Transferring knowledge in the Project Management Communities of Practice: The case of the PMBOK Guide

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ABSTRACT

The evolution of the Project Management Book of Knowledge (PMBOK) Guide as a standard artefact in the project management profession played an important role in the emergence and progressive formation of diverse project management communities of practice. The project management institute (PMI) instigated such development through a strategy which replicated its chapters (communities of practice) worldwide. In this case study we undertake a qualitative investigation using existing versions of the PMBOK Guide and the PMI website content as data, in an attempt to identify how the PMBOK evolved and what role it played in the communities of practice, using a sociomaterial perspective (Orlikowski and Scott, 2008). Our findings suggest that as communities of practice proliferated, they played a determinant role in transferring and internalising knowledge to the PMBOK Guide and other foundational standards of the PMI. We explain such proliferation and the spread of PMI chapters worldwide by using the theoretical notions of "Template" and "Arrow core" linked to strategy as replication (Winter and Szulanski, 2001). Our empirical results suggest that the relationship between the PMBOK Guide and the communities of practice is one of mutual constitution and co-evolution, and fits the metaphor of imbrication (Leonardi et al, 2012). This imbricated relationship enabled episodic bi-directional knowledge transfer cycles to occur in a process which alternates between exploration and exploitation, thus enabling both the evolution of the artefact and that of communities of practice.

Keywords: Artefacts, Communities of Practice, Knowledge transfer, Project Management, Replication

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INTRODUCTION

Since the publication of its first version in 1987, the Project Management Body of Knowledge (PMBOK) Guide of the Project Management Institute (PMI) enjoyed unprecedented popularity and rallied a substantial number of project management professionals through its membership scheme, and the various certifications it delivers. Recent versions of the PMBOK Guide have seen an increase in the number of processes in the project management life-cycle model, accompanied by an associated increase in tools and techniques. These tools and techniques fall under two categories: the first has its roots in the engineering and hard sciences and represents the rational view which received considerable criticism from management scholars (Cicmil and Hodgson, 2006; Lenfle, 2008; Winter et al., 2006); while the second comes from the field of management and the social sciences (Polack, 2007).

Undoubtedly, the PMBOK Guide represents an artefact that has evolved significantly over time. Such evolution represents a unique phenomenon rarely witnessed in other management disciplines, but one that certainly necessitates a closer look in terms of the diffusion of its standards, its gradual construction, and the global distribution of its communities. According to PMI Today –the monthly publication of the PMI-, there are in excess of 4 380 000 members of the PMI worldwide; 265 chartered chapters (communities of practice spread around the world) in 84 countries; over 4.3 million copies of the PMBOK Guide in circulation (including PMI-published translations); and, as of November 2013, there are 617 240 active holders of credentials/certifications from which 548 000 are certified project management professionals (PMP).

Despite the global reach of the PMI and its dominance as a global institution in the field of project management, what seems to have evaded the attention of management scholars is the shear importance and critical mass of the communities of practice (CoPs) that have formed around its global standards in general, and around the PMBOK Guide in particular, as a core source of project management knowledge and a foundational standard. Specifically, how they organise their actions while continuously updating various repositories with knowledge flows (which subsequently serve to enrich and develop the project management profession and its

related functional areas such as program management and portfolio management) remain unexplored.

The heightened importance of CoPs in this context owes to the determinant role they can play in capturing tacit knowledge and lived experience (Wenger, 2000) and sharing it across the entire global community of project management professionals via their involvement in the network of chapters worldwide. Therefore, it becomes pertinent to draw on the very existence of these communities and their interconnectedness in an attempt to understand how their knowledge transfer activities are organised, bearing in mind that a significant number of their members acquire certification from the PMI to achieve recognition and professional status.

Our aim in this article is two-fold: to shed light on the interplay between the PMBOK Guide and the CoPs in the realm of the project management profession, and to theoretically articulate this relationship. We investigate particularly the evolution and role of the PMBOK Guide and its relationships with the CoPs. In so doing, we recognise the evolution of this artefact over time and adhere to an interactionist view. Therefore, we use for this study the various versions of the PMBOK Guide as a data source and analyse their content for each new edition. Concurrently, we use data from the official website of the PMI which provides substantial information about the activities of CoPs and their active discussions, and the competencies they contributed to develop through their interactions. The process of knowledge flows through these interactions represents an important focus in this article.

Today, the size and diversity of the PMI's globally distributed CoPs, who organise their actions around the PMBOK Guide - and enrich it with constant knowledge flows and lived experience, raise the following questions:

1. How did the PMBOK Guide evolve over time?
2. How did project management CoPs evolve?
3. What are the mechanisms of interaction between CoPs and the PMBOK Guide?

We draw on sociomateriality and use a process perspective (Orlikowski and Scott, 2008) for our theoretical framing. Thus, we consider that the social and the material are ontologically related and in mutual interaction. However, we consider them imbricated rather than entangled (Leonardi et al, 2012) because of the very existence of a spatial dimension between the artefact (PMBOK Guide) and a given CoP. Furthermore, to answer the research questions, we need to acquire a new set of theoretical constructs, so we draw on the analytical notions of Arrow Core

(AC) and Template (Winter and Szulanski, 2001) to explain the process of knowledge flow leading to the successful replication of PMI chapters worldwide. These notions are further developed in subsequent sections.

This paper is organised as follows. In the first section, we outline some fundamentals about the notions of artefacts and communities of practice. In the second section, we set out the context of our empirical work. Section three presents the empirical analysis of our field and our analysis. In the last section, we discuss our findings and present our theoretical framework. We conclude in the last section and make recommendation for further work.

1. KNOWLEDGE IN THE COMMUNITIES OF PRACTICE: A SOCIOMATERIAL APPROACH

The knowledge management literature suggests two basic epistemologies. The first takes the view that knowledge is something that can be possessed, altered, and stockpiled. This view is referred to as the "commodity view" (McIver et al, 2012). It regards knowledge as an objective entity and attempts to understand it as an artefact. Concurrently, this view conceptualises how different types of knowledge impact other organisational phenomena such as innovation and alliances (Nonaka and Takeuchi, 1995), thus the role that knowledge, as a commodity, plays in the process of innovation and inter-organisational relationships. The second epistemology views knowledge as the ability to act on what is known, hence focusing on knowing as a dynamic phenomenon enacted in the act of knowing and using that knowledge. This second view is referred to as the "community view" (McIver et al, 2012). The proponents of this view follow Lave and Wenger (1991) Communities of practice (CoPs) learning theory and tried to shift the attention from exploring knowledge to exploring the connections between knowledge and the practices of individuals in organisations. In other words, examining the process of knowing through the practice of which its value becomes visible. More recently, a practice-based perspective has emerged in an attempt to integrate the commodity and community views. This view shifted the focus to practices or work activities accomplished within organisations. It affords the potential for integrating the commodity view with the community view by focusing on how knowledge is used and the value creation that stems from the situated actions of the members of an organisation (Nag et al, 2007; Orlikowski, 2002).

The concept of community of practice (CoP) was first introduced by Lave and Wenger (1991). The notions of shared practices and mutual engagement underpin a CoP and describe it as "*a set*

of relations among persons, activities, and world, over time and in relation with other tangential and overlapping communities of practice". Furthermore, Wenger (2000) adds that "*a community of practice is a collection of people who engage on an ongoing basis in some common endeavour. Communities of practice emerge in response to common interest or position, and play an important role in forming their members' participation in, and orientation to, the world around them*". Subsequently, Wenger et al, (2002) redefined a CoP as "*a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis*", adding the idea that knowledge evolves over time in these communities. These communities are potentially important organizational phenomena as they can leverage the performance of an organisation by favouring social interactions and developing their own knowledge. This has attracted the attention of academics working on the management of knowledge in organisations; hence the emergence of a corpus of literature has been witnessed.

CoPs are non-hierarchical communities and can often be an essential component of a knowledge management strategy of an organisation (Lesser and Everest, 2001). CoPs provide numerous opportunities for collaboration and collective sense-making, while offering the possibility to develop the participants shared knowledge. Furthermore, a CoP provides the context for its members to build their professional identity and sets a joint history thus, enabling them to establish professional standards and to acquire a social recognition. Consequently, they provide an explanatory context for standardisation processes by establishing best practices and by building identities. In this sense, CoPs are "*significant repositories for the development, maintenance and reproduction of knowledge*" (Brown and Duguid, 2001, p. 202). However, engaging in this knowledge dynamics may be challenging and perilous for CoPs. Challenging because of the causal ambiguity associated with the process of knowledge flow / transfer, translating into an inability to reap its benefits. Perilous because the accumulation of such knowledge must imperatively lend itself to some kind of formalisation and storage for subsequent utilisation, otherwise knowledge can be lost.

Although a myriad of models conceptualized Knowledge Transfer (KT) as a multi-stage process (Abou-Zeid, 2005; Duanmu and Fai, 2007; Inkpen, 2008a; Martinkenaite, 2011) by identifying and describing various stages, there is a wide recognition that KT is an evolutionary process which entails changes in relationships between organisations, in mindsets of people within

organisations, in the use of knowledge, and the type of knowledge to be transferred. This process perspective on inter-organisational KT has also focused on barriers inhibiting knowledge flows (Argote et al, 2003); characteristics of source and recipient organisations; and inter-organisational dynamics (Tsang et al, 2004).

Szulanski, (1996) points to the difficulties of transferring knowledge and suggests that they are linked to a constellation of sources which fit into broad rubrics: characteristics of the knowledge transferred; characteristics of the source of knowledge; characteristics of the recipient of knowledge; and characteristics of the context. Further studies argued that beyond acquisition and exploitation of specific knowledge, its integration and exploitation remain problematic (Mowery et al., 1996; Powell et al., 1996), suggesting that knowledge acquisition - as an ongoing activity - mediates the relationship between a number of antecedents and performance outcomes (Lyles and Salk, 1996).

Therefore, accumulating knowledge with the intention of transfer and/or replication to different contexts poses the pertinent question of how to empirically ensure replication of knowledge in different contexts if only human actors are considered. This situation requires the intervention of additional inanimate entities such as artefacts. Therefore, in this paper, we hypothesize that introducing artefacts and considering their agency may help organisations circumvent the problem of knowledge integration and exploitation, since artefacts play a significant role in forming practices via their interaction with human actors (Latour, 1992). Here, we introduce socio-materiality where the notion of “artefact” is central. Artefacts are characterised by a spatio-temporal materiality reflecting their physical existence (Kroes and Meijers, 2006). They are purposely enacted and mobilised by human actors to perform specific tasks, thus they fulfil functions which represent their intentional and normative component making their use and utility dependent on human intentionality; hence it becomes possible to use them either appropriately or inappropriately; and have a structure representing them physically. In a nutshell, artefacts encapsulate social or scientific knowledge, and thus, are delegates of human action, but prescribe also –at least partially- human behaviours (Latour, 1992).

Sociomateriality evokes the sociology of science, notably the works of Latour (2005) who has argued for a relational ontology which entails that material and human agencies are emergently and mutually constitutive of one another. In practice, such agencies have a temporal emergence via a dialectical process. The term materiality also hints to the significance of artefacts individuals use for their work. For example, Actor Network Theory (ANT) offers a new way of

thinking about the relationship between artefacts and humans. In this perspective there is no difference between the agency of an artefact and that of a human. They are considered equivalent and participate in a network of different agencies that work in concert to accomplish particular effects. Thus sociomateriality entails an "entanglement" between the social and the material and this fits what Orlikowski and Scott (2008) refer to as research stream II where the social and the material are considered mutually dependent ensembles involved in a process where interactions and outcomes are viewed as reciprocally dependent, integrative, and co- evolving in time.

The proposed relational ontology between the social and the material blurs the analytical boundaries (Pickering, 1995; Knorr-Cetina, 1997; Latour, 2005) between artefacts and humans. This entanglement through socio-materiality proscribes also how precisely artefacts and humans interact to form practices which are the outcome of their patterned imbrications (see Figure 1).

Figure 1. An interactive view between Artefacts and CoPs

Although CoPs are informal and organic (Lave and Wenger, 2001), they can significantly contribute to the formation of a knowledge sharing culture, while providing the means for collaboration. One important advantage of setting up CoPs for organisations is their ability to develop capabilities that focus on knowledge exchange within but also between organisations that are geographically dispersed. Thus, sharing knowledge beyond the boundaries of an organisation also enables the sharing of expertise. Furthermore, CoPs can be a main component of an organisation's knowledge management system where the captured tacit knowledge may leverage its competitive advantage and enable it to tighten strategic gaps in the flow of knowledge, hence improving its performance. However, the role of the agency of artefacts such as databases and similar information technology tools has a significant bearing on the actions of CoPs. This is because on the one hand CoPs use repositories such as databases to anchor human knowledge, while the database itself serves as knowledge diffusion tool (Latour, 1992), hence the interactive relationship between artefacts and humans (Figure 1).

2. BACKGROUND OF THE STUDY

2.1. PMI AND THE STANDARD MODEL

The history of project management is scattered by major projects (Polaris, Apollo, Arpanet, Iridium, Chunnel…), technological breakthroughs (Internet, personal computer) and tools (PMI, Pert, Gantt, CPM…). But timeline is fuzzy as project management can be traced back to the construction of pyramids or to the emergence of modern tools in the 20th century around the Second World War. Indeed, it depends on considering the architects or engineers as the first project managers, or on considering the emergence of professionals dedicated only to project management. If we adopt this last view, project management emerged in the late 60s as a profession and begun to take shape by strong professional associations who played a determinant role in the dissemination of the instrumental project management model known as the "standard model," based on engineering projects. One such association is the Project Management Institute (PMI) which was founded in 1969 in the United States by a handful of volunteers whose goal was to set up an organisation where its members can discuss relevant issues and share their experiences in managing projects. PMI widely organises project professionals, and serves the interests of the project management practice as a whole. Its underlying premise is that the tools and techniques of project management are common across the diversity of project application areas, ranging from the pharmaceutical industry to construction. Thus, PMI focused its efforts on project management while considering that differences between various business sectors are of less significance and can even impede the development of the standard model (Garel, 2013).

Initially, PMI relied on scientists, engineers and technicians from a myriad of organisations, but mainly from NASA and the Department of Defence (DOD) who have used a highly technical and rational view by sharing knowledge and experience from numerous successful projects. For example, the methods and best practices of the Apollo and Polaris projects were institutionalised and disseminated (Johnson, 2002; Webb, 1969). Furthermore, the American Federal Government played an important role in further disseminating the PMI's standard model making it a requirement for any response to a call for tender. The Pentagon played a major role in training European military engineers in the use of an arsenal of tools such as PERT[1], CPM[2] and the Gantt chart. Some of the engineers and technicians subsequently left the military and became

[1] Program Evaluation and Review Technique
[2] Critical Path Method

independent consultants. They helped diffuse planning methods and tools to other sectors and far from local markets (Blomquist and Söderholm, 2002).

A management system for large engineering projects illustrates the mechanism for diffusing management tools through institutions and practices (Garel, 2013). The aim was to control budget and schedule deviations with respect to a point of reference. For example, earned value is a reference to the "cost specifications" of the PMI. This tool originated in the 1980s at the initiative of main American agencies such as, the Department of Defence (DOD), the Department of Energy (DOE) and NASA. These institutions forced their sellers (suppliers) to use the same project monitoring tools instead of other progress indicators. This, in turn, triggered a snow ball effect leading a worldwide spread of these tools, thus affecting thousands of subcontractors around the world. Soon, the method was to become the norm for large engineering projects ranging from nuclear power stations, ship building, to oil refineries and infrastructure.

PMI organised annual conferences which progressively enabled it to standardise professional practices in project management by drawing on further knowledge and experience of project management professionals and other academics from the engineering professions. The results of this standardisation are embodied in the following initiatives which contributed significantly to the institutionalisation of the standard model:

- Introduction of the PMBOK Guide as a process-based (see Figure 2) descriptive foundational standard for project management in 1987. Subsequent versions were further updated in 1996, 2000, 2004, 2009, and most recently a fifth edition (in January 2013). The PMBOK Guide is available in at least eight languages,

- Development of certifications which recognise the proficiency of project professionals in many areas including their compliance with a code of ethics. These certifications are based essentially on the PMBOK Guide as the main source of standardised body of knowledge in project management,

- Adoption of an ethics charter and an oath with the objective of producing the professional project manager (based on the model of standard professions).

The aforementioned initiatives contributed succinctly in creating a shared identity for project actors. According to Blomquist and Söderholm (2002), their professionalization and certification enabled them to constitute a "new social group." Such a group can be called a "community of

practice" (Wenger, 2000) as they share the same professional orientation and also their experience to improve their own knowledge.

2.2. PMBOK GUIDE

In our study, the artefact we consider is the PMBOK. As we will see, it has largely evolved since its inception in 1987. The latest version of the PMBOK Guide includes the following 10 knowledge areas, each comprising a set of processes as shown in Figure 2 below. These knowledge areas are: (1) Integration management; (2) Scope management; (3) Time management; (4) Cost management; (5) Quality management; (6) Human resource management; (7) Communication management; (8) Risk management; (9) Procurement management; (10) Stakeholder management. According to the PMBOK Guide, project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. Thus, the 47 processes which are organised into 5 groups (see Figure 3) require rigorous application and integration. The interaction of these processes is specific to each project life cycle phase.

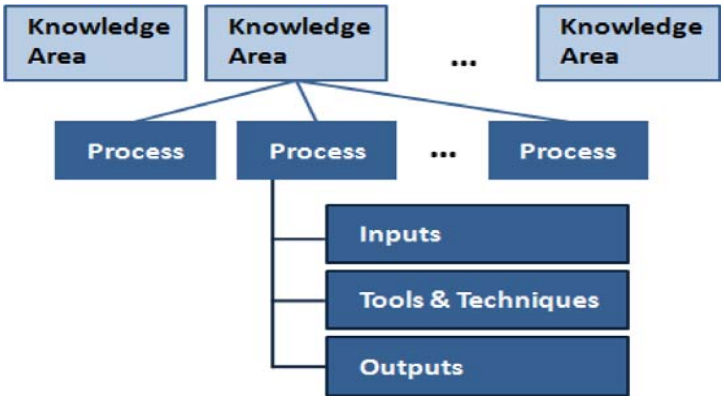

Figure 2. PMBOK Standard Model Components (Von Wangenheim et al, 2010)

These process groups are (see Figure 3): (1) Initiating process group which involves the definition of a new project or new phase and obtaining authorisation; (2) Planning process group which requires to establish the scope and refine objectives while defining an implementation strategy; (3) Executing process group are the processes performed to complete the work defined in the project management plan; (4) Monitoring and controlling process group are the processes required to track, review and regulate the project's progress and performance; (5) Closing process group are the processes required to finalise all activities across the process groups including procurement closure and administrative closure of the project. A process is a set of interrelated activities performed to accomplish a pre-

specified result, product or service. Each of the aforementioned processes is characterised by a set of inputs, a number of tools and techniques that may be applied, and the resulting outputs (Figure 2).

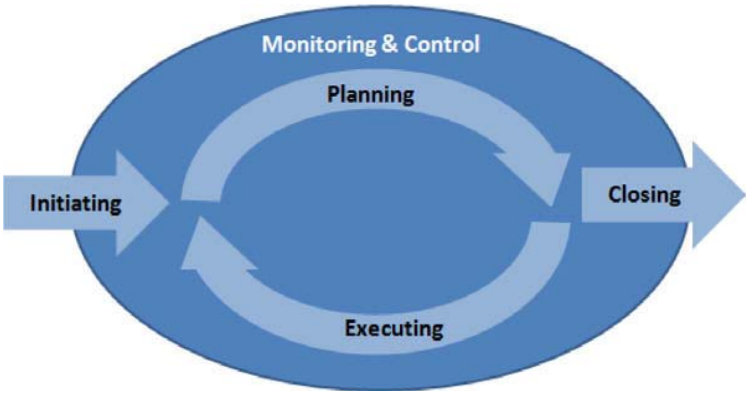

Figure 3. Project management process groups (source: PMI, 2013)

3. METHOD AND DATA

To answer our research questions, an exploratory single case study method is adopted following the recommendations of Eisenhardt (1989), having specified a priori the theoretical notions that guide our enquiry. We use two data sources to explore our research questions: existing versions of the PMBOK Guide and the content of the official website of the PMI which holds information about diverse CoPs. The joint qualitative data analysis of these data sources enabled us to identify key indicators to activities, mechanisms, and their interplay which enabled us to answer the posed questions. Furthermore, the examination of different versions of the PMBOK Guide starting from its initial development enabled us to identify a set of content changes that we summarised in Table 1. In addition, we also note changes in structure, writing style, project management process designation, and the use of terms which would presumably facilitate translation into other languages while minimising the risk of semantic confusion.

Subsequently, we examined the PMI's official website where there is a dedicated section to CoPs and their activities (see Table 4). This section also includes a knowledge repository which consists of all the official project management standards that the PMI has developed over time through the involvement of its members, volunteers and various CoPs. These standards represent application area extensions and are referred to as "Competencies." They are shown in Table 2. In addition, empirical material based on some CoPs activities was used to triangulate our data.

3.1. DATA ANALYSIS

EVOLUTION OF THE PMBOK GUIDE

The data summarised in Table 1 shows a myriad of facts which suggest a substantial evolution of the PMBOK Guide supported by diverse indicators affirming gradual changes in a number of important aspects. Accordingly, we note a pattern of change corroborated by an expansion in the volume of knowledge areas, associated with a similar expansion in the number of processes, and tools and techniques. Similarly, we note that the shear size of the PMBOK Guide has more than tripled over the years. The 1996 edition comprised 182 pages, while the 5th edition of 2013 reached 606 pages. Furthermore, we identify that recent editions have started to show more emphasis on general management tools and techniques and interpersonal skills. We believe this reflects a cross-fertilisation of project management with general management. This may be in fact due to the increasing recognition by the PMI that the PMBOK Guide should integrate some of the recommendations emanating from the long standing criticism it received from various academics in the field, notably Cicmil and Hodgson, (2006); Winter et al., (2006); Lenfle, (2008) for its heavy reliance on rational determinism.

PMBOK Guide	**Initial Development**	**1986-87 Update**	**1996 Update**	**2000 Ed**	**3rd Ed 2004**	**4th Ed 2008**	**5th Ed 2013**
N° of Processes			**37**	**39**	**44**	**42**	**47**
Project Management Tools and Techniques <u>All assigned to processes</u>	**NA**	**NA**	**NA**	**32**	**56**	**148**	**155**
General Management Tools and Techniques <u>Unassigned to processes</u>	Gradually introduced since the 1996 Update, the majority of these tools has <u>not</u> been <u>assigned to processes</u> but is nevertheless useful for project management. These tools include various contract forms; document template such purchase order, hierarchical organisational charts, responsibility assignment matrix (RAM); motivation theories and models such as hierarchy of needs, motivation needs model, theories X, Y, and Z; project manager's interpersonal skills; Tuckman team development model; procurement templates such as invitation for bid and request for proposal.						
Knowledge Areas	**6**	**6**	**9**	**9**	**9**	**9**	**10**
Volume (pages)	**NA**	**NA**	**182**	**257**	**404**	**506**	**616**

Table 1. Some key indicators of the evolution of the PMBOK Guide

However, the aforementioned periodic changes that this artefact has undergone over the years suggest the existence of a set of antecedent conditions which led to such evolution. These conditions relate to the historical events mentioned earlier in this article. Concurrently, its use as

a standard by various project management professionals around the world and in different contexts means that it has an ongoing interaction with human actors. The data analysis reflects considerable increase in the number of participants and volunteers who represent PMI chapters worldwide, and who have – the majority of them, and despite their diversity – to a greater extent been PMP certified (see table 3).

Data analysis also shows an insightful pattern which reflects significant changes in the committees structure of the participants in the standards development projects (see table 3). This structural change has been ongoing since initial development; nevertheless, it appears to have been relatively stable from the 3rd edition onwards. Participants, not only increased in number, but their credential and qualifications also increased. This may be partly due to a requirement from the PMI. For example, we note that from the 3rd edition of the PMBOK Guide onwards, an average of 80% of committee members were PMP certified, while an increasing number holding PhD, Msc, and MBA degrees. Evidence from the PMI's website shows that other foundational standards, practice standards and frameworks, practice guides and PMI standards extensions represent additional knowledge artefacts that were developed by the PMI (see table 2), but the scope of their success remains very limited. Therefore, the PMBOK Guide remains the foundational standard that enjoys the most global success.

PMI Document Standard	Competencies
Foundational Standards	PMBOK : A Guide to the Project Management Body of Knowledge Fifth Edition
	The Standard for Program Management- Third Edition
	The Standard for Portfolio Management- Third Edition
	Organizational Project Management Maturity Model OPM3-Third Edition
Practice Standards and Frameworks	For Project Risk Management
	For Earned Value Management- Second Edition
	For Project Configuration Management
	For Work Breakdown Structures-Second Edition (reaffirmed)
	For Scheduling-Second Edition Practice Standard for Project Estimating
	Project Manager Competency Development Framework-Second Edition
PMI Standards Extension	Software Extension to the PMBOK Guide-Fifth Edition
	Construction Extension to the PMBOK Guide-Third Edition
	Government Extension to the PMBOK Guide-Third Edition
Practice Guides	Managing Change in Organizations: A Practice Guide

Table 2. PMI document standards (source: www.pmi.org)

EVOLUTION AND PARTICIPATION OF CoPs

Data from the PMI's official site shows 33 CoPs designated mostly by professional category i.e., financial services industry, information systems; and to a lesser extent by project management knowledge area i.e., requirements management, scheduling (see table 4 and figure 4). However, although this information is useful, it remains parsimonious for our purpose. This is because, in addition to the other data sources we used for this study, we have been unable to identify in which country they (CoPs) are based. Our understanding leads us to suggest that since CoPs occur mainly online, geographical location becomes somewhat irrelevant. Furthermore, we can assert that since acquiring a PMP[3] is a pre-requisite for project managers and not project management enthusiasts, we have considered that most members of CoPs are project managers who share real experiences and stories with their relevant CoPs. The aggregate effect of this process entails some form of knowledge accumulation and diffusion to / by a given CoP.

Knowledge concerning project management is created locally through the experience shared within each chapter worldwide. Membership to the PMI precedes that of CoP, but nonetheless appeals to project management professionals who seek it to achieve visibility to other CoPs and professional organisations. Such membership entails - quite informally - an enrolment on various CoPs who may be categorised by competencies according to their diverse areas of expertise. Concurrently, membership also provides recognition by other project management professionals. Enjoying such recognition means not only acquiring an identity, but sharing common practices which might trigger tacit knowledge flows. However, the process of knowledge flow requires that various CoPs organise their activities - either formally or informally - while interacting with artefacts (PMBOK Guides).

Prior to its integration and stabilisation in the PMBOK Guides, the transfer of knowledge between PMI chapters is primarily associated with access to new knowledge in networks of inter-chapter relationships. These relationships form through PMI official website tools such as blogs, wikis, knowledge repositories, and tools available at the CoPs section of the PMI site, hence CoPs occur mainly online to acquaint themselves with practitioners on a global level (table 4 and figure 4). This section of the PMI website often offers discussion forums and webinars for PMI members. In addition, the PMI organises some annual events and activities which rally multi-sector practitioners in project management periodically under the banner of

[3] Project Management Professional (PMP) is a certification delivered to project professionals in recognition for their literacy in all knowledge areas and related processes of the PMBOK Guide. The certification exam lasts 4hrs and the PMI requires the demonstration of a set of rigorous conditions for candidates' eligibility to book an exam session

global congresses and events. Examples of such events include the PMI research and education conference; PMI global congress North America; PMO symposium; a set of Asia Pacific regional events (for more details, please visit: http://www.pmi.org/Professional-Development)

PMBOK	Initial Development	1986-87 Update	1996 Update	2000 Ed	3rd Ed 2004	4th Ed 2008	5th Ed 2013
Standards MAG[4] members	NA	NA	15	6 67% PMP[5]	8 62.5%PMP	11 64% PMP	13 77% PMP
ESA[6] management group	10	NA	NA	NA	NA	NA	NA
Core team members	NA	NA	NA	8 50% PMP	9 89% PMP	9 67% PMP	12 83% PMP
Update Project team members	NA	NA	NA	NA	235 67% PMP	144 53% PMP	NA
Significant Contributors	NA	20	14	12 (75%PMP from chapter 11)	10 82% PMP	8 50% PMP	9 77%PMP
Update Sub – team / sub-committee members	NA	6	NA	NA	11 82% PMP	10 80%PMP	17 82.7%PMP
Content Contributors/ committee	NA	NA	NA	NA	NA	62 68% PMP	52 80.7%PMP
Operations team	NA	NA	NA	NA	9 89% PMP	15 93% PMP	NA
Draft Reviewers	NA	NA	93	148 66% PMP	134 53% PMP	381 84%PMP	496 73% PMP
Volunteers	25 US chapters	NA	NA	NA	437	NA	NA

Table 3. Evolution of CoPs members with the PMBOK Guide

[4] Members Advisory Group
[5]This is the percentage of PMP certified member volunteers from the total number of volunteers or participants in the various committees who took part in the successive PMBOK Guide standards development projects
[6] Ethics Standards and Certification committee

According to Lave and Wenger, (1991); Powell et al, (1996); Hansen, (1999) the aforementioned activities are representative of the evolution of CoPs.

Membership to the PMI precedes certification for any PMI participant. Therefore, to get involved in a standards development project, participants must be members and/or certified participants. This facilitates their further involvement in various CoPs. However, we have not been able to identify at this stage, on what basis volunteers and participants in standards developments projects are selected. Though the data analysis in conjunction with the summary provided in table 3 indicate that a PMP certification and higher academic credentials may be advantageous for any potential participation.

Empirical analysis of the various editions of the PMBOK Guide points to its evolution as a consequence of a number of episodic KT cycles whose key actors and contributors are the CoPs involved in the various globally distributed PMI chapters. These, by virtue of the diversity of their functional areas capture valuable knowledge which is formalised in subsequent editions of the PMBOK Guide. Members of a given chapter typically engage with project practitioners from varied sectors and confer for networking and educational events. Furthermore, these practitioners share their interest in specific sectors or area of practice. Typically, members of a CoP would collaborate to create project management knowledge and resources that fit the needs of the community, while advancing the profession. To achieve this, they resort to information technology tools made available by the PMI on its website platform. These may be forums, wikis or some kind of content management system, or webinars. Even new members can help shape activities in specific CoPs. In addition, according to the PMI, chapters and communities present great opportunities for developing leadership skills. All activities are organised and led by members (PMI website).

The aforementioned KT process repeats itself cyclically, the results of the data analysis suggest that PMI first routinised the KT cycle by involving a diversity of CoPs who standardise their project management practices by learning the PMBOK Guides as a pre-requisite for certification. Then these CoPs interact through annual events, symposiums and conferences organised by the PMI, and through the PMI's official member's website. This allows them to contribute significantly to the knowledge flow process. Subsequently, the PMI, through its episodic standards developments projects involves various CoPs members who engage into these projects with a view of producing standards and further developing them.

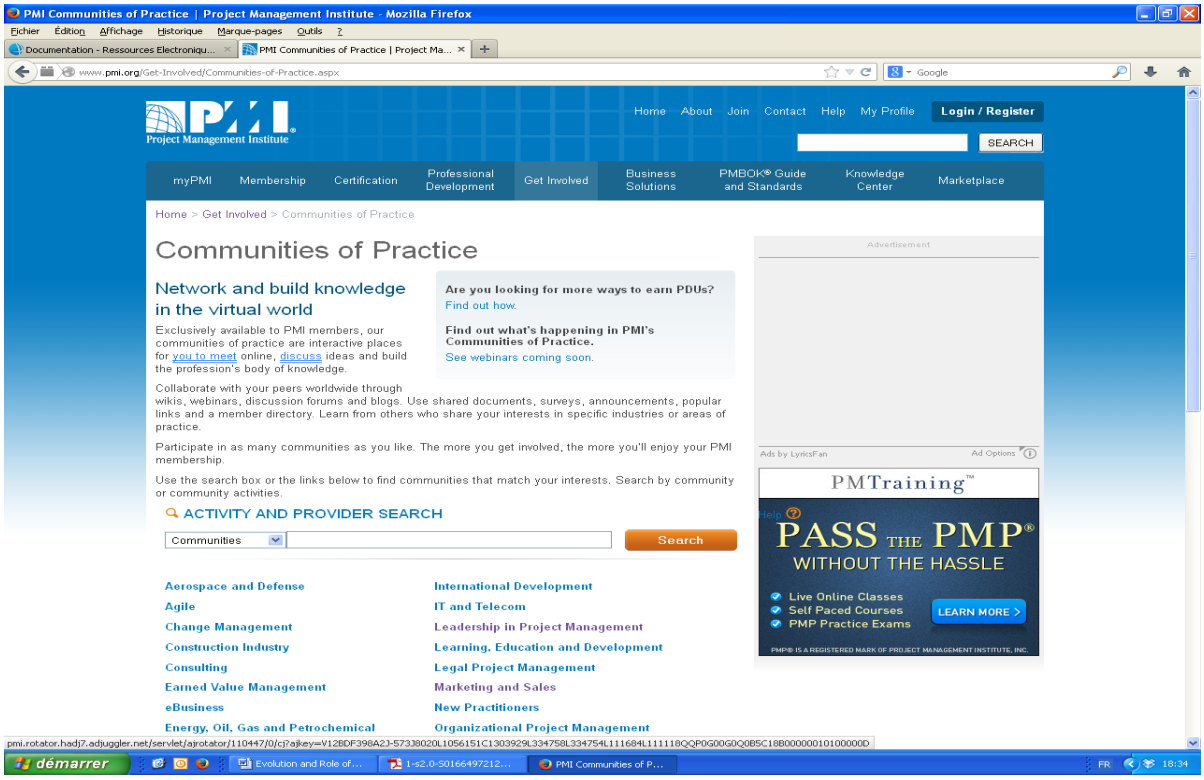

Figure 4. Communities of Practice page on the official PMI website (http://www.pmi.org/Get-Involved/Communities-of-Practice.aspx)

Such episodic process enabled the PMI to routinise KT, internalise knowledge and integrate it into its various standard artefacts such as the PMBOK Guides, and many others (see Table 2). Therefore, we contend that the inter-chapter activities of diverse CoPs who get involved in the KT process is an indication of their evolution, an evolution that is interactive and integrative of the PMBOK Guides. Further evidence of this argument can be found by corroborating data from tables 3 and 4. Accordingly, interpreting the data enabled us to observe an episodic bi-directional cycle of KT from the PMBOK Guides to the CoPs. And this cycle reflects that during this process the increased knowledge encapsulated in the successive editions of PMBOK Guides serves as certification material for further project management professionals who inevitably become members of the PMI, and most probably of a CoP. We can then assert that CoPs co-evolve with the PMBOK Guides through the KT cycle.

PMI CoPs: (1) Aerospace and Defense; (2) Agile; (3) Change Management; (4) Construction Industry; (5) Consulting; (6) Earned Value Management; (7) eBusiness; (8) Energy, (8)Oil, (9) Gas and Petrochemical; (10) Ethics in Project Management; (11) Financial Services Industry; (12) Global Diversity; (13) Global Sustainability; Government; (14) Healthcare ; (15) Human Resource Project Management; (16) Information Systems; (17) Innovation and New Product Development ; (18) International Development; (19) IT and Telecom; (20) Leadership in Project Management ; (21) Learning, Education and Development; (22) Legal Project Management; (23) Marketing and Sales; (24) New Practitioners; (25) Organizational Project Management ; (26) Pharmaceutical; (27) Program Management Office ; (28) Project Management Quality; (29) Project Risk Management; (30) Requirements Management; (31) Scheduling; (32) Service and Outsourcing; (33) Utility Industry .

Each of these communities of practice has a mission and a focus on sharing knowledge and practices and creating awareness of the current industry sector's challenges. i.e., **PMI Government CoP:** Public sector project management practitioners with a mission to help advance principles and practices in public sector project management, while promoting the exchange of information among government professionals; **PMI Innovation and New Product Development Cop:** Aims to provide forums for advancing the state of the art project management applied to new product development; **PMI Leadership in Project Management CoP:** For project practitioners in all stages of their career to come together to share knowledge and build their own leadership capabilities.

Table 4. CoPs involved with the PMI (source: www.pmi.org)

The standards developed by the PMI whose main foundational standard is the PMBOK Guide describe the principles and processes that shape the practices that are unique to projects (PMI, 2013). Standardisation can be seen as the cornerstone of a replication process, the implementation of which led to the unprecedented success of the PMI in replicating chapters on a global scale. However, these standards evolve as the characteristics of the environments of their distributed chapters change. More experience is accumulated as local chapters explore new contexts. Therefore, alterations and improvement are periodically (episodically) carried out and organised as standards development projects which involve a significant number of committee members (see Table 2 for changes occurring across different versions). Therefore, the PMI routinized chapter replication worldwide using the PMBOK Guide as the central source of knowledge for the project management profession. Such routinisation was significantly supported by the certification programme. Thus, it is through certification and / or membership to local chapters that CoPs are created. This process is depicted in Figure 5.

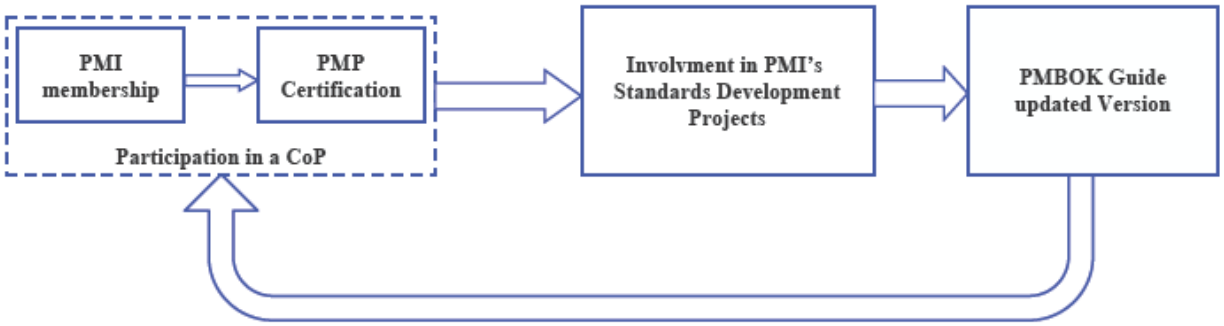

Figure 5. The PMI's Knowledge Transfer process

INTERACTION MECHANISMS

This empirical case enabled us to identify interaction mechanisms between the CoPs and the PMBOK Guides. These interaction mechanisms represent the organizational mechanisms that support the organisational KT process. Thus, we identify three mechanisms, the first is the PMI website and its associated information technology tools such as discussion forums, databases, wikis and webinars; the second is the standards development projects; and the third represents the annual events organised by the PMI. These events include the PMI Global Congress, the research and education conference, the PMO symposium, and the Asia pacific regional events. Most of the interactions between the PMBOK Guides and CoPs go through these mechanisms. CoPs standardise their project management practices by learning the PMBOK Guide as a first step towards certification. Then these some CoPs members interact through annual events organised by the PMI and through the PMI's official member's website and its associated tools. This allows them to contribute significantly to the knowledge flow process. Subsequently, the PMI, through its episodic standards development projects involves various members of CoPs who engage into these projects with a view of codifying new knowledge learned through the practice of their relevant disciplines and producing and developing further standards.

The PMBOK Guide recommends one way of capturing knowledge from projects through the "lesson learned" in the close project or close phase process groups which correspond to project integration management knowledge area. "Lessons learned" is a document that is filled by a project manager and perhaps other project partners, depending on the project organisation. This document includes what has been learned in a given project and will often serve as an input to future similar projects under the banner of "organisation process assets". It is a way of capturing knowledge that is novel and practically useful. However, we believe that CoPs accumulate knowledge and shared experience through the mechanisms we have cited above. The process of

knowledge selection by CoPs and the transformation of tacit knowledge to knowledge that is easily codifiable in artefacts go beyond the scope of the present work, though we do not downplay its importance.

4. DISCUSSION AND FRAMEWORK

In the present work we have addressed three questions. First, how artefacts like the PMBOK guide of project management has evolved over time? Second, how project management CoPs have evolved? Third, what are the interaction mechanisms between the PMBOK guide and the project management CoPs?

Building on sociomateriality (Orlikowski and Scott, 2008) and the theoretical notions of arrow core (AC) and template from the works of Winter and Szulanski (2001), we shed light on the knowledge transfer process and the co-evolution of the PMBOK guide and project management CoPs. In so doing, we aim to better articulate the interactive relationship between the social and the material by showing how KT occurred and how it enabled this co-evolution process.

Our findings stand in contrast to prior assertions which stated that beyond acquisition and exploitation, the integration and exploitation of knowledge remain problematic for organisations (Mowery et al., 1996; Powell et al., 1996). We argue that this owes to the fact that previous studies largely disregarded the determinant role that CoPs can play in the KT process, in addition to their imbrication in artefacts. Thus, we define knowledge flow as an interactive co-evolutionary process which involves the “agencement” of artefacts and Cops (see Figure 6). Wenger, (1999) describes this phenomenon as reification of knowledge and contends that the duality of participation and reification is key to learning processes in the context of CoPs. He adds that via their (CoPs) participation, knowledge is constructed and reified. Conversely, reified knowledge triggers more participation.

We identify that artefacts not only matter, but they determine action, which depends to a certain extent on an adaptation to local conditions. Evidence of this assertion is supported by the certification program of the PMI which is based on learning and mastering the standard of the project management profession, i.e. the PMBOK Guide as a pre-requisite for certification. Only after this step is achieved can a project management professional get effectively involved in a

PMI committee and become a volunteer contributor in standards development projects[7] which embed skills and knowledge into the PMBOK Guide and other foundational standards (see Figure 4). However, this stands in sharp contrast with the statement of Hatherly et al. (2007) that artefacts plainly matter, but do not determine action. Concurrently, the empirical analysis reflects that, once embedded in artefacts, skills and knowledge tend to be more stable, and this accords with the assertions of Latour, (2005) and D'Adderio, (2008). We argue that this stability owes to the inanimate characteristic of this knowledge and its stickiness and reification in artefacts such as the PMBOK Guide and other foundational standards and practices. This assertion is supported by the degree of dissemination of project management knowledge from the PMBOK to millions of professionals.

We could also add that standardized knowledge participates largely to the recognition of project management as a profession. Indeed, reification of knowledge and certification processes are typically associated with professionalization, viewed as applying abstract knowledge to particular cases (Abbott, 1988). Thus, reification appears as a cornerstone for the claims of jurisdiction, i.e. the control of a social group over a social activity. Finally, through the elaboration of artefacts, the profession transfers knowledge in such contexts as the engineering and business schools, leading to specific curricula in these institutions.

The identified interaction mechanisms alongside the process depicted in Figure 5, point to an episodic cyclical KT process which alternates between exploration and exploitation. Indeed, the former enables the repeated creation of chapters and associated CoPs. These capitalise on existing project management standards and best practice – as codified in a current used version of the PMBOK Guide -, while the latter enables the exploration of additional knowledge captured by existing CoPs in their relevant domains of expertise, in different chapters. This last process facilitates the refinement and evolution of the knowledge reified in the PMBOK Guide. Thus, this cycle is repeated episodically (see figure 6). In fact, it has been routinised by the PMI through the standards development projects and PMI chapter replication.

In contrast with intra-organizational CoP, our case explores an inter-organizational diffusion and transfer of knowledge. We determine that various PMI Chapters replicated worldwide bear considerable resemblance to outlets in replication as strategy (Winter and Szulanski, 2001) and that the interaction between CoPs and the PMBOK Guide is central to the KT process. The

[7] Standards development projects are projects undertaken by the PMI on a temporal basis when there is sufficient evidence supporting significant changes in professional practice areas with regards to project management. For example, the PMBOK Guide's standards development project is organised on the basis of a five year life cycle.

routine activities developed by the PMI occur between the globally distributed CoPs. Following Winter and Szulanski, the replication process entails two main sub-processes: Arrow core (AC) and template refinement (see figure 6). These sub-processes laid the theoretical foundations for replication as strategy and build in a significant way on evolutionary theory as conceived by Nelson and Winter (1982).

The phenomenon of replication is commonly known as the "McDonald's Approach", and involves the successful reproduction of similar outlets, on a large scale, in different geographical environments to deliver a product or provide a service. Replication is present in numerous business sectors including the hospitality industry, the insurance industry, and the education sector. Replicating organisations implies to replicate a model in a variety of locations. In doing so, organisations develop dynamic capabilities to routinise knowledge transfer (KT). To effectively leverage causally ambiguous success, replicators become adept at reproducing complex routines and maintaining them in operation in dispersed locations. Replication strategy lends itself to two basic activities: exploration in which the model is created and honed to unravel the arrow core and then exploitation in which the model is stabilised and leveraged through replication (Love 1995, Schultz and Yang 1997, Bradach 1998). The transition between such phases involves the creation of dynamic capabilities to support subsequent KT routine activities. Replication is a strategy that relies on uncovering and rapidly implementing the AC.

AC is defined as the knowledge whose attributes are worthy -or perceived as worthy- to replicate. Therefore, the AC comprises the local information which accounts for the value-creation potential of the model when it is leveraged by replication; it specifies which traits are replicable. Furthermore, knowledge regarding the AC is not available at the outset; it is acquired through experiential learning, i.e., through KT cycles.

Template is another central component of replication and refers to the successful example of an outlet; the outcome of a successful replication strategy. Some of the features of a template are not in the AC, those that are un-replicable such as the leadership skills of the manager of a given outlet. In addition, some of the features of a template might be tacit. A template is understood as a working example and the AC and is embedded in the template because its content is learned from early experience from the outlet, it informs about the replication process.

In our case, the AC corresponds to the PMBOK Guide, while the template corresponds to the PMI chapters and their enrolled members. Knowledge flows occur during each KT cycle where CoPs play a significant role, notably through their participation in the standards development

projects. However, this does not mean that knowledge exchange does not occur between them outside of the standards development projects. Accordingly, the AC knowledge evolves with each KT cycle as reflected by the PMBOK Guide (see figure 6). Therefore, more of the AC becomes known as more knowledge is transferred to the PMBOK Guide. Concurrently, the template also undergoes a refinement as a consequence of this process. Indeed, the creation of additional PMI chapters in different locations involves additional local enrolments of project management professionals from diverse activity sectors. Some of these professionals may have been certified using a particular version of the PMBOK Guide. Through the various interaction mechanisms, these professionals share their specialised knowledge and contribute to its evolutions in the project management profession. Such knowledge is codified in various document standards including the PMBOK Guide (see table 2). This process of de-contextualising knowledge and its consequent codification in various repositories and standards has transformed knowledge into something easier to describe, share, visualise and transfer in time and space across heterogeneous CoPs and multiple locations. Thus, we may add that stickiness is overcome due to the long cycle of 5 years during which sufficient knowledge, practices and debates would have stabilised through the interaction mechanisms between artefacts and CoPs.

Management scholars have treated questions of KT in inter-organisational contexts from two distinct theoretical conceptions (Winter and Szulanski, 2001). The first considers KT as a one time act aimed at replicating knowledge that is fully known at its source, while the second conceives it as a process enacted by an organisation to reproduce causally ambiguous and complex sets of routines in new contexts and environments. Subsequently, the organisation progressively hones its ability to manage this process through repeated experience, thus developing dynamic capabilities. Thus, drawing on past research, and for the purpose of our study, the definition of KT requires the examination of further concepts related to replication strategy (Winter and Szulanski, 2001). This is because the literature on KT has largely viewed KT as a process that is centered on “learning performance” and “organisational performance”, while largely ignoring who are the real actors who contribute to the capturing and transferring of knowledge. In this paper, we argue that these actors are CoPs and that their actions are facilitated by their interaction with artefacts such as the PMBOK Guide, as well as other foundational standards. We contend that in this empirical example both of the aforementioned theoretical conceptions of KT (Winter and Szulanski, 2001) are relevant.

This analysis has helped to clarify the process of KT which has somewhat received little attention in the sociomaterial debate by making explicit the interactions between different agencies. Sociomateriality has enabled us to bring to life actions and artefacts. Artefact-embedded knowledge shapes subsequent actions and is often shaped in return.

The evidence put forward had thus captured the complete cycle of interaction and adaptation between an artefact and CoPs. This evidence conforms to what Orlikowski and Scott (2008) refer to as research stream II, where the social and the material are viewed as mutually dependent ensembles involved in a process where interactions and outcomes are reciprocally dependent, integrative and co-evolving. In fact, we contend that this particular theoretical conception resolves the causal ambiguity associated with inter-organisational knowledge flows enacted by communities of practice.

In a similar fashion to the works of Orlikowski and Scott (2008), the attempt made by McIver et al (2012) to integrate the "commodity view " and the "community view" focused on the act of knowing through practice. This practice-based perspective integrates knowledge as an artefact (commodity) and a CoP (community) by focusing on value creation that emerges out of their integration from the situated actions of members of these CoPs. In fact, some agencies inscribed their worldviews in artefacts. Therefore, enrolling artefacts in this integrative view created stronger agencements that are more stable and closely interconnected into the web of inter-organisational relationships.

The KT process orchestrated by the PMI as an episodic bi-directional process was identified as a practice that emerged out of the imbrication of artefacts and humans. This practice developed into a routine that enabled the PMI to sustain the continuous development of professional standards in the domain of project management. The sociomaterial approach we have adopted in our empirical example fits adequately with the theoretical notions of AC and template, as both are underpinned by the interaction of artefacts and humans in a co-evolution perspective. Thus, both our theoretical anchoring and methodological approach are coherent.

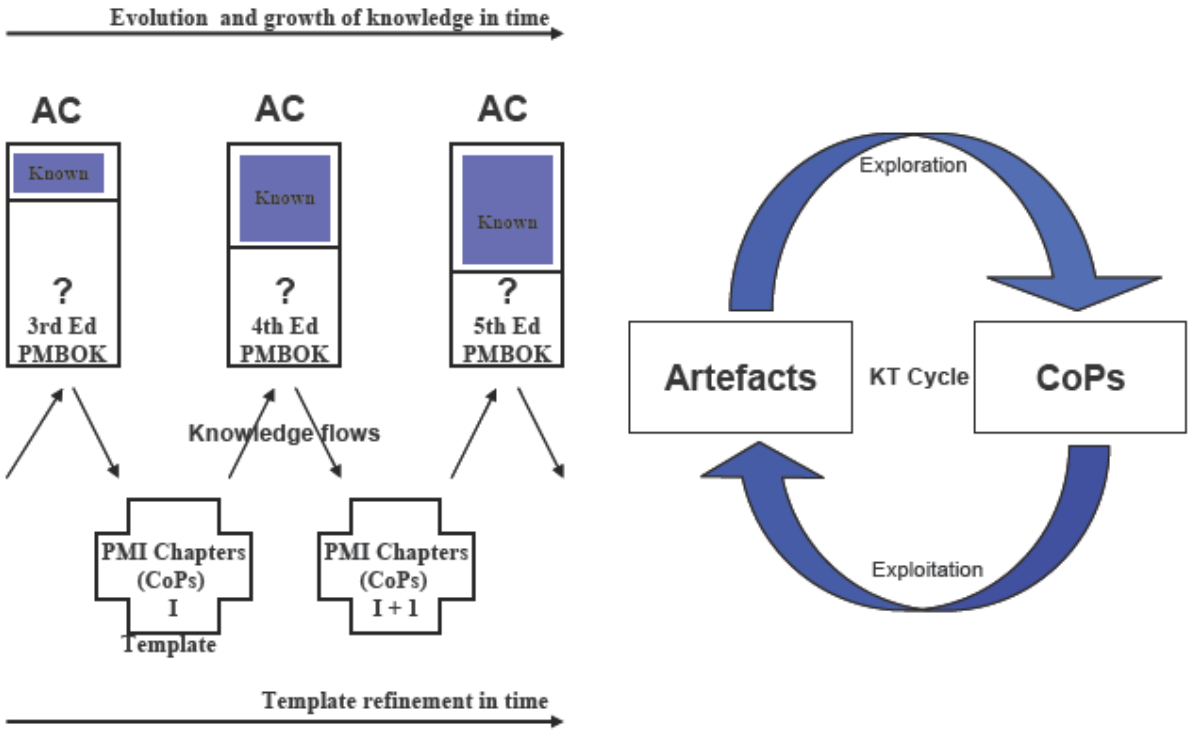

Figure 6. Theoretical Framework

5. CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

We have put forward empirical evidence which suggests that the PMBOK Guide co-evolved with the PMI's CoPs from different chapters through a set of episodic bi-directional KT cycles alternating between exploration and exploitation. A theoretical explanation of the knowledge transfer cycle was also put forward. Such cycle is programmed by the PMI as a series of standards development project (every five years for the PMBOK Guide). Members of various CoPs offer their valuable time and expertise as volunteers and are organised as committees in the project. We have also been able to identify how the PMBOK Guide has evolved in relation to the involved CoPs and that such evolution involves KT from CoPs of various PMI chapters. Supported by the aforementioned discussion, the results of the present work stand in sharp contrast to some of the long standing assertions made in past literature, these assertions relate to KT and the co-evolution of the imbrication between the social and the material. Here, we refer to Hatherley et al, (2007) and their claim that artefacts do not determine action; and the co-evolution the social of the material in the works of Orlikowski and Scott (2008) who used the term entanglement to refer to an evolution in time. We believe our case reflects a co-evolution in time and in space.

Both the sociomaterial approach and the theoretical notions of AC and template enabled us to explain the process of knowledge flow and the role played by CoPs in the replication process engaged by the PMI. This organisation created value sustainably by selecting the suitable components to replicate its model globally. Such components represent its geographically distributed chapters whose routine creation is facilitated by the PMBOK Guide and the CoPs. In so doing, the PMI developed dynamic capabilities to routinize KT. These, facilitate the transition between the two fundamental activities of exploration and exploitation, thus enabling KT. We contend that the AC is represented by the PMBOK Guide and the template by the PMI Chapters. Thus, we contribute by showing that the template and the AC are interactive and co-evolve in a joint agency to form practices through their imbrication. Furthermore, reference to Table 2 suggests the existence of many deleterious features of the PMI's foundational standards which have not been part of the replication process i.e., OPM3, program management, portfolio management. This, once again confirms that indeed the PMI did choose a suitable AC as a component to replicate globally.

We suggest that future work could make use of the theoretical notions of Arrow core and template in a process view to explain knowledge flows in inter-organisational relationships. This could be achieved by exploring the knowledge transfer at the micro-level of the CoP and the PMI, especially to deepen our understanding of knowledge selection. Furthermore, we believe that, although included in the template, the arrow core acts as an interaction mechanism while the template assumes a dynamic role in the process of replication.

Our underlying assumption, so far, has been that the knowledge considered in this article refers to codifiable knowledge, while tacit knowledge transfer has not been the focus of our study. We recommend that future studies should attempt to investigate the process underlying the transformation of tacit knowledge into explicit knowledge by CoPs, in other words trying to answer the following question: How do communities of practice capture and transform tacit knowledge into explicit knowledge? We believe that unraveling such process may solve a significant number of challenges for today's knowledge-based organisations. Finally, we hold the firm belief that the PMBOK Guide will continue to develop for many years to come, and that volunteers from different CoPs will also sustain their offer of time and expertise in the pursuit of higher standards of quality and improvement.

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