Method for CMMI-DEV Implementation in Distributed Teams

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Abstract—**Organizations tend to perform their work in offshore sites to become more competitive. But managing these teams is not an easy task because it is needed a great level of coordination. So, some organizations adopt maturity models as CMMI-DEV to normalize and coordinate the tasks across the different sites. But it faces difficulties due to the different work practices and cultures in the distributed teams, which can imply a great resistance to change. Thus, when an organization wants to put their development process in compliance with CMMI-DEV, we propose that a first assessment should be done by an understanding of the development processes in each location, making it possible to normalize/standardize the work processes with smaller changes, reducing the cost and resistance to change. This proposal was evaluated by applying these methods in a distributed organization with two development branches. One branch has ISO 9001:2008 certification and works in two countries, and the other branch in three countries. The data below supports the objectives of our proposal, pointing to a careful analysis of the different teams, and therefore easier to adopt models such as CMMI-DEV.**

Keywords- Development Process, CMMI-DEV, Geographically Distributed Teams, Organizational Change.

I. INTRODUCTION

Software projects management has been and remains as one of the crucial problems of computing. Although there have been several efforts to make project management more effective and efficient, it still has several problems such as [1] [2]: objectives of the project unrealistic or disorganized; inaccurate estimations of the resources necessary to implement the project; requirements of the system ill-defined; weak monitoring of the status and progress of the project; risks poorly or inadequately managed; lack of communication between stakeholders (customers, users and developers); immature use of technology; lack of capacity to deal with the complexity of the project; careless and poorly formalized development practices; poor project management; politics of stakeholders; commercial pressures; inadequate quality control; ineffective control of change.

In addition to these problems outlined above, organizations must be much more effective and efficient due to the high competitive environment in the market where they perform their work [16].

So, resulting from that fact, a solution that has grown and tended to become more popular, is the outsourcing of information technology services in offshore sites [16]. (According to an IDC market research report [23], the estimated market size of IT offshoring reached US$29.4 billion by 2010).

It holds, as the key benefits, the product launch to market sooner, with lower development costs through access to skilled manpower and specialized resources [3] [4].

Over the past ten years, emerged a series of facts that must be taken into consideration when selecting suppliers of computer services such as [4]:

- Globalization - opening the borders to the international market;
- Business environment - growing interest of countries in developing the economy, creating mechanisms for attracting foreign investment through tax incentives, reduction of bureaucracy and building technology parks;
- Decrease the cost of telecommunications;
- Standardization of methodologies and tools in software development.

To these facts, join two more important ones as the large difference in wages in different locations around the globe to perform the same function and the increasing standardization of the culture of companies that are increasingly multinational.

As managers have to make commitments, most often based on price/quality of service rather than patriotic or emotional factors, the choice of suppliers began to be increasingly made outside the country of origin of the company - offshoring [4].

When the managers of organizations opt for the offshoring choice, they rely on two key factors [5]:
1. Reduction of development costs
2. Rapid increase of skilled labor

Despite all the benefits resulting from offshoring, managing distributed teams is not an easy task, because these teams frequently suffer crises of trust and coordination problems [12].

So, many organizations choose to do the alignment between operations and processes based on maturity models, which suggest the best practices in the industry, giving the organization a competitive advantage [6] [7].

Traditional maturity models as Carnegie Mellon's Capability Maturity Model Integration (CMMI) [21] help organizations find their state of optimization, providing a structure that allows alignment between process areas suggested by the model and process management. CMMI-DEV enables organizations to achieve a high level of process optimization, following the goals suggested by the model, considered as best practices within the development branch. With the adoption of the model, the organization takes deep knowledge of their processes and patterns of behavior that should be established [8].

In this paper, we present geographically distributed teams and organizational change in distributed team's related work. Thereon, we approach the problem of CMMI-DEV implementation in distributed teams, and its resolution proposal. Additionally, we will be present and evaluate the preliminary results in an organization that has its workforce distributed, by the application of the proposal.

II.   RELATED WORK

Aiming to achieve a better control, coordination and monitoring, a first analysis of the distributed teams and the organizational changes is in order. To point out the main details, issues and implications became our main goal in Section II.

A.   Geographically Distributed Teams

These teams are located in countries where manpower is cheaper, usually with additional time zone with the country of origin of the organizations in order to take advantage of 24 hours of daily work [9].

The distributed teams were the result of globalization, but this has no implication as the standardization of cultures, as they continue to be diversified with different values and beliefs that result in different behaviors [11]. Since organizations are dependent on people, all these differences in the context of distributed teams become of utmost importance when one wants to maximize and make use of distributed teams to a competitive advantage [11].

Organizations must cope with challenges such as conflicts arising from their employment relationship between their teams. Conflicts at the completion of tasks [13] are due to differing views and opinions regarding the tasks of the team. These resolutions are more complicated due to lack of physical meetings, which means that the agreement between different views is complicated due to limitations in terms of trust arising from the singularities of distributed teams [10] Conflicts also arise in terms of processes [13], i.e., teams use different ways of working to accomplish the same result.
Hence, understanding the differences urges as an extreme need in the help in improving relations of trust between teams [11] this understanding should be done by [12]:

- Sharing identity, so that the effects of geographical dispersion are reduced

- Sharing context, i.e., the team members can access the same information, using the same tools

- Possibility of spontaneous communication through access to tools [10] that allow informal, unplanned interactions between members, thereby strengthening the relations of trust [14].

Understand and respect the particularities of the distributed teams is essential to get the maximum benefits and reduce its complications and shortcomings. The problems that most commonly affect these teams are not technical problems as they become salient faster than the non-technical [15].

B.   Organizational Change in Distributed Teams

The CMMI-DEV can have implications as a process of change, since there may have to be redefinitions of procedures performed, in order to conform to the model.

This process of change reaches further complexity in the context of offshoring, i.e., put all organizational units under the objectives suggested by the model. Once alone, the offshoring originates process of change [17].

The framework of change processes must be studied very carefully as they can be influenced by three contexts that influence change in organizations [17]:

- External Context: Factors of legislation, commercial and social

- Internal Context: social aspects of the organization, technical infrastructure, management style

- Individual Background: actors who develop their roles in the organization with their views of working methods.

So it has to be taken into account in the phenomena of change, the surrounding environment, processes and people in order to avoid negative aspects for the organization and for business. Understanding this framework of change processes is important for this to an end, thus reducing the resistance to change that tends to increase with the number of different organizational units. (Figure 1)
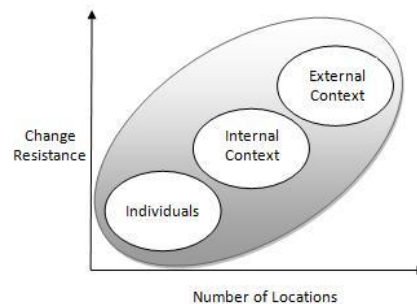

Figure 1 - Relation between the change resistance impact with the number of different locations

During the process of change there are other factors (hard factors) also important to be taken into consideration [18]:

- Duration: The time it takes for the changing process to be implemented
- Integrity of the performance of the development team to complete a task on time. This factor depends on the skills of employees in respect of a project component
- Commitment among top managers and employees affected by the change
- Efforts caused by the change process

All these factors must be taken into account, since the intention is that the change generated by the adoption of CMMI-DEV is less abrupt as possible so that implementation is done with greater adherence by all participants in the process, in order to reduce resistance to change.

III. PROBLEM

To take advantage from offshoring, organizations must have an effective coordination in the different locations, which have great influence on productivity and performance [24].

There are different opinions related with the coordination between these teams. One relates with standardization of processes to reduce the conflict and differences between the sites, and another, which refers that its normalization can generate suspicion and resentment at offshore sites embedded in different cultures and ways to execute their work.

So, there are organizations, which adopt CMMI-DEV to be enabled to benefit from greater control, coordination and monitoring, resulting in improvements in the development process [5]. However, this model still suffers from significant shortcomings regarding the best practices that should be followed to organizations whose work focus is based on distributed teams [6].

When an organization decides to adopt CMMI-DEV has to be very careful, as its adoption usually involves a standardization/normalization of processes. However, the maturity models are poorly adapted to the reality of offshoring [6], and it might not make sense that distributed teams run processes in the same way as they have different frameworks. From these frameworks emerge some of the limitations of offshoring as [6] [16] [22]:

- Difficulty for clarification of requirements for lack of physical meetings;
- Failure of coordination due often to failures of communication;
- Large differences in experience among staff, with implications on the performance of the project;
- Time zone Difference, which can influence the time to solve problems;
- Different infrastructures, such s unstable Internet connections or electricity;
- Cultural differences.

Some of the problems posed by distributed teams still do not have the best response from the CMMI-DEV, such as the lack of communications in person, redundant information, lack of motivation, conflict resolution. This model is still based on traditional working practices and does not take into account the growing trends of global organizations and distributed teams [6]. The adoption of CMMI-DEV can imply the existence of organizational change processes, difficult to manage.

In the different locations, there are various formal and informal rules that have predominance in the interaction of the workspace, since there may be differences in organizational politics, in government legislation for human resources, stability and efficiency in economic and political environment. These factors are often not taken into account, since what usually happens is the definition of new processes without giving sufficient attention to its implementation, hoping that the new procedures and technologies make by themselves the change of processes. This situation means that there is misalignment, since the teams change their practices but not its definition. The resultant misalignments of these facts make it difficult to share the best practices across the organization.

The problem arises since the adoption of CMMI-DEV already tends to standardize the business processes, which in a distributed organization with various implementations of the same process, face great resistance to change (Figure 2).

Figure 2 - Applying CMMI-DV in different locations

IV. PROPOSAL

We believe that only through a detailed analysis of the particularities of each of the distributed teams, understanding their differences, taking advantage of its strengths and identifying its limitations, we are able to first know their work processes, to boost and improve them afterwards.

Understand the current processes of the teams also allows to assess the level of adherence that their methods of work already have with the CMMI-DEV model, thereby finding the areas in, which no change is necessary, reducing the difficulties inherent in the processes of change. So our objective is to archive a great level of coordination between the different sites, based in the model CMMI-DEV, but respecting the local work processes and cultures.

Thus, in order to meet the objectives outlined above this paper proposes a method to implement CMMI-DEV trying to keep the various implementations of processes in the distributed organization, reducing risks and costs of implementation. It is

also expected a decrease in resistance to change by stakeholders in the processes.

To evaluate this proposal, it will be use in an organization that works with teams distributed in Canada, Guatemala, Portugal and India and wants to implement CMMI-DEV.

V. PRELIMINARY RESULTS

Under this project, some work was already done in order to better understand the processes undertaken in an organization that uses distributed teams. This organization intends to evaluate and put their processes in accordance with CMMI-DEV, so they can improve their work processes and have a better coordination and control between the different sites. The choice stood by this model because, in their opinion, it is the most famous in development area and with better known results.

In this company there are two distinct branches of development. One (branch A), which makes maintenance and minor improvements to an old product, and is certified with ISO 9001:2008 headquartered in Canada, with team members also in Portugal. The software development is done between Portugal and Canada, the definition of requirements and quality analysis is performed in Canada. There is another (branch B) to develop a product, which is not yet in production with the software development done in Guatemala, Portugal and India, with the respective definition of requirements and quality analysis performed in Guatemala.

Thus, in an early stage of this work, there was an incorporation in the team of internal auditors of ISO 9001:2008 of the organization, This analysis led to better understand the processes carried out and based on existing work in the area done by Mutafelija and Stromberg [19] [20] it was possible to perform a mapping between the ISO 9001:2008 and CMMI-DEV 1.3. This mapping aims the notion of taking advantage of the resources and synergies between the two models, having no influence in the SCAMPI of the CMMI-DEV.

There was thus a first survey of the faults to cover so that the branch (A) can converge with CMMI-DEV model. An example of the mapping between ISO 9001:2008 and CMMI-DEV is in Table 1, with the process area project planning.

SP 2.2 Identify Project Risks	Identified risks; Risk impacts and probability of occurrence; Risk priorities;
SP 2.3 Plan for Data Management	Data management plan; Master list of managed data; Data content and format description; Data requirements list for acquirers and for suppliers; Privacy requirements; Security requirements; Security procedures; Mechanism for data retrieval, reproduction, and distribution; Schedule for collection of project data; Listing of project data to be collected;
SP 2.5 - Plan for Needed Knowledge and Skills	Inventory of skill needs; Staffing and new hire plans; Databases (e.g., skills and training);
SP 2.6 - Plan Stakeholder Involvement	Stakeholder involvement plan
SG 3 – Obtain Commitment to the Plan	
SP 3.1 Review Plans That Affect the Project	Record of the reviews of plans that affect the project
SP 3.2 Reconcile Work and Resource Levels	Revised methods and corresponding estimating parameters (e.g., better tools and use of off-the-shelf components) Renegotiated budgets Revised schedules Revised requirements list Renegotiated stakeholder agreements
SP 3.3 Obtain Plan Commitment	Documented requests for commitments Documented commitments

In branch B, for each process area there has been made a first survey of the practices, which are followed, against the specific practices of CMMI-DEV in order to have a first iteration of the flaws to cover. This work was already made to all process areas of CMMI level 2. Please note that this survey of flaws is based on interviews with top managers.

An example of this more detailed survey for Project Planning is in Table 2.

TABLE 1- GAP IDENTIFICATION BASED ON ISO/CMMI-DEV MAPPING

Project Planning	
	Required Improvement based on Typical work products suggested by CMMI documentation.
SG 1 – Establish Estimates	
SP 1.1 - Estimate the Scope of the Project	Task descriptions; Work package descriptions; WBS;
SP 1.2 Establish Estimates of Work Product and Task Attributes	Technical approach; Size and complexity of tasks and work products; Estimating models; Attribute estimates
SG 2 – Develop a Project Plan	

TABLE 2- GAP IDENTIFICATION BASED ON INTERVIEWS WITH TOP MANAGERS OF THE ORGANIZATION

Project Planning	
	Required Improvements
SG 1 – Establish Estimates	
SP 1.1 – Estimate the Scope of the project	Stakeholder Form; Milestones Form; Meetings Form
SP 1.2 – Establish Estimates of Work Product and Task Attributes	Metrics Spreadsheet
SP 1.3 – Define Project Lifecycle Phases	In conformity
SP 1.4 – Estimate Effort and Cost	In conformity
SG 2 – Develop a Project Plan	

SP 2.1 – Establish the Budget and Schedule	Schedule and Project Cost Form
SP 2.2 – Identify Project Risks	Risks Form
SP 2.3 – Plan Data Management	In conformity
SP 2.4 – Plan the Project's Resources	Needed Ressources Form
SP 2.5 – Plan Needed Knowledge and Skills	Employees Skills Form; Relation Skills/Needed Resources Form
SP 2.6 – Plan Stakeholder Involvement	Involvement Plan
SP 2.7 – Establish the Project Plan	In conformity
SG 3 – Obtain Commitment to the Plan	
SP 3.1 – Review Plans That Affect the Project	Revision Plans Definition
SP 3.2 – Reconcile Work and Resource Levels	In conformity
SP 3.3 – Obtain Plan Commitment	Establish commitments

Based on mapping already done by Mutafelija and Stromberg, for each section of ISO there were a percentage of conformity related with the specific practices of CMMI-DEV (0%, 30%, 60% and 100%). So, our analysis of the branch A, based on this mapping, applies for the branch B, since the assessment was supported with the same percentages, resulting the following graphics.

The graphic below (Figure 3) is an example of the conformity analysis that the two branches have with each of the process areas, based on the assessment done, so, it was possible to know how far away each branch is to have their processes in compliance with CMMI-DEV.
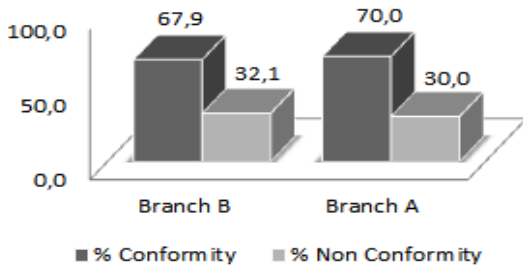
Figure 3- Percentage of confrmity with the process area project planning

VI.   EVALUATION

In this first analysis of a case of practical application of our proposal, it was possible to make a first evaluation.

Although the two branches of the same organization make development and want to adopt the same CMMI-DEV model across the organization, both branches and the teams are very different and work in dissimilar way.

This fact is a result not only from the particularities of the distributed teams, which have been discussed in this report but also from other factors more related to their work processes. Therefore, the initial factor, with a branch certified ISO 9001:2008 and the other not, raises great differences with regard to working methods. The adoption of CMMI-DEV, although not directly, allows it to become easier through the

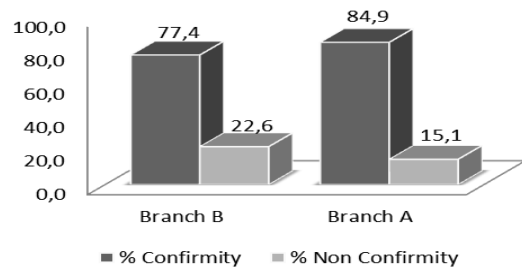work already done, the mapping between ISO-CMMI (Figure 4).

Figure 4- Total percentage of conformity with CMMI-DEV level 2

It was also possible to denote that although a branch being certified ISO 9001:2008, is not, in some cases, closer to the objectives of the model CMMI-DEV (Figure 5). We can, for example, remove that stance from the tables of preliminary results section, noting that the SP 2.3, which has no ISO 9001:2008 certification in the branch, already is consistent with the model, while the other branch certified resulting from the analysis made of the mapping done with CMMI-DEV, has some flaws that should be covered.
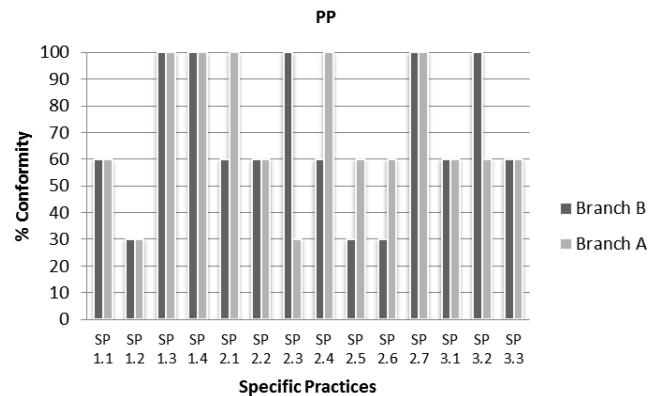

Figure 5- Percentage of conformity for each specific practice in process area project planning

Another factor that makes completely different the work practices is related to the development of the products of these two branches, which use different processes and tools. Consequently, its development cycle has also wide disparities in both the type and the manner of tasks to perform.

VII.   CONCLUSION

This study proposed a method to evaluate the compliance that an organization has with CMMI-DEV, to enable their easier implementation in the nearest future. We propose that the differences between sites should be taken into account, respecting the distributed practices and culture, reducing the conflict between the various processes performed by geographically distributed teams. These allow a better knowledge of organizational processes, often unknown by top managers. This knowledge is essential to an organization in order to define the adjustments to apply to their processes.

So, in our work we study an organization with distributed teams. First it was done an assessment to know the compliance or each branch with CMMI-DEV, and after that there were proposed improvements to the processes, in order for them to be in accordance with the model.

Thus, it is expected that the proposed method contributes to solving the problem of organizational adaptability to CMMI-DEV. Expected to reduce the impact of the change processes through a deep understanding of current processes of the organization, allowing us to find the flaws in order to develop an action plan. It is believed that this would make the compliance with CMMI–DEV easier to implement even in work performed with resource to distributed teams.

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