Development of an interface for managing and monitoring projects in an automotive company

Andreia Reis[1], Anabela Tereso[1,2], Cláudio Santos[1], Jorge Coelho[3]

[1] Production and Systems Department
[2] Centre ALGORITMI
University of Minho, Campus de Azurém
4804-533 Guimarães, Portugal
[3] Bosch Car Multimédia Portugal, S.A.
4701-970 Braga, Portugal
andreia_sousareis@hotmail.com; {anabelat, claudio.santos}@dps.uminho.pt;
Jorge_Manuel.Coelho@pt.bosch.com

Abstract. In a competitive world, companies lose customers and opportunities due to lack of organisation, failure to meet deadlines, bad planning, among other reasons. Project management is presented as a form to guarantee compliance with deadlines, costs reduction, sales increase, revenues growth, clients' satisfaction, among other benefits. This paper presents the development of interfaces for managing and monitoring projects at Bosch Car Multimedia in Braga, Portugal. With the increasing number of projects under the supervision of CM/MFT3, the section had greater difficulties in monitoring projects' status. In order to tackle the situation, tools for project status control and project status overview (cockpit chart) were proposed, so that the project management practices could be improved.

Keywords: Project Management, Cockpit Chart, Performance Measurement System.

1 Introduction

Nowadays, companies face challenges such as fierce competition [1], narrow profit margins, rigorous customers and constant technological advances. This environment requires the implementation of more robust project management practices, since many activities have to be performed in increasingly tight schedules, using less resources without compromising quality.

Project management has been considered a core competency at Bosch since 2000. Internal projects, international dependencies, increased complexity, and the fact that increasingly non-product development activities are conducted as projects has led to good practices being implemented [2]. With the increase in the number of projects to be managed at Bosch, the following research question was established: *"How can the*

monitoring and control of projects be improved in a section of an automotive company?" From this research question, the subsequent objectives were derived, which support the development of the work:

- Define and use Key Performance Indicators (KPIs) for project management (time, resources, cost and quality);
- Extract KPIs through the tool used by the section;
- Develop and implement a tool for the overview of the projects' status;
- Implement a mechanism for the classification/prioritization of projects;
- Improve Project Management (PM) practices in CM/MFT3.

This paper is organized as follows. After the introduction (section 1), a literature review is presented in section 2. Section 3 presents the research methodology. Section 4 presents the work developed and results obtained and finally section 6 concludes the paper and presents some suggestions for future research.

2 Literature Review

A project can be understood as an activity that is carried out only once, having well-defined goals, where resources and time are limitations for its accomplishment [3]. Projects may be carried out at all levels of the organisation and may involve a single person or many thousands. Their duration varies from a few days to a few years. Projects may involve one or more organisational units, and even partnerships between organisations. Projects are a way to organize activities that are not developed in an organisation's normal operating standards [4].

There is a rapid increase in the number of companies that adopt project management practices to accomplish specific goals. Not even the most optimistic analysts predicted the explosive growth that took place in the field [5]. Several authors recognise that project management can be understood "as the application of knowledge, skills, behaviours, tools, and techniques to project activities to meet specific project requirements" [4, 6, 7].

Performance evaluation is a strategic process that can be used as a management tool. The evaluation of performance in management aims to inform the company's current situation to top management and employees feedback on the work performed. Its main objectives are to improve productivity, motivation, the development of personal capacities and help in the decisions of organisation and management of the personnel [8, 9]. According to Andersen and Fagerhaug [8], performance indicators are tools used to determine whether organisations' objectives are met and whether they are moving towards the correct implementation of the organisations' strategy. Generally, these can be described as standards used to evaluate and communicate performance.

Earned Value Management (EVM) integrates cost and schedule control under the same framework and it provides performance variances and indexes which allow managers to forecast future performance and project completion dates and costs. EVM supports project risk assessment and control by measuring project evolution in monetary terms [10–12]. EVM requires three key parameters to measure the project performance: Planned Value (PV), the Actual Cost (AC) and the Earned Value (EV)

[12, 13]. By monitoring the evolution of these indexes over the project life cycle, managers can take corrective actions as soon as deviations are detected [10].

When implementing an indicator, it is necessary to assign it a target value, so that there is a benchmark for what is being measured. Constant goal compliance can mean that value should be revised and raised to a higher level of performance. For its part, the control limit is the minimum allowed value of an indicator, below which corrective measures must be immediately taken for the control. However, in some cases the control limit may be a permissible upper limit, in the case of the use of human resources being evaluated, for example, where excessive use could mean an overload of work [8].

Regarding the way results are presented for further evaluation, it becomes pertinent to use formats that make the information synthetic, attractive and easy and quick to visualise. Cockpit charts are an eye-catching format that brings together various indicators in a visually appealing way, and enables to measure, monitor and manage effectiveness and progress in achieving goals in a comprehensive manner. Cockpit charts are a form of alertness to easily detect deviations [8, 14]. In a simplistic way, the visual management of a project can be compared with the cockpit chart in a car, where a person can quickly see what happens in each function. In five minutes all the company's performance indicators can be covered [15].

Briefly, it is very important to monitor and control the state of the project during all stages of the project, so that the whole team has a clear view of the project state and is able to highlight the areas that require additional attention. The creation of tools that aid the supervision of projects is fundamental. In this sense project visual management gains importance. Visual management proposes the use of panels, schedules, charts, graphs, among other techniques to facilitate the visualisation and understanding of the flow of activities. With this set of practices, it is possible to improve the process, the management and the commitment of the team.

Despite the fact that the many existing project management interface tools follow the design principles aforementioned, their implementation must follow contextual specificities. This paper aims at contributing to this body of knowledge by describing the case of implementation in a section of a component manufacturer for the automotive sector, traditionally used to operations management, but which has been experiencing a substantial increase in projects lately, hence the need to improve their project monitoring practices.

3 Research Methodology

The research methodology used was Action Research, following the phases: diagnosing; planning; taking action; and evaluation [16]. The methodology for data collection was based on observation of the practices used in CM/MFT3 and analysis of the documents used before in the section. Then meetings with CM/MFT3 collaborators were held in order to better understand the problem and propose improvements. These meetings took approximately one-and-a-half hours and occurred in the first four months of the research work. Finally, meetings were held at least once a week in order to follow the status of the work and adjust the proposals if necessary.

It is important to note the highly interactive nature of the research design, which involved constant meetings with the company staff in order to complete the analysis of the current situation, with inputs, especially of the project manager. Based on the analysis of documents and the meetings, some improvements were proposed. These meetings were intended to monitor the status of proposals, and if necessary, to adjust some points.

4 Work Developed and Results

This chapter describes the improvements developed in order to attain successfully the overall objective to this work: the development of an interface for managing and monitoring projects in an automotive company.

Before proceeding to any proposal for improvement, it was necessary to study and evaluate the status of project management in CM/MFT3, section of BrgP/MOE1 department, by using the methodology proposed in the previous section.

The CM/MFT3 section is the Worldwide responsible in the area of Printed Circuit Board Assembly and Interconnection Technologies and belongs to a centralised organisation in Hildesheim. The section is structured into four different areas, according to the work developed. The area of Project Office and Information Management is responsible for the incorporation of all areas in order to have the work developed in the section connected, which makes essential the collaboration and good communication of all section collaborators even if they work in separated areas. This section is currently experiencing an increasing number of projects to be managed in the last years, hence the need to improve their project management practices.

As a consequence of the increase of the number of projects in the section (from 2 projects in 2013 to 16 projects in 2017), it became clear that the file used by the section (file to track and control projects) had to be improved since it was becoming too complex, difficult to update and no longer being appropriate for the needs it was intended for.

Another problem identified was the lack of a tool to show the overview of all projects. Only the status of individual projects could be analysed. This reflects the low maturity level of the section in terms of project management. There were no clear and well-defined rules or criteria for the characterisation of traffic lights (Green, Yellow and Red). For example, the characterisation of what means a red in quality or timing was not defined. To provide this overview, the data was discussed in meetings and through the perception of those involved, it was decided how the timing, for example, would be characterised as red, yellow or green. Key Performance Indicators (KPIs) are essential in project management. These indicators facilitate the management of the projects and indicate their status. In CM/MFT3, these performance indicators were not defined. With the absence of KPIs and the lack of tools that follow closely projects, it was difficult to do good control practice in project management in terms of time, cost, quality and resource planning.

4.1 Tool for the project status control

The CM/MFT3 projects overview process has become more complex with the increase of the number of projects managed in the section. Whereas with few projects the overview was adequate, due to the increase of the number of projects (and their complexity), the overview has become out-of-date and not easy to analyse and maintain.

Several meetings were held with the project management team to discuss some ideas that could improve the project management practice in the section. One of the main difficulties reported was the impossibility to see the projects' phase. So, when someone (for example the head of section) wanted to know the stage of a project, there was no document/tool to show it. An Excel sheet where all the team members could see the project status was created to solve this problem. The most important stages to manage and control the projects were discussed with project managers and the section head. The resulting Excel sheet is shown in Figure 1.

CM / MFT3 Projects	Roadmap	Budget (k €)	Priority	T&R	Project Category	Requirement Colection	Cost Calculation	Project Orga.	Schedule (TGs)	Project Charter
[redacted]	2017	0	Very High	https://rb-wam.bosch.	C	In progress	Done! 16/02/2017	In progress	In progress	In progress
[redacted]	2017	100		https://rb-wam.bosch.	B	In progress				
[redacted]	2016 2017	10 20		https://rb-wam.bosch.com/tracker	B					
[redacted]	2016 2017	70 100		https://rb-wam.bosch.	B	Done! 29/03/2016	Done! 15/03/2016	Done! 12/04/2016	In progress	Done! 29/03/2016

Fig. 1. Overview of projects evolution
(Note: Some information is blurred due to confidentiality)

The steps are marked as green when they are concluded, and the realisation date is shown; yellow means they are in progress and blank is used if the steps have not started yet. The exceptions are the columns Docupedia; T&R and SharePoint since they are three computing platforms that open via a direct link (Figure 1).

Having this overview, the separation between projects and activities was facilitated, allowing the projects prioritization, in the column Priority, as shown in Figure 1. The options for priority are: very high; high; medium; low; very low and on hold. This column is fundamental for project management since it allows the work organization and definition of which tasks are more urgent to perform.

By taking advantage of the tool developed to control the project status, the team concluded that it would be interesting if it was possible to cross projects' and products' activities. For this reason, an extra functionality was added to the base tool. The result of this extra functionality is presented in Figure 2. In parallel, a software tool (Track&Release) was used to support the management of activities scheduling.

Figure 2 presents a double entry table. The projects are listed on the rows, while the products are listed on the columns.

In Figure 2 it is possible to note:

- Light grey colour: the crossing between projects and their products;
- Dark grey colour: when more than one product is associated to a project, the one with the earlier audit is selected first;

- Not Applicable (N.A.): sometimes projects don't have any product associated due to many reasons (could be a strategic project or an innovative project);
- Missing Information (M.I.): when the font colour is red (as it is possible to see in one project and four products (Figure 2) it means that important information is missing, such as the current schedule.

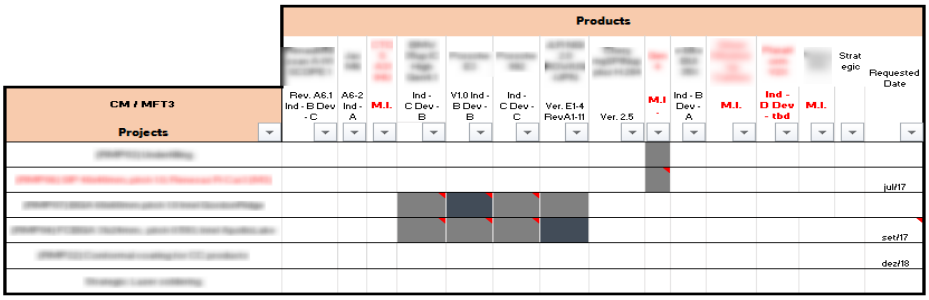

Fig. 2. Cross analysis of projects and products after improvement
(Note: Some information is blurred due to confidentiality**)**

The cross analysis between projects and products was made possible with this table, so the relationship between a project and the products or between one product and all the associated projects can be easily see. A software tool was used to see the relationship between the projects activities and products over time – Track&Release.

In Figure 3, orange blocks correspond to project tasks and blue blocks correspond to product tasks.

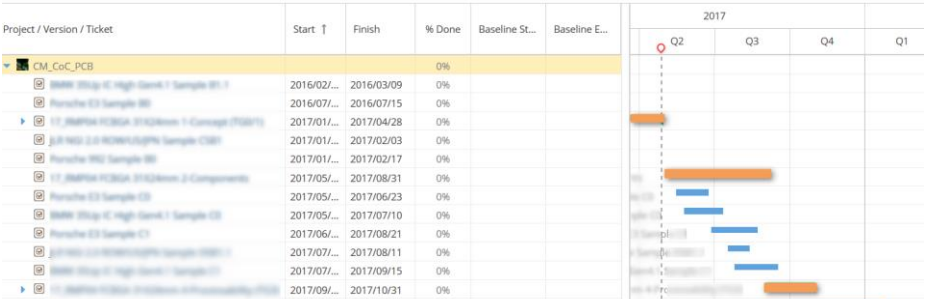

Fig. 3. Cross analysis between project and projects over time
(Note: Some information is blurred due to confidentiality**)**

The tool Track&Release complements the Excel file (Figure 2). In the Excel file, the project manager sees the relationship between projects and products. In T&R, the project manager selects the project and products (that were identified in the Excel file) that he/she wants to see in the long run.

4.2 Tool for the project status overview

The capability to have an overview of projects' statuses is critical for project management. A cockpit chart to assist in project management was developed to fill this gap.

In order to sustain and help the creation of these cockpit charts, "master sheets" were developed. An Excel sheet was created for each constraint that needs to be evaluated: cost, resources, quality and time. Additionally, an Excel sheet to show the status of the tasks related to projects was also created. Figure 4 presents one of the cockpit charts developed for the project management of the CM/MFT3 section.

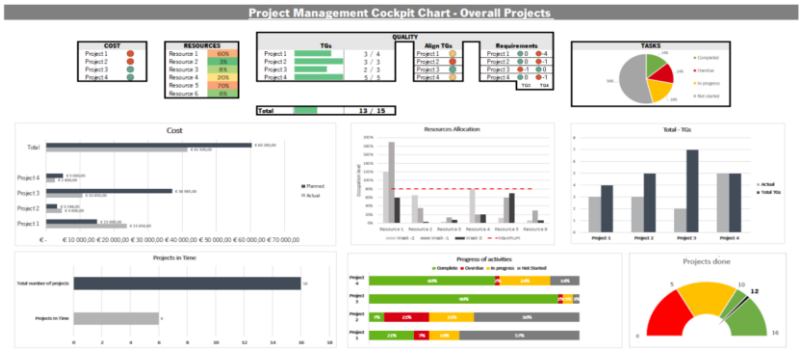

Fig. 4. Cockpit Chart: overall projects' view

The cockpit chart presented in Figure 4 is more oriented towards the head of section and to the top management since in this cockpit chart there is no excessive detail. There is, on the contrary, a very superficial view of the status of CM/MFT3 as regard to projects' management. On this cockpit chart (Figure 4), a report of the general status of all the projects supervised by CM/MFT3 can be analysed.

Another cockpit chart was developed (Figure 5), which in fact complements and serves as basis for the previous cockpit chart presented (Figure 4).

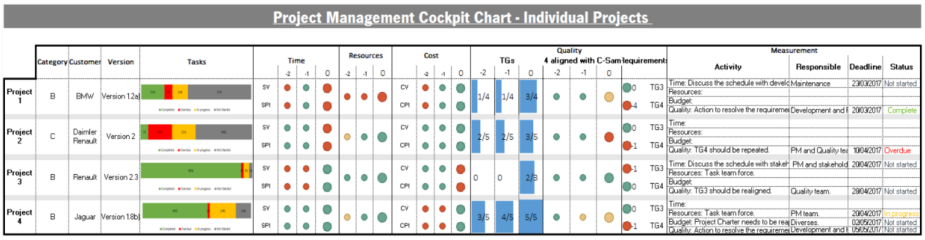

Fig. 5. Cockpit Chart: Individual project

In this cockpit chart (Figure 5) it is possible to examine the individual status reports of all the projects under supervision of CM/MFT3. The purpose of a cockpit chart is to provide information in a format that is both intuitive and insightful. The cockpit charts proposed are an attempt to go to paperless project management and report the most critical information to the stakeholders in the fastest way possible. This proposal enables viewers to evaluate exactly how well the project is performing.

Each line corresponds to one project. The first column represents the project category (A, B, C or non-project). The second column describes the customer and the third column is related to product schedule version. Numbers presented on the heading (-2; -1; 0) represent the week information: 0 represents the present week; -1 represents the last week and -2 two weeks ago.

The constraints evaluated are the same in both cockpit charts (time, resources, cost and quality). These four constraints are evaluated weekly, and the report presents the current week status and the previous two weeks. A table called "Measurement" was also added in order to connect the critical constraints. The measurement considers the action, the responsible, the deadline and the action status: "not started", "in progress", "complete" and "overdue".

The items that appear in the cockpit charts portrayed in Figure 4 and Figure 5, are elements that both customers and project managers track. These items are referred to as key performance indicators (KPI). The key performance indicators used in the cockpit chart and how they were calculated will be presented next.

Each project task has a designated responsible, a start date, an end date, the duration and the current status. Then a calculation is made to determine the percentage of tasks "complete", "overdue", "in progress" and "not complete".

The EVM methodology was used to evaluate the constraint time. The Schedule Variance (SV) and the Schedule Performance Index (SPI) were calculated.

Currently, the section does not use any resource management platform, which makes it difficult to quantify resource utilisation. In order to overcome this limitation, Track&Release was used. Once tasks are introduced in this tool, it is simultaneously allocated to one or more resources and the tool automatically describes the allocation of the resources over time.

The EVM was the methodology chosen to support the calculation for the cost constraint. The Cost Variance (CV) and the Cost Performance Index (CPI) were evaluated.

Quality is evaluated in three ways (see last paragraph of this section). To understand how the constraint quality is evaluated first it is fundamental to understand two fundamental concepts at Bosch: (1) Technology Gates (TGs) are milestones used as a quality tool and access the assurance of the production process development from the beginning until the end of the project. At the end of each phase a TG is performed to evaluate the work done. In TG3 occurs the processability validation. This means that the evaluation of process capability indexes required by the Bosch standards is made in this phase. Reliability is evaluated in TG4 in order to comply with the quality assurance given to the customer; (2) The product C-Sample is the sample of the product which shall be representative of the series production.

The first form of quality assessment is to evaluate the number of quality milestones achieved versus the number of quality milestones planned. Another way of evaluating project quality involves verifying if the TG4 is aligned with the product C-Sample. The alignment between the TG4 and the product C-Sample is a very important milestone since it is on this step that it is evaluated if the production line is adequate for mass production. Lastly, in TG3 and TG4 occurs the evaluation of the requirements' fulfilment (capability requirements, process requirements, and legal requirements).

6 Conclusions and Future Work

The scope of this paper was associated to the project management, more specifically, to the development of an interface for managing and monitoring projects in an automotive company – Bosch Car Multimedia – at Braga, thus answering the research question: *"How can the monitoring and control of projects be improved in a section of an automotive company?"*.

The main objective of the company is customers' satisfaction and to create actions that improve performance, for standing out, positively, in the market. In order to achieve these objectives successfully, good project management is essential. It is the efficient project management that enables activities to be performed in an increasingly shorter time and using less resources.

As a consequence of the increasing number of tasks under CM/MFT3 supervision, existing project management practices have become inappropriate: documents used to plan, control and monitor became obsolete. Thus, the need for the creation of tools for monitoring and control the projects arose. One of the problems identified in CM/MFT3 was the impossibility of knowing, in real time, the project stage. For that reason, an Excel sheet was created where all the team members are able to see projects' progress. This Excel file has all projects listed, and its columns present the more important steps that the project has to go through until completion. These steps were marked as green if completed, yellow if in progress, and with no fill if task was to be done yet. With this file, it is possible for the whole team to see at what phase the project is.

For CM/MFT3, it is critical to have an overview of the project status. In order to fill this gap, a cockpit chart to support project management was developed. Firstly, it was necessary to identify which KPIs would be interesting to display on the cockpit chart. After that identification, some of them were selected to be extracted through Track&Release, a tool currently used by the section. Having this clear objective, the separation between projects and activities was facilitated, allowing the projects' prioritization.

The cockpit chart development has brought numerous advantages to the section, such as:

- Ability to see projects' statuses;
- Visual representation of performance measures;
- Ability to identify and correct negative trends;
- Ability to generate reports;
- Ability to make decisions based on collected data;
- Save time over running multiple reports.

Therefore, it can be concluded that the research question was answered and all the objectives agreed were achieved. This research work positively contributed to the performance of CM/MFT3.

Despite the advantages listed above, the software still needs some utilization time so that the benefits to be achieved in operational terms, can be measured. As future work it is crucial that the section keeps improving the cockpit chart based on new needs that may arise (new projects, new products or/and new updates). The idea is to keep it as a living document.

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