

A Model of Project Knowledge Management

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ABSTRACT ■

Knowledge is the most important resource needed for project management. The aim of this article is to present a full, consistent model of project knowledge management. There are two basic types of project knowledge: micro-knowledge, needed for performing a single task (or its part), and macro-knowledge (in other words, all the knowledge possessed by people from a given organizational level). Project knowledge is managed at four distinct levels: individual, project, organization, and global. The article describes the micro-knowledge life cycle and macro-knowledge life cycles from each organizational level, as well as the processes of vertical knowledge flow between organizational levels.

KEYWORDS: project knowledge management; micro-knowledge; macro-knowledge; knowledge life cycle; vertical knowledge flow; organizational knowledge; global knowledge; individual knowledge; project knowledge.

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INTRODUCTION ■

Proper knowledge is a basic prerequisite for effective project management.

According to Sankarasubramanian (2009), all projects have one thing in common—knowledge. The Japanese project management standard recognizes knowledge and experience as the main sources of project value (Project Management Association of Japan [PMAJ], 2005a, p. 86). Projects may be seen as knowledge management processes (Sauer & Reich, 2009). Project knowledge management, especially in complex projects, is one of the main success factors in project management; lack of project knowledge management is one of the main reasons for project failure (Desouza & Evaristo, 2004). Knowledge about project management, explicit as well as tacit, plays a decisive role in understanding this discipline (Morris, 2004).

Systematizing the area of project knowledge management is the main goal of this article. This area, which developed in parallel to other areas of knowledge in project management like risk management, quality management, or communication management, has up until now not been as systematized as those areas, which are described in detail in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*. The relatively short period in which practitioners and researchers have been interested in project knowledge management is probably the main reason for this situation. The first papers about project knowledge management date back to 1987 (Boddie, 1987; Gulliver, 1987) and have attracted the attention of practitioners and researchers since that time. Many articles, some books (Love, Fong, & Irani, 2005; Milton, 2005; Sense, 2007a), and special issues of professional journals devoted to project knowledge management (DeFillippi, 2001; Lampel, Scarbrough, & Macmillan, 2008; Love et al., 2005; Reifer, 2002; Susman & Majchrzak, 2003; Sydow, Lindqvist, & DeFillippi, 2004) have been published. Project knowledge has been collected in bodies of knowledge (e.g., Association for Project Management [APM], 2006; Project Management Institute [PMI], 2008a), standards (e.g., International Organization for Standardization [ISO], 2003), competency standards (e.g., International Project Management Association [IPMA], 2006), methodologies (e.g., Office of Government Commerce [OGC], 2005; PMAJ, 2005a, 2005b), and maturity models (e.g., PMI, 2008b; Software Engineering Institute [SEI], 2006).

In order to systematize the area of project knowledge management, we first have to understand the main approaches to the definitions of knowledge management. These definitions may be divided into two main groups; the first focuses on processing the single knowledge element and enumerates functions of its life cycle. The following definitions may be mentioned here:

- Knowledge management is a process of systematically and actively identifying, activating, replicating, storing, and transferring knowledge (Probst, Raub, & Romhard, 2003).

A Model of Project Knowledge Management

- Knowledge management is a method to simplify and improve the process of creating, sharing, distributing, capturing, and understanding knowledge in a company (Karlsen & Gottschalk, 2004).
- The processes of knowledge management include knowledge identification, creation, acquisition, transfer, sharing, and exploitation (Abdul Rahman, Yahya, Beravi, & Wah, 2008).
- Knowledge management is a method of controlling processes of knowledge creation, its codification, ordering, storing, retrieval, processing, transfer, and application (Jemielniak & Koźmiński, 2008).
- Knowledge management scope is about the generation, communication, transformation, and application of knowledge that is sufficient unto the reasoned action in situated contexts in which individuals and organizations find themselves (Zhu, 2008).

Another group of knowledge management definitions and characteristics focuses on the whole knowledge possessed by individuals and organizations and the benefits of its application:

- Knowledge management is a process of systematically and actively managing and leveraging the stores of knowledge in an organization (Laudon & Laudon, 1998).
- The challenge of knowledge management is how to generate and leverage collective knowledge in the firm to create value that leads to competitive advantage (Zhang, 2007).
- Knowledge management is about harnessing the intellectual and social capital of individuals in order to improve organizational learning capabilities (Swan, Newell, Scarbrough, & Hislop, 1999).
- Knowledge management is a systematic approach to managing and leveraging an organization's knowledge assets, which may include knowledge of the organization's customers, products, market, processes, finances, and personal services (Cope, Cope, & Hotard, 2006).

- Knowledge management refers to the developing body of methods, tools, techniques, and values through which organizations can acquire, develop, measure, distribute, and provide a return on their intellectual assets (van Donk & Riezebos, 2005).
- Knowledge management is a disciplined, holistic approach to using expertise effectively for competitive advantage (Arkell, 2007).
- Knowledge management deals with the organizational optimization of knowledge through the use of various technologies, tools, and processes to achieve set goals (Kamara, Anumba, Carrillo, & Bouchlaghem, 2003).

This general classification of knowledge management perspectives and definitions is valid and important for project knowledge management and processes from this area. For example, papers by Prencipe and Tell (2001); Smith (2001); Boh (2007); Tan, Carrillo, Anumba, Bouchlaghem, Kamara, and Udeaja (2007); Blessing, Goerk, and Bach (2001); Schindler and Eppler (2003); Kotnour (2000); Enberg, Lindkvist, and Tell (2006); Jackson and Klobas (2008); Sense (2005); Söderlund (2004); and Whyte, Ewenstein, Hales, and Tidd (2008) describe processes performed in projects on knowledge needed to perform a single activity, or needed for solving a single problem or a component part of one. In the field of project knowledge management, there are also other types of processes that pertain to all the knowledge possessed by people from different organizational levels (i.e., their knowledge assets). Processes pertaining to a project team's knowledge assets are described by, among others, Kotnour (1999); Cuel and Manfredi (2006); Kasvi, Vartiainen, and Hailikari (2003); Bower and Walker (2007); Blessing et al. (2001); K. G. Cooper, Lyneis, and Bryant (2002); Levin and Rad (2007); Hanisch, Lindner, Muller, and Wald (2008); and Reich, Gemino, and Sauer (2008). Other project knowledge management

processes are performed at the level of the organization that carries out the projects. Processes from this level are described by, among others, Kivrak, Arslan, Dikmen, and Birgonul (2008); Disterer (2002); Keegan and Turner (2001); Arthur, DeFillippi, and Jones (2001); Prencipe and Tell (2001); Suikki, Tromstedt, and Haapasalo (2006); Boh (2007); Prencipe, Brady, Marshall, and Tell (2005); Kotnour and Landaeta (2002); Love et al. (2005); Liebovitz (2005); Hill (2003); Levin and Rad (2007); Brady and Davies (2004); van Donk and Riezebos (2004); and Lesseure and Brookes (2004). Project knowledge is managed at the global level, too—the preparation and existence of global sources of knowledge are evidence of this. Vertical knowledge flow—processes of transferring knowledge between different management levels—represents yet another type of project knowledge management process. A relatively low number of publications are devoted to these types of processes, and papers by Walta (1995); Garcia (2005); Snider and Nissen (2003); Nissen and Snider (2002); Ahlemann, Teuteberg, and Vogelsang (2009); Ramaprasad and Prakash (2003); and Gann and Salter (2000) may be mentioned here.

Processes of all these types belong to one discipline: project knowledge management. The development of project knowledge can encounter obstacles. None of the available publications systematizes the field of project knowledge management in a way analogous to systematizing other areas of project knowledge in the bodies of knowledge and standards. The lack of a systematic review of the state of research is considered to be one of the main obstacles to the development of project knowledge management (Hanisch et al., 2008). Inconsistencies in its literature are to be noted; development of work on project knowledge management is not carried out in any systematic way.

The existence of many perspectives, processes, and types of processes

in a given area makes it natural to aim to systematize that area in order to build a consistent whole. The vast range of reasons for and goals of project knowledge management, combined with the existing evidence for the influence of project knowledge management on project success (Cope et al., 2006; Karlsen & Gottschalk, 2004; Kotnour, 2000; Landaeta, 2008; Liebovitz & Megbolugbe, 2003; Mohrman, Finegold, & Mohrman, 2003; Newell & Edelman, 2008), constitute the rationale for systematizing the current output of project knowledge management research and practice.

Systematizing the field of project knowledge management area is the goal of this article. Building a consistent model that covers all activities related to project knowledge management and taking into account the current state of this discipline is the way to achieve this goal.

Knowledge Scale and Life Cycles

The definitions and general project management processes cited in the previous section show that there is a dimension of knowledge that we will call scale, and there are two main values in this dimension.

• Micro-knowledge

Micro-knowledge is a piece of knowledge needed to perform one task (or its part) or to solve a problem (or its part). A record of price list, the name of a person who may perform some task, or the way of fixing software bugs of particular types are examples of such knowledge.

• Macro-knowledge

Macro-knowledge is the total knowledge possessed by a given person. Training of a single team member in order to supply him or her with the general knowledge needed to participate in project execution is an example of a process performed on all the knowledge possessed by one person. Completing a project team with sufficient knowledge to perform a project is an example of a project knowledge

management process performed at the project level (dealing with all project team knowledge). Implementing a project knowledge management system in an organization deals with all of the knowledge of the organization as a whole. Developing global project management bodies of knowledge is an example of a process performed on all the globally accessible project management knowledge; hence, there are four subvalues to project macro-knowledge:

- individual macro-knowledge (knowledge possessed by one team member),
- project team macro-knowledge (knowledge possessed by the project team),
- organizational macro-knowledge (knowledge possessed by the organization), and
- global macro-knowledge (knowledge possessed by the whole global community of project managers).

The dimension of scale enables us to classify and systematize all the processes of project knowledge management. The area of project knowledge management consists of processes working on the project knowledge of all scales. Each project knowledge scale (including subvalues) has its own life cycle. There are five project knowledge life cycles:

- micro-knowledge life cycle (briefly, micro-cycle),
- individual-level macro-knowledge life cycle,
- project-level macro-knowledge life cycle,
- organization-level macro-knowledge life cycle,
- global-level macro-knowledge life cycle.

The following sections of this article describe all these life cycles. The project micro-knowledge life cycle, although performed at several different organizational levels, makes a complete process for one micro-knowledge element; this

is a full management cycle. The macro-knowledge life cycles at separate organizational levels constitute full cycles at each level. This is the reason why we have decided to describe project knowledge life cycles starting with the full micro-knowledge life cycle, followed by descriptions of the four well-defined macro-knowledge life cycles.

Micro-Knowledge Life Cycle

Identifying Needed Knowledge

Knowledge identification (Dickinson, 2000) is a process that targets the precise specification of a needed micro-knowledge. For example, to perform the task of building the foundation of a building, you need knowledge about construction norms, worker productivity, and the technology of building foundations. The characteristics of micro-knowledge needed to perform a task (solve a problem) determine the results of this process. The knowledge itself is not the result of this process.

Knowledge Acquisition

Knowledge acquisition (Dickinson, 2000; King, Chung, & Haney, 2008; Rus & Lindvall, 2002; Tiwana, 2000) means getting knowledge from outside the team performing the task. According to a classification of ways of learning (Carbonell, Michalski, & Mitchell, 1983), the strategy of direct knowledge absorption or learning by instruction is applied in this process. The knowledge may be acquired from the organization's own knowledge repository, may be transferred directly from people with the needed knowledge, or it may be acquired according to the requirements of the particular task from an environment outside the organization (e.g., from a global norm or standard). In order to use this knowledge, the micro-knowledge must be subject to the process of internalization (Nonaka & Takeuchi, 1995); the subject willing to use the knowledge must also learn it, and then incorporate it into his or her own structure of concepts. In everyday jargon, this process is called "understanding" something.

A Model of Project Knowledge Management

Knowledge Creation

Knowledge acquired from outside the project team is often not sufficient to perform a planned task or solve an emerging problem. The knowledge may be too general or it may be sufficiently detailed but relates to a case similar, yet not identical, to the one at hand, to which it should be applied. In such cases, new knowledge is created (Alavi & Leidner, 2001; Davenport & Prusak, 1998; King et al., 2008; Rus & Lindvall, 2002; Snider & Nissen, 2003; Ward & Aurum, 2004). Knowledge creation is a process of developing new micro-knowledge or replacing the current content of knowledge with new content (Alavi & Leidner, 2001). Knowledge creation is performed on the basis of existing knowledge possessed by a subject and the knowledge acquired from outside sources for the needs of performing a given task. There are some well-defined ways for knowledge creation.

Knowledge combination (Nonaka & Takeuchi, 1995) is its grouping, new classification, summarization, aggregation, or similar techniques. The preparation of periodical project reports may serve as an example of knowledge combination. Replacing the content of micro-knowledge with new content that allows for more efficient task execution or more effective problem solving (or its categories) is called "creating knowledge by evolution" (King et al., 2008; Snider & Nissen, 2003). An example of knowledge evolution is the creation of new technologies applied to the production of analogous products (integrated circuits, aircrafts, or agricultural products). Knowledge adoption (Ward & Aurum, 2004) corresponds to the strategy of learning by analogy (Carbonell et al., 1983). Knowledge created when performing a given task or solving a given problem may be, after carrying out the necessary transformations, applied to the performance of an analogous task or the solution of an analogous problem. For example, knowledge created while constructing a bridge may be used in the construction

of another bridge. The ways of reacting to risk that are applied in one project may be applied, after some modification, in another project or to similar risks in the same project.

Knowledge Application

Knowledge application is the main process of the micro-knowledge life cycle. This is the process in which the knowledge is directly applied to task performance or problem solving. Knowledge may be possessed and applied by individuals or by whole teams (Ajmal & Koskinen, 2008; Chen, 2005) but in each event for the needs of the project as a whole. Companies benefit not from the existence of knowledge but from its proper application (Alavi & Leidner, 2001). Organizational routines, direct guidelines and instructions, and self-organizing teams constitute the main mechanisms that guarantee the integration of knowledge with work that is performed; in other words, its application (Grant, 1996). Knowledge application may take on different forms, such as its elaboration (when knowledge requires a different interpretation than in the original situation), infusion (finding underlying issues), or thoroughness (when different people or teams develop different understanding) (King et al., 2008).

Knowledge is an immaterial resource, which, in contrast to material resources, may be used for many tasks without it being lost. Passing on knowledge is a process that increases organizational capabilities without reducing the possibilities for its application in the original location. Occurrence of identical or analogous situations during the performance of identical or analogous processes and projects is the rationale for passing on knowledge. There are two main ways to pass on knowledge: transfer and sharing.

Knowledge Transfer

Knowledge transfer is an act of communication between two specific subjects: the sender and the receiver. The roles of

the sender and the receiver may be played by individuals as well as teams of people (Alavi & Leidner, 2001). Socialization (i.e., knowledge transfer by direct contact with people possessing knowledge), through observing people and watching their behavior, constitutes a specific form of knowledge transfer (Nonaka & Takeuchi, 1995). Implicit knowledge relates mainly to knowledge socialization and is applied without any permanent medium (documentation). Codified knowledge (e.g., project reports) as well as noncodified knowledge may be transferred. For transfer of noncodified knowledge, its prior identification is not necessary, and a person with micro-knowledge may not be aware of possessing it (Nonaka & Takeuchi, 1995).

Identification and Documentation of Created Knowledge

Each micro-knowledge element may be documented on external media (Bower & Walker, 2007; Damm & Schindler, 2002; Kasvi et al., 2003; Prencipe & Tell, 2001). The first step in documentation is identification of a micro-knowledge element—a person performing a task or solving a problem must be conscious that a new piece of knowledge has been created or that existing knowledge has been modified (Ward & Aurum, 2004). The important part of the identification process is defining the name of the knowledge unit. Documented knowledge may be subject to transfer, especially within the project team that produced the knowledge. In order to document the piece of knowledge, one has to state that new knowledge has been created. A person who is conscious of having created new knowledge may externalize this knowledge (Nonaka & Takeuchi, 1995). The process of externalization causes knowledge to be shared with other people or teams. Externalization is the process of moving knowledge to a medium independent of its original possessor. The medium may be more (knowledge documentation) or less (oral statement) permanent.

Knowledge identification and documentation may be results of knowledge review (Boddie, 1987; Gulliver, 1987; Smith, 2001). Knowledge is documented after and not before its application because its application serves as a kind of validation for it: successful application is a prerequisite for its application by people and teams other than its creator(s). Knowledge identification and documentation are the first steps in project knowledge review.

Knowledge Sharing

Knowledge sharing (Alavi & Leidner, 2001; Davenport & Prusak, 1998; Dickinson, 2000; King et al., 2008; Rus & Lindvall, 2002; Snider & Nissen, 2003; Tiwana, 2000; Ward & Aurum, 2004) along with knowledge transfer is another type of knowledge passing. Documented knowledge may be used by the author of the documentation or may be submitted to the organizational repository. Sharing knowledge from the person who created the knowledge is not oriented toward a particular recipient; each worker in the organization (to the extent his or her security system privileges permit) may have access to the repository. Knowledge sharing consists of stating that some earlier documented knowledge may be useful to the organization and placing it in a knowledge repository. Placing acquired and documented experiences into an organizational repository may serve as an example of knowledge sharing (King et al., 2008).

Externalization is necessary for knowledge sharing. Externalization is sometimes called knowledge formalization (Nissen, Kamel, & Segupta, 2000), because knowledge outside of the person who created it must have a well-defined form and structure. Formalization may be called “codification” (Davenport & Prusak, 1998).

Formalized knowledge is organized (Rus & Lindvall, 2002; Snider & Nissen, 2003; Ward & Aurum, 2004). Knowledge organization is the creation of a structure for knowledge repositories that

enables efficient access to micro-knowledge that is needed in particular defined situations. Knowledge is properly classified within the process of organization; for example, by assigning keywords or classificatory categories to them. Micro-knowledge elements prepared in this way may finally be stored in the organizational repository for the purpose of their later use.

External Knowledge Acquisition

Knowledge may be put into an organizational repository not only for the purpose of solving a particular problem. Many organizations have organizational units or teams for the purpose of acquiring knowledge from external sources, with the goal of increasing general organizational capabilities or for the needs of specific projects. Knowledge for a project may also be acquired from outside an organization on its own.

Knowledge management is not a purely managerial activity because it may be performed by all project team members and not only by the management team. Each team member, especially in a project that makes intensive use of knowledge, can and should take part in the creation, storage, and distribution of knowledge (Damm & Schindler, 2002).

Figure 1 schematically presents the project micro-knowledge management processes described here.

The above-presented processes make up the micro-knowledge life cycle—a set of processes performed on micro-knowledge, ranging from identification of the need for its existence to its storing in the knowledge repository. The micro-cycle is performed at four management levels: individual, project, organization, and global. For example, the identification of needed micro-knowledge may take place at the project level, its creation at the individual level, and its sharing at the organization level and, in some cases, at the global level. Processes of project micro-knowledge performed at particular organizational levels are described in the paragraphs that follow.

Processes directly oriented toward increasing knowledge—its acquisition (including transfer and acquisition from external sources) and creation—are called learning processes.

For the sake of simplicity, the processes for identifying needed knowledge and creating it will be called knowledge-generation processes; processes of knowledge acquisition (internal and external), transfer, identification, and documentation of created knowledge and knowledge sharing will be called knowledge distribution processes. The last group of processes consists of one process—knowledge application.

Organizational Levels of the Project Micro-Knowledge Life Cycle

The full micro-knowledge life cycle consists of processes performed at all management levels, as defined previously.

Individual Level

Identification of needed knowledge is performed at the individual level when a project team member receives a task for execution without the needed knowledge being specified, so that he or she must determine what knowledge is needed for him or her to execute the task. This is the usual way in which a task with a high level of innovation is defined. Some forms of individual knowledge acquisition are, for example, contacts with other team members or workers at the organization that do not belong to the project team, and that have been established and initiated by the team member. Team members may acquire the knowledge from an organizational knowledge repository. Individual knowledge creation may be, but does not have to be, an effect of individual identification of knowledge needed for task execution or problem solving. After knowledge application (performed at the project level, all work that is performed is always managed from a level above that of the individual), a team member may identify the knowledge just created as a new element

A Model of Project Knowledge Management

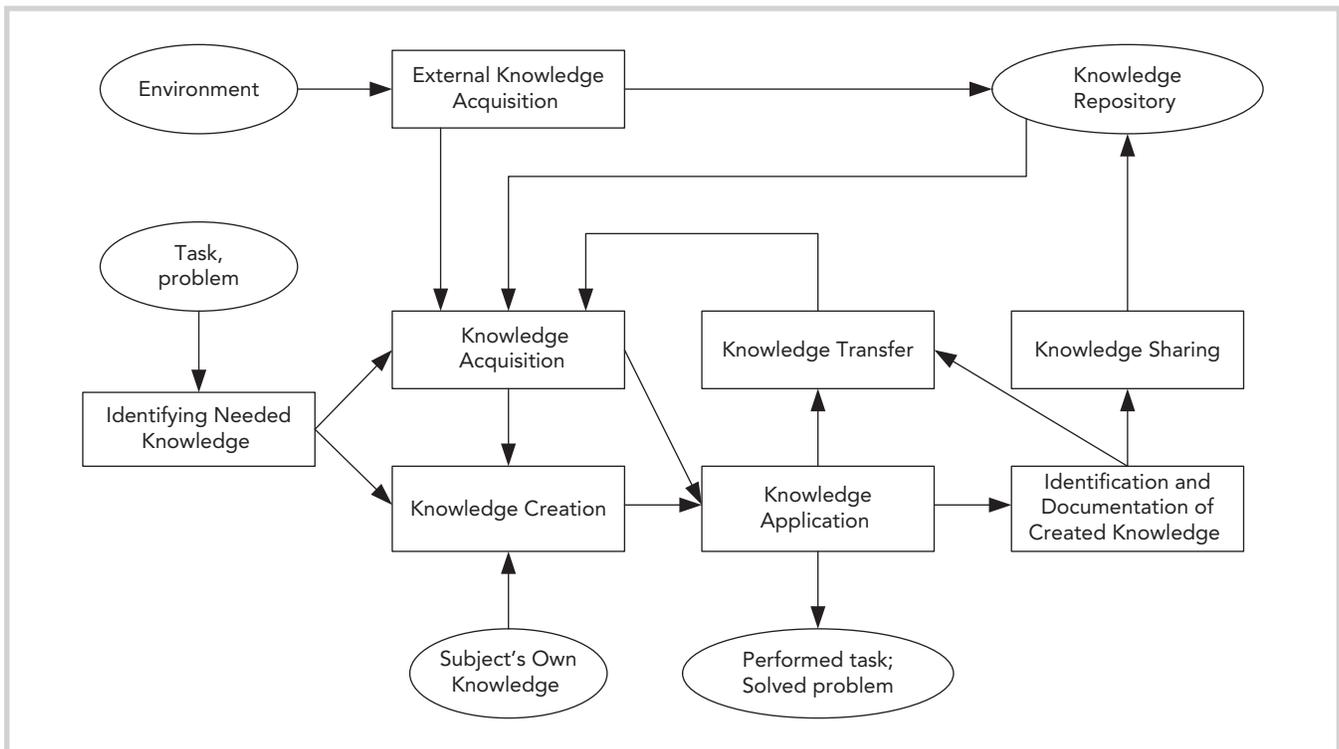


Figure 1: Processes of knowledge elements management.

of micro-knowledge. This knowledge may be transferred to other team members and initiated by the knowledge creator; hence, the following processes are performed at the individual level (see Figure 2):

- identifying needed knowledge,
- knowledge acquisition,
- knowledge creation,
- knowledge transfer, and
- identification and documentation of created knowledge.

Project Level

Identification of needed knowledge may be performed at the project level when a manager passes a description of needed knowledge along with the task definition to a team member who is performing an activity. This type of situation occurs when a similar task has been performed earlier. The project team as a whole may acquire knowledge needed for task execution or problem solving. If a micro-knowledge

element must be acquired from the organization's environment, then the participation of the project management team is necessary, because usually only members of this team have the authority to decide about activities that cross project borders. The whole project team or part of it may be the recipient of the knowledge transfer. Knowledge may be created collectively by a project team—this method of knowledge creation is stressed by people who view knowledge as a social product. Meetings, discussions, and group work tools are examples of the ways and instruments that can be used for collective knowledge creation. As mentioned in the previous section, project knowledge is always applied at the project level because its application is totally integrated with task execution (problem solving), which is always managed from the project management team level. After knowledge application, the project team may state

collectively that a new micro-knowledge element has been created. The project team may be a sender in the process of knowledge transfer. Tasks aiming to acquire knowledge from outside the organization may be defined in the project; hence, the following processes are performed at the project level (see Figure 3):

- identifying needed knowledge,
- knowledge acquisition,
- knowledge creation,
- knowledge application,
- knowledge transfer,
- identification and documentation of created knowledge, and
- external knowledge acquisition.

Organizational Level

The process of identifying the knowledge needed for a project may be performed at the organization level, when the goal of the project in the area of knowledge management is defined by the organization; the organization, in

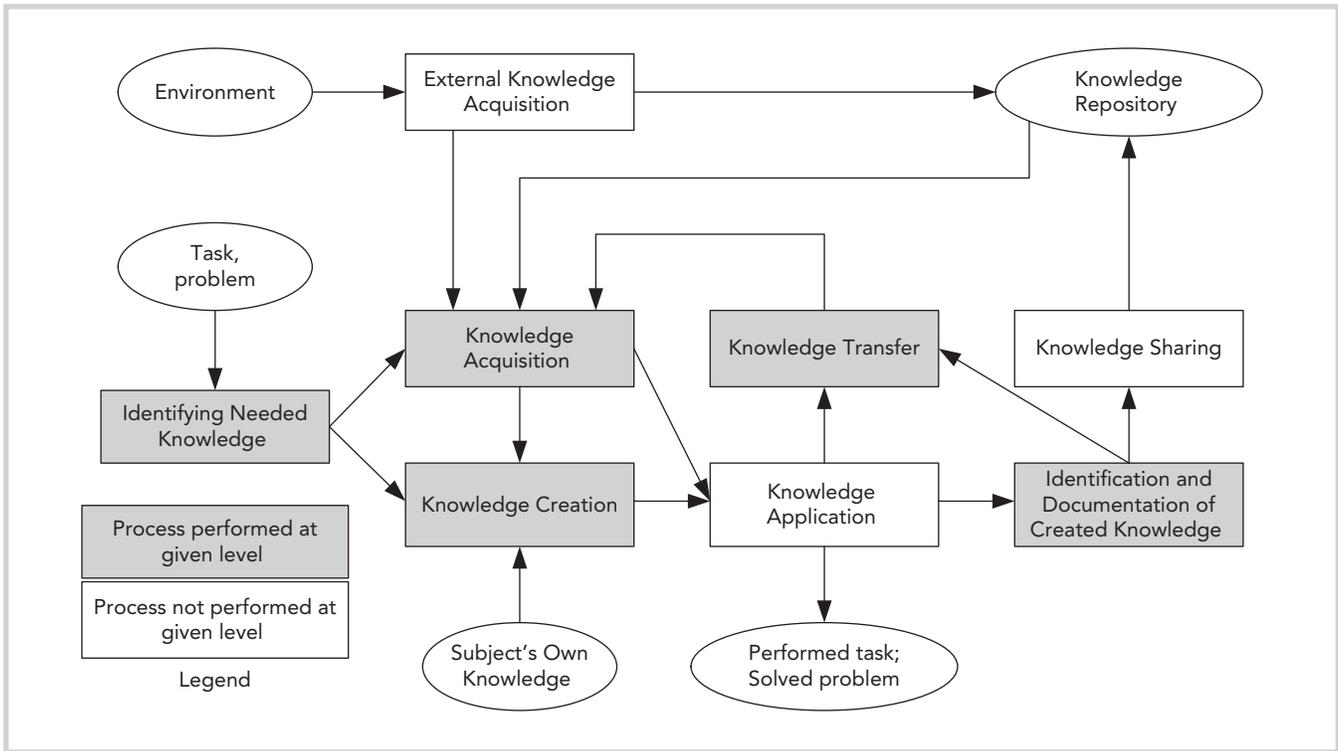


Figure 2: Micro-knowledge life-cycle processes at the individual level.

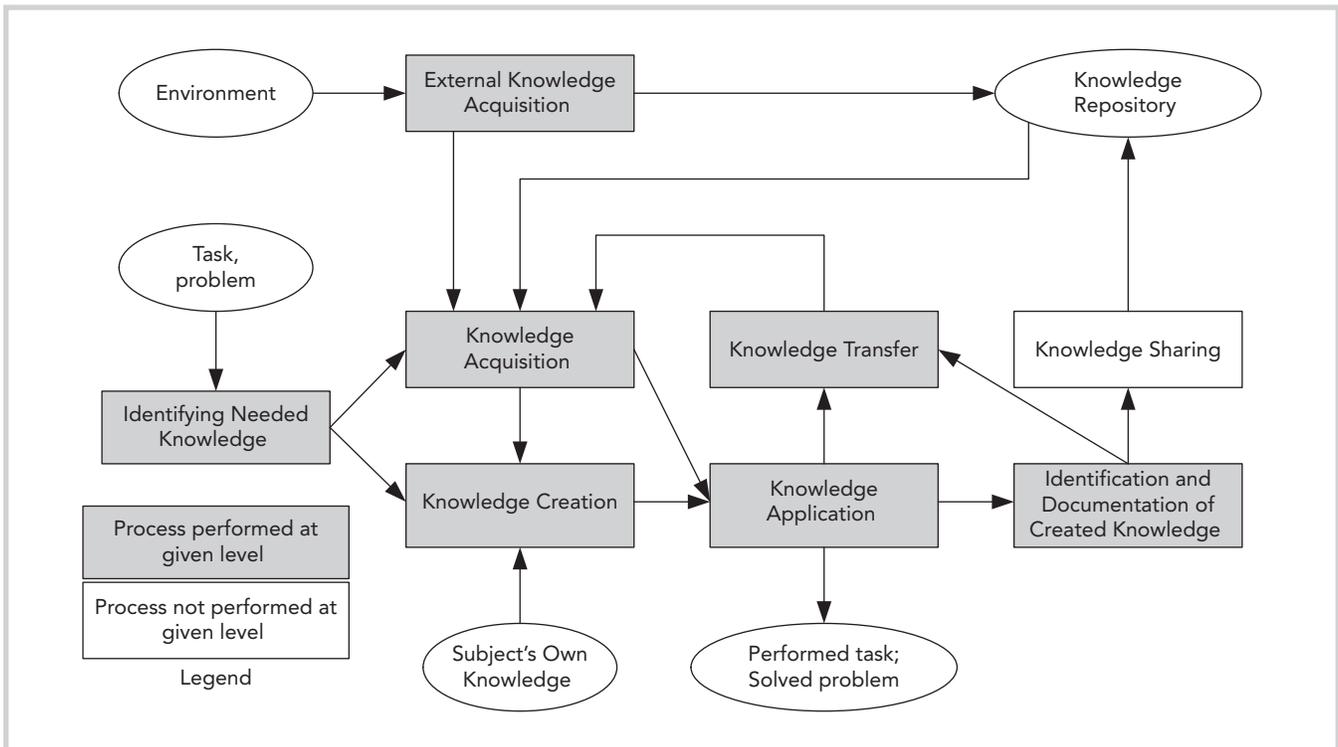


Figure 3: Micro-knowledge life-cycle processes at the project level.

A Model of Project Knowledge Management

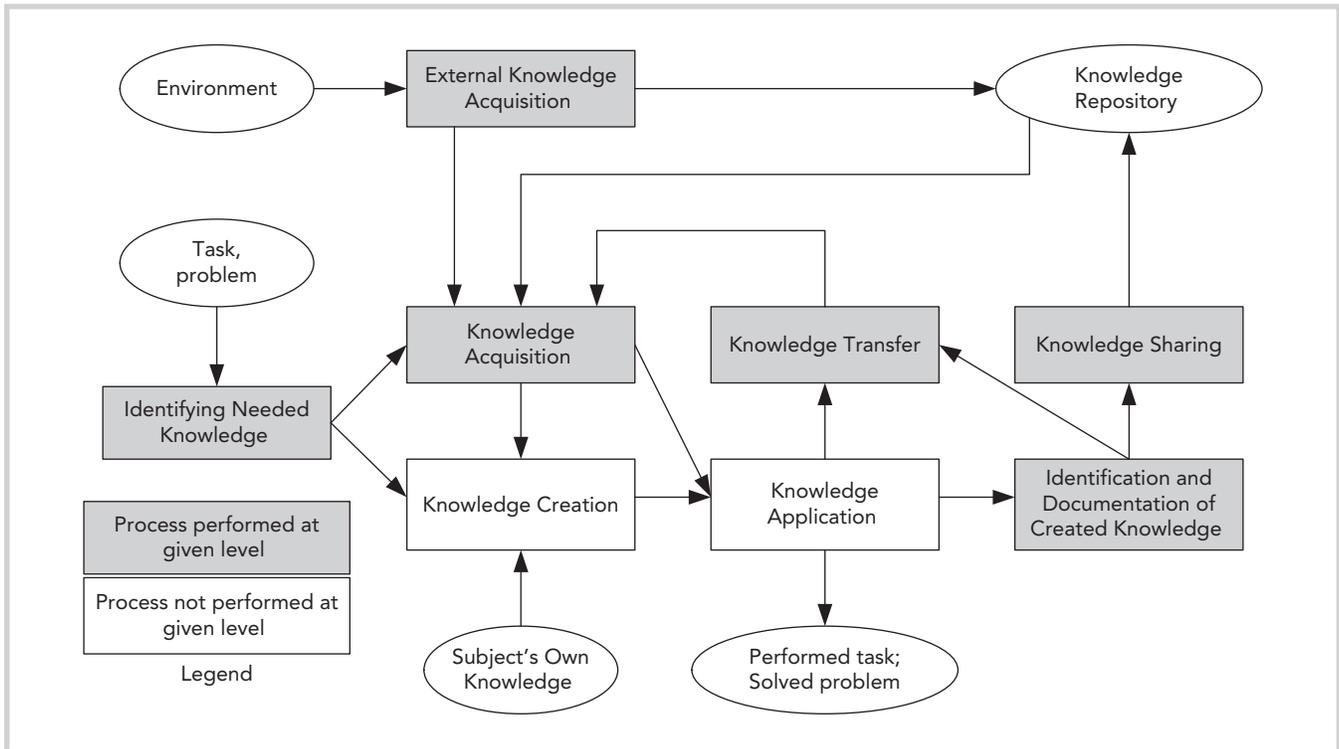


Figure 4: Micro-knowledge life-cycle processes at the organization level.

accordance with its strategy, points to the knowledge, which must be produced by a project. Knowledge acquisition at the organization level is its transfer from other organizations or from a project coproduced or performed by other organizations. This type of knowledge acquisition usually calls for agreements at the executive levels of the organizations participating in the knowledge transfer. Organizations may undertake special initiatives (of project types or other types of work) that aim to acquire knowledge from their environments. The process of knowledge transfer at the organization level is its being sent to another organization, in tandem with the process of knowledge acquisition in the other organization. The processes of project knowledge review should be recognized as those performed within the process of identifying and documenting knowledge at the organization level, if they are performed by organizational teams (e.g., those belonging to project

management offices). Knowledge sharing (i.e., its storage in organizational repositories) is performed under supervision from the organization level in order to assure knowledge uniqueness and proper classification and to guarantee the consistency and integrity of the repository as a whole; hence, the following processes are performed at the organization level (see Figure 4):

- identifying needed knowledge,
- knowledge acquisition,
- knowledge transfer,
- identification and documentation of created knowledge,
- knowledge sharing, and
- external knowledge acquisition.

Global Level

The global level also takes part in the project micro-knowledge life cycle. From this level, the process of knowledge sharing is performed—elements of micro-knowledge necessary for project execution, contained in global bodies of knowledge, are passed to projects

and organizations. In order to make knowledge sharing possible, the knowledge that may be potentially useful for many projects carried out in the area of interest of the organization creating the global bodies of knowledge, is identified, classified, and edited at the global level. Knowledge transfer is also performed at the global level. Such transfers occur during conferences or at the forums of global communities of practices (like PMI or IPMA);

Hence, the following processes are performed at the global level (see Figure 5):

- knowledge transfer,
- identification and documentation of created knowledge, and
- knowledge sharing.

Vertical Project Knowledge Flows

In order to carry out the full project knowledge micro-cycle, it is necessary to execute knowledge flows between organizational levels.

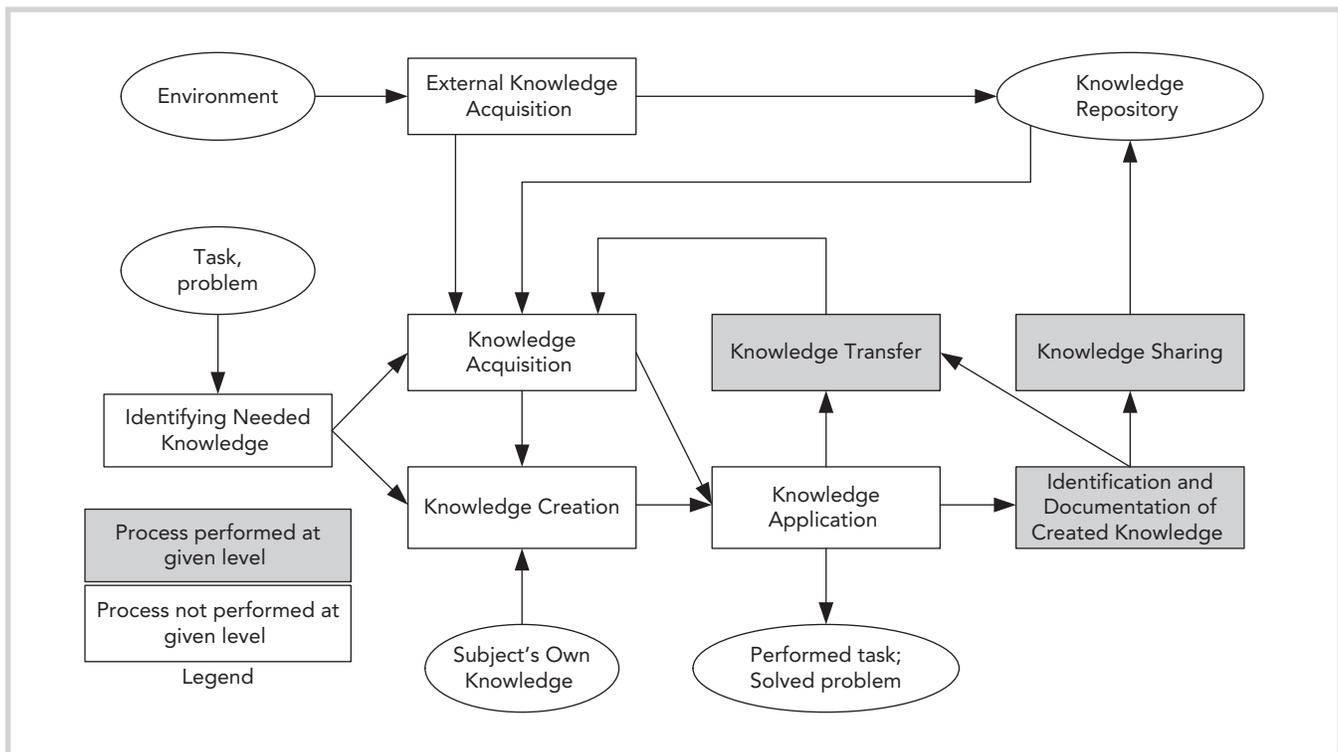


Figure 5: Micro-knowledge life-cycle processes at the global level.

For example, project knowledge contained in global knowledge sources is passed from the global to the organization level by issuing at the global level and implementing at the organization level the project knowledge contained in its global sources (bodies of knowledge, standards, etc.). Organizations provide their projects with the knowledge needed for execution, which is also a process of vertical knowledge flow. If an organization has a strategy of knowledge development, then specifications describing the knowledge that has to be acquired are passed from the organization level to the project level, even if this knowledge is not needed for the particular project's product development. A task or problem, the execution or solution of which requires some knowledge, may be passed from the project to the individual level. A team member specifies needed knowledge independently

in this case and decides about the ways it is to be created or acquired. Identification of the knowledge needed to perform some tasks may be passed from the project to the individual level, too; in such cases, the team member has to plan ways of acquiring this knowledge and carrying out the planned activities.

In the opposite direction, step by step, from the bottom to the top of this hierarchy, created knowledge is moved. The knowledge of project team members is passed to the project level in order to make it possible to use it at that level. The knowledge is passed from the project level to the organization level in order to distribute it to other projects that are implemented by the organization (or use it in line processes). Knowledge is passed from the organization level to the global level for the purpose of using it in global sources of knowledge. Figure 6 schematically

presents the vertical project management knowledge flows.

While analyzing the existing approaches to vertical knowledge flow, two research streams have been found. The first, which we call "top-down," focuses on investigation of the utilization of global knowledge sources at lower levels (e.g., Ahlemann et al., 2009; Crawford & Pollack, 2007). The second stream focuses on the ways of implementing global sources of knowledge at lower levels (organization, project) and is called by us the "bottom-up" approach to vertical knowledge flows (e.g., Garcia, 2005).

Macro-Knowledge Life Cycles

Each scale of macro-knowledge has its own specific life cycle, which is fully performed inside a single subject possessing project knowledge. The temporal extent of each macro-knowledge life cycle covers the whole period of the particular subject's existence:

A Model of Project Knowledge Management

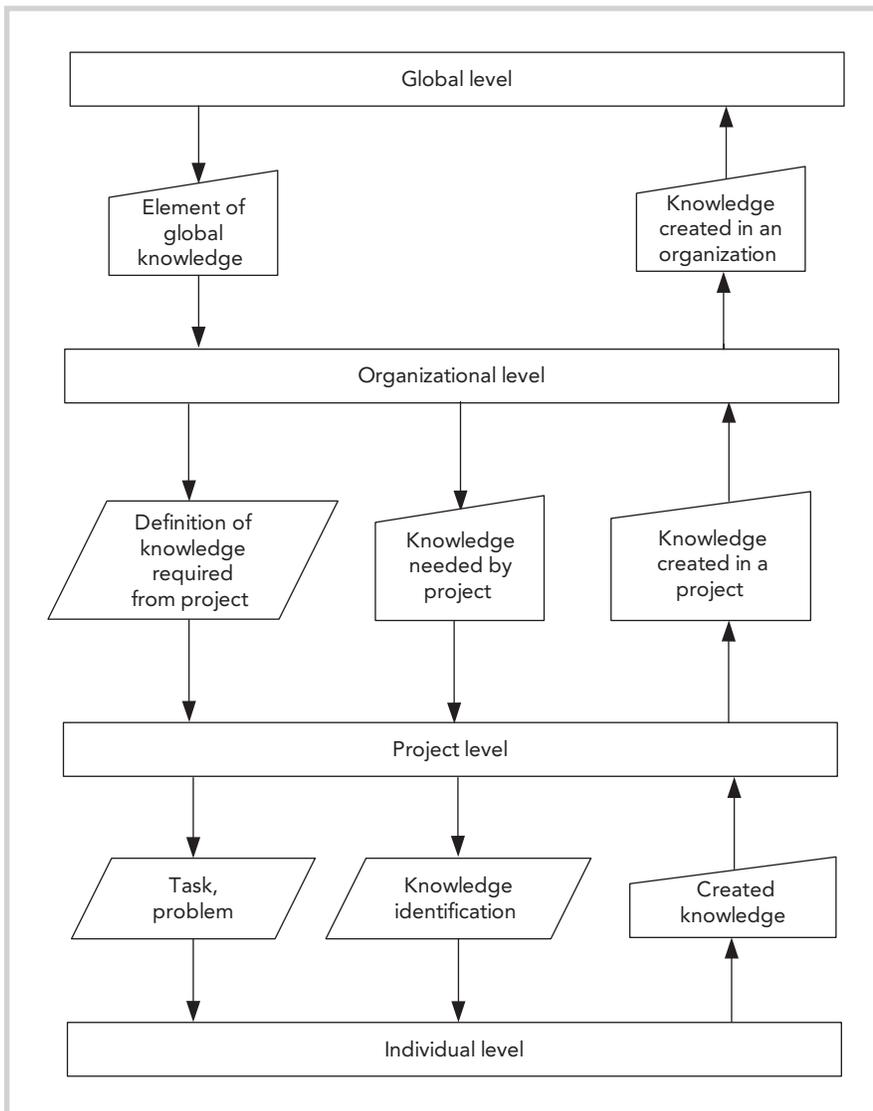


Figure 6: Vertical project knowledge flows.

participation of a team member in the work of a particular project, the period during which the project exists, the period during which the organization exists, and—at the global level—the existence of the profession of project management. The goal of the macro-knowledge life cycle is to extend a subject's capabilities of participation as a whole in effective project execution. Processes performed at particular levels do not have to provide results at the same levels. For example, project

reviews performed at the project level increase not only the capabilities of the projects that perform these reviews, but also the capabilities of the whole organization. The influence of the macro-knowledge life cycle may be indirect, which is the case with the global macro-knowledge life cycle that has no direct influence on any particular project but whose ultimate aim is to increase global project knowledge in order to execute projects more effectively.

Individual-Level Macro-Knowledge Life Cycle

Knowledge possessed by an individual project team member and that is relevant to the project and the execution of which involves that particular person is the concern of the project knowledge macro-cycle at the individual level.

There are the following project macro-knowledge life-cycle processes at the individual level (see Figure 7):

- assignment to a project,
- knowledge building, and
- knowledge development.

A person assigned to a project brings the knowledge he or she possesses at that time to the project team. This is the technical or managerial knowledge collected during all the former education, training, and participation in completed projects. If this knowledge is not sufficient for participation in the tasks of the project, then the team member is encouraged to participate in the process of knowledge building. A project team member's knowledge building may take on different forms. Training is probably the most popular of them, but reading relevant books, procedures, or manuals or coaching may also be helpful. After gaining a sufficient level of knowledge, the team member uses this knowledge to participate in the tasks of the project while at the same time developing his or her knowledge. After completing the project, the team member attains a new level of knowledge.

Project-Level Macro-Knowledge Life Cycle

The total knowledge possessed by a project is pertinent to the project-level knowledge macro-cycle; this cycle is much more developed than the individual-level knowledge macro-cycle and consists of four main phases:

- organization knowledge analysis,
- knowledge management preparation,
- execution of knowledge management, and
- knowledge summarization.

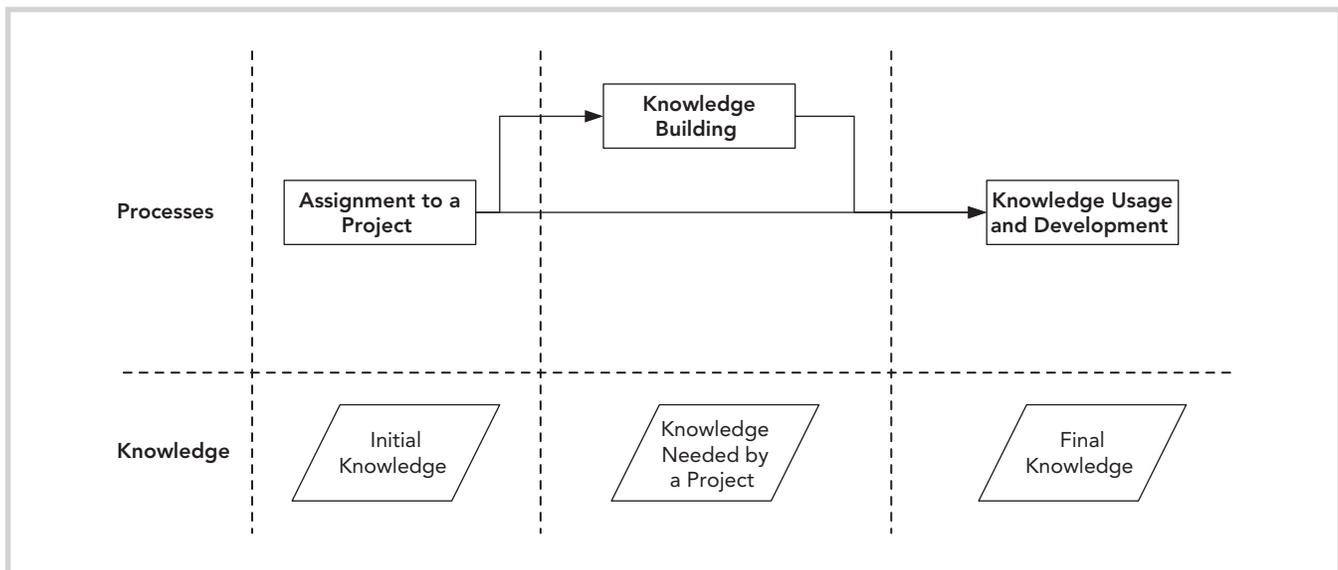


Figure 7: Individual-level macro-knowledge life cycle.

There is only one knowledge management process performed in the phase of organizational knowledge analysis. This process is also called “organizational knowledge analysis.” Knowledge about the internal and external environments in which the project would be executed, as well as knowledge about resources possessed by the organization, is collected in this process. The third element of knowledge processed by this process is the knowledge about organization strategy that primarily covers its business goals. These three knowledge components together form the foundation for the decision of project initiation.

Two processes are performed in the knowledge management preparation phases: project understanding and knowledge management planning. The definition of the knowledge needed for project execution is the intended result of project understanding. Micro-knowledge needed for performing each activity is defined. The sum of knowledge needed for starting the execution of project activities constitutes a project’s initial macro-knowledge. This forms the basis for the process of knowledge management planning,

which produces the project knowledge management plan (PKM Plan). The PKM Plan addresses all the topics related to project knowledge management and covers both the personalized and codifying techniques of knowledge management (meetings, knowledge exchanging teams, and using knowledge repositories) in alignment with project type and needs. The PKM Plan explains how the initial macro-knowledge will be acquired. The project micro-knowledge life cycle is defined there, too. The repositories used by the project team, internal and external knowledge sources, and ways of knowledge creation, transfer, and sharing are the other elements described there.

The knowledge mobilization (Lampel et al., 2008) and knowledge development processes are performed in the phase of executing knowledge management. Acquiring the universal knowledge, in codified as well as personalized forms, that is necessary for project execution is the content of the knowledge mobilization process. People with adequate knowledge are assigned to the project team. A group of the project’s external experts may be nominated. Team members who do not have the

knowledge needed for performing their roles are trained. Team members acquire knowledge, which is contained in codified sources (manuals, instructions, repositories, articles, books, etc.). The goal of the knowledge development process is creation of specific knowledge, which is needed for executing project activities and solving arising problems. These pieces of micro-knowledge may be created by individuals as well as by groups or the whole project team. The newly created knowledge may be stored in project or organization knowledge repositories or directly transferred to other team members.

The process of knowledge summarization, which aims to collect the knowledge produced by a project, is performed in all the other phases of project knowledge management. New knowledge may be developed in every project action, but as the project progresses, there is more and more knowledge to collect. Project review is the most frequent technique used to collect new knowledge. Project review is a technique oriented to macro-knowledge; it tries to collect all the new knowledge developed by a project. This technique belongs to the codified

A Model of Project Knowledge Management

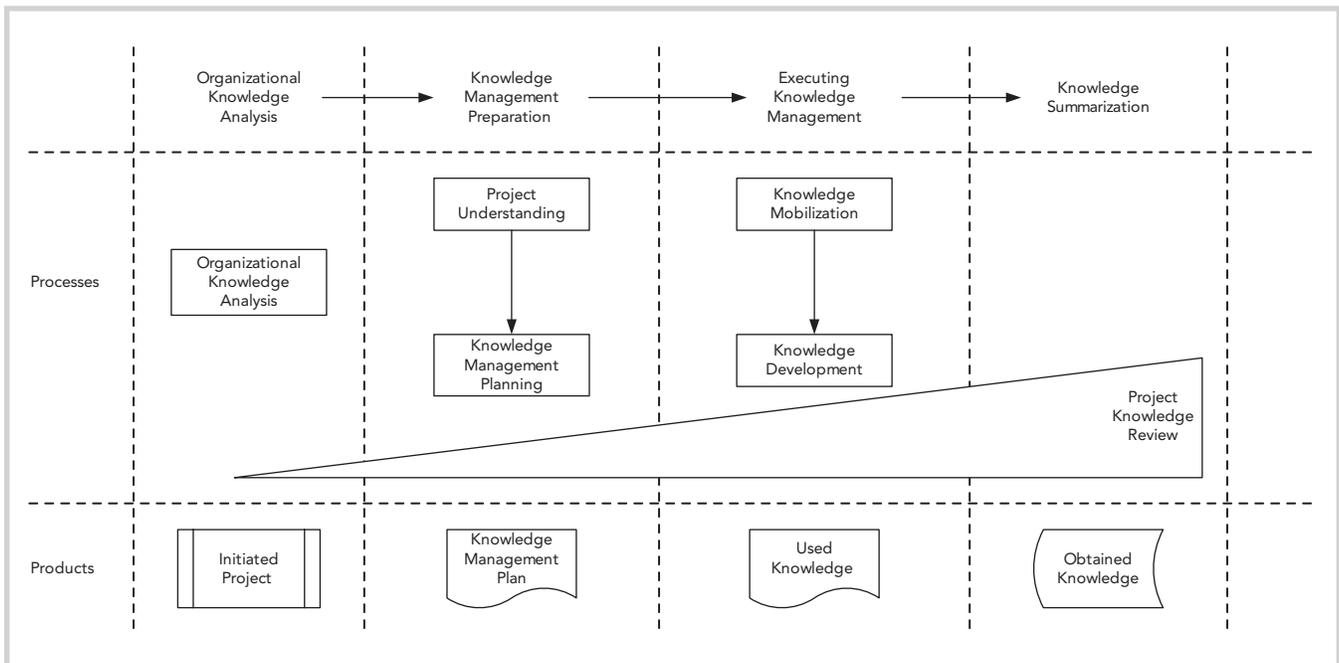


Figure 8: Project-level macro-knowledge life cycle.

approach of knowledge management—lessons learned are documented. Please note that direct knowledge transfer between two subjects usually operates at the micro-knowledge and not at the macro-knowledge level; team members obtain just the knowledge needed to solve a problem or to perform a task based on the knowledge possessed by a team member or the whole team. Thus, the personalized techniques of knowledge management are not mentioned as techniques of knowledge summarization at the project level.

Project knowledge management processes are intertwined with other project management processes and their groups. Organizational knowledge analysis should be part of the Initiating Process Group, as defined in the *PMBOK® Guide*. Knowledge management preparation should be part of the Planning Process Group, executing knowledge management should be part of the Executing Process Group, and knowledge summarization should be part of the Closing Process Group.

Figure 8 schematically presents the project-level macro-knowledge life cycle.

Organization-Level Macro-Knowledge Life Cycle

The total project knowledge possessed by the organization constitutes the subject of the organization-level macro-knowledge life cycle. This knowledge is a subject of knowledge management implementation, its further expansion and development, and improvement of the methods of its management. There are three main phases of the organization-level knowledge macro-cycle:

- informal phase,
- implementation phase, and
- exploitation and improvement phase.

From the moment an organization executes its first project, it manages its project's knowledge, because knowledge is one of the most important resources needed by each project. It seldom happens, though, that a deliberate full system of project knowledge management—including formal processes, tools and repositories, and social

environment facilitating knowledge creation and exchange—is ready at that time. Rather, project knowledge management practices are developed in an informal way, often supported by emerging informal communities of practices, which is what we refer to as the informal phase of project knowledge management.

The implementation phase starts when an organization recognizes the value of project knowledge and its management. This phase consists of the following processes:

- definition of the goals of project knowledge management,
- description of current practices,
- definition of the target state of knowledge management,
- implementation plan development, and
- implementation plan execution.

The general approach to project knowledge processing, knowledge requirements at the general level, and descriptions of methods of implementation of the organization's project

knowledge management system constitute the results of the definition process for the goals of project knowledge management.

The descriptions of project knowledge practices provided at the moment of initiating the process of project knowledge management implementation constitute the output of the process of describing current practices. Later on, these practices may be converted into the final processes of project knowledge management.

The process of defining the target state of knowledge management takes as input the results of the processes of definition of the goals of project knowledge management and description of current practices and defines the target state of the organization's project knowledge management infrastructure, the roles and organizational units engaged in project knowledge management, and the specific details of the processes of knowledge management.

The process of implementation plan development is applied to develop a detailed plan of activities that aims to implement the organization's project knowledge management system. These activities are performed later in order to implement this system. Implementation-plan execution usually takes place in several phases and may take from several months to several years to complete, depending mainly on the organization's size, initial project knowledge management needs, practices, and culture.

The project knowledge management system (PKM System) is the result of implementation plan execution. This system has two main components: the social component and the project knowledge management processes. The social component is the sum of all the organization's human resources, their relationships, and the knowledge available through these relationships (Kotnour & Landaeta, 2002).

The main organizational processes of knowledge management are:

- processes of micro-knowledge life cycles at the organization level and lower management levels,
- processes of macro-knowledge life cycles at the individual and project levels, and
- supporting organizational project knowledge management processes like:
 - knowledge repository maintenance,
 - maintenance of organizational structures engaged in project knowledge management,
 - social processes of project knowledge management,
 - development and transfer of knowledge outside of project, and
 - exploitation of IT applications supporting knowledge management.

Knowledge Repository Maintenance

Activities performed outside of the project knowledge micro-cycle, aimed at maintaining consistent content that is useful for project execution, make up the process of knowledge repository maintenance. Verifying knowledge actuality, assessing knowledge usefulness, updating knowledge, and deleting knowledge no longer useful to an organization are the main activities of this process. The rights to knowledge repository maintenance are restricted to people working at the organization level (Blessing et al., 2001; Petter & Vaishnavi, 2008). This way of defining responsibilities supports the consistency of knowledge repository content. Unnecessary knowledge is not placed in the repository, and the organization avoids redundant placement of the same knowledge in the repository by applying such an organizational solution.

Maintenance of Organizational Structures Engaged in Project Knowledge Management

Activities that aim to assure effective functioning of organizational structures of project management—the project management office (Desouza & Evaristo, 2006; Hill, 2003), knowledge managers, knowledge facilitators, knowledge coordinators, and knowledge brokers (Hobday, 2000; Kivrak et al., 2008;

Prencipe & Tell, 2001) who are oriented directly or indirectly toward supplying the right knowledge to projects—comprise the basis of this process. Knowledge managers are the workers responsible for knowledge management, including its creation, usage, retention, and other types of processes. Knowledge managers are responsible for all or part of the organizational knowledge assets: repositories and knowledge workers. Defining the strategy of knowledge management is one of their duties. Knowledge facilitator is a role responsible for all the actions, making it easier to perform all the knowledge-related processes. For example, he or she may prepare an environment (social or physical) better suited for knowledge creation and may capture knowledge from experts and remove the barriers of knowledge creation or sharing. Knowledge coordinator is a specialized role responsible for the integrity of an organization's knowledge assets; he or she may be responsible for knowledge classification, maintaining the knowledge repository, or linking potential or actual knowledge sources with knowledge areas. Knowledge brokers play a key role in knowledge exchange; they know who knows what and link demand with knowledge sources. They may operate between individuals, formal organizational structures, or communities of practice (Garrety, Robertson, & Badham, 2004). Organizations may create competence centers (Keegan & Turner, 2001) or organizational units grouping project managers (Eslerod & Skriver, 2007). It is possible to create organizational units responsible for project knowledge management in separate departments of a company (Desouza & Evaristo, 2004). Organizational units taking part in project management are also involved in project knowledge management; these units develop the specialized knowledge needed for functioning (Prencipe & Tell, 2001).

These structures, as elements of the company's organizational structures, formulate and execute plans in the area of project knowledge management.

A Model of Project Knowledge Management

Activities described in this article, like knowledge repository maintenance, work that facilitates the organization's social capital development or training measures, are components of such plans. Project management offices document the processes and practices of project management (Keegan & Turner, 2001) and analyze them in order to improve their effectiveness (Landaeta, 2008). Processes of project knowledge management at the project and organization levels are special kinds of processes that are controlled by a project management office (Julian, 2008), and promoting project knowledge management in the organization is among these processes (Hill, 2003).

The Social Processes of Project Knowledge Management

According to the community perspective on knowledge management, the presence of wide-ranging, positive relationships among the organization's members are a basic prerequisite for knowledge transfer; so, conducting activities that create and develop such contacts creates the optimal conditions for knowledge transfer. Team-building activities, group integration, and activities fostering interpersonal and communication skills are among these types of activities. The organization supports the creation of communities of practice (Levin & Rad, 2007; Prencipe & Tell, 2001; Sankarasubramanian, 2009) that increase the knowledge level of the organization as a whole (Ruuska & Vartiainen, 2005). Organizations create and maintain a directory of their communities of practice (Delisle & Rowe, 2004). The development of social networks of project team members, including project managers, may be considered an element of the development of conditions for knowledge transfer (Grabher, 2004; Kotnour & Landaeta, 2002; Rus & Lindvall, 2002). Creating knowledge exchange arenas, knowledge cafés (Boh, 2007; Lam, 2009; Suikki et al., 2006), discussion forums (Boh, 2007; Sankarasubramanian, 2009), organizing meetings, seminars,

and workshops for project managers (Duarte & Snyder, 1997; Eskerod & Skriver, 2007; Fong, 2005; Landaeta, 2008; Prencipe & Tell, 2001; Suikki et al., 2006) are conducive to the development of conditions for knowledge transfer. Organizations support cultural changes in the area of project knowledge management by creating, for example, organizational systems of incentives for knowledge management (Ayas & Zeniuk, 2001).

Development and Transfer of Knowledge Outside of the Project

Project knowledge is created and processed in an organization not only as a result of a particular requirement for it, but also during the course of activities performed at the organization level that aim to develop not knowledge directed toward the execution of particular projects, but knowledge in areas defined by the organization's project knowledge management strategy. An organization's knowledge may be increased through its transfer from outside of the organization. An organization may hire people with knowledge the organization lacks (Bellini & Canonico, 2008). The knowledge transferred to an organization by new workers is collected and distributed among other workers who may potentially need it. The knowledge possessed by workers is codified before they decide to quit the organization (Atkinson, 2006). Training programs that aim to extend the knowledge of the organization's members are carried out (Duarte & Snyder, 1997; Fong, 2005; Rus & Lindvall, 2002; Suikki et al., 2006). Organizations may undertake projects with the goal of procuring or creating the knowledge needed by that organization (Söderquist, 2006). Knowledge may be transferred to an organization through specialized manuals and guidelines (Rus & Lindvall, 2002). An organization strives to make project managers familiar with the same materials (Eskerod & Skriver, 2007), and this is conducive to creating a common language

and mutual understanding among project managers. Implementation of a project management standard is also a kind of knowledge acquisition outside of projects.

Analyzing information stemming from sets of projects in search of regularities and templates that may be useful for performing other projects constitutes a special kind of work of this type (Rus & Lindvall, 2002). Such activities are oriented toward an organization's future projects (Julian, 2008).

Exploitation of ICT Applications Supporting Knowledge Management

The exploitation of ICT applications is necessary for the proper functioning of an organization's knowledge management system. The main types of ICT applications that may be used for supporting project knowledge management are: project management systems (like MS Project, Oracle Primavera), knowledge repositories, groupware applications, expert seeking systems, modeling systems, project intelligence systems, teaching systems, and knowledge portals. The detailed definitions of each of these types of systems extend beyond the scope of this article.

In order to enable these systems to truly support project knowledge management, several types of activities are performed. The implementation of such an application is the first element in such a process. Implementation of an ICT application supporting project knowledge management may be considered a part of implementation of the organizational integrated system of project knowledge management, but it requires specific activities. Implementation of an ICT application is performed on the basis of specific requirements. Knowledge contained in an ICT application is classified according to a taxonomy that is useful for achieving the organization's goals. The knowledge management application must be aligned with the organization's culture. The ICT application supports achievement of the organization's goals; therefore, it has to have the support of its

highest-level executives. The shaping of such an application is determined by the reactions and opinions of its users (Liebovitz & Megbolugbe, 2003). Implementation of supporting tools should not change the natural work processes, habits, or roles performed by team members. Integration of knowledge management and team collaboration should result from implementation of the ICT application. The implemented application supports work at different levels of granularity (general idea, architectural design, detailed solutions). First and foremost, an application should support mundane, laborious activities (like searching large databases). Each application should provide the right knowledge at the right time (e.g., as it relates to project work progress), and each application enables its user to get contextual knowledge

(covering details of a situation in which knowledge has been created). Applications support different ways of thinking—for example, those of the producer (knowledge of product development) and the product user (knowledge of the modes of product usage) (L. P. Cooper, 2003). After implementation, an application is exploited in accordance with its intended function. The day-to-day utilization of the application is managed by its administrator, who is responsible for its adaptation to changing needs and the security of contained knowledge.

The exploitation and continuous improvement is the last phase of the organization-level macro-knowledge life cycle.

An implemented organizational system of project knowledge management enables projects' demands for

knowledge to be satisfied. Activities performed after implementation plan execution that aim to improve efficiency and effectiveness constitute the process of continuous improvement to the system of project knowledge management (Levin & Rad, 2007). This phase may be seen as the exploitation phase of the project knowledge management system. Continuous improvement may be seen as achieving higher levels of maturity in project knowledge management. There are two types of learning performed in this phase: single-loop learning (aimed at mastering implemented ways of project knowledge management) and double-loop learning (aimed at improving the system) (Brady & Davies, 2004).

Figure 9 schematically presents the organization-level macro-knowledge life cycle.

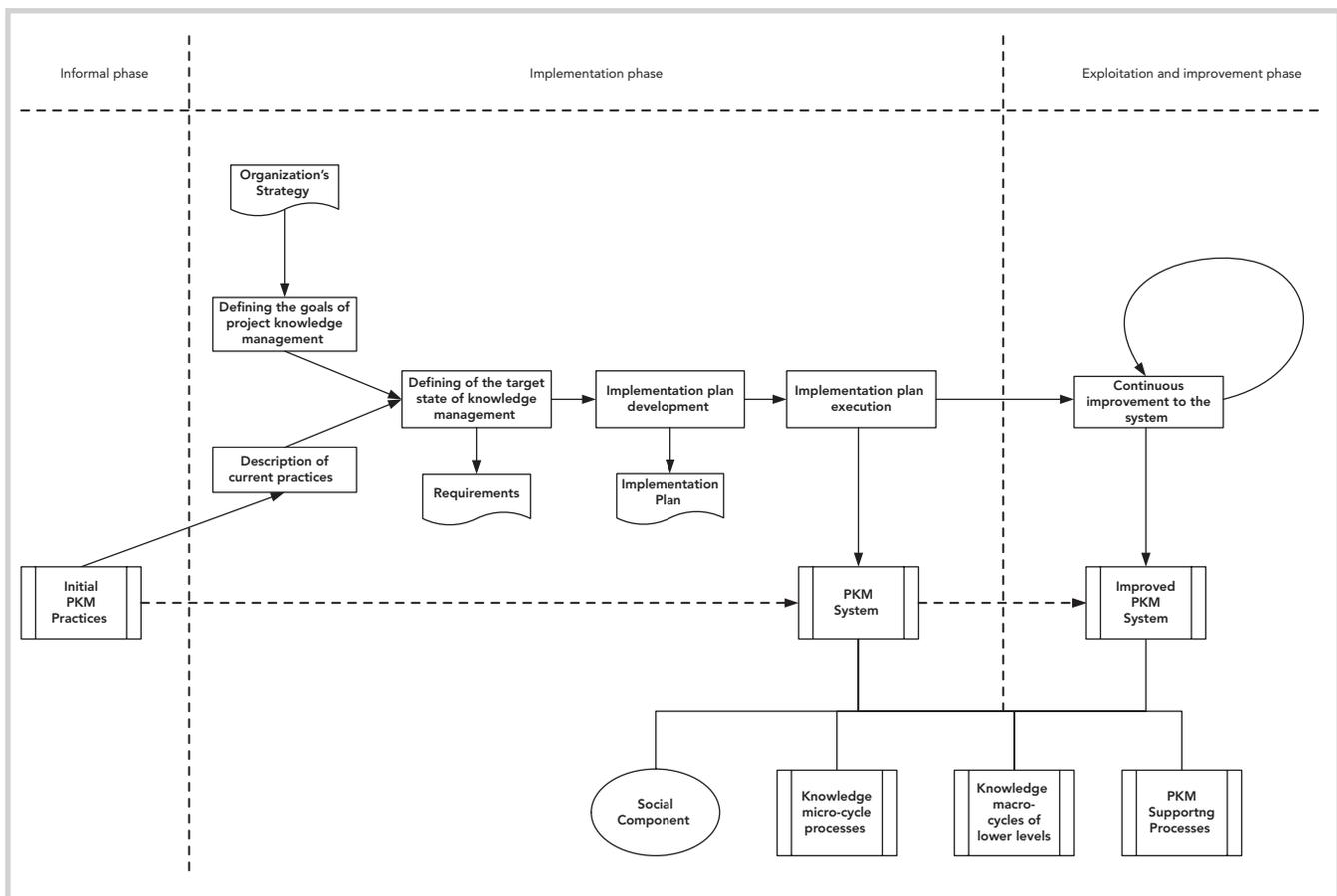


Figure 9: Organization-level macro-knowledge life cycle.

A Model of Project Knowledge Management

Global-Level Macro-Knowledge Life Cycle

Ways of treating and processing project management knowledge by the global community of project managers define the global-level macro-knowledge life cycle. The output of these processes—global project management knowledge—is more and more advanced and sophisticated in each of the phases; the later phases use output from techniques and processes initiated and performed in former phases. Therefore, we may say that global knowledge is subject to a continuous process of development.

The global macro-knowledge life cycle encompasses the following phases (some of which may be found in Crawford, 2007):

- hidden phase,
- initial phase,
- investigation of topics of project management,
- creation of bodies of knowledge,
- creation of general standards,
- creation of specialized standards, and
- project management as an academic discipline.

All of the phases mentioned above are important with respect to the ways that project management knowledge is

processed. Some of the phases are especially important for practitioners of project management (like the creation of bodies of knowledge or specialized standards), whereas others are primarily important “internally” for researchers working in the area of project knowledge management (like the investigation of topics of project management or project management as an academic discipline). Phases of the advanced global-level macro-knowledge life cycle are not performed sequentially (see Figure 10): the initiation of processes attributable to later phases does not terminate the knowledge processing initiated in earlier phases.

The hidden phase was the period in which people managing a project were not cognizant of belonging to this discipline. The knowledge needed for project management was probably considered to be a part of the knowledge needed for developing product projects (e.g., construction).

The concept of “project” is introduced in the initial phase; the collection of knowledge begins in this phase, often in the forms of stories and anecdotes (Wideman, 1995). Some subsequent projects use experience from previous projects in an unsystematic way.

The scientific investigation of select topics with the goal of gaining knowledge begins in the next phase of the investigation of project management topics. Models of operational modes and observations that generalize hypotheses begin to be created (Wideman, 1995). This phase started in the 1950s, with the development and investigation of concepts like critical path method (CPM) or program evaluation and review technique (PERT) (Bredillet, Turner, & Anbari, 2007).

Documents describing the sum of knowledge on project management begin to be drawn up in the creation of bodies of knowledge phase. Shortly thereafter, as a result of the development of knowledge, bodies of knowledge contain descriptions of the knowledge and not the knowledge itself. The first document of this type was published in 1983 by the Project Management Institute (PMI, 1983). The creation of bodies of knowledge facilitates vertical flows of knowledge.

The phase of general standards creation is the period in which standards are created on the basis of bodies of knowledge. Standards are the documents used to assess the level of acceptance of the ways of managing a project. With the first edition of the *PMBOK*®

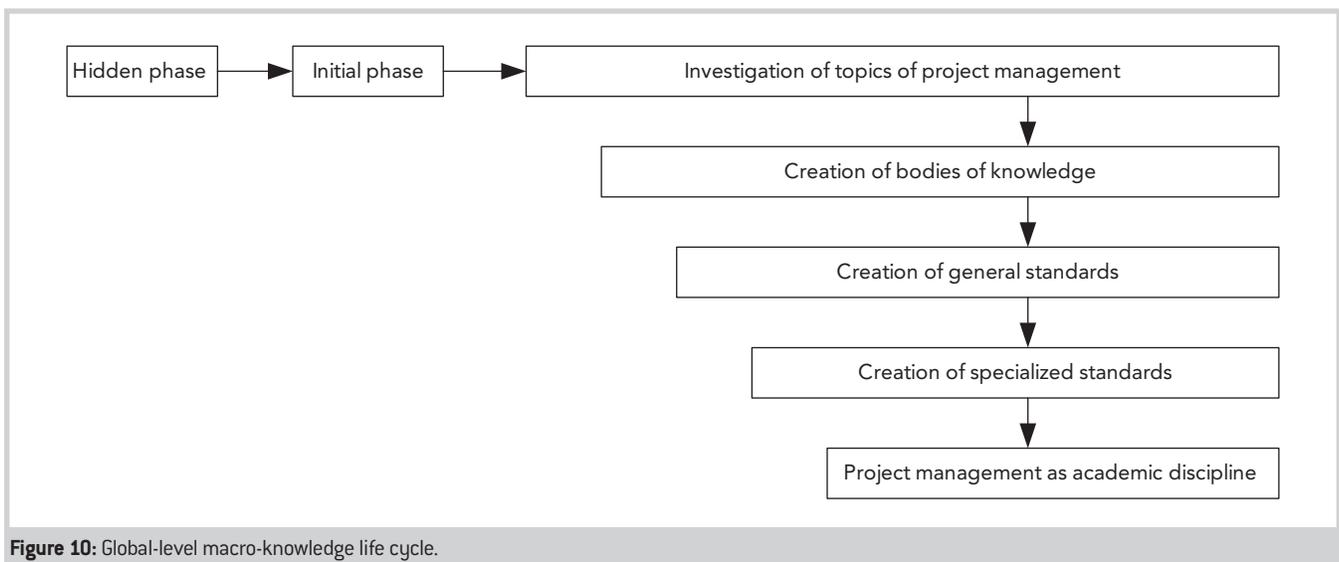


Figure 10: Global-level macro-knowledge life cycle.

Guide, which was later adopted by the American National Standards Institute as a national standard, PMI initiated this phase (PMI, 1996).

The phase of specialized standards is the developmental period of project management knowledge in which not only general standards and bodies of knowledge applicable to all projects executed all over the world are created, but also publications on matters that are relevant to select sets of projects (construction, government, etc.). The *PMBOK® Guide* extension for the construction sector (PMI, 2003) initiated this phase.

The most advanced level of knowledge development is that in which project management is considered to be an academic discipline. An academic discipline has its own various theories and schools of thought that relate to the discipline as a whole. A particular discipline has its own methodology of performing scientific research; it is an open-ended question as to whether or not project management has entered this stage. The works of Bredillet and his collaborators (Bredillet et al., 2007) make important contributions to this subject.

Summary and Conclusions

There are many papers that deal with the various issues of project knowledge management. Some authors describe ways of procuring particular knowledge elements; and some are interested in the whole knowledge possessed by project teams, whole organizations, or the global community of people engaged in project management. Our article proposes a model linking all of these perspectives for viewing project knowledge management. By introducing the concepts of the project micro-knowledge life cycle and project macro-knowledge life cycle and using the concept of vertical knowledge flow, we illustrate how all of the processes from the area of project knowledge management are mutually linked.

Many researchers (e.g., Basili & Caldiera, 1995; Boddie, 1987; Kotnour,

1999) explore the cognitive view of project knowledge and project knowledge management processes, in which project knowledge is seen as a resource that may be created and stored on external media. All types of repositories are the central constructs of this approach. Historically, this was the first approach to project knowledge management and is sometimes called “first generation knowledge management” (Delisle & Rowe, 2004; McElroy, 2000). A new stream of the community view of project knowledge, sometimes called “second generation knowledge management,” emerged later on. The works of Sense (2004, 2007a, 2007b, 2008), Scarbrough and his co-workers (Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003; Scarbrough, Swan, Laurent, Bresnen, Edelman, & Newell, 2004; Swan et al., 1999), and Jackson and Klobas (2008) are examples given here. The concept of communities of practice and social interactions as engines for knowledge creation and sharing are perhaps the most important for this approach. Our model combines both views of project knowledge management; for example, at the organization level it covers processes of knowledge repository maintenance as well as developing conditions of project knowledge management that covers community project knowledge management techniques. At the individual level, it refers to Nonaka’s socialization process as well as to processes of documented knowledge storage and retrieval; thus, the model shows that both approaches to project knowledge coexist and complement one another. The balanced application of techniques from both groups provides the optimal effects of project knowledge management.

From the epistemological point of view, this article introduces two concepts related specifically to the domain of project knowledge management: project micro-knowledge and project macro-knowledge. It is impossible to precisely understand the domain of project knowledge management without the conscious use of these concepts.

The sets of processes operating on micro-knowledge and those operating on macro-knowledge are different. Solving problems with the use of micro-knowledge is quite different than, for example, implementation of project knowledge management in an organization, working on an organization’s macro-knowledge. Nonetheless, processing both types of project knowledge belongs to the same area of project knowledge management—our model shows the roles of both of these groups of processes; moreover, it systematically defines all the processes of project knowledge management and their relationships. The proposed classification of knowledge types enables us to systematically define all the processes operating on both these types of knowledge—you may not define proper processes unless their subjects are systematically defined. So, the proposed knowledge classification has very practical implications: showing the way to consistent, systemic, and complete project knowledge management.

The proposed model shows how to systematically combine processes executed at all the organizational levels. The model shows how project micro-knowledge is processed at the lowest individual level and how this process cooperates with processes performed at other organizational levels. According to our model, such knowledge is passed along a vertical organizational axis, to the project, organizational, or global level. Conversely, knowledge needed by a project may be generated at the project level or acquired from another level: global, organization, or individual. This article shows that all the processes dealing with project micro-knowledge, in fact, constitute one consistent approach to micro-knowledge processing. Organizations and projects will profit from project knowledge management only when they will be able to effectively implement such a process.

On the other hand, project macro-knowledge processes are different at each organizational level; there are

A Model of Project Knowledge Management

specific goals for project macro-knowledge management at these levels. Project knowledge creation is the main goal of the individual level and an important goal of the project level. The main, final goal of project knowledge management lies at the project level; this is its application for executing activities and solving problems. The organization as a whole facilitates project knowledge management and provides it to its projects. The highest, global level of project knowledge management is responsible for documenting and distributing project knowledge to its final users: projects (performed in organizations).

There is a specific level of project knowledge management—the global one—and it is not managed in the way in which the lower levels are managed. Project knowledge is not managed at that level by any single governing body like it is at any local level; there are several of them, and PMI and IPMA are the leading organizations in this field. Project knowledge at the global level is processed by communities of practice; these global organizations collect, structure, and distribute project knowledge to local levels. Although the way of developing and processing global-level macro-knowledge (i.e., all the bodies of knowledge of project management; we do not mention here any particular Body of Knowledge, like *PMBOK® Guide*) may not be called “management” in a classic sense, the importance of these activities is crucial for providing the right knowledge to organizations and projects in which it may be used for their purposes. Thus, in order to understand all aspects of the area of project knowledge management, the global level must be seamlessly incorporated into a full model of this domain of activity.

Defining the levels of project knowledge management and the types of knowledge life cycles enables us to provide the general definition of the concept of project knowledge management:

Project knowledge management comprises processes that aim to generate, utilize, and distribute the micro-knowledge necessary for project execution and processes that are performed on the macro-knowledge of people at all organizational levels and that aim to increase the capabilities of direct or indirect participation of people in effective project execution or to increase their possibilities for influencing project execution.

The holistic, consistent model of project knowledge management, which covers cognitive and community views, project micro- and macro-knowledge, and all the levels of project knowledge processing—from the individual to the global level—that are presented, enable researchers to situate their works in a well-defined location and thus may contribute to systematizing all works and research on project management and, indirectly, to the systematized development of the area of project knowledge management. In particular, the macro-knowledge life cycle of the project level may be a basis for defining the area of project knowledge management in the same manner as other areas (e.g., cost management, procurement management) are defined in the project management standards and bodies of knowledge. ■

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