

Software Project Management in Distributed Software Development Context

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Abstract: Distributed software development (DSD) became a reality in project development involving geographically dispersed teams and brings challenges regarding to software project management (SPM). So, aspects such as infrastructure problems, local organizational culture, time zone and others become part of the concerns of software project management. This paper presents a proposition to manage software projects in DSD context including planning and controlling aspects. Particularly it deals with human resources management, risks and cost's estimations as well as control of activities, fulfillment of deadlines and resources allocation.

1 INTRODUCTION

Software Project Management (SPM) became over the years, a relevant subject to the software engineering area. Since it brought concepts from Business Management area, such as the manager's role and also important concepts regarding to organize, coordinate, lead and control, the SPM contributes to obtain high quality software product.

Aspects about SPM such as ethics and new way to manager are discussed. Moreover, the integration between technical and organizational aspects to software projects development as well as the incorporation of the manager role in the software project with leader role, enabled to create a different approach to the planning and accompaniment of the software projects.

Therefore, this approach includes technical (technological infrastructure) and organizational aspects (organizational structure) in the development and also for software project management.

Moreover, the technological evolution led to increasing demands as it is the case of the distributed software development (DSD) (Conchuir et al., 2006); which became a reality with geographically dispersed teams. The management of software projects, in this context, is a challenge for the need of a planning and accompaniment of the software, because, beyond the traditionally known peculiarities, it starts to deal with infrastructure problems, local and organizational culture, time

zone, among others in the DSD. The monitoring stage, includes: the control of the realization of the activities, the meeting deadlines, and the control of resources allocation, among others.

In this scenery, this article presents a proposition to manager software projects in the distributed software development context including items of planning, controlling, human resources management, risks and cost estimations as well as control of activities, fulfillment of deadlines and resources allocation. Each one these items were evaluated with enterprises that use DSD approach (Soares et al., 2012; Cibotto et al., 2011; Pagno et al., 2009; Trindade et al., 2008; Leme et al., 2007; Enami et al., 2006) and form a set of activities to support project management in DSD.

To do so, the article presents in the Section 2, the SPM vision is introduced to the project development by distributed teams. On the third Section, the necessary characteristics of SPM professional in the context DSD. The Section 4 presents the proposition to manage software project in DSD with the functionalities regarding to planning and accompanying in terms of risks, costs, schedule, resources distribution and others. A comparison between the traditional management practice and the DSD management practice is presented in the Section five. Section 6 presents works on SPM area and a comparison with the SPM proposition presented in this paper. The Section 7 presents the SPM tendencies and future works.

2 PROJECT MANAGEMENT WITH DISTRIBUTED TEAMS

Aiming at the sharing of physical and human resources, the software development with distributed teams requires from the manager new abilities and concerns associated to those that are usual in the management area such as planning, leading, coordinating and monitoring.

Project Management (PM) involves technical and human factors. So, a project manager must consider these factors, to know the tools and techniques that might be used to plan and to control the project and also to motivate and coordinate the team. Still, it is responsibility of the manager to solve the problems and to use the most appropriate tool and technique for each situation. Studies in the management project area (Favero, 2010) also point new challenges to the managers in the actual configuration of the organizations guided by high competitiveness and globalization of the services.

The DSD increases the need of formalism in the PM's activities and, also, the need of a support tool to the PM. Thereby, new challenges are introduced to those involved such in management level as operational. While it deals with geographically dispersed staff, DSD allows the integrations between different cultures and the sharing of ideas and knowledge.

However, it is necessary to support the manager activities with tools that storage information which can be recuperated in anytime. So, these tools must be mechanisms to provide the integration between social, cultural and organizational aspects as well as offer support to deal with problems and solutions that occur during the project development.

Some practices to support project managers in DSD are: to storage cultural, social and organizational differences in places where the teams are allocated; to storage the knowledge accumulated by project manager; to storage organizational and technical problems and their respective solutions; to disseminate knowledge between team members and to organize meeting to promote the experience share.

Other cultural factors beyond those already covered as gender differences and individualism are approached by Evaristo et al., (2004). Aspects related to software development, such as communication between teams and intellectual property, become also more complex when dealing with the DSD (Enami et al., 2006).

3 THE PROFESSIONAL SPM

The software project manager in a distributed environment must know the local, national and organizational culture so that the project has more chance of achieving success. Two elements have become critical to the SPM: the communication and knowledge (Sato et al., 2006).

When planning communications, the manager must take into account the geographical distribution in the analysis of communication requirements, so that the processes of information distribution, performance reporting and managing stakeholders are carried out effectively. It is important to invest in communication tools, such as teleconferencing, messaging, groupware and awareness tools that focus on the development of group work and vision of the group about the work that each individual develops.

In relation to the knowledge of the project manager, it was concluded that the knowledge needed to manage the software project concerns the body of knowledge about administrative processes in software management with the addition of technical expertise for software development.

In terms of culture, there is a simple way to identify them because they are embedded in every action. People do not think of themselves having values or culture, they just think that the values they bring with them are those who care to all mankind (Olson and Olson, 2004). The manager cannot take their culture as standard or right. Not only by the manager, but all participants should be aware that different people have different cultures.

4 A PROPOSITION TO MANAGE SOFTWARE PROJECTS IN DSD

This proposition named Software Project Management in DSD (SPM-DSD) is resulted from studies, applications and evaluations carried out in enterprises that adopt DSD approach (Soares et al., 2012; Cibotto et al., 2011; Trindade et al., 2008; Leme et al., 2007; Pagno et al., 2009 and Enami et al., 2006). SPM-DSD is organized in two steps: planning and monitoring project as illustrated on figure 01.

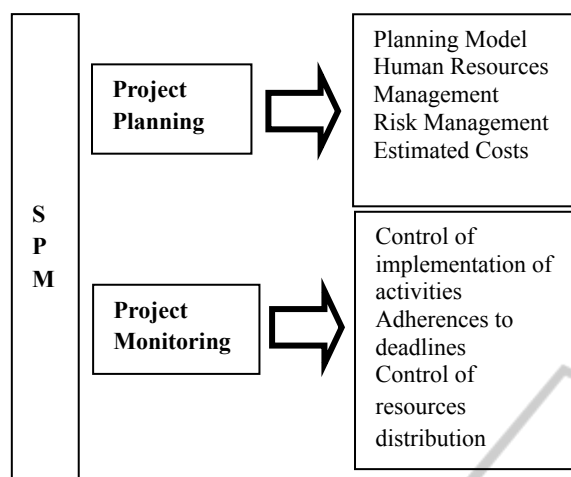


Figure 1: SPM-DSD structure.

Those two steps are required for project management software because the first step actions are taken to indicate what should be done in the project and the second activity, the follow-up, must be verified whether the actions that were defined in the planning stage are actually being performed. Its purpose, besides checking if the activities are being carried out, is the detection of errors or problems for subsequent corrections, ensuring thus the success of the software project. Subsequently are treated model elements of planning, human resource management, risks and costs as part of the planning activity. In the monitoring activity of projects the control and monitoring of activities and meeting deadlines are addressing.

4.1 Planning

Currently, with a software distributed development environment, a number of challenges is given to companies engaged in this area as: personnel selection and control; risk management, communication, measurement software, among others. One cannot neglect the formation of teams in such an environment known as Virtual Teams (Smite, 2004), which, besides being physically dispersed, they reflect the organizational culture.

The software development has been increasingly enhanced by the existence of models and techniques that contribute to its quality development (Pressman, 2005). However, problems remaining in the area complicate the development process, such as lack of documentation and lack of use of methodology. In turn, the storage and retrieval of information have a considerable development of techniques such as

Data Warehouse (DW), aimed at optimization of the data.

It should be noted, too: (1) the importance of considering organizational culture as a motivator of success and failure of projects and, especially when dealing with geographically dispersed teams, when each team has its own culture and how to develop projects (Enami et al., 2006), (2) the differences between the stakeholders themselves, which reflects different organizational and national cultures (Conchúir et al., 2006). Therefore, when dealing with these teams that are configured as virtual teams, a distributed environment should address issues of intellectual property, local culture, time zone, among others.

4.1.1 Planning Model

Within the context of DSD, by establishing an information systems planning model, it becomes relevant to: consider matters concerning the form of work organization in distributed development of software; specify how to select and allocate teams distributed; define the tools, support for project management, defining the types of documents and establish the form of communication for the achievement of planning at various levels. Even now the peculiarities concerning the development of distributed software should be raised, which can impact the success or failure of projects.

With regard to the planning model, we can highlight the concern to include the characteristics of DSD as well as the needs of management, culminating in the composition of the following steps: (1) distributed teams management, (2) aspects of standardization and infrastructure, (3) virtual and face meetings and (4) documentation management. Each of these stages comprises a set of activities to be undertaken for planning (Cibotto et al., 2011)

The first phase is the formation of teams located in different geographical locations and addresses the determination of those responsible for planning as well as the appropriateness of the activities they perform in organizational planning for the DSD.

In the step of standards and infrastructure aspects, are dealt several items necessary to maintain the organization's infrastructure to provide conditions to work in DSD, and care with the specific laws of the places where teams are located.

In the virtual and face meetings, the process used for meetings is defined, especially for planning meetings. In addition to virtual meetings are handled aspects of relationships between people, such as

communication, brainstorming, partnership and engagement of the teams.

The document management step consists in managing the necessary documentation generated during the meetings regarding the planning. Aside from storage, media of cataloging and organizing are handled for future research.

The actions of planning within the four stages are distributed in three organizational levels exposed by Enami et al. (2006), namely: general manager, local manager and project manager.

4.1.2 Human Resource Management

The lack of communication between distributed teams is one of the biggest problems faced by the SPM in coordinating and controlling the activities of a software project (Casey, 2010). With the development of a tool to handle communication between virtual teams (Trindade et al., 2008) came to the organization the features: meeting schedule, meeting in progress and finalize meeting. In addition to communication and the preparation of the minutes after the end of the meeting, the tool sought to replicate the needs and existing functionality in a formal meeting and place, adding the unique characteristics such as a DSD timing and parallelism.

The communication between virtual teams brings the need to: support synchronous communication, explicit and formal, to support the DSD; need to make group decisions, need for leadership in virtual meetings. This communication is configured in two types: (1) Communication Systems between Groups, by enabling real-time communication and enable the recording and parallel communication and (2) Decision Support Systems Group, for coordination of the present communication to promote the sharing of ideas and resolution of impasses through voting, thus encouraging the search for better solutions.

In this sense, the communication tool presented in Trindade et al. (2008) has as main features: Allow synchronous communication; To not limit the number of participants; Support differentiation profiles; Provide formal control of the process; Allow viewing project artifacts; Enable share documents and images; Allow to keep history of conversations; Allow editing cooperative; Allow to store the document generated by the meeting (minutes) so that it can feed back corrective actions with the environment and their projects and allow for the vote decision.

4.1.3 Risk Management

According to Karolak (1998), the risks in DSD projects are likely to be greater emphasis on aspects not so visible. There should be activities to identify risks and plan mitigation strategies, and there may be three categories of risks in DSD projects: organizational, technical and communication. In addition, there may be risks in more than one category, and these should be high on the priority list.

The strategy presented by Leme et al. (2007) is stratified by the scope which the risks can impact: Projects, Products and Business. Its phases are: Discovery Risk, Risk Assessment, Mitigation, Monitoring and Learning and Dissemination of Risk and the solution adopted.

During the course of software design, software engineer should report the problems experienced and observed during development, which are stored in a database system. Such information will be used by the project manager in monitoring and control.

A knowledge base of risks should be configured to store classifications, definitions, diagnosis and risk assessment systems, and capture feedback from the team's experience. The risk review process should be well managed to ensure that all knowledge was captured such as the changes and actions taken when identifying a risk.

Therefore, one challenge for the SPM to manage risk in DSD is in relation to communication of the occurrence of a particular risk for the various units distributed and the dissemination of the risk as much of the solution.

4.1.4 Cost Management

To Pagno et al. (2009) two large groups can be considered when dealing with cost estimates: (1) focus on software development organisations (2) focus on software product, what refers to the elements considered by (Boehm, 1981) apud (COCOMO, 2008): product attributes, hardware, personnel and design. However, estimation of costs involves traditionally known aspects of hardware, software and training, and incorporates other costs not covered by the organisations such as the direct and indirect costs.

Specifically in the DSD, the particular characteristics of such development were raised, which generate additional costs in terms of communication infrastructure, standardization, and others linked to geographic dispersion. A tool for estimating the cost to the DSD, with the incorporation of the types of costs of accounting

area, can contribute to a cost estimate closer to the project reality.

The characteristics of the DSD bring elements that influence the cost estimates (Pagno et al., 2009) are: (1) there is the geographical dispersion that needs infrastructure for efficient communication with fault tolerance; (2) with regard to human resources, it may be necessary to conduct training meetings and training sessions to standardize communication between teams; (3) laws in different places, which influence the cost estimates because there are different taxes, whether they are labor, civil or commercial; (4) among the relevant aspects of the tools available, can be approached the use of the COCOMO model to calculate the effort, time and costs involved in the project, adopted in practically all the tools; (5) increase the types of software development costs in accordance to the classification of the accounting area; and to include the direct and indirect costs as part of the costs to be covered in the cost estimates and the need to use a tool to support the project management cost estimate for the DSD.

4.2 Software Projects Monitoring

The completion of the software projects planning also assists in preparing the follow-up phase. Thus, the data stored in the planning phase such as human resources, schedule, cost estimation and others will be monitored to verify if the project is running according to plan.

4.2.1 Schedule

The schedule appears as an instrument of great value to check if the activities are being carried out on time. Activities should have, beyond the periods of start and end, those responsible for implementing them. It is necessary controlling Local, Result and project current situation.

The item Local is taken in order to identify where the activity is being set, because as in distribution the monitoring of local responsibilities is relevant as people are in different places working in the same project. The item Result of the activity must contain the product generated in the execution of the activity, which may be to consider a document, the compilation of information in the analysis of requirements, the completion of a procedure, among others. The current situation may be indicated in four ways: completed, in progress, delayed and suspended.

The software developer is responsible to update the status of activities attributed to him/her.

However, the computerized system that controls the schedule can check the end date of activity with the current date and indicate the delay in activity, with warning shot for the software project manager so that they can take appropriate action.

4.2.2 Resource Allocation

SPM function is to provide the proper allocation of both human and material resources. For the development of software both features are present, which can be verified in human resource management, in estimating costs and risks treated in the planning activity.

The resources can be allocated in two ways: (1) in stages, respecting the implementation periods of activity, (2) for the entire project at the beginning of activities. In the case of DSD, one must also consider the local situation in terms of both infrastructure and human resources.

During the performance of activities, monitoring of the distribution can avoid future problems and ensure a successful project. Therefore, the monitoring of the project can be based on the physical and financial budget for the project, comparing the estimated value and the amount actually used in the project.

5 SPM TRADITIONAL PRACTICES X DSD PRACTICES

From the studies and application of research results in a Distributed Software Environment (Cibotto et al., 2011; Pagno et al., 2009; Trindade et al., 2008; Leme et al., 2007; Enami et al., 2006), we set up the Table 01, below, bringing a basic comparison between the traditional and SPM to DSD, presenting differences in the items: profile, human resource, cost and risk.

It is observed that in SPM in DSD the manager's works demand is increased as they must add to the traditional activities other ones such as monitoring the activities in each local and the knowledge of the socio-cultural reality of the members of the team. This implies that every project designed to distributed teams should consider the technical aspects inherent to the project and to each location geographically dispersed as well as social, cultural and religious aspects that can impact in the success or failure of the project if it ignored the influence in the staff.

Table 1: Comparison between Traditional SPM and SPM in DSD.

	Traditional SPM	SPM in DSD
Activities	Ability to plan, coordinate, motivate and control. Leadership.	Knowledge of local, national and organizational culture; Increased communication skills; leadership; Use of communication tools; Knowledge of various laws
Human Resource	Requirements for selection / allocation: profile, skill and competence.	Integration, specific feature as domain of language
Risk	Local control	Dissemination of risk
Cost	Local	Distributed Consider regional differences in infrastructure, manpower etc. Adding training event, updating etc.
Control and monitoring activities	Local and side-by-side	Scheduling activities on site; Distributed; consider time zone and cultural differences; Verification of implementation of activities at each site; Contact with local coordination and local management.

6 RELATED WORKS

The SPM presented in this paper results from researches conducted within the activities of planning and monitoring of software projects specifically in management of human resources, costs and risks in the context of distributed software development.

In the context of DSD, recent research directed to other aspects, as relevant, such as:

- Casey & Richardson (2006) and Casey (2010) who discusses aspects to the management of virtual teams with focus in the areas: alignment with the goals and organizational objectives,

risk management, infrastructure, virtual team process and conflict management;

- Lewis & Katsorchi-hayes (2006) who introduce the virtual work in the organisations from a case of a global industry;
- Jiménez et al (2009) that, by introducing the challenges in DSD, highlight the difficulties of communication between people as the subject of most researches;
- Noll et al. (2010) present barriers to collaboration among globally dispersed teams, highlighting, among them the language and cultural difference;
- Peixoto et al. (2010) dealing with ways to reduce costs in the developed projects globally, from estimation of effort;

It can be seen by the research cited that there is a recurrent concern in dealing with DSD that are people participating in the development process, whether in cultural aspects or in effort estimation.

The difference between this related works and the approach presented in this paper is the direction for management activities that encompass planning and monitoring activities directly, related to the daily affairs of the development process and its management in the context of SPM, obviously with the consideration of aspects such as organizational strategy or cultural differences that, in principle, are handled in a strategic level in organizations.

7 TRENDS IN SPM

When dealing with virtual teams, SPM brings additional elements to the planning and control software projects such as cultural differences, effort estimation distributed, among others, addressed from Carmel (1999) to Casey (2010). A significant factor emerged from the risks management approach calls attention to the DSD, which is spreading the risk from storing information about the type of risk and the solution for the treatment of it. Accordingly, the information store becomes a necessity in DSD as a way to provide data for decision making process by SPM, which can lead to future work the introduction of specific areas such as data warehousing, data mining and knowledge management.

So, to treat the information generated in DSD it is primordial developing technical and automatic tools that provide support in manager in according with the knowledge conversion process to externalization process: to create a data repository with information about problems and solutions and

to accumulate all information relevant for the project since to know cultural differences until solutions.

Another important aspect, the measurement of software in distributed projects is in development with the search for indicators that enable the measurement as a factor to improve the quality of processes and product development by geographically dispersed teams given that the traditional measurements may not correspond with activities related to distribution.

Future research also points to greater integration of technical, organizational and social aspects as the area of SPM is a multidisciplinary field involving areas such as Business, Psychology, Law, Computer, among others. The knowledge of each of these areas helps to establish a framework that provides support for SPM, especially in planning activities and controlling project software.

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