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# Introducing a Framework to Capture and Reuse Tacit Knowledge in Software Project Management

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## ABSTRACT

In rapidly growing global companies, comprehensive training programs as well as in depth sharing of knowledge are essential factors to maintain the quality of human capital despite rapid expansion. Different dimensions of Knowledge management address the need and approach to leverage dispersed knowledge in order to make it visible and accessible for everyone to improve organizational performance. However, there has been a scarcity of successful and holistic models that define and categorize *tacit* knowledge in order to capture and distribute it for the benefit of others. This paper focuses on developing a framework in order to capture experiences regarding software project management and to provide a platform for managers to inherit knowledge from and bequeath their learning to others at large organizations. In order to build up and enhance the framework, the majority of information was gleaned from intensive interviews with top software project managers at Infosys, a well-known global company in the field of software development and consulting services. The final framework we developed can act as a comprehensive data-repository for capturing, storing, searching, and distributing *tacit* knowledge of project managers.

## Keywords:

Knowledge Management, Software Project Management, Framework, Data Repository Construction, Tacit Knowledge, Infosys

## INTRODUCTION

Knowledge management (KM) is the cornerstone of every successful community, whether it is a small organization, giant company or even an entire society. During the course of history, those nations who succeeded in distributing and storing knowledge and passing it on to the next generation were the ones that were able to expand their learning, build empires and extend their territory beyond their borders. Science, art, and culture are a result of receiving the experience and skills of their predecessors, revamping them, and ultimately bequeathing them to their successors.

The very same principle of knowledge sharing is true for organizations. In a flat world with growing competitiveness in every industry (particularly in the field of information technology and software development); factors such as quality of products, cost of manufacturing and the time to deliver are of great importance. Organizational knowledge becomes a strategic asset in this regard due to its nature of acting as a mediator between the above mentioned factors. The ability to marshal and distribute knowledge dispersed across an organization is an important source of competitive advantage because it can enhance the efficiency significantly (Teece, 1998). Long-term sustainable growth relies on efficient dissemination of knowledge making knowledge management an inevitable part of an organization. Frequently referred to as a mechanism for capturing and transferring the knowledge that exists within the organization, knowledge management in a nutshell is the leveraging of knowledge towards the improvement of organizational performance.

Categorization is the first step in the management of knowledge. There are basically two kinds of knowledge: *Explicit* and *Tacit*. *Explicit knowledge* is a kind of information that can be defined easily; it can be expressed in words, diagrams or numbers and shared in the form of structured data such as scientific formulae, principles, manuals, orders, specifications, and so forth. Explicit knowledge can be transmitted across individuals in a systematical and well-structured manner. *Tacit knowledge*, on the other hand, is highly personal and harder to formalize, making it difficult to communicate or share with others. Subjective insights, intuitions and hunches fall into this category of knowledge. The challenge lies in the transfer of such unarticulated knowledge in a person's mind. Furthermore, tacit knowledge is deeply rooted in an individual's behavior and experience, as well as in the ideals, values or emotions he or she embraces (Edvinsson & S., 1997). In relation to an organization, tacit knowledge of employees is one of the most precious and intangible assets of companies. Although knowledge management constitutes both tacit and explicit knowledge, it is mostly in dealing with tacit knowledge that difficulties arise.

Two perspectives can be observed in an organization regarding the management of knowledge, regardless of it being *tacit* or *explicit*; from a management perspective, it is important to utilize KM systems for improving communication and collaboration in order to enhance employee skills and improve productivity. From a leadership perspective, it is critical to ensure that KM investments result in promoting collaborative culture both at individual and organizational levels to encourage knowledge sharing for better *decision making* and *innovation* (Anantatmula, 2008). In this paper, We tried to focus on the tacit knowledge regarding software project management.

The question now is how to leverage tacit knowledge for improving organizational performance. Generally, managing knowledge is, at least, two dimensional; the first dimension is a methodology of collecting and storing the dispersed information in an organization and the next dimension is the manner in which the appeal and the user-friendliness of the system is increased. Some believe that gleaning knowledge that is not sought by anyone is like providing the answer when the question does not exist! Michael Zack states in (Zack, 1999) that "If managing knowledge is the solution, then what's the problem?" This makes the performing of KM a very critical and complicated process, especially in massive corporation with a huge amount of data and a broad variety of personal characteristics and organizational behavior.

Unlike explicit knowledge related to technical skills and learning which utilize off-line or on-line documentation systems, there exists almost no effective system that captures and distributes the tacit knowledge of employees, particularly managers. In this paper we have tried to introduce a repository framework that can be leveraged in this regard.

We start with defining the study project objective followed by the methodology of our work, then moving on to the identification of the relevant projects and themes. Next, the findings extracted from the interviews we conducted are discussed and finally, the conclusion and future work are provided.

## **MOTIVATION**

Capturing the tacit knowledge of managers is of great importance in order to enhance the quality of management, as the major reason for project failures stems from poor management and can cause severe financial damages. For instance, failed and poorly managed projects cost U.S. companies and agencies about \$145 billion per year (Phillips, Bothell, & Snead, 2002). Which is why channeling sufficient effort and monetary resources towards the enhancement of managerial skills is a vital investment for companies. Moreover, training managers inside a company and pushing them up the ladder appears to be much more advantageous than hiring outsiders and putting them on critical positions. In a meticulous research that was conducted at the University of Colorado (Collins, 2001), the final results showed that the managers of ten out of eleven great companies that made a sustained improvement from a mediocre companies to great and successful ones had been promoted internally. This supports the premise that the best leaders and managers for a company are those who have been grown and trained at the same company and risen up in its culture. To be able to train and prepare talented people internally, it is profoundly important to have a sophisticated, yet pragmatic mechanism to transfer knowledge from top management to the managers at lower levels.

Principally, Knowledge management is a four-stage implementation that involves technology, content, process, and people behavior (Stratigos, 2001). The goal of our work was to design a sophisticated and well-structured framework to capture, store and distribute tacit knowledge of software project managers. Also in the knowledge matrix introduced by Nanoka (Nanoka, 1994) that categorizes the transfer of knowledge in an organization, this process is called the externalization (turning the tacit knowledge into explicit). Our approach to achieve this goal was to concentrate on *people* by conducting interviews and meetings to capture valuable *content* as well as *behavioral patterns* to be able to define a *process* and eventually find a suitable *technology* to be implemented later (Rehäuser & Krcmar, 1996).

From another perspective that considers both the cognitive and social nature of organizational knowledge, an organization as a knowledge system consists of four sets of socially enacted knowledge processes: (1) creation (also referred to as

construction), (2) storage/retrieval, (3) transfer, and (4) application (Holzner & Max, 1979; Pentland, 1995). Our desired framework will facilitate the transfer and the storage process of tacit knowledge that has been created individually through managerial experiences.

For this purpose, we identified 14 projects at Infosys as the company of focus and arranged meeting with their corresponding managers. The managers were asked about their managerial experiences, challenges and findings while engaging in the project(s). Having started with a basic, preliminary framework, we tried to revise it upon completion of each interview, in which the captured data could be inserted and stored in the most appropriate and appealing way possible.

To be more accurate based on the previous literature, we try to facilitate the individually oriented learning system toward a more organizationally oriented one (Shrivastava, 1983).

After finding out during our interviews that most of the managerial challenges are direct or indirect causes of poor communication, either between team members or more importantly between the team and the client (stakeholders or customers), we strongly hope to reduce this kind of conflicts by putting this framework into action. We tried to design the framework with regard to the nature of management and the personal traits of managers.

**RELATED WORK**

**Locus of knowledge**

As discussed before, knowledge is a resource that is valuable to an organization’s ability to innovate and compete. It exists within the individual employees, and also in a composite sense within the organization (Bollinger & Smith, 2001). The approaches to knowledge management differ fundamentally based on two important attributes: The *nature* and the *locus* of the knowledge. These two attributes along with their underlying knowledge management systems are depicted in the form of a matrix in Figure 1 (Hahn & Subramani, 2000). In this matrix, the lowest right part (the checked cell) is what is believed to be the *tacit knowledge* of individuals and is the type of knowledge we would like to construct a repository for. This category of knowledge is the hardest to formalize.

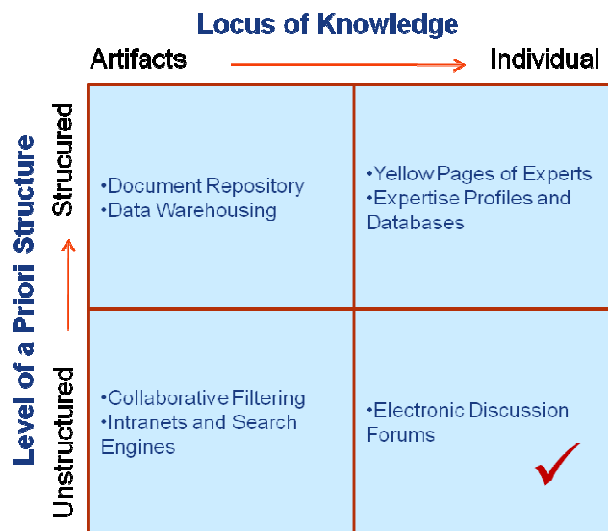


Figure 1 - Different types and locus of Knowledge and the existing solutions to capture them

**Existing IT Solutions**

So far, the only IT systems that has been successfully implemented and used to collect and share unstructured and individual knowledge are discussion forums and mailing lists. Although electronic discussion systems such as forums or news-groups provide an easy framework with minimal barriers to use, users can be showered with irrelevant information and get lost and irritated while searching in an unstructured repository. This often leads to quitting the system or ignoring the received data to avoid the burdensome hassle.

Discussion forums are, in fact, a good solution if and only if the users are eager to share knowledge and actively enter discussions and debates. This media has not proved to be of great avail when certain demoralizers such as lack of time,

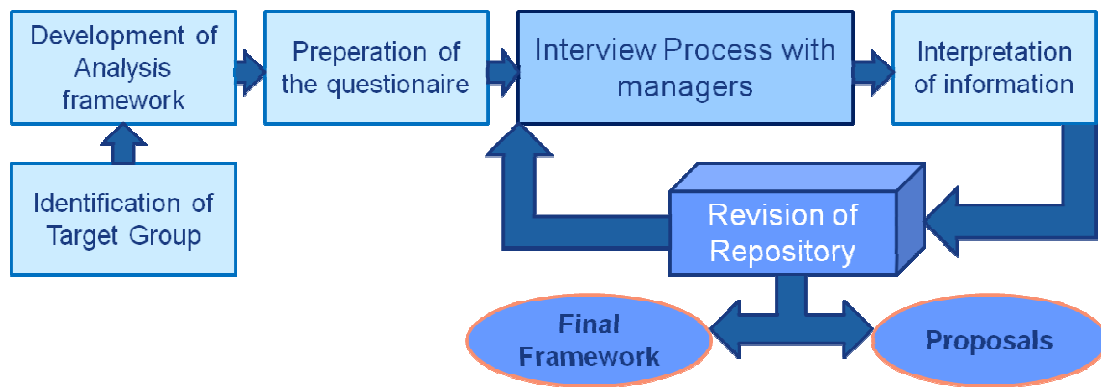
worries of misinterpretation of non-verbal communication, difficulty of following up discussion with a large amount of participants and lack of self-motivation exist (Hartley & Collins-Brown, 1999). All of these issues can be applied to project managers, leading to the conclusion that discussion forums and mailing-lists are not an effective solution for them.

Accepting the absence of a holistic solution towards structuring tacit knowledge, our goal was to create a framework that would serve as a repository of managerial experiences, taking into account the nature of management and the personal traits and behavioral patterns of managers.

**METHODOLOGY**

As briefly explained in the Motivation Section, our approach toward designing a framework to store experiential knowledge regarding project management was to consider a basic framework based on own experience and then enhance it by expanding it in some criteria to cover important issues or prune it to reduce the redundant or immaterial information. In designing the preliminary framework, we tried to think more knowledge-centric than the traditional data-centric design of databases (Szykman, Sriram, Bochenek, Racz, & Senfaute, 2000).

The creation process is depicted in Figure 2.



**Figure 2 - The Research Design**

In this section, we explain the identified projects, the target interviewees and the topics that were discussed and asked during our interviews.

**Target Group**

*Focused Projects*

First, we identified few recently completed software projects at Infosys. Then we excluded those that were not a development or maintenance project. In the next step, we looked for projects that had internal recognition.. We identified about 20 projects with such qualifications.

*People*

Project managers seemed the most valuable source of knowledge in our research, as our major goal was to extract and structure experiential project management knowledge in software development process. We focused on managers with at least three years of experience in the field of software project management in order to target professionals with a high level of tacit knowledge. Fourteen available managers from 13 projects were subsequently identified among which, three were maintenance and the rest were development projects.

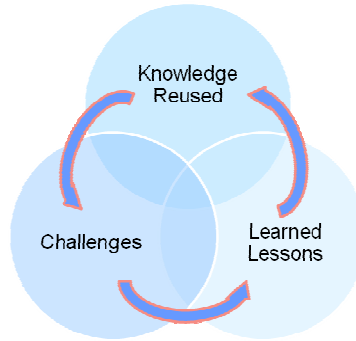


Figure 3 – The Intuitive Circle of Experiential Knowledge

### Knowledge Categorization

During the interviews, we tried to concentrate on three criteria in order to extract different aspects of the managers' experience.

**Knowledge Reused:** The managers were asked about the knowledge they mastered before their management experience in order to tackle problems and deal with challenges. This knowledge could be from social experience, academic background or personal readings.

**Lessons Learned:** The second criteria regarding managers' experience was the lessons they learned during their career as a manager. This knowledge could stem from the confronted challenges or observation of project results or the interaction between members.

**Challenges:** The third part of the interview focused specifically on the challenges and problems that the managers faced. We tried to concentrate on project management aspects, mainly through non-technical challenges.

As depicted in Figure 3, the three criteria are tightly connected with each other in a circular form. This is to some extent similar to the complete cycle of learning introduced by (March & Olsen, 1975). The difference is that this process focuses more on the individual aspect of learning than organizational. An experience is usually created after facing a challenge which leads to learning new lessons. These lessons can be used later as tacit knowledge to solve similar challenges which again will enhance the learned lessons and so forth.

To categorize and structure the answers to the above mentioned questions, a preliminary framework was designed in which the extracted information after each interview was entered.

### The Basic Framework

To design the basic (preliminary) framework, we consulted a group of experts at Project Management Center of Excellence at Infosys and drew a structure to start with during our brainstorming sessions.

Based on our discussions, three common branches were identified that are the same in each of the three criteria.

#### Levels

Level refers to the level of the issue that led to some learning, challenge or reuse of knowledge. We divided it into six interaction sub-branches of *personal*, when the issue lies at a personal level of individuals, *interpersonal*, when it stems from interaction between individuals, *managerial*, when it is incited at management's level, *organizational*, *social* and *global* when the issue is induced due to rules or policies in an organization, society or around the globe. Technical and legal levels were also added during the course of interviews.

#### Stages

*Stage* of an issue represents the stage of its occurrence during the project. *Pre-sales* refers to issues at the stage of signing the contract and hiring people, while the other stages are standard software development stages such as *Planning*, *Design*, *Build* or *Transition*. For maintenance project it is limited to *Pre-sales*, *System Appreciation* and *Steady State*. After our interviews, we came up with two new stages (*General* and *Team Building*) and merged *Pre-sales* and *Planning* into one *Planning* stage.

*Impacts*

*Impact* can refer to the impact of applying (reusing) knowledge or the impact of confronting a challenge on a project. It can be on quality, time, cost, customer satisfaction, effectiveness of members of it can inflame conflicts or impose or prevent risks.

In addition to the branches discussed above, each criterion has also some specific branches of its own. For Reused Knowledge, the source and for Learned Lessons the documenting options were the specific options. For challenges confronted and experienced by managers three extra attributes were considered:

**Direct Cause:** *Direct Cause* is the direct incident incurred by the team or the project. For example, a direct cause of the frustration of members might be due to some repetitive tasks.

**Prime Reason:** *Prime Reason* refers to the very major reason of a problem. In the example mentioned above, the prime reason is improper delegation of repetitive works which leads to frustration. Prime reason is in fact the underlying cause of a problem, not the direct one.

**Category:** The prime reason of a challenge can be sorted into specific categories such as unclear visions or objectives, internal or external changes, unrealistic expectations, lack of resources/time and so forth.

This basic framework was then extended and perfected based on our interviews.

**FINDINGS**

**Facts at Giant and Small Firms**

In small firms, major challenges for managers mostly lie with defining the right strategy, proper marketing, budget management, recruiting, cost estimation, external and internal changes, risk management as well as interpersonal conflicts between project members (Karlsson & et-al, 2007) and (Stevenson & Jarillo, 2007). These are not the major issues at multi-national, well-established companies. Great organizations usually have to tackle problems like lack of efficiency, high attrition rates, applying widespread changes and cumbersome bureaucracy.

Given the results of our interviews, distinguishable features can be found in challenges regarding project management in small versus large companies. Considering the same managerial skills at both organizations, in small firms, the problems usually stem from incomprehensive risk calculation as well as unrealistic cost estimations. Moreover, small companies are more vulnerable to unpredictable (internal or external) changes such as location, tools, budget, requirements, members, roles, management, authorities, customer policy or even government policy and legislations. Unlike massive, well-funded corporations, they do not possess the safety financial margins to mitigate the effect of unexpected changes and underestimated load of work. They are also very dependent on individuals and more liable to collapse upon losing one or more of their key members.

Managers at larger corporations, however, typically confront challenges like interpersonal conflicts and improper or insufficient communication with client(s). Moreover, based on the long-term aspect of many projects at big companies, there are additional concerns to deal with. For example, the incomplete transfer of technical knowledge upon team members' displacements/replacements and the frustrations of individuals as a consequence of repetitive tasks are of great concerns.

**General Issues**

To obtain an overall insight into the different aspects of challenges in an organization as a sample of large, global corporations, we studied the *Level*, *Impact* and occurring *Stage* of all the points discussed at our interviews. Referring to Table 1, the total number of points considering *Levels* was 58. Regarding *Impacts*, 38 were studied. Finally, 78 points pertaining to the *Stage* of injection (or when their prime cause took place) were also examined.

	Knowledge Reused	Lessons Learned	Challenges	Total
Level	17	21	20	58
Impact	17	21	-	38
Stage	17	21	40	78

**Table 1-Total Number of Issues regarding Different Criteria and Aspects**

The distribution of issues regarding different criteria is depicted in Figure 4. Clearly, most of the issues in *Level* criterion belong to managerial level, followed by interpersonal and personal levels. This is due to the fact that most of the learned lessons and reuse of knowledge is related to the managerial level. However, considering only the challenges experienced by managers and excluding the other two criteria, 30% of the issues are interpersonal, followed by 20% personal issues.

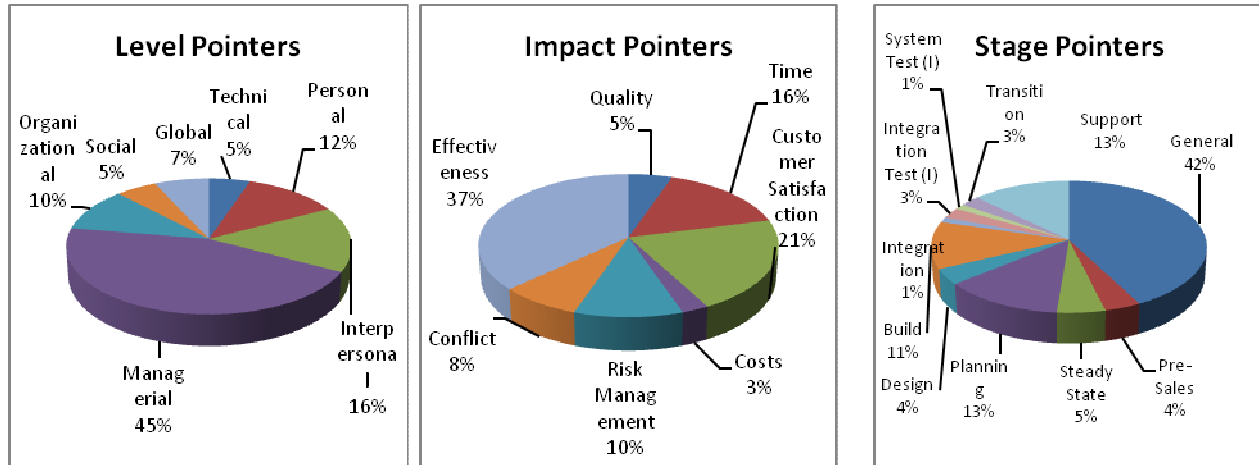


Figure 4 - The Distribution of Points regarding the Different Criteria

Effectiveness, customer satisfaction and making a better use of time are the major issues considering the *Impacts* of actions corresponding to reuse of knowledge. Regarding the *Stage* of problems, Most of the issues (42%) were general based on the results of our interviews. The planning stage is the one with the most issues overall. This means that the majority of issues either happen at the stage of planning or their chief reasons stems from this stage. The Support stage comes next with 13%. These results are the same for all three criteria of our study.

**Summary**

In massive corporations like Infosys, the *hard data* items such as productivity, profitability, cost control and quality control are already defined and well-developed. Based on their strong reputation, marketing is less critical to overall success as their business network and partnership is secured through outstanding relationships with existing clients. Managers at such companies do not typically worry about inability to pay from the client, sudden changes in a client’s business model or government policies, or lack of resources as many smaller firms must consider.

The challenging part for managers of projects, as a sample model of a large and rapidly growing company, appeared to be handling and improving *soft data* items such as employee attitude, the flow and distribution of knowledge and the customer satisfaction. For example, difficulties because of poor collaboration and improper communication between members on-site and offshore were being heard very often at our interviews.

According to our data, the majority of challenges faced by managers were at interpersonal and personal levels. The improper behavior of an employee towards a customer, unprofessional response to client’s requests might tarnish the image of the company severely. This is a critical issue and area of focus, considering the majority of Infosys business is based on repeat customers (Infosys Annual Report, 2007). Another interesting outcome in this regard was that the number of challenges that were due to the cultural differences at a global level were more than those at a national level.

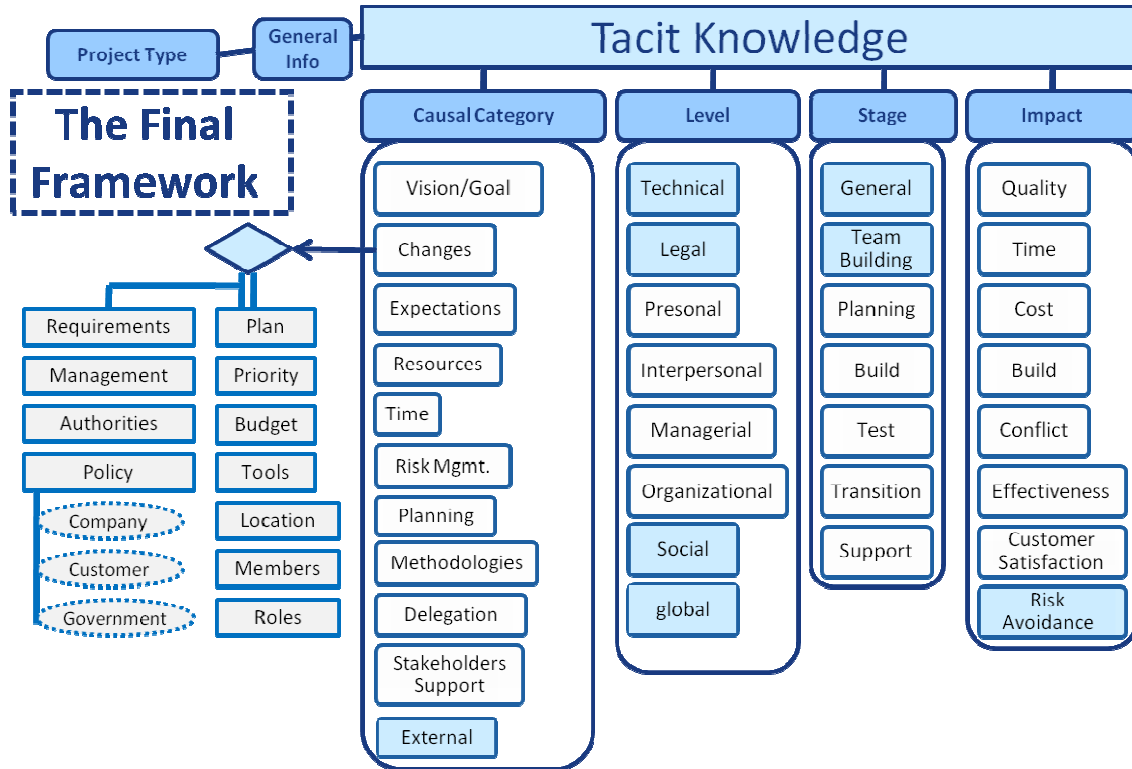
In order to improve the framework into which the collected data was categorized, some attributes and options were added while some other ones were excluded. For example the General option for the stage of an issue was considered necessary and social and global levels were added to the level of challenges. The next section will elaborate the new framework in great detail.



**THE DEVELOPED REPOSITORY**

**The Final Framework**

The final framework is demonstrated in Figure 5. Based on this framework, managers can share their management experiments and categorize their knowledge in order to give it a reasonable structure and enhance the searching process and the level of access to data. The colored attributes are those which were added to the preliminary framework after our interviews.



**Figure 5 - The Final Framework to Store Tacit Knowledge of Managers**

Possible Methods of Contribution for this framework are regular data-entry such as distributing questionnaires to managers at specific milestones or sending agent to conduct interviews with managers in order to glean information and insert the processed data into the system. In addition, the framework should be accessible through a web-interface and a search engine. Managers can visit and use the system at any time. This way of contribution does not require extra contribution of external agents or divisions; however, a regular flow of data-entry cannot be guaranteed.

**Considerations regarding the Framework**

In designing and developing new information system, three aspects should be pondered with careful scrutiny. First, who is going to feed the system with relevant data in an effective way. Second, who is going to avail it efficiently and third how to keep the live-experiences as a whole and update the structure as well as the content it wisely. This way one can make sure that the knowledge in an organization is maintained, utilized and enhanced perpetually.

**Flow of Data**

Regarding our framework, it is of great importance to secure an effective way of collecting data from legitimate sources. Forcing or awarding employees to insert data into a system leads to filling up the database with sheer garbage. Therefore, it is a vital part of deploying a repository to ensure the enrichment of its content with pertinent data.

### *System Acceptance*

Another issue regarding information systems is how the respective employees facilitate it. There is no point of having a comprehensive and perfectly built-up system, when nobody is using it at all. Therefore, an effective way to increase system acceptance is with no doubt the involvement of users during the development of the system (P. Tait, 1998).

Managers should become convinced that the new framework is a useful source of tacit information and refer to it when they confront a challenge or enter data when they learn something new. Otherwise, the whole system becomes obsolete gradually.

### *Lack of Innovation*

It should be also be noted that the availability of existing solutions may encourage the employees to adopt the already applied solution, which might have been successful under circumstances, in other contexts rather than try to find a better and more suitable answer.

## **CONCLUSION**

The objective of this work was to study and analyze the experiential knowledge (also known as *tacit knowledge*) of project managers at Infosys in order to construct a framework in which this specific kind of knowledge can be stored and shared. To achieve this goal, 14 project managers at a global company, Infosys, were asked about their experiential knowledge in three topics: the knowledge they reused during their experience (*Reused Knowledge*), the lessons they learned during the project (*Learned Lessons*) and challenges they confronted as a manager (*Challenges*).

After conducting the interviews and having the required information collected, a framework was designed to act as a knowledge repository. Four major attributes regarding tacit knowledge were identified and implemented in this framework: the *Category* of the major causal of an issue that leads to learning new knowledge, the *Level* of the knowledge, the *Stage* of the incident inducing the knowledge and the *Impact* of this finding on the performance of a project. The framework can be filled with the corresponding data either by managers or by agents conducting interviews with the responsible managers.

It should also be noted that utilizing the proposed framework may mitigate some problematic issues to a certain level, however, companies can prevent by performing preemptive actions in order to prevent crisis or conflicts from the very beginning. Given the analytical results of our interviews, personal and inter-personal issues appeared to count for almost 50% of all the challenges and the prime reason of 35% of challenges are instigated by poor communication. Moreover, nearly 20% of the major reasons for challenges lie with unrealistic expectations or inappropriate delegations, both mostly as the corollary of lack of knowledge about the personality and characteristics of people.

Based on this outcome, we believe that improving the communication and understanding between the members of teams as well as between members and clients can be of great avail. To achieve this purpose, we introduce some proposals to put into practice by Infosys.

Our next work will be to develop the framework and put it into use in order to observe the results in a one or two-year period at a big organization like Infosys.

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