Software projects' most important activities of quality management: A Delphi study

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Abstract

Quality management is a very important contributor for the success of software project management. In quality management area we can find multiple activities to carry out, however organizations cannot always execute all those tasks and many times it is indispensable to make choices about what can and should be made. In order to help the organizations to identify the most important activities in quality management, we carried out a Delphi study with the participation of several senior project managers. The result is the identification of several groups of activities, ordered by importance for the project success.

Keywords: Quality management, Project management, Project success

1. Introduction

Organizations recognize that an efficient management is the key for the success of their projects [1], and the number of organizations that use project management to reach strategic objectives is increasing.

Quality management is the area of knowledge of project management which activities ensure that the project will satisfy the needs for what it was created [3, 4].

Quality management is therefore an important area of software projects management but, since it has many activities, it is not always possible in all projects to dedicate the same resources to all the activities.

To help organizations in the identification of the activities that have more impact in the project's global success, we carry out a Delphi study with the participation of several senior project managers aiming to classify the most determinant activities of quality management.

This paper presents the results of the Delphi study. After a literature review, we present the methodology and discuss the results obtained.

2. Background

Many business processes of organizations depend on their software. These systems are crucial for the success of most organizations. However, the failure rate for software projects remains high, and more than half of IT projects have unsatisfactory outcomes [3, 5]. According to Standish Group, about 75% of all Information Technology (IT) projects didn't have success because they are cancelled before completion or, when they are finished and delivered, they are over budget, behind schedule or with fewer features and functions than initially specified [5, 6].

The Project Management is a complex area that includes many management areas and other components, such as time management, cost management, scope management, quality management, risk management, communications management, human resources management, procurement management and integration management [3]. Each area has a large number of activities and it is not always possible to handle all the activities in all projects. In this way, it is very important to understand which activities are determinant to the project success to put them the main management efforts. Our study is focused in the most important activities of quality management.

Quality management is the area of knowledge of project management which activities ensure that the project will satisfy the needs for what it was created [3, 4] leading to a continuous improvement of the project [7]. Quality management should be present in all the stages of the project, in all its life cycles, because if the bad quality is detected at the end of the project, little can be made to solve the problem [8]. Therefore, project management is not something that is applied in a single moment but should be a continuous process [9].

The three main processes of quality management are the quality planning, quality assurance and quality control.

In the quality planning process, are identified the quality standards that are important to the project

success. After identifying the quality standards, the standards must be described as well as the way to satisfy them [4]. It is important to define quality standards in all stages of product development. In the software development a great number of operations exists in each development phase.

The quality assurance aim is to accomplish periodic evaluations of the project performance to provide confidence that the project will satisfy the quality standards. Quality activities previously planned are applied to ensure that the project is to respect the requirements. Any individual or group that is related with the project and that is prepared and guide to the job, can perform this task. The main aim of this process is to minimize the risk of failing the goals, the deadlines and the costs of the project. According Kerzner [2], a good quality assurance system is multifunctional and oriented for prevention. The plan should appeal to a continuous improvement of the project and should include a plan for the establishment and maintenance of performance measures. The plan should also include a quality audit which is an independent evaluation performed by qualified personnel that ensures that the project is conforming to the project's quality requirements.

In quality control, the quality standards previously defined are compared with specific project results in order to analyze if the project respects the quality standards. Usually the person responsible for this process is the project manager [4].

From literature revision [6, 10-14] and from semi-structured interviews to project management experts we identify the following list of important activities for software project quality management:

1. Define the metrics plan;
2. Define the project plan;
3. Elaborate the plan of change management;
4. Elaborate the quality plan;
5. Elaborate the acceptance plan for the customer;
6. Plan and manage deliveries;
7. Elaborate the plan of claims management;
8. Plan and accomplish kick-off meeting;
9. Elaborate the progress plan;
10. Identify and define the critical aspects of the project;
11. Collect, record and analyze elements for the construction of metrics;
12. Receive, record and treat changes requests;
13. Audit the project in agreement with the quality plan;
14. Realize claims management;
15. Make changes management;
16. Realize the non-conformities management;
17. Accomplish meetings of progress control (internal and external);
18. Produce internal progress reports;
19. Produce reports for the customer;
20. Validate control points of the project;
21. Produce a final project report;
22. Elaborate an inquiry of the customer's satisfaction;
23. Project record management;
24. Systematize and enrich the knowledge base.

3. Methodology

To identify the most determinant activities in software quality management we used the Delphi method. The Delphi method began at the end of the 40s when the RAND Corporation started to investigate the scientific use of expert opinion. The method was used, with all its defining characteristics, for the first time by this organization in 50s in a military project [15, 16]. Only in the following decade it was used in other areas [17].

Delphi had some different definitions. Today it might be defined as "a social research technique whose aim is to obtain a reliable group opinion using a group of experts. It is a method of structuring communication between a group of people who can provide valuable contributions in order to solve a complex problem" [16, 18].

The Delphi method has been used in several formats, having a small number of investigators that used the method as initially structured [19, 20].

In the Delphi method questionnaires are given to a group of experts in the area in study. The experts that answer the study represent the Delphi panel. The specialists' choice has extreme importance because their answers originate the conclusion of the study. The experts should be relatively impartial to the study conclusions and the Delphi panel should be relatively heterogeneous to their professional and social groups. The size of Delphi panel can widely vary and there can be a disagreement about the appropriate panel size. This size depends on the characteristics of the

study [20, 21]. A Delphi process is an interactive process, normally with three or four rounds. In each round the experts rank the factors in terms of significance and they can suggest new factors. The results of each round are compiled and returned to the participants [5]. The number of rounds finishes when a certain agreement is reached among the Delphi panel [20, 22, 23], on average three rounds take place [19, 20]. The average time of Delphi study could take 45 days to 5 months, but it depends on the used methods and the number of rounds [24, 25].

We can consider that the Delphi study presents the following main characteristics: it is a repetitive process because the experts are consulted at least twice; it maintains the anonymity of the experts; it has a controlled feedback; the questions are formulated so that the answers can be processed quantitatively and statistically; the answers are individual [16, 20, 25].

In our study we used the Delphi method applying Q-sort to order the activities previously identified. For that we used a web site, which gave us independence and guaranteed the procedures of the Delphi and Q-Sort methods.

In the first round of Delphi method 30 specialists were contacted to participate in the study. These specialists work in the project management for more than two years and participated in more than ten projects. This round had a duration of 37 days and it was reached an answer rate of 87 percent (26 experts). We asked to experts to order the activities from the list presented in section 2. The activities order was accomplished through the calculation of their means.

To know if concordance exists among the experts we used the Kendall's coefficient of concordance W. This is based on values of the sample and it appears for the test of hypotheses of statistics Kendall's Tau [26]. The value of Kendall's coefficient of concordance W was calculated with SPSS and the result was W = 0.393. As the value is smaller than 0.5 we said that there is not a strong correlation among the Delphi panel's answers. Although this value demands us a second round this is a quite high value for the first round.

In the second round the same 26 experts were contacted. This round lasted for 6 weeks and 21 experts answered. This number is good because with the answer of more than 13 experts the confidence of the study is larger than 0,8 [20, 27].

The results obtained in the end of the second round of the study are presented in table 1.

Table 1 – Ordered list of quality management activities

Position	Activity	Round 1	Sum	Mean	Standard deviation
1	Define the project plan	1	59	2,81	3,11
2	Identify and define the critical aspects of the project	2	85	4,05	3,25
3	Validate control points of the project	6	146	6,95	3,8
4	Plan and manage the deliveries	4	154	7,33	5,77
5	Accomplish meetings of progress control (internal and external)	3	163	7,76	6,01
6	Elaborate the acceptance plan for the customer	5	166	7,9	5,66
7	Plan and accomplish kick-off meeting	12	218	10,38	6,78
8	Receive, record and treat changes requests	8	230	10,95	5,13
9	Make changes management	9	235	11,19	5,21
10	Elaborate the quality plan	10	243	11,57	6,99
11	Elaborate the progress plan	7	250	11,9	5,68
12	Produce reports for the customer	11	258	12,29	4,5
13	Realize the non-conformities management	14	277	13,19	6,08
14	Elaborate the plan of claims management	13	283	13,48	6,25
15	Elaborate an inquiry of the customer's satisfaction	20	329	15,67	4,81

16	Realize claims management	15	336	16	5,12
17	Systematize and enrich the knowledge base	17	336	16	4,87
18	Collect, record and analyze elements for the construction of metrics	23	344	16,38	5,09
19	Define the metrics plan	18	346	16,48	6,36
20	Produce a final project report	19	351	16,71	5,95
21	Audit the project in agreement with the quality plan	21	356	16,95	4,94
22	Elaborate the plan of change management	22	357	17	6,4
23	Produce internal progress reports	16	383	18,24	5,46
24	Project record management	24	395	18,81	5,21

The Kendall's coefficient of concordance W for this round was 0.412. The concordance between the Delphi panel increase but is still smaller than 0.5 which means that is does not exist a strong correlation among the Delphi panel.

To know if a third round was necessary other statistical non parametric method was used, the Spearman's Rank Correlation Test. This allows us to calculate the correlation among two ordered series of data, in an ordinal scale. The value of Spearman's Rank Correlation Test was calculated with SPSS and the result was 0.93. As the value is much larger than 0.5 we say that there is a strong relationship between the two series (first and second rounds).

With the results of Spearman's Rank Correlation Test we concluded that the third round would not be necessary. The third round would be pertinent to try to obtain a Kendall's coefficient of concordance W higher. However, the value of Spearman's Rank Correlation Test is so high that it would be very difficult to get a significant change of the order of activities subsequent rounds.

4. Discussion

If we analyze the function of the mean, we identify four main groups of activities. In the first group the activities one and two with means 2.81 and 4.05. In the second group, constituted by four activities, the means are less than 8. In the group of position 7 to 14 the means are approximately between 10 and 14. In the group of the ten activities the means are very near or superior to 16. These groups are identified by the slope of the function of the mean, and the slope between the positions 6 and 7 and the positions 14 and 15 is larger than 2 (2.48 and 2.29). In other words, the angles are larger than 60 degrees. For the remaining activities the angles are always quite less than 45 degrees. The main difference between activities of the first and the second round are the activities in position 5 and 6 that previously were because those activities are distant of the activity 7 and near of activities 3 and 4. Other difference is in activities 1 and 2 that are most displaced of the activities 3, 4, 5 and 6.

We confirm the identified groups by applying analyses of clusters with resource to the method Ward's for hierarchical clusters to variables of the mean and standard deviation to identify groups of activities. In the following figure we can see that four main clusters.

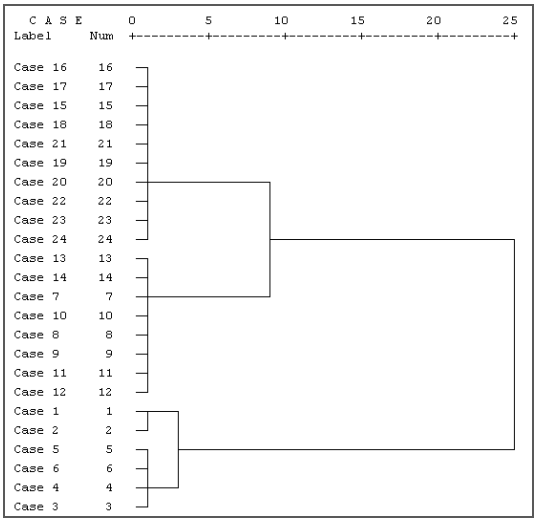

Fig. 1 – Dendrogram using Ward Method

In agreement with the results we attributed the classification to the activities: critical (group one and two), very important (group three) and important (group four). The table 2 represents this classification. So, the critical activities should always be made. The very important activities should be made in as many projects as possible. The other activities should be made if it is possible.

Table 2 – Classification of activities groups

Classification	Critical	Very Important	Important
Activities groups	1 to 6	7 to 14	15 to 24

We evaluated the significance of the three activities groups calculating the inverse function of the function of the sum of the activities. The results allow us to extrapolate that the six critical activities have a contribution level for the project success strongly significant, and by itself represent 47% of the relevance comparatively to all the other ones.

"Define the project plan" and "Identify and define the critical aspects of the project" are the two most critical activities and are clearly identified because their means have very low values very low comparatively to the others (2. 81 and 4.05 respectively). The standard deviation of these activities is also low, which means that Delphi's panel has a high level of agreement on these two activities.

All others activities, "Plan and manage the deliveries", "Validate control points of the project", "Accomplish meetings of progress control (internal and external)" and "Elaborate the acceptance plan for the customer" have very close scores. So we consider that these four activities are equally important for the projects quality. With such close values, it would be wrong to say that some activities are more important than other ones.

The group of activities classified as very important is composed by eight activities and the means vary between 10.38 and 13.48. As they are eight activities, the values of their means are all very close. The mean's standard deviation is 5.8 which is a very high value. This means that the expert's opinion significantly varies in these activities. For this reason, we consider all these activities as a group with several activities that contribute in a similar way to the success of projects.

The activities classified as important must be seen from two different views, activities 15 to 22 and activities 23 and 24. The first eight activities of this group have minimal differences in the values of the medium, and the average of that value is 0.19. Moreover, the average standard deviation of these activities is quite high: 5.53. Through this, we believe that these activities equally contribute to the quality of the projects. Activities 23 and 24 are more at the bottom. This means that according to experts these activities are from the list provided to the Delphi's panel the less contributive to the quality of projects.

The most critical activity that distinguishes from others is "Define the project plan". This result is justified because the project plan is the foundation of the whole project. If an efficient project plan that covers all the requirements and necessary tasks for its construction is not created, there is the risk the project to go in a different direction from its real objectives. In case that happens, and the project is built on a wrong basis, it will be difficult for the change management, claims, non-conformities, control meetings, and others, to solve the problem of the final project quality. Supported by the study results, we can say that the building of the project plan is the activity that most influences the final project quality of software development. Project managers must allocate the necessary resources in the creation of this plan, because the quality of the project directly depends on its quality.

The activity that comes in second in the final list of critical activities is "Identify and define the critical aspects of the project". It is obvious that the customer's needs are a priority. It is necessary to understand which aspects are vital to the customer and its business, so that all project's tasks guarantee that those critical points are taken in consideration. These aspects are extremely important when the project managers need to take decisions, because a wrong decision, which does not comply with critical aspects of the customer business, may lead to the whole project failure. Therefore, after the project plan, identification and definition of the critical aspects is essential for the final projects quality and, consequently, for the client satisfaction.

Project managers must dedicate themselves in a more intense way to the defining of the project plan; identifying and defining the project critical aspects relatively to the needs of its customers; validating all control points, planning and, consequently, managing the deliveries; holding progress control meetings, both on project teams, as with the customer; and elaborate the acceptance plan by the customer. It is important to refer that these conclusions cannot be seen as blind rules. It is the project manager responsibility to accomplish the link between the presented conclusions and the project where he participates (as always should be).

6. Conclusion

The project management is a vast area of knowledge that helps the project managers and the project teams to make and control the tasks of their projects. Although all the knowledge areas of project management are important, to understand the area of quality management is crucial to guarantee that the project accomplishes the aims for what it was created, because the several activities of quality management have this function. We focus our investigation in quality management because the most software development projects typically fail in this area.

Through a Delphi study associated to the Q-Sort method, a list of relevant activities was analyzed and then was ordered by importance, with the project management specialists' participation. This study

allowed us to identify the activities that are more critical for the quality of software development projects. We identified three activities groups that were classified as critical, very important and important. This classification can be useful for the project managers when they have to choose between accomplishing a certain task or other because project constraints.

We conclude that the quality management has six activities that are the most important to the project quality. This six activities are the definition of the project plan, identification and definition of the critical aspects of the project, validation of control points of the project, planning and managing the deliveries, accomplishment of meetings of progress control (internal and external) and elaboration of the acceptance plan for the customer. The first two activities, define the project plan and identify and define the critical aspects of the project, are stood out clearly of all the other ones.

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