AGILE approaches in project management

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ABSTRACT

Agile methodologies have numerous advantages over the classical methods used in Project Management. These methodologies are usually applied to software development projects. However, their characteristics make them appropriate to be applied to projects in other areas, including Electrical Engineering projects. The aim of the study conducted in this thesis was to verify the applicability of agile methodologies to projects in Electrical Engineering.

To this end, the applicability of these methodologies to various fields of engineering was studied. We first analyzed a case study in the area of Computer Engineering, an area in which these methodologies are most commonly applied. It was also analyzed a case study in the area of Civil Engineering to assess the application of these methodologies to projects with more rigid constraints. Finally, based on best practices identified in each case study, we evaluated the possibility of application of agile methodologies in Electrical Engineering projects.

It was found that good practices arising from the application of agile methodologies to Computer and Civil Engineering projects can be easily extrapolated to the area of Electrical Engineering, and also that those good practices could be adapted to the needs and specifications of the projects.

Index Terms — Agile methodologies, Project Management, Outsystems, LEAN, Good Practices, Electrical Engineering.

1. INTRODUCTION

Over the last few years agile methodologies have been developed and are now widely used in different types of projects. Agile methodologies have numerous advantages over the classical methods used in project management and the implementation of these methodologies in projects of different areas and scopes is very interesting.

Typically, this type of methodology is used in software development projects, which by their nature makes a perfect match with the principles introduced by agile methodologies.

However, projects in other areas such as civil engineering, less flexible and with more physical constraints, have been trying to apply these methodologies.

Still, there is no record that agile methodologies have been used in projects in the field of Electrical Engineering. So we considered important to analyze the applicability of agile methodolgy to projects in the Electrical Engineering domain.

So, the goal of this study is to reflect on the applicability of agile methodologies to Electrical Engineering projects and to identify good practices already used in applying agile methodologies to projects in other domains and try to project these good practices into Electrical Engineering projects.

2. AGILE METHODOLOGIES

I. OVERVIEW

With the increasing adoption of agile principles, several processes for project development have emerged. Although they can be used in other areas, the most common agile processes are mainly applied to software development.

Currently, the agile processes most used are Scrum and Extreme Programming (XP), although there are others such as Adaptive Software Development (ASD), Agile Modeling (AM), Family Crystal, Dynamic Systems Development Method (DSDM), Feature-driven Development (FDD), Internet-Speed Development (ISD) (Abrahamsson et al., 2003).

Agile methodologies introduce significant changes in relation to classical methods; the most significant change is to develop projects in an iterative cyclic way. Iterations divide the work to be performed by several stages, making deliveries to the customer at the end of each stage.

In most cases the duration of the iterations is set at the beginning of the project and should only be changed in an extreme case. The maximum duration of iterations is typically a month. This is, as stated above, one of the main particularities of agile methodologies.

Besides the advantage from the iterative operation - the progressive delivery of the product rather than just at the end of the project cycle - these methodologies allow a better participation of the client and an effective monitoring of the progress of the project, allowing the project manager to know whether the project is ahead or behind of predictions.

Regular meetings between the people involved in the project allow better control of the project progress, as well as more efficient management of all resources involved in the project. We depict a comparison in Figures 1 and 2.

Figure 1 - Agile methodologies general process.

Figure 2 - Classical methodologies general process.
As shown in Figure 1 and Figure 2 there is a big difference between the two approaches. In agile methodologies, represented in Figure 1, it is observed that there is a short period of time in the beginning of the project for the analysis, being this work done progressively throughout the project.

On the other hand, in the projects according to classical methods, shown in Figure 2, the analysis is carried out in the beginning and the project only begins when all requirements have been discriminated and have been accepted by all parties involved in the project.

In the case of agile methodologies in the beginning of the project, the project manager makes a quick analysis of the requirements because they are open to constant changes, so it is more advisable to make progressive analysis along the project.

Another significant difference between the two figures is the difference in approach to the project. As previously mentioned, agile methodologies are based in iterations instead of classical methodologies that choose to do the entire development and only deliver the product to the customer when it is completely finished.

The differentiation of the scope of the project should be emphasized. If the objective of the project is to make a single delivery to the customer and the iterative method, with progressive deliveries, does not bring any added value to the project, the project manager should opt for classical methods.

The risk associated to the application of classical methodologies is lower than in agile methodologies because those are the methods used in most cases nowadays and the people involved in the project have, in theory, more knowledge of classical methodologies application.

On the other hand, if a project is being developed using classical methods and it is discontinued, there is no return for both parties. In those cases, if the project is developed using agile methodologies, there is always the possibility to take advantage of what has already been developed, so the loss is smaller (this situation only occurs in cases where this is possible, and may vary from project to project).

The greatest asset of Agile is the versatility and the possibility of change through the project lifetime. In the case of traditional methodologies, project risk is all on the side of the supplier of the solution, on the contrary, in the case of agile methodologies, due to a greater proximity between the customer and the project team, the risk is shared.

Another factor to consider is that if the project is developed using agile methodologies, the risk associated to not meeting deadlines or to the end result not being what was intended is much smaller, since, as mentioned before, there is a closer monitoring of the project by the customer. The project can be changed according to customer’s needs and that, depending on the project, can be a huge asset.

II. OUTSYSTEMS METHODOLOGY

Outsystems methodology follows the principles of agile methodologies that have previously been analyzed.

One of the main principles on which this approach is based is that the features in a given solution have to be presented to the customer, evaluated and can be changed as the project evolves.

The requirements analysis phase is much smaller than in a conventional methodology and development is done in small cycles (iterations), after which is made a demonstration to the customers and the users.

During the presentation, an evaluation to the progresses made so far is done by users, and the development team collects the feedback. This feedback is crucial in order to get an idea of the business value of the features presented.

The fact that this methodology is based on iterations with progressive demonstrations to the end users makes the final product more close to the real needs of the customer.

a. CONCEPTS

To plan and execute a project based on Outsystems methodology there are four main concepts that have to be taken into consideration:

- **Project backlog**: the list of requirements to implement should be made according to a priority level and must be dynamic, so it can be changed as the project evolves;
- **Budget**: the budget for the product development must not be changed. It is crucial that the final cost of the project is the same that have been planned in the beginning;
- **Sprint**: period of time, usually 2 to 4 weeks, to make an iteration of the project. After a sprint should occur a demonstration of the product developed so far to the customer;
- **Timebox**: period of time in which the project must be concluded. The timebox is fixed and cannot be changed in any circumstances.

b. Project Teams

According to outsystems methodology the requirements collection and analysis, project monitoring and testing require the participation of elements of the customer.

Below are presented the main participants in the project, either from the development side as from the customer side.

i. Customer Team

- **Business Sponsor**: typically the director / responsible for the business department that requested the solution and should be part of the steering committee;
- **Business Manager**: responsible from the customer side for the development of the project;
- **IT Manager**: responsible for the IT infrastructure needed to implement the project;
- **Business User**: this element has business experience and will use the developed solution in a daily base;
- **Maintenance**: Responsible for the operation, maintenance and post-production of the developed solution.

ii. Development Team

- **Engagement Manager**: manages the client and collaborates with the Business Manager in business analysis and definition of the project backlog;
• **Delivery Manager:** responsible for the development of the project;

• **Developer:** element from the development team.

The Engagement Manager from the development team will present regular progress reports. This presentation will be conducted through a recurring meeting for this purpose, which involves at least the Engagement Manager and the Business Manager.

3. **CASE STUDIES**

I. **COMPUTER ENGINEERING**

The case study is based on a project implemented in July 2011 by the company Do iT Lean, whose aim was to develop a computer application that would improve and expedite the transmission of information between the various entities involved in the management and air traffic control. The entities involved in the project in question are an airline company, a handling company, the company responsible for the management of airport infrastructure and the project development team.

Each flight has an associated form that contains several information about the flight such as the origin and destination of the flight, the passenger list, among others. The forms, on paper, were filled manually by the handling company employees. The application developed allows generating automated electronic forms previously filled by the airline with all the flight information. On the track, the handling company employees have computers in which they can access the electronic forms, having only to verify the information given and to complete the form with additional information, if necessary. Finally, the information collected in the forms is transmitted to the company responsible for the management of airport infrastructure. Note that, typically, about 90% of the forms are correctly filled, so it is not necessary to make any additions to the forms. The additional information required to the remaining forms is due to the occurrence of anomalies such as missing luggage or passengers who lose the flight. In average, 500 forms are filled daily.

To manage the project of developing the application outlined above it was used Outsystems Network. Below are presented the main tools used in the Outsystems Network that helps the Project Manager to do his job.

a. **Sizing**

To forecast for the duration of the project and then submit a proposal to the client, the sizing of the project was carried out. Therefore, the requirements of the project were analyzed and the estimated time of implementation of each of the features was foreseen according to the highest standards in the Outsystems methodology. According to the temporal estimation obtained and the number of resources available, it can be determined the approximate duration of the project.

With the Outsystems Network it is possible to list all the requirements in the project and to make an estimated duration of each. The end result of the sizing is the duration of the project.

The estimated duration of the project in the Outsystems Network is based on standards previously established. The project manager, when preparing the proposal and listing the various requirements, establishes which of the existing standards is most closely to what actually will be developed.

b. **Timebox**

Timebox is the period of project implementation. In timebox the start date and end of the project are set. These dates are fixed and must not be altered in any circumstances. If these dates are not met or if more time is needed for the project execution, it can be negotiated a new project for improvement, but this will increase the costs to the customer.

An advantage inherent to agile methodologies is the versatility of the projects and of their requirements. If the customer wishes to change any of the requirements of the project during its development, that is possible. However, the dates of beginning and end of the project and sprints remain unchanged.

c. **Sprints**

The Outsystems methodology is based on Scrum methodology and so the development of the project is carried out based on sprints.

For the development of the project two sprints were planned and subsequently to implement the solution developed was planned one more iteration.

The OutSystems Network has an option of listing the sprints where the status of each sprint in terms of duration can be checked. It can also be verified that the project is proceeding on schedule and if this is not happening, try to rectify it.

d. **Sprint Planning**

After defining the number of sprints to be made, the various requirements are distributed by the sprints. Given that, when the sizing has been made, also the duration of each requirement has been set, after the sprint planning it is possible to know the order of implementation of each functionality as well as the sprints duration.

At this time the analysis of features dependency is critical, since it is on this stage that is set the order of implementation of the features.

In this specific case study the first sprint began before the predicted date and ended in time. The second sprint started shortly after the foreseen date and ended a little after the intended date. The sprint made for the implementation of the solution had a big deviation due to software bugs resolution and application support that was requested by the customer and negotiated during the implementation.

e. **Team Leveling**

Resources are needed to develop the work items. The Team Leveling tool allows you to distribute resources among the various sprints and, depending on the requirements to
implement, it is necessary to allocate the resources required to implement them.

A given resource can be used with different roles in the project, and its time is distributed to match the project needs.

After having an estimate of the hours to be performed by each resource, it is easier to make an estimate for the project cost.

Usually, to make a proposal to the client, the project manager assigns a cost to the resource, which is already included in the profit margin of the company and based on the hours of work is obtained the total project cost.

Team Leveling is a fundamental tool for the project management based on Outsystems methodology because it allows you to make a direct correspondence between resources and sprints, therefore it is possible to control the duration/cost of the project.

f. Who Does What

After defining the resources allocated to each sprint, it is necessary to define for which each of these resources will be responsible for. For this purpose, there is a tool that allows allocating to each work item (previously defined) the resource that will perform it. Upon completion of each work item, the resource indicates how many hours he spent on implementing the work item. This stage of the project is very important since it is through it that the progress of the project can be tracked and the various project resources can be managed.

This is the last step of project management, and it is a tool used daily by the people involved in the project.

The management of a project using this methodology and using the Outsystems application allows the process to be easier and faster, given that the resources involved, being connected to the Internet, have access to information in real time. Any errors arising from poor communications are significantly reduced as well as the costs associated with the process.

In sum, the main gains for the companies involved in this project due to the development of the application described in this case were: Human intervention in the process was reduced by 95%; Errors arising from manual filling were eliminated; It was introduced the possibility of updates and corrections being done immediately;

The results obtained in this case using the Outsystems methodology reflect perfectly the objectives of agile methodologies.

II. CIVIL ENGINEERING

In order to determine the advantages of applying the ideals of Lean philosophy against the methodologies currently used in the construction industry, we present in this section some examples of works in which monitoring, analysis and data collection were conducted and that served as the base for the work and analysis done (Gonçalves, 2009).

The cases presented below are the result of a research partnership with a company that operates in the construction sector in Portugal. The constructions under study – Novo Pier Norte, Church Boa Nova Estoril, Torres Sana Vasco da Gama Royal Hotel, Theme Park KidZania, Condo Jardim de S. Lourenço and PT’s Building Afonso Costa - were analyzed from five aspects: Planning and Strategy, Organization Work, Production System and Materials Management, Communication and Employee Engagement and Construction Management.

Data collection was done through direct observation in the construction site, surveys and document analysis.

After a detailed analysis of the data collected, some important aspects about the operation of the constructions under study were identified, as well as constraints on the process discovering potential areas for improvement.

In all constructions an initial planning is carried out, which is reviewed and adjusted if necessary. The scheduling is done by constructing a Work Breakdown Structure, where the activities are presented by building trades. It was found that the planning of work to be done is not always effective and that it is rarely completed at the date control set. Planning can, therefore, be seen as a point of improvement in which the application of Lean methodology could bring benefits.

Wastes inherent to the execution of each contract were also identified: waste associated with the correction of errors, unnecessary procurement of materials at site, unnecessary transport movements and waste directly connected to the hand labor, equipment and materials. Other examples of waste resulting from insufficient planning and misallocation of resources are related to internal miscommunication and poor preparation for the tasks to be started (Gonçalves, 2009). Naturally, the existence of waste has negative impacts, especially on the financial results, deadlines and customer satisfaction. The application of Lean philosophy, which suggests the elimination of waste as a way to add value to the product, presents itself as an asset to mitigate the constraints identified on the functioning of the process.

In order to minimize or eliminate, whenever possible, the problems arising from the management methods used in the constructions studied, it was proposed a model which the main objective is to introduce the Lean methodologies that relate the main contractor and several subcontractors. With this model it is intended to reduce or eliminate waste, variability and inflexibility of management system, improve communication in all processes and make the flow continuous value and simplified.

The model proposed is based on the tool ‘value stream mapping’ and presents five key parts: Selection of the product or service; Draw of the map of the current state of the process; Analysis of the map of the current state of the process; Draw of the map of the future state and Implementation and control of the evolution of the improvements implemented (more detailed information regarding these principles can be consulted in (Gonçalves, 2009)).

The proposed model was implemented in the assembly of window frames in the Novo Pier Norte construction. The implementation of the proposed model was not possible as a whole due to some impediments such as limited time to do the implementation, the nature of the work and the conditions provided for its implementation. Two of the proposed tools were introduced, the Last Planner System (which includes the weekly planning and medium-term planning) and Visual
Management, given that they cover the entire process and they allow performing a general check of the production.

The application of the Last Planner System was started at the beginning of the work, allowing the assessment of problems that could jeopardize the planning for the execution remaining. The analysis of the weekly planning and of the causes for non-compliance with planning is also advantageous for determining liability and for negotiating new deadlines and working conditions with the client.

The use of Visual Management was achieved by placing a board within the construction site, visible to all employees, updated daily and weekly monitored. The information in the board allowed a better control of the performance. The Visual Management had a great response by employees and its benefits were widely recognized.

After a careful analysis of the presented case, it is clear that the Lean philosophy is an innovative feature in the construction industry, since it allows projects to become more competitive due to its potential to reduce costs and increase customer satisfaction. This is achieved by reducing waste, improving product quality and guaranteeing delivery within the stipulated deadlines. Another important factor is the possibility of viewing losses and opportunities for improvement in the production system - the focus is the process as a whole (optimization of production flows) rather than just the conversion operations (localized optimization).

4. CONCLUSION

For the areas of Computer Engineering and Civil Engineering several good practices that led to the increase of efficiency of the project were identified.

The good practices identified were: Regular deliveries of the product to the customer, Planning and discriminated definition of requirements to implement. The use of online platforms to manage the project, Setting unchangeable deadlines, To make the point situation with all members of the project team, a clear definition of the role of each element, Maximum reduction of waste, Increasing the transparency of the project, Implementation of a method of accounting for the percentage of project undertaken and Providing project status to all participants. The good practices identified were generally common to both areas of Engineering studied, with the exception of periodic deliveries to the customer, which was only valid for computer engineering.

For all the good practices identified, there are apparently no constraints indicating that the same cannot be applied to projects of Electrical Engineering. As such, it can be concluded that they are applicable to projects within the Electrical Engineering, even if they may have to be slightly adapted to the project requirements. The good practices identified above can be applied on all types of projects within electrical engineering, such as planning and design of a project to implement a telecommunications network, implementation of a telecommunications network or introduction of a new technology in the network mobile.

In conclusion, Agile methodologies when applied properly allow a substantial reduction of the duration of the projects and therefore their costs. When applied to electrical engineering projects, agile methodologies can be a major asset for them and for their participants.

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