

Improving Project Management Practices in a Software Development Team

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Abstract. Software development projects continue to deliver results that fall short on organization's expectations. The present research was carried out at InfoPortugal, a technological company specialized in Geographic Information Systems and Tourism and Leisure Solutions, where project management practices were underuse. Therefore, the focus of this paper is to describe the proposals and their implementation to enable the improvement of project management practices in a software development team. Guidelines are provided by a matrix with key areas to be improved and related proposed improvement initiatives. The definition and application of a hybrid project management methodology was the most important improvement initiative to address some of the key problems identified in case under study. Traditional plan-oriented methodologies do not have the flexibility to dynamically adjust to the software development process. While, agile methodologies combine iterative and incremental approaches to adapt to high levels of change, with early and continuous delivery.

Keywords: Software Development, Project Management, Agile, Planning.

1 Introduction

Today, the increased need to reduce costs, the increasing demand for quality, and the need to reduce delivery time can be considered as major challenges of a software development project, where everything goes almost at the speed of light. Many methods, techniques and tools have been developed; however, Project Management (PM) remains a highly problematic endeavor. Projects still do not meet stakeholder expectations and/or do not achieve the expected benefits [1].

PM in software development has shown different results from those known in other areas, having special characteristics such as complexity, compliance, flexibility and invisibility [2].

Planning is essential to the success of a project [3]. However, planning in software development is particularly difficult, and plans are often wrong. Plans should be sys-

tematic, flexible enough to handle unique activities [4]. In 2001 came the Agile Manifesto that adapts to high levels of change and adds more value to the project [3]. Overall results show that agile projects have almost four times more success than traditional managed projects [5].

This paper aims to address the following main research question: How to improve PM practices in a software development team? Having a secondary question: What is the impact of lack of project planning on the software development team? In order to answer these research questions, the following specific objectives were defined: (1) Identification of the PM problems/difficulties experienced in the organization; (2) Identification of proposals for improving PM practices that reduce the difficulties experienced in the organization; (3) Implementation of some of the identified proposals to improve PM practices.

This paper is organized as follows. Section 2 presents the literature review on PM in software development projects and traditional and agile approaches. Section 3 presents the research methodology applied. Section 4 describes the case study context and presents and discusses the main research results. Finally, the conclusions and highlights for further research are presented.

2 Literature Review

2.1 Project Management in Software Development

Project, program and portfolio management has been increasingly valued by organizations. Organizations have been increasingly investing in improving PM practices to maintain their competitiveness within a global market in constant change. Software development projects continue to fail despite decades of research. In 2018, 19% of software development projects failed [6]. The causes identified for this failure are the inadequate planning, estimation, metrics and control [7]. To address these problems, there are several studies that present critical success factors, such as decision latency, minimum scope, project sponsors, agile process and talented team [6]. Objectives clearly defined in conjunction with the project mission are identified as the most important key factor to success [8]. A project without a clear structured process is impossible to manage. Therefore, it is important the standardization of a PM methodology (processes, tools and techniques) to reduce risk and uncertainty, and to increase the governance of the software development process [9, 10].

2.2 Traditional (Waterfall) vs Agile Approach

With the growing tendency of using a more agile management in different projects, it is clear that there are two distinct PM approaches - the waterfall and the agile approach [11].

The waterfall model is a sequential software development process, divided into sequential phases that must be completed one after the other. The movement into the next phase is only made when all the previous work phase is completed [12]. This approach

can be applied to any project environment, but in situations where projects involve requirements volatility, high degree of uncertainty of change, ambiguity when dealing with complexity in project environment, this waterfall approach presents difficulties in responding quickly. In this scenario the adaptive (agile) approach can and should be considered, since agile development has proved to be adequate to dominate the presented situations and to capitalize the changes as opportunities [11].

VersionOne and CollabNet [13] report on agile methodologies most commonly used in projects in 2017. Scrum is found to be the most popular, 58% of teams claiming to be agile are using Scrum alone or combined with other methods. Extreme Programming is the second most used (10%), and then Kanban (5%).

Many teams are not able to switch to agile methodologies overnight, as agile techniques look very different from those they are used to. For this reason, it makes sense to plan a gradual transition [3] using a hybrid approach. That is, you need to value the specifics of each approach and, if possible, work with both at the same time, as each adds value in its own way.

The use of project management practices and the accomplishment of planning are important factors for the success of a project [14–16]. The plan is based on the assumption that project goals are clearly defined in advance. A project that uses good planning ends 18% to 36% before a poorly planned project [17]. Estimation and planning are critical to the success of any software development project of any size. Good planning reduces risks and uncertainties, increases understanding, improves efficiency, supports better decision making, builds trust, and conveys information [15, 17].

Regarding project management practices, there are four main reasons for applying best practices: improving efficiency; improving effectiveness; standardization; and consistency [16]. Best practices are those actions or activities performed by the company or individuals that lead to a sustained competitive advantage in PM, while adding value to the company, the customer, and stakeholders. Tereso et al. [14] identify the 20 most commonly used tools and techniques. According to this study the kick-off meeting, activity list, progress meetings, Gantt chart and baseline plan are the top five positions in the ranking.

Scrum, Extreme programming and Kanban are methodologies that present a set of agile practices that are fundamental to the adoption of these methodologies (e.g., product backlog, sprint, pair programming, testing and planning game). Their practices can be combined or implemented in isolation, taking into account the needs of each organization.

3 Research Methodology

This research is supported by theories already developed, following therefore a deductive approach. The study followed an action-research strategy that is an interactive process that involves the researcher and practitioners working together in a particular cycle of activities [18], focusing on change. In order to achieve the research objectives, in the first phase, a literature review was carried out regarding PM, focusing on software development projects. Subsequently, systematic data were collected through semi-

structured interviews, document analysis, informal conversations and observation of PM practices, with particularly attention to planning. The analysis of the collected data was performed, in order to understand the main problems, present in the development team. Following this detailed analysis, improvements in PM practices and their implementation are suggested. Finally, the contribution of the implementation of new PM practices in the organization is analyzed.

4 Case Study Analysis

4.1 Context

One of InfoPortugal's areas of expertise is software development. The team works closely to the Design knowledge area to create Web Geographic Information Systems (WebGIS) solutions, websites and apps for tourism and for planning and territory management. The organizational structure is based on “One Man Show”, that is, all decisions go through the company's executive director assuming a role similar to the project manager. The software development and design team leaders have the role of informing and giving feedback on the status of projects to the executive director. There are no systematic and well-defined processes, so management processes depend largely on the leaders' project decisions. The PM methodology is not clearly defined, making the execution of projects more complex. Project planning takes place weekly at a meeting between the executive director, the development team leader and the design team leader to monitor the status of projects. The task completion dates are set, and the planning is clearly top-down. The company uses some PM tools that help with internal organization and communication such as Redmine, Slack, Gitlab and Openproj.

4.2 Results

Results were obtained through three iterations throughout the investigation. In each iteration four steps were performed: diagnosis, planning, action and evaluation. In the first iteration the primary objective was to identify the problems felt in the software development team, in the second iteration the primary objective was to analyze the number of projects that were on time and on budget, in order to benchmark the best PM practices used, to finalize, the last iteration had the focus on the definition of a hybrid PM methodology in the development team. Data collection was achieved through techniques such as: observing PM practices, both on a day-to-day team basis and weekly meetings with management, and through semi-structured interviews with the software development team. Informal conversations held twice a week with team members in order to gather feedback on the tasks and projects they were carrying out and documentation on the active projects studied, including consideration of proposals and budgets, as well as the number of hours associated to every task.

Six semi-structured interviews were conducted with the four software programmers and the leaders of the development and design team. Interviews were analyzed with

NVivo software and the most frequent answers to be addressed in this study were consolidated and synthesized. Regarding the difficulties and problems felt in PM, Table 1 and Table 2 summarizes the interviewee answers:

Table 1. Difficulties/problems felt in PM

67%	No clear PM methodology
50%	Lack of communication
50%	Shared leadership
17%	Manage projects by recording work hours
17%	Timely report to customer

Table 2. How project planning is done

83%	No initial planning, tasks defined and created in Redmine
67%	Various interpretations of functional analysis. Requirements not detailed enough for team understanding
33%	The focus is lost with the exchange of projects
33%	Schedule should be done by the team leader and the team

The team development and design leaders identified 17 PM practices applied in the organization while team members identified only 5. Although there are PM practices in place, these are not identified by the employees because they are not involved in the process. Overall, respondents suggested 65% use of agile practices in contrast to 35% of traditional practices. During the analysis period, 9 projects were active, 7 external and 2 internal. In the active projects it was found that 77% of the projects were developed by only one programmer and 23% by two programmers. It was found that the cause of this situation is the small number of existing programmers for the high number of active projects. It was only possible to collect information regarding the estimate made for external projects. For these, a comparison was made between estimated and actual cost and time. Of the 7 projects analyzed, 4 have a longer development time than planned. The main causes are lack of resources, project start-up later than planned, difficulty in interpreting functional analysis, layout complexity, poorly budgeted projects, and clients request changes that are not planned. In addition to these causes, another factor focused exclusively on the development phase is related to unrealistic estimates. During the observation period it was found that 63% of the estimates set at the weekly meeting were not met. These are some factors that not only affect the duration, but also the cost of the projects. In relation to cost, the two projects whose difference was relatively larger than the budgeted value were projects B1 and C1, the first being over budget and the second under budget. These two projects represent 34% and 32% of the total costs, so the reason for this disparity was investigated. In the case of Project B1, which was a public tender, it was concluded that it was poorly budgeted, given the high workload associated with the project. In addition, during the development of the project, several customer change requests were made. Project C1 was not a public tender, the price was not limited, so the budget took into account the degree of uncertainty associated with the requested requirements. Taking a final balance, it was concluded that 43% of the projects analyzed were on time and within budget. Through the results

were identified Key Areas (KA) that should be improved, which are summarized in the following Table 3.

Table 3. Identified key areas that should be improved

KA1 – Methodology	KA2 – Communication	KA3 – Process
KA4 – Leadership	KA5 – Planning	KA6 – Focus
KA7 – Control	KA8 – Requirements	KA9 – Commitment
KA10 – Transparency	KA11 – Motivation	KA12 – Stakeholders

4.3 Discussion

This section discusses the proposed improvement initiatives for the key areas identified. These proposed improvements were based on the literature review and the organization context. Then the links between the proposed improvements and the identified key areas for improvement are shown in Table 4 and the link between the proposed improvements and effective implementations are presented in Table 5.

P1 – Define a PM methodology: As there is no official methodology in use, the risk of moving to an agile methodology is reduced. In the interviews, the willingness of the interviewees to apply agile methodologies was emphasized. Thus, it was proposed to use Scrum, in a first phase with the team training in the methodology and then with the rigorous application of methodological processes. This proposal should be applied to internal projects, taking into account the type of projects and the lack of objectives. As the customers are organization collaborators, it is easier to communicate directly with them and involve them in the process. However, many teams are not able to switch to agile methodologies overnight [3], as InfoPortugal's external customers require a more traditional approach at an early stage, with a timely proposal and project costs, a functional analysis and design that must be previously approved. Thus, in external projects, it is proposed to implement a hybrid methodology, combining the waterfall model and Scrum methodology. Finally, we proposed to use Kanban for projects that have already been delivered and require maintenance.

P2 – Restructure of the software development team: To implement an agile methodology, the hierarchical structure of the software development team will need to be revised and the choice focused on the matrix type, based on the “Tribes” presented in Spotify Squads model [19].

P3 – Redefine Leaders’ Responsibilities: The development team leader becomes Team Facilitator / Scrum Master and is responsible for assisting the team in all projects, sometimes referred to as the “servant leader”. And all projects should have a Product Owner, which varies by project type.

P4 – Set clear project objectives: Throughout the research it was found that the lack of well-defined objectives was constant. Thus, the researchers proposed the definition of objectives at three distinct levels: development team, project and collaborator.

P5 – Define good metrics: Define metrics that contribute to the control of the various projects and help the team detect possible deviations from the planned or identify the causes of software project failure. For example, Schedule Performance Index (SPI)

and Cost Performance Index (CPI), the number of projects on time and within budget and the number of hours spent fixing bugs after projects are completed.

P6 – Define clearly the requirements: We proposed converting customer-driven documents to something simpler and clearer, targeted at programmers, avoiding loss of information and multiple interpretations. In agile methodologies, the requirements are presented in user stories, which are easily interpreted by the team.

P7 – Engage the team in PM processes: Implementing an agile approach requires the project team to adopt an agile mindset. Agile success teams embrace the growth mindset, where people believe they can learn new skills. A policy of transparency in the organization is essential, sharing the objectives, plans and information needed for project development. The team should be involved in the PM processes.

P8 – Explore Software Tools: The organization presents a set of tools that can be explored and used continuously and systematically. As OpenProj is obsolete it is proposed to change this software to ProjectLibre.

P9 – Develop the Responsibility Matrix: With the high number of projects, it sometimes became complex to realize which human resources were allocated to each project. Thus, it was proposed to create a matrix of responsibilities, adapted to this context.

Table 4 illustrates the link between the identified proposals and key areas for improvement.

Table 4. Link between the identified proposals and key areas for improvement

	P1	P2	P3	P4	P5	P6	P7	P8	P9
KA1: Methodology	x	x	x					x	
KA2: Communication	x			x	x	x		x	x
KA3: Process	x			x	x	x	x		
KA4: Leadership		x	x						
KA5: Planning	x					x	x	x	x
KA6: Focus				x	x		x		
KA7: Control	x				x			x	x
KA8: Requirements	x					x		x	
KA9: Commitment	x			x			x		
KA10: Transparency	x			x	x		x	x	x
KA11: Motivation				x					
KA12: Stakeholders	x				x	x			

Regarding the effective implementations in the organization, these were carried out taking into account the current projects and the prior approval of the leaders and team consent.

I1 - Change of the software used in the development of the project proposals: ProjectLibre, which is a branch of OpenProj, was used, allowing the quick adaptation of this tool to the team. The team mentioned that they use the software and it was found that this choice was characterized by something “very useful and practical”, “the adaptation was quick” and “we use it a lot and it makes a lot of sense in the development of the project proposals”. It is also “adopted in projects in other organization’s areas”.

I2 - Introduction of the Responsibility Matrix: The creation of this matrix enabled the visualization of the resources that are allocated to each project and it is also possible

to visualize the state of the project. After its inception it was found to be widely used at the time when the team had several external projects, however with the decrease in the number of projects, the responsibility matrix was not used.

I3 - Streamlining PM processes: In order to plan a gradual transition, agile practices have been added to improve learning and alignment between the team and remain project stakeholders. In order to encourage teamwork, increased motivation and increase project delivery speed, project development with just one programmer is currently avoided. Thus, we adopted the strategy of working in pairs whenever possible and use pair programming. Estimates are set by the team together with the team leader. Sprinting began, with well-defined tasks shared within the team. For this purpose, the Redmine is used.

I4 - Development of a Kanban Board: One of the projects had a high number of tasks. Therefore, the Kanban board was implemented. The main objective was to simplify the process and help the team improve their organization and increase visibility, delivering value faster. The opinion of the team members was similar. They said that it allowed for “more organization”, “it is great in segregating work”, “it is easier to change the state of tasks”, which allows a “project overview” and “this is the first thing I do before I start the project”.

I5 - Bottom-up planning: A pilot project was developed, with the main objective of doing bottom-up planning. The tasks for the first sprint were selected based on the priority tasks defined by the Product Owner. The control was done through the burn-down chart. The metric used to track project progress was the SPI. In the first sprint the team worked with 75% of the planned rate. The main factor was an interruption at the end of the sprint. The programmers were told that they would have to change projects, so they did not have time to finish all the tasks they had planned. In the second sprint it was found that the team worked with 145% of the planned rate. This was because there were no interruptions or change of projects during the sprint and tasks that were pending in the previous sprint were quickly completed after doubts were cleared with the Product Owner. The conclusions from project observation and follow-up are the following: (1) setting objectives at the initial meeting made it possible for stakeholders to clearly understand what was intended, as well as aligning the entire team on the desired goal(s); (2) programmers' definition of planning (time estimates and selection of tasks present in each sprint) allowed for increased commitment and motivation to meet set deadlines; (3) more real time estimates; (4) the creation of a planning enables its control; (5) focus and motivation are lost with the exchange of projects.

Table 5 relates the proposals identified with what was effectively implemented during this research project.

5 Conclusions and Future Work

During this research, the best practices in software development PM were studied from a theoretical perspective as well as in practice through the action-research research

strategy. Keeping in mind the research question, there is a strong possibility of improving software development project practices through streamlining processes, making it easier to adapt to the changing market of today.

Table 5. Link between the proposed improvements and effective implementations

Proposed Solutions	Implementations
P1: Define a PM methodology	I3: Streamlining PM processes I4: Development of a Kanban board
P2: Restructure of the software development team	(Not implemented)
P3: Redefine Leaders' Responsibilities	I5: Bottom-up planning
P4: Set clear project objectives	I5: Bottom-up planning
P5: Define good metrics	I5: Bottom-up planning
P6: Define clearly the requirements	I5: Bottom-up planning
P7: Engage the team in PM processes	I3: Streamlining PM processes I4: Development of a Kanban board I5: Bottom-up planning
P8: Explore Software Tools	I1: Change of the software used in the development of the project proposals I3: Streamlining PM processes
P9: Develop the Responsibility Matrix	I2: Introduction of the Responsibility Matrix

The main contribution of this research was at the practical level. This paper gives software PM professionals guidelines on how to improve PM practices in organizations with an indefiniteness of PM processes. Identifying the problems felt in the software development team made it possible to select a set of key areas that are common to most small and medium-sized companies in the industry. The choice of proposals focused on solving the identified key areas and through the implementations, it was possible to validate that the proposed solutions work. Lack of planning makes it impossible to monitor and control the status of projects, there is a lack of commitment to meet deadlines, there is a lack of organization, there are various interpretations of requirements and the team is not aligned with the intended project objectives. However, during the implementations of the solutions, it was observed that the involvement of employees in the planning, especially in the definition of time estimates, increased motivation, commitment to meet the estimated deadlines and the achievement of more realistic deadlines. The fact that this study is directed to PM in the software development area limits the study results to this area only.

In the future, the organization should define priority actions to apply to this development team that can also be tested in other sections within the organization. Through the results presented in this research, it is clear the need to implement agile methodologies and have a transparency policy, involving the team in the whole process. Thus, it is suggested the rigorous application of Scrum in a pilot project and analyze the results. As well as the application of the proposed hybrid methodology in a project with low degree of risk and uncertainty.

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