managers (16%); most (82%) had been working at their organization for more than three years.

The first step of the analysis was to compare the averages of each phase and test the significance of the differences between them. The normality of the answers of each question and phase was ensured by the D’Agostino K-squared test [5], and since they all followed a normal distribution, the averages were compared with several one-sided T-tests. Table 3 shows the biggest difference between phases’ averages that is significant.

Table 3. Differences between phases’ averages.

	Recognize	Create	Store	Share	Apply	Learn	Improve
Average	2.26	2.18	1.88	1.88	1.97	2.05	1.74
(std)	(0.55)	(0.40)	(0.56)	(0.53)	(0.60)	(0.59)	(0.56)
Recognize	-	NS	0.2 *	0.2 *	0.1 *	<0.05	0.3 *
Create	NS	-	0.1 *	0.1 *	0.05 *	NS	0.2 **
Store	-0.2 *	-0.1 *	-	NS	NS	NS	NS
Share	-0.2 *	-0.1 *	NS	-	NS	NS	NS
Apply	-0.1 *	-0.05 *	NS	NS	-	NS	NS
Learn	<0.05	NS	NS	NS	NS	-	0.1 *
Improve	-0.3 *	-0.2 **	NS	NS	NS	-0.1 *	-

NS—not significant difference, *—significant at 0.05, **—significant at 0.01, <0.05—there is a difference but is smaller than 0.05.

It can be seen from the table that with the exception of *Create*, the averages obtained for *Recognize* were significantly higher than those of the remaining phases. It can also be seen that the *Create* average was higher than those of most phases, with the exception of *Recognize* and *Learn*. Even though the differences obtained between *Recognize* or *Create*, and *Store*, *Share* and *Apply* suggest that *Store* and *Share* were lower than the latter, the difference between them is not significant. Finally, the table shows that the *Learn* average was higher than the *Improve* average.

The second step of the analysis examined each phase to find significant differences between the questions that described them. Only *Store*, *Share*, *Learn* and *Improve* showed significant differences between their descriptive questions. Table 4 shows the relationships that are significant at 0.05 level and the respective difference for each phase. For instance, it can be seen that S1’s average is at least 0.4 higher than S3 or S4’s averages. Even though S2 is also at least 0.2 higher than S3 and S4, there was no significant difference between S1 and S2.

Table 4. Differences between questions’ averages.

Phase	Relationship	Significant Difference
Recognition	R2 ($\mu = 2.71, \sigma = 0.46$) > R1 ($\mu = 1.83, \sigma = 0.88$)	0.6
Store	S1 > S3 ($\mu = 1.61, \sigma = 0.74$), S4 ($\mu = 1.67, \sigma = 0.78$)	0.4
	S1 ($\mu = 2.31, \sigma = 0.61$) > S5, S6 ($\mu = 1.76, \sigma_5 = 0.73, \sigma_6 = 0.85$)	0.3
	S2 ($\mu = 2.17, \sigma = 0.71$) > S3, S4	0.2
	S2 > S5, S6	0.1
Share	T2 ($\mu = 2.25, \sigma = 0.55$) > T9 ($\mu = 1.51, \sigma = 0.78$)	0.5
	T2 > T1 ($\mu = 1.59, \sigma = 0.80$)	0.4
	T8 ($\mu = 2.12, \sigma = 0.68$) > T9 T2 > T7 ($\mu = 1.69, \sigma = 0.70$)	0.3
	T2 > T6 ($\mu = 1.78, \sigma = 0.64$) T3, T4 ($\mu = 2.03, \sigma_3 = 0.73, \sigma_4 = 0.72$) > T9 T4, T8 > T1 T8 > T7	0.2
	T2 > T5 ($\mu = 1.90, \sigma = 0.70$) T3 > T1 T4 > T7 T5 > T9 T8 > T6	0.1
	L2 ($\mu = 2.37, \sigma = 0.66$) > L1 ($\mu = 1.73, \sigma = 0.77$)	0.4
	L2 > L4 ($\mu = 1.78, \sigma = 0.77$) L3 ($\mu = 2.29, \sigma = 0.69$) > L1	0.3
Improve	L3 > L4	0.2
	I2 ($\mu = 2.35, \sigma = 0.65$) > I4 ($\mu = 1.31, \sigma = 0.85$) I2 > I1, I3 ($\mu = 1.65, \sigma_1 = 0.43, \sigma_3 = 0.76$)	0.7 0.4

The differences between phases and questions were also analyzed according to segmentation of hierarchical position and company size. Only four differences were significant: bigger companies often had more records of knowledge to be consulted than smaller companies; bigger companies were more likely to restart the creation and capture of knowledge if they found it insufficient during the project than medium companies; top managers more than project managers defended that there were networks to share knowledge between different projects; and top managers believed that “management and transfer of knowledge in project management” was a crucial topic to their organizations more often than middle managers.

5. Findings

The KM maturity analysis was divided in two levels: first, assessment of the KM cycle phases and relationship between them, and second, evaluation of the differences between the several questions that characterized each phase.

When considering the first level (Table 3), these first results suggest that *Recognize* and *Create* were the stages which were more addressed by organizations, followed by *Learn*, *Apply*, *Store* and *Share* and finally, *Improve*, even if not all relationships are significant. Nevertheless, it is important to evaluate each stage individually. For instance, *Learn* had one of the highest averages of the KM cycle. However, when considering the individual questions, it can be seen that this average is only high because its importance to individual improvement was recognized. The most critical aspect of *Learn*, analyzing the knowledge gathered to improve future projects, had the lowest average of the phase. This indicates that this phase was not as developed as the first analysis suggested. It is clear that all companies recognized the importance of KM while knowledge improvement was the phase least exploited.

With this information it is possible to estimate in which maturity stage these companies fit by comparing these results with the four models presented in Table 1. It is clear that the organizations included in the survey were aware of KM systems and recognized its importance; there were some measures in place, but there was still no monitoring or measure of the practices in place. According to [32], the organizations had successfully completely stage 2 and may be going through stage 3. For [36], these companies were in stage 3 with their knowledge management mechanisms partially deployed. On the other hand, it cannot yet be said that KM was promoted through culture and regulation, so according to [33] these organizations had not yet reached stage 2. On the other hand, the basic infrastructure was already in place which positioned these organizations at the end of stage 3 according to [34]. Overall, this indicates that European project-based organizations are at least in the second stage of KM maturity, conscious of KM importance, but definitely not yet in the last stage where improvement is the main concern (Table 1).

When analyzing the different phases individually (Table 3), the results confirm that KM was more than a “hot topic” for the organization; its importance for developing projects was widely recognized, which confirms Hartono et al.’s [40] findings. Regarding knowledge storage, it can be seen that it was crucial for the organizations and that most did collect it. Even if employees confirmed that they did record it when necessary and there were repositories to be consulted, they did not defend that knowledge was correctly organized for future use as strongly. As stated by [3], KM initiatives in project-based context need an appropriate system, and more than collecting knowledge, this has to be properly stored so it can be used by others in the future. Most employees confirmed that they shared and applied knowledge to new projects, and that organizations and managers promoted these behaviors. However, knowledge was not shared between departments, emphasizing Ajmal’s [3] findings, and benefits of sharing for future projects were not evaluated. Sokhanvar et al. [6] found that knowledge creation and capture are the most important processes at the lowest level of maturity, which these organizations already had achieved. The next stages should focus on proper storage and sharing [17–19] in order to make this created and collected knowledge widely available within the organization, so any team can benefit from it. It was generally agreed that knowledge improves employees’ and managers’ maturity; however, the consensus was not as strong regarding the benefit for future projects. As mentioned before, *Improve* was the phase less developed. Despite recognizing its importance for future projects, there were no effective mechanisms to analyze and store lessons learnt from each project. The analysis performed on the distinct phases shows that there were basic infrastructures in place, and that organizations and managers promoted sharing, learning and storage of knowledge. Therefore, European project-based organizations are in the third stage of KM maturity (Table 4), a period that is characterized by formalization of KM protocols and introduction of basic measures and instruments, as defined by [32,36].

Even though KM is already promoted by organizational cultures and there are already some procedures in place, there is still a long way to go in order to achieve an efficient KM system. The information gathered from each project is collected and recorded, as inspired by *Project Vita* [6]; however, this is not done with the intention of sharing and improving future projects. More than accumulating information, it is important to analyze it and reflect about it in order to gain insights that can help future projects and therefore improve performance [17–19,26].

6. Discussion: Open Innovation in Knowledge Management Maturity

Open innovation can be summarized as building collaborative networks with external partners to benefit from their experience and knowledge [41]. However, it cannot be implemented without a proper foundation [42]. Open innovation has been linked to improved performance in several studies; nevertheless, trying to change too much or too fast can actually impair performance [41,42]. One of the bases needed to properly be able to use exterior knowledge is having an effective KM system in place [43]. It is not possible to absorb knowledge from the outside if one cannot even create or store internal knowledge in a way that it can benefit the whole organization. It was also showed that small and medium enterprises are more prone to develop open innovation due to being more flexible [41,44].

Organizational sustainability is increasingly linked to the ability to manage new knowledge and ideas and turn it into new business value [45]. Open innovation can also play a major role in turning knowledge into assets that promote sustainable innovations. It is increasingly important to shift the traditional view of sustainability as an externality imposed by legal entities and include it in the core business [45]. Local government can play a crucial role in promoting innovation ecosystems; in a first stage, their planning capabilities are indispensable to lead limited-resource entities to share knowledge and promote joint product development [46]. Through funding to all parties involved and promoting sharing, governments can foster the ecosystem until it is capable of self-management, needing only some supervision and quality control [46]. Culture can also play a major role in promoting sustainable development through open innovation, even though there is no consensus on which traits define this culture. Yun et al. [47] found that this culture will include entrepreneurship, intrapreneurship and organizational entrepreneurship. Martinez-Conesa et al. [41] added that organizations with dynamic environments are more prone to pursue open innovation, although this does not eliminate the importance of a solid KM system.

Knowledge is one of the main assets of all organizations, and if they have not yet managed to successfully implement a proper system to make the most out of it, it is hard to imagine how organizations can make sustainable decisions in other areas. How can organizations be part of a circular economy when they are not capable of reusing knowledge they already created? Proper storage, which this study found to be a weaker aspect of the organizations included, is crucial according to [42]. Although not directly related, it is impossible not to draw a link between proper KM systems and broader goals of sustainable development for organizations.

7. Conclusions

The present study was able to assess the global level of KM maturity in European-based project-oriented organizations. According to the gathered data, these organizations are currently halfway through the implementation of a resourceful KM system. Organizations are aware of the importance of KM and have started applying some measures and infrastructure to support it. However, the main contribution of the present study was the analysis of each phase individually, which allowed us to characterize the maturity stage and tailor future initiatives.

The main theoretical contribution of this study is a comprehensive analysis of which knowledge management maturity stage European-based project-oriented organizations are in. It raises awareness of the lack of global analysis that has been performed and lack of largescale strategies that have been identified or tested. Although the importance

of effective KM systems has already been acknowledged, is important to study their implementation as a whole process instead of a fragmented one, as has been done so far.

As practical implications it became clear that organizations need to change the way knowledge is recorded; the goal cannot be just the construction of a project's history but building a guide to help conduct future projects. More important than registering what was done and the outcome, organizations need to share what they learnt and what they would make different if they had to do it again. Furthermore, the KM cycle needs to be seen as a whole and requires a global strategy, instead of some isolated measures to address each phase. Nevertheless, the first steps were taken and there are policies to promote knowledge creation and sharing already in place.

Although it was possible to identify the overall KM maturity level of project-focused organizations, the collected sample was small. Furthermore, in spite of representing several different organizations, the sample may not show the general reality of European project-based companies. The lack of significance found when segmenting different hierarchical positions or company sizes may be due to the sample size as well.

KM and KMMM have been widely studied, but not as much in project-based environments. There is a need for a KMMM conceived entirely for the reality of projects, and understanding how to promote KM systems with minimum impact on projects' budget and timeline. Moreover, it would be of interest to see if more flexible models produce more accurate evaluations and can help guiding the next stages of KM system implementation. People, infrastructure and organizational culture and regulations are currently examined indistinctly, although it is more likely that they are in different maturity stages and require distinct measures.

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