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Knowledge Management in a Project Environment: Organisational CT and Project Influences

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Abstract

Purpose: During a project implementation various forms of information and experience are generated within the organization. If this accumulated knowledge is not recorded and shared amongst other projects, this knowledge will be lost and no longer be available to assist future projects. This may lead to increased future projects costs as resources, time and money will be wasted on redefining the knowledge that once existed within the company. By not capturing and redeploying this knowledge, the quality of a project's deliverables may adversely suffer.

Design/methodology/approach: First this paper reviews the concept of project knowledge management. It defines the reasons for managing project knowledge, the benefits it brings to organizations and challenges that exist within the organization that prevent the process from being successfully deployed. Secondly, the sources of knowledge within projects and strategies that can be used by organizations to manage this knowledge are reviewed. Further more the paper examines a number of studies to identify the practices of project knowledge management within different organizations. Finally, the paper draws conclusions on the influences and implementation of project knowledge management by project-based organizations.

Findings: It is evident that the nature of the projects and organizational culture has a significant impact on the ability to manage project knowledge which in turn aids to the projects success or failure.

Originality/value: The paper assists practitioners in understanding the complexities of establishing organizational and project culture to enable knowledge management activities within projects in order to improve project performance and enhance chances of project success.

Keywords: Project Knowledge Management, Knowledge Management; project knowledge.

Paper type: Conceptual paper.

1. Introduction

Knowledge is becoming one of the main assets for organizations that seek a competitive advantage in a dynamic market place. Knowledge comes from many different sources within the organization. Such sources include internal processes, projects, customers and stakeholder information. As markets change, the way of doing business evolves. In today's market place many companies implement different projects to deal with these changing environments. Projects accumulate a lot of intellectual knowledge which can be later used by these same companies to add value, competitiveness and improve future projects performance.

Companies use Knowledge Management (KM) to create, identify and distribute knowledge and lessons learned within the organization. However, as projects have specific goals and unique deliverables that are never the same this may lead to a difficulty in efficiently capturing project knowledge. The use of KM in the project environment is gaining increased importance as it helps to improve the chances of a project success. The success or failure of projects is highly dependant upon the ability and willingness of people to identity knowledge and share it within organization. This characteristic is dependant on the culture and environment organizations create for their employees.

Activities that are required to establish KM within projects include capturing, organising, refining and the exchange of captured knowledge. Many companies record Work Breakdown System, lessons learned, templates and other aspects from past projects, but fail to capture knowledge and experiences obtained from project implementation. This break down in KM can be due to variety of reasons, which include the lack of time, insufficient resources, lack of means and ways of sharing and reusing knowledge and the inability of management to fully understand and underline the importance of having knowledge captured and shared. This lack of KM can lead to project failures, as no documents may exist to support the implementation of current and future projects. This paper underlines these important and fundamental conceptual issues for reader consideration.

2. Projects and Project Management

Project can be defined as a combination of resources pulled together to create something that did not previously exist (Cleland and Ireland, 2002). Many organisations implement different projects to produce a desired outcome or to reach specific goals. Projects can have both tangible and intangible outcomes. For instance, the creation of a new piece of software or car manufacture is a project, whether the production of thousand of cars or software programs is not a project. Each project produces some sort of an outcome and every project has a beginning and end (Verzuh, 2005). Project Management (PM) is used to predict as many dangers and problems as possible and to plan, organise and control activities so that projects are completed successfully in spite of all risks (Lock, 2007). PM is the process of application of knowledge, skills, tools, and techniques to project activities in order to meet project requirements (PMBOK, 2005). PM helps people involved in the projects, as it provides them with step-by-step activities, inputs, outputs and tools that can be used at each of project phases. As stated by Kerzner (2009), each of the projects involves a number of people and is considered to be any series of activities and tasks which:

- Have a specific objective to be completed within certain specification;
- Have defined start and end dates;
- Have funding limits;
- Consume human and non human resources (for example money, people and equipment);
- Are multifunctional (cut across several functional lines);

Many factors influenced the emergence of PM for conducting business related activities, such as global competition, compression of product lifecycle, new product development, corporate downsizing, outsourcing, customer focus and innovative technologies (Frey et.al, 2009). In response to such influences and in order to remain competitive organizations need to learn how to manage the knowledge that they acquire and accumulate from projects more effectively. This requires a cultural change within the organization, as there is a need to encourage learning through contemplation and reapplication of best practices from lesson learned. Management of knowledge, whether explicit or tacit, is a necessity for a project success in today's changing environment.

3. Knowledge Management for Organisations and Projects

KM is a discipline that is focused on systematic and innovative methods, practices and tools for managing the generation, acquisition, exchange, protection, distribution, and utilization of knowledge, intellectual capital, and intangible assets (Montana, 2000). KM has emerged from and tends to synthesize ideas from various disciplines, such as psychology, philosophy and sociology and can be perceived as an 'umbrella' for wide spectrum of academic orientation (Nonaka, 2005). KM provides processes through which organizations create value from their intellectual and knowledge-based assets. This value involves capturing what employees, partners and customers know and sharing this knowledge among employees, departments and even with other companies in order to create best practices. At present, KM is '*a central concern - and must become a basic skill of a modern manager*' (Sanchez, 2003). Organisations that don't manage their knowledge allow organisational memory and knowledge to dwindle as they don't support and enable their employees to become knowledge workers. KM should be given a high importance within the organisations, as based on DuPont Research data it can be seen that a lot of professional time is spent on the tasks, which could be initially avoided, as shown by Figure 1.
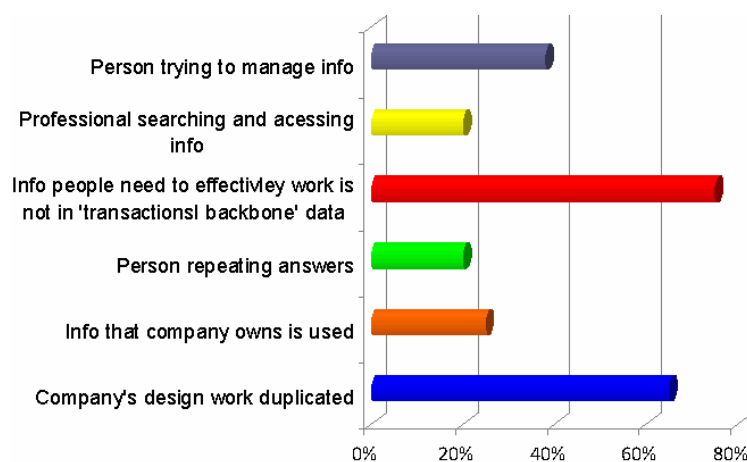

Figure 1. Time spent on organisational re-work

Knowledge in organisation is relatively observable: operational rules, manufacturing technologies and customer data banks are tangible representations of organisational knowledge (Kogut and Zander, 1992). Kogut and Zander (1992) categorise organisational knowledge into information and know-how based knowledge. Information is knowledge that can be transmitted without loss of integrity once the syntactical and the syntactical rules required for deciphering it are known (Kogut and Zander, 1992). Information is produced from processed data and has a meaning, purpose and relevance. Information is accessible by people in organization through networks, intranet, email, and internet or hand delivery. Know-how on another hand is accumulated practical skill or expertise that allows one to do something smoothly and efficiently (Kogut and Zander, 1992). Know-how is the description of what defines current practice inside the organisation. The characteristics of both types of knowledge need to be analysed along dimensions of codifability and complexity (Rogers, 1983; Winter, 1987). The main characteristic between two organisational knowledge types lies in transferability and mechanisms used for transfer across individuals, space and time (Grant, 1996).

KM allows the capture and deployment of a company's collective experience located anywhere in the business, for instance on hardcopy documents or in databases (explicit knowledge) and knowledge contained in people's minds (tacit knowledge) (Awad and Ghaziri, 2004). Interaction of tacit and explicit knowledge was introduced by Nonaka and Takeuchi in 1990's in the form of Knowledge Spiral Model (KSM), as shown by Figure 2 (Dalkir, 2007). Tacit knowledge is gained through learning, experience, common sense, values and beliefs. Tacit knowledge is considered to be more valuable, although it is more difficult to capture into a recorded, documented or codified form (Magalhaes, 2004). Tacit knowledge is revealed through its application, as it cannot be codified and can only be observed through its application and acquired through practice. Tacit knowledge transfer between people is slow, costly and uncertain (Grant, 1996). Explicit knowledge is codifyable and transmittable in formal language, for example manuals and documents. Explicit knowledge is revealed by its communication, the ease of which is fundamental property. Explicit knowledge can be evaluated, organized and made available to the people who can use it to support the organization (Davenport and Prusak, 1998). Therefore, information within the organization can be viewed as explicit knowledge, whether know-how is rather a tacit knowledge. The key to knowledge creation lies in the way it is collected, converted and distributed through technology.
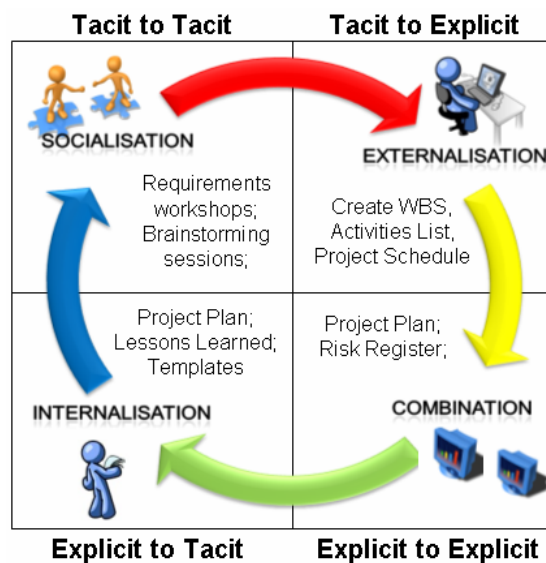

Figure 2. Knowledge Spiral model and project activities

KSM works in hand with project phases as shown by Figure 2. For instance 'Socialisation' process of KSM happens on the project during project meetings, post project reviews, brainstorming sessions, workshops and project evaluations. If during project's 'Socialisation' process there is a resistance or hoarding of knowledge, the knowledge becomes stagnant. During 'Externalisation' process of KSM the project's tacit knowledge is codified by creating Project Schedule, Activities List or WBS. The explicit knowledge can be merged during 'Combination' process of KSM, for example by creating Project Plan that combines all other project plans, such as Risk Management Plan, Activities List, Scope Management Plan and Project schedule. When people review codified knowledge during 'Internalisation' process of KSM, such as project's lessons learned or project plan from previous projects, they may gain new tacit knowledge, which they can apply in future projects implementation. As project environment matures within the organisation, knowledge also matures. As project progresses the knowledge moves from tacit to explicit and back to tacit knowledge through the KSM. It is vital

to ensure that knowledge is circulated correctly through the cycle allowing project requirements to be defined, explained and deliverables established with final product delivery to the customer as per requirements established at the beginning of the project. It is necessary to ensure that knowledge is not lost between project phases and during integration of phases. This happens, for example, when various people are assigned to work on a project. They may feel that the knowledge in their head is their own knowledge or perhaps the project's tight deadlines do not allow sufficient time to actually document and pass on the knowledge. Often within a project's scope some additional requirements may emerge during project implementation, which creates budget restraints. This also has implications on the management of knowledge within projects.

4. Project Knowledge

Project knowledge is usually established by people involved in the projects, which include project managers, project team, stakeholders of the project and sometimes even a customer. Knowledge in the projects comes from different internal sources, such as risk logs, lessons learned and experience, and external sources, such as seminars, benchmarking and competitor analysis. As underlined by Ajmal and Koskinen (2008), project managers must find ways of preserving and utilizing knowledge within established practices of everyday teamwork. In undertaking this task, project-based organizations require a clear understanding of the types of knowledge and knowledge bases that should be included in effective knowledge-management system. Conroy and Soltan (1998) have identified three knowledge bases in projects:

- **Organization knowledge base** - which includes knowledge specific to organizations and environments in which projects are implemented;
- **Project-management knowledge base** - which includes knowledge of the theory and application of PM;
- **Project-specific knowledge base** - which includes specific knowledge acquired within the implementation of a particular project;

Conroy and Soltan (1998) also have divided project-created knowledge into three general categories as follows:

- **Technical knowledge -** which relates to techniques, technologies, work processes, costs and other things that are involved in discipline-specific issues of the project;
- **Project management knowledge -** which relates to methods and procedures required for managing the implementation of projects;
- **Project-related knowledge -** which refers to knowledge about the customers and other people or entities that are of significance for the future business of the company.

Project knowledge is created within each of project phases. Already during project 'Definition' and 'Planning' phases the working steps, time and budgets are dedicated to capture and transfer knowledge and expertise (Disterer, 2002). Those phases also define the responsibilities, in which areas new knowledge generation is expected and how experiences have to be documented, stored and perceived. During 'Execution' and 'Monitoring and Controlling' phases of the project the knowledge is usually created and captured as project work is being implemented. Activities such as lessons learned are conducted to document the knowledge about the performance of these phases. Lessons learned is a documentation that covers full and detailed descriptions of identification and solution of concrete and detailed explained problems, which can be used as examples in future projects (Disterer, 2002). Lessons learned and their reflection covers things like technical issues, organizational aspects or social situations and also covers approaches that have failed and/or approaches that weren't chosen for given merits. Through detailed descriptions of problems and successful or less successful ways to their resolution the lessons learned are considered to be a way to uncover and store the implicit knowledge (Disterer, 2002). Another documentation tool for project knowledge according to Disterer (2002) is project profiles, which covers the project characteristics and summaries. For example, for a software development project the details should be systematically stored, such as programming environment, production environment, hardware, system software, tools, involved functional areas, departments and participating employees. Overall, collection of project profiles provides a source of knowledge about projects and can be used to find people or documents to get some help or support. Databases can also be created, which show the employees' assignment to the projects, so that work experience can be tracked. These databases would create internal 'yellow pages' where a person can find someone they can contact for a specific project problem or knowledge. The project 'Closing' phase is becoming the most important phase for identifying and capturing new knowledge. This encompasses the preparation of knowledge for transfer to other projects. The 'Closing' project phase represents an opportunity to identify and secure the knowledge and experiences of team members (Disterer, 2002). During the 'Closing' phase the following activities allow the management of knowledge based aspects of the project:

- Post project reviews;
- Post project appraisal;
- After action review;
- Debriefing;
- Reuse planning;
- Cooperative project evaluation;
- Reflection;
- Corporate feedback cycle;
- Post installation or implementation evaluation;

Knowledge transfer from and between projects is expert knowledge, methodological knowledge, procedural knowledge and experience knowledge. This knowledge contributes to overall organization knowledge base (Frey et.al, 2009). As all of the projects are different and unique, it is still possible to classify projects into different categories in accordance with a need to use explicit and tacit knowledge in them (Koskinen et.al, 2001):

- **Research, Development and Design projects:** these are projects in which goals are not always clear. Also the resources and procedures required for the project implementation are often vague. This means that at the start of the project the possibilities to determine the future results and success of the project are rather poor. For these kinds of projects the plentiful use of tacit knowledge is often needed.

- **Delivery and Investment projects**: these are projects in which the goals of the projects are often clearly defined at the beginning of the project. Also the methods needed for the implementation of the project are well known. This means that the possibilities to identify the goals at the beginning of the project are good. For those kinds of projects the explicit knowledge is mainly used.

In an ideal case a project would have much explicit knowledge and little tacit knowledge about the activities to be implemented. However, in practice a project team is likely to know only a little about some important issues.

Knowledge transfer within project may occur at different levels in an organization - between individuals, from individuals to explicit sources, from individuals to groups, between groups, within groups, and from the group to the organization. As stated by Fong (2005), KM in project-based environments occurs:

- **Project-to-Project (P2P) –** passing the experience and ideas from one project to another;
- **Project-to-Business (P2B) –** movement of experience from project teams to the central business function;
- **Business-to-Project (B2P) –** dissemination and development of new skills and competencies in central departments to project teams.

5. Project Knowledge Management

Project Knowledge Management (PKM) is a management of knowledge in project situations and thus, the link between the principles of KM and PM (Frey et.al, 2009). KM and PM components are very similar. PM components include system, people and tools and KM components include people, technology and organisational factors (Awad and Ghaziri, 2004; Lewis, 2005). As components are analogous this allows for components from both disciplines to be placed on top of each other, so they can merge and work in conjunction with each other as shown by Figure 3.
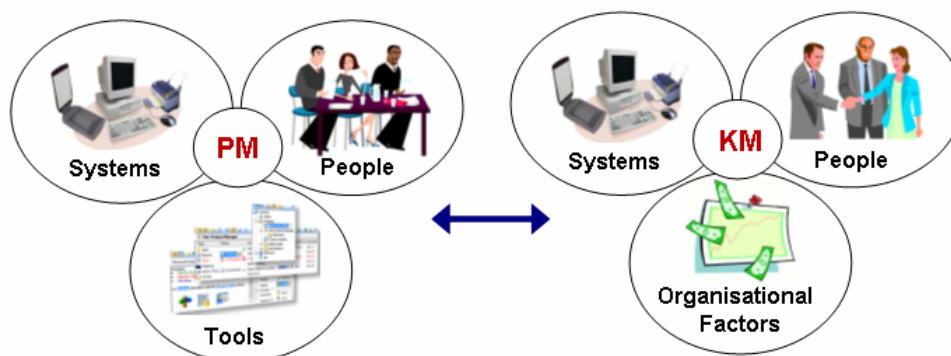

Figure 3. Knowledge Management and Project Management components

The ability to manage knowledge on projects includes the capacity to create, absorb and share project-related information, which is a big part of organization's culture. Using gained knowledge to learn from the failures and successes in previous projects is vital for long-term sustainability and competitiveness of the organisation. Although project basing is often conceived as an appropriate way of organizing for innovation, the research on project-based learning consistently highlights the problems involved in attempting to capture, share and diffuse knowledge and learning (Bresnen et.al, 2004). Effective KM in the project environment is about creating the kind of organization that promotes the creation and sharing of knowledge and which must exceed multiple cultures in order to produce a single project culture that makes use of collective experience and information to benefit future projects (Ajmal, and Koskinen, 2008).

The growing complexity of project work means that an increasing number of technical and social relationships and interfaces must be taken into account by project managers in adapting knowledge and experiences from the daily work of a company and from earlier projects. Project team members frequently need to learn things that are already known in other contexts. In effect, they need to acquire and assimilate knowledge that resides in organizational memory. Their effectiveness in doing this determines their personal effectiveness, the project's effectiveness, and ultimately, the company's effectiveness (Ajmal and Koskinen, 2008). Usually, knowledge from past projects is accumulated in an individual's mind or documents and repositories. People with knowledge about past performed projects assigned to similar projects where their knowledge can be shared to benefit the project implementation and widen overall organizational knowledge base as can be seen from Figure 4.
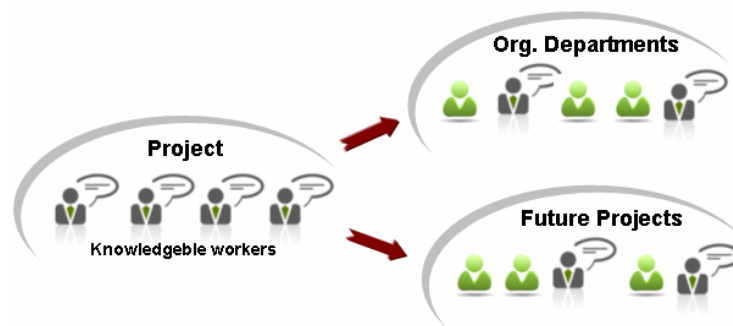

Figure 4. Project knowledge workers and knowledge spread

6. Project Knowledge Management Strategies

Two strategies can by adapted by organizations to manage project knowledge (Fong, 2005). Both strategies are needed for fully comprehensible project work. Organizations can enable capture and sharing of accumulated knowledge within the projects and organization by using codification or personalization strategies.

6.1. Personalization strategy

Where personalization strategy is used, the knowledge sharing is attached to the person who developed the knowledge, and the experience is shared through direct interaction. Personalization as a knowledge sharing mechanism has the inherent flexibility of transmitting tacit knowledge, and allowing for discussions and sharing interpretations that may lead to the development of new knowledge (Prencipe and Tell, 2001). Personalization strategy defined by:

- The knowledge that is tied to persons who developed it and is shared by personal interaction, such as dialogue, workshops or meetings;
- 'Soft' items - stories, recollections of incidents, details about decision processes, capitalization of lessons and experiences from given projects;
- A well-defined set of meta-knowledge which is used to determine how and when the knowledge or content should be applied.

By using personalization strategy the knowledge is shared through:

- **Integrating processes between Individuals and Groups:**
  - Meetings amongst communities of individuals interested in a particular topic area
  - Meetings amongst high level staff
  - Word of mouth - sharing information through approaching individuals with deep institutional knowledge
  - Informal one-on-one discussions
  - Building a transitive memory, where individuals specialize in different areas, and are referred to for specific expertise
  - Mentoring
  - Broadcast email
  - One senior person coordinating all staffing needs
  - Friendship network
  - Meetings on performance assessment
  - Project briefings and project presentations

- **Processes institutionalised in Routines and Structure:**
  - Yellow pages of expertise
  - Having a common project director shared across projects
  - Project debriefs
  - Cross-staffing across projects
  - Project reviews, after-action review, etc.

Personalization knowledge-sharing mechanisms are more suitable for organizations conducting tasks or encountering problems that are more unique in nature (Boh, 2007).

6.2. Codification Strategy

Where codification strategy is used, knowledge is captured and stored so it can be accessed and used by the whole organization. Codification can be a good mechanism to store large amounts of knowledge and to create an organizational memory for all employees (Goodman and Darr, 1998). Codification strategy defined by:

- Codifying the knowledge and storing it in databases;
- 'Hard' project data - database records, documents, standard operating procedures, project definition, activities, history and results;
- A knowledge base which contains the content or knowledge that is of value to the organization;

By using codification strategy the knowledge is shared through:

- **Integrating processes between Individuals and Groups:**
  - Sharing prior project documents (e.g. specifications) informally
  - Manuals written voluntary

- **Processes Institutionalised in Routines and Structure:**
  - Database of project abstracts, proposals and resumes
  - Templates

Codification knowledge-sharing mechanisms are more suitable for organizations conducting tasks or encountering problems that are more standardized and routine in nature (Boh, 2007).

7. Reasons and benefits of Project Knowledge Management

Successful PKM facilitates project-oriented organizations and employees with the information required for better decision making. This in turn enables considerable cost saving in time and effort. In many cases successful project completion is based on accumulated knowledge, and individual and collective competence (Kasvi et.al, 2003). On projects the creation and transfer of knowledge is done for the following reasons (De Long et.al, 1996):

- **Capturing and reusing structured knowledge**. The knowledge from project or project phases, such as project proposals, reports, implementation documentation or software code can be reused to reduce the time and resources needed to produce a new output.
- **Capturing and sharing "lessons learned" from practice**. Captures more experiential knowledge that must be interpreted and adapted by the user in a new context.
- **Embed knowledge in project's products and processes**. Seeks to enhance or create new knowledge-intensive products, services, and processes.
- **Identifying sources and networks of expertise**. Includes making expertise more visible and accessible to employees. The aim is to facilitate connections within the projects between those who possess knowledge and those who need knowledge.
- **Structuring and mapping knowledge needed to enhance performance**. Project efforts, like new product development or process redesign are reduced by making clear the specific knowledge that is needed at particular stages of the project.
- **Sharing knowledge from external sources**. Unstable business environment increases the importance of organizational intelligence systems. The electronic information innovations combined with increasing complexity, specialization, and speed of market changes has lifted up the knowledge component of these systems.

In order to improve the success of a project, it is necessary to improve its management and decision making processes. KM is very important as it can bring significant benefits. Organisations should enforce the importance of KM into their culture. Where organisations can encourage employees to reuse the existing knowledge on future projects, the more creative project outcomes can be produced. Enhancing PKM can help to shorten project schedules, reduce costs, improve quality and enhance customer satisfaction (Tong and Nengmin, 2009). Usage of KM on projects helps to reduces errors, it creates less work, provides more independence in time and space, generates fewer questions, produces better decisions, reinvents fewer wheels, advances customer relations, improves service and develops profitability (Singley and Anderson, 1989). General advantages of PKM include:

- Adds competitive advantage as well as reduces cost of the projects.
- The experiences and knowledge from the past projects can serve as a base for future projects and help to solve different obstacles and issues.
- For the people involved in the projects, such as project team members or project managers and other stakeholders, it gives documented knowledge information about each performed project.
- Beneficial to customers of the project, as project outcomes may be delivered in more efficient way. Quality is engineered from the project start based on past/shared and common experiences.
- Access to bad and good practices of the project is very important source for the organizations, which helps to improve implementation of future projects and help to fill in knowledge gaps.
- Facilitates organization and people with the information required for better decision making as well as saves the time and resources usage on the projects.

8. Challenges of Project Knowledge Management

Although managing the knowledge is very important for the success of projects, it has its own challenges. While learning is generally cumulative, the discontinuous and temporary nature of project-based systems makes the rapid assimilation of new knowledge throughout project-based organizations challenging (Landaeta, 2008). Most companies are not able to evaluate projects and learn from them. As underlined by Karlsen and Gottschalk (2004), it becomes difficult to develop steady routines that maximize knowledge flow and capture learning, both within the project and from one project to the next. KM in project-based organizations is often a complex task, as project teams often consist of people with diverse skills working together for a limited period of time. Project teams often includes members who have never previously worked together and do not expect to work together again (Ajmal and Koskinen, 2008). Many projects lack knowledge and experience capture, which can lead to future projects failure due to the lack of supporting documentation. As stated by Obaide (2008), technologies such as knowledge bases and lessons learned systems are available to support knowledge storage and documentation, but that documentation is rarely meant for future projects. Documentation needed for future projects represents methods, proceedings, outlines of precise problems, description of successful and unsuccessful solutions, and a directory of persons who posses specific knowledge and expertise.

The failure to effectively deploy PKM means that many project-based organizations are unable to appraise projects and learn from them. At its simplest, a failure to review a finished project means that the past errors are likely to be repeated. In some cases, project-based organizations can fail to learn from their mistakes for years on end (Ajmal and Koskinen, 2008). A number of challenges within PKM lay in the nature of the projects themselves. Projects are unique, these differences give rise to a requirement for different resources and they

integrate internal and external expertise and knowledge. Also, organizations that are project based can lack organizational memory, routines and other mechanisms for knowledge capturing, storing, disseminating and organizational learning (Prencipe and Tell, 2001). There are many problems associated with knowledge transfer within a project environment. As emerging technology can accomplish the communication of existing knowledge, only human social interaction can result in the creation and sharing of new knowledge (Ajmal and Koskinen, 2008). Based on this, people must be willing to participate in knowledge transfer within the project or even the organisation. Thus, it can be an issue due to different obstacles within the organisational culture, which include:

- **Time and budget constraints**. Lack of time due to the fact that staff may need to be assigned to work on a different project as soon as the current one finishes.
- **Resistance to talk about mistakes**. This is normal behaviour of most of the people, which will result in lack of analysis of mistakes and errors happened on the project.
- **Low motivation**. Low motivation of people involved in the project in order to transfer the knowledge, as they don't take it as a priority and being beneficial to themselves.
- **Lack of leadership**. Project managers may not put emphasis on importance of knowledge transfer within organisation. Due to poor leadership and communications among people or if team conflicts may exist, it will prevent people to exchange the knowledge.
- **Lack of KM strategy for projects**. The sufficient KM structure for capturing and sharing the project knowledge is not put in place.
- **Lack of technology**. The technology that is required to store and share knowledge and experiences doesn't exist within organisation.
- **Lack of common understanding and cultural differences**. The inability of people involved in the project to communicate successfully can lead to misunderstanding, work not being carried out or work being duplicated.
- **Lack of concern**. People are more concerned with tasks upon which they performance is evaluated and they are not keened on tasks of storing and retrieving the knowledge, especially when the time is limited on the projects.
- **Lack of training**. Lack of training within the organisation on how to document experience or knowledge arising from the project, how to share that knowledge and what tools should be used for PKM activities.
- **Project Uniqueness**. Projects are done in different areas; they include different people (internal and external to organisation), requirements and timelines.

Many projects could be more successful if organizational culture would support the knowledge transfer and sharing process. These projects often fail because (Cameron, 2002):

- No incentives to promote sharing knowledge and insight among employees;
- Little time or attention is given to identifying lessons learned from past project failures and successes;
- Assumptions about new projects are not challenged;
- Organization hires and promotes individuals based on technical expertise alone;
- Management is reluctant to talk about projects that did not work well.

9. Project Knowledge Management Empirical Studies

A number of studies have been completed in last decade on topic of PKM and many of them indicate that systematic 'know how' transfer from, between and within projects has a significant impact on the success of a project. This is illustrated in Table 1. All of the mentioned studies indicate that PKM helps to improve a projects' implementation and has a positive influence on project's deliverables. Although, organisations and employees see the value of managing project knowledge, not all organisations implement that process. The main barriers to KM within the project as identified by the conducted studies were recognized in areas of social culture and project culture. Studies indicate that organizational practices require change in order to successfully enable PKM. As people are the main elements in creating and sharing knowledge, the focus must be placed on people and tools which enable them to perform KM activities. Studies indicate that cultural factors play a huge role for the success of PKM. Organizations must create a trusting environment for their employees to encourage them to codify and share the knowledge without hording it. As well as organizational factors, project factors have a big influence on the success of managing project knowledge. As projects normally allocate time and budget for the project activities, there might be no time or space for the employees to participate KM activities.

A study performed by Kasvi et.al (2003) is an example of the project that lacks KM strategy and where all the challenges that relate to PKM were not addressed by an organization. The study demonstrates the consequences of not performing PKM on the projects. The study defines that both personalization (as an

interaction with colleagues) and codification (in form of paper documents) strategies were used to manage knowledge. Although, no particular document management groupware system were used by the organization (i.e. codification strategy is weaker), which prevented employees to share the codified knowledge, build up organizational and project memory and which had increased the risk of loosing documented knowledge and experience. The programs and project described within the study were undertaken by one company but funded by other outside organizations. Each involved party required different project information, which had proven to be the difficulty due to the lack of a centralized document repository. The efforts to reproduce the information for each of party were duplicated. The study defines that some of the project related documents were stored unsystematically onto computer systems in each organization. As project information was taken form different Information Systems, it was not synchronized and had a possibility of errors and being out-of-date. Weak codification of project experience and information means that no information exists to support future or similar projects. This results in redefining and reinventing the knowledge. The study also defines that the supplier company didn't have people with the required skills to document the work performed. The appropriate training should be given to employees to ensure that they can perform necessary activities. Organization also needs to review employees abilities on a regular basis to identify gaps in their skills set in order to take an action to resolve those gaps. The study mentions that only three project participants defined KM to be crucial for project success. This shows that organizational culture didn't promote the importance of implementing KM activities nor that management encouraged its employees towards participating in PKM activities. The study also identified that program managers were more concerned with their own personal goals and little importance was given for knowledge distribution outside their own area. It is clear that programs and project lacked defined KM strategy; therefore observed KM practices were weak and unsystematic. The lack of availability of codified knowledge lead to issues within the projects, as involved parties had miscommunications in relation to the project items and obtained knowledge was not utilized to improve project performance.

Another example of unsuccessful project implementation due to the lack of proper PKM strategy is described by Koskinen (2000). The study describes the project that was implemented by Finnish enterprise manufacturing automation systems the customer of which was a Finnish steel mill. The project deliverable consisted of an automation system, which was designed at the supplier's plant and installed and commissioned at the steel factory's coarse rolling mill. Due to the lack of knowledge on the automation system and rolling mill by the supplier and customer organisations, people from both companies were involved in the project. At initial stages of the project both parties were communicating via telephone and telefax, therefore a majority of knowledge was tacit. Lack of codified knowledge resulted in rework and the same questions being repeatedly asked. As each party didn't understand each process in detail, there was no common language among them. The general training course about system automation was given to the customer; whether the supplier company was not given any training about the rolling mill. Due to the lack of understanding between two parties, the project plan was changed numerous times, which resulted in project delays. As previously mentioned, lack of training for those people involved in the project is a big barrier to knowledge transfer on the projects. In this case, lack of training led to the lack of understanding between the involved parties. If the appropriate knowledge was given to both parties before project implementation, the unnecessary delays could be avoided. This inability to understand one another led to a negative atmosphere within the project and reduced both parties commitment to the project. During the project there were no common social events between the customer's and supplier's project groups. This suggests that personalisation strategy used for the project was poorly implemented. The trusting atmosphere between involved organisations was not created, therefore during the project there were no activities which could have increased openness and mutual confidence between the individuals groups. This had reduced the 'Socialisation' process of KSM on the project and had limited the ability to question project activities and how the system should be implemented. During the installation and commission phase of the system it was necessary to change the system significantly, as only at this stage the function and character of a rolling mill process begin to be clear to the supplier's project. At the end of the project the tacit knowledge relating to rolling mill automation of both the supplier and of the customer had increased significantly, as both partners had learned a great deal about ways of functioning, communicating and understanding each other's points of view. During the project implementation the related project knowledge stayed motionless, restricting it to move through the spiral of knowledge. If the appropriate training was given to involved parties at the start of the project it would have allowed project knowledge to move through KSM, which would have improved project performance. As communication between two parties was limited due to the lack of common understanding, the project completion was delayed, project exceeded the allocated budget and customer of the project was dissatisfied with overall experience.

In contrast to the unsuccessful PKM implementation by the organizations, the study described by Liebowitz and Megbolugbe (2003) shows how an organization with successful project implementation portfolio uses KM to increase the success of projects. The study describes NASA environment, where PM is a crucial element in accomplishing NASA missions. KM is given a high priority for the project success within the company. NASA provides organization-wide Knowledge Management Systems (KMS) for managing project

Author and Article	Methodology	Findings
Frey et.al (2009) Project Knowledge Management: Organisational Design and Success Factors	The research approach follows a two step procedure: a qualitative study based on 26 expert interviews and the questionnaire based study that included 496 participants.	The results show that companies and experts are aware of the problem of PKM throughout industry lines, enterprise sizes, and project types. Apart from cutting costs, several other objectives of PKM were stated: • Increasing work efficiency and reducing risk by capitalizing the experience and knowledge gained during earlier projects. • A continuous learning process throughout the overall project work allows revising and developing the processes applied as well as the created products constantly, including the prevention of repeated mistakes. • Continuous improvement in terms of methods and standards related to PM. • Identification and fostering of innovation
Hanisch et.al (2009) Knowledge management in project environments	The study is based on 27 expert interviews in different companies mainly located in Germany. The interviews were designed as semi structured, qualitative expert interviews.	The priority of PKM should be stronger emphasized as it is crucial for the securing of the sustainable development of the factor knowledge as one of the central competitive factors. The use of a standardized PKM method offers general conditions and routines to employees and therefore facilitates concentration on the gist. PKM is a topic of highest relevance in contemporary forms of organization, although based on observation; the implementation of KM in project settings nowadays still appears to be insufficiently used. This general shortcoming in business practice is striking concerning the high potential benefits regarding efficiency, effectiveness and innovation resulting from successfully implemented PKM in different types of firms.
Kasvi et.al (2003) Managing Knowledge and Knowledge Competences in Projects and Project Organizations	The methodology involved interviewing 24 project participants from two programs and one project. The interviews were semi-structured with 80questions.	Projects and project organizations require exceptionally efficient KM, if they are to learn from their experiences. This was established by a majority of the interviewees, who mentioned various KM problems and competence needs. The study defines that the failure to identify KM as a critical project competence area may have contributed to the KM problems. In order to systematically manage knowledge created in a project, the projects themselves must be systematically managed. Observed KM practices were weak and unsystematic. New organizational practices were considered to be the main new area to be created in the projects in order to improve KM process.

<div align="right">(continued)</div>

Table 1: Summary of emperial PKM studies

Author and Article	Methodology	Findings
Landaeta (2008) Evaluating Benefits and Challenges of Knowledge Transfer Across Projects	The data collection effort was primarily based on surveys, with 46 respondents who completed the survey.	The body of knowledge of projects obtained from other projects is positively associated with project performance. The results demonstrate that the level of knowledge transfer across projects effort is associated with an increase in the capabilities and performance of projects; however, it is suggested that an extended project effort in transferring knowledge across projects can also hinder the compliance to the schedule and budget of projects. Investments in knowledge transfer methods and technologies can also impose an increase in the costs of projects. Despite these challenges, knowledge transfer across projects provides projects and project-based organizations with an effective way of dealing with the issues, problems, crisis, and even disasters caused by the uncertainty generated by the complex and unpredictable nature of projects.
Lierni et.al (2008) The relationship between improving the management of projects and the use of KM	The survey was carried out to collect the data. The total of 99 project managers from around the world responded to the survey.	Performed research and use of regression analyses showed that there is reasonable certainty that project managers perceive that the use of KM practices has a positive influence on the improvement of the management of projects. The relationship between the use of KM and the improvement of the management of projects is not too strong but remains significant. Study defines that use of KM tools on the projects facilitates: • Project schedule reduction. • Reduction of project schedule slippage. • Project process reusability. • Project artefact reusability. • Fulfilment of project functional/technical requirements. • Project products exceeding buyer expectations. • Reducing project miscommunication. • Reducing the number of risks to the project.
Koskinen (2002) Tacit knowledge as a promoter of project success	The action research method is used in gathering the information.	The level of communication within a project is significant to its success. It is important to manage the conversion of tacit and explicit knowledge on the project, if the project was to succeed. The user of the knowledge need to understand the generation and character of the knowledge well enough to take advantage of it.

knowledge. For instance a Project Management Web Site serves as a repository of documents to help the various flight programs and projects in seeing what others have done. Use of such KMS enables sharing of best practice documents, lessons learned, PM and systems engineering methodologies, examples of review packages and rationale for why some strategic decisions were made. Another example of a KMS that aids NASA programs and project managers is the Process-Based Mission Assurance (PBMA) framework that relates to the NASA Procedure and Guideline for NASA Program and Project Management Processes and Requirements. Best practice documents, lessons learned, video nuggets of experts, online communities, and other features are part of this system. Codifying the knowledge and experiences related to the performed projects and making them available within the organization allows innovating and improving feature projects, reducing reinvention of wheel and increases the reuse of organizational knowledge and experiences. NASA's organizational culture promotes knowledge sharing among the employees by providing related training and education via the Academy of Program and Project Leadership (APPL). APPL has been engaged in such initiatives as: teaching and administering the Project Management Development Environment curriculum; holding knowledge sharing forums with project managers at the various NASA Centers; developing case studies of successful and unsuccessful NASA missions; and other knowledge sharing initiatives. It is clear that NASA encourages and leads its employees to knowledge based culture, which in turn helps to produce better project deliverables and more successful projects.

10. Conclusion

This paper has presented some theoretical findings on various aspects of KM in project environments. From the paper it can be concluded that many organisational factors as well as project related requirements and uniqueness are influencing the success of PKM. The culture and environment that organisation creates for their employees determines the enthusiasm of employees to record and share their knowledge. As knowledge comes from different phases and sources during the project implementation, it is very important to monitor the knowledge conversion to ensure its recorded and transferred to all of the interested parties involved in the project.

PKM requires KM practices and processes to be embedded into organisational and project culture. PKM helps to improve organisational performance, increase its competitiveness and improves organisational offerings and intellectual capital by improving projects implementation. For PKM to be successful, the organisational culture must support KM and provide incentives for the employees who are willing to share knowledge without hoarding it. Usage of accumulated knowledge to learn from failures and success that have occurred in projects is vital for long-term sustainability and competitiveness of the businesses.

PKM process has its own challenges and difficulties as many organizations do not consider KM to be the important asset, so they do not embed KM practices in their culture and employees do not see the importance of sharing knowledge with their colleagues. KM within projects is very complex as project teams consist of people working together for a limited period of time. Project knowledge such as knowledge bases and lessons learned systems are available to support knowledge storage and documentation, but that documentation is rarely used for future projects. Failure to practice effective KM means that many organizations are unable to appraise projects and learn from them. Failure to review past project means that the past errors are likely to be repeated.

Although a lot of obstacles come in the way of successful PKM, the benefits of managing project knowledge outweighs all the difficulties that organizations face in defining PKM processes. Enhancing PKM can help to shorten project time lines, reduce costs, improve quality and customer satisfactions, reduce errors, generate fewer questions, produce better decisions, reinvent fewer wheels, advance customer relations, improve service and develop profitability.

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