

The effectiveness of communication in software development project management

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ABSTRACT

Project management is in our days a complex and high demanding discipline that brings the need of following standards and methodologies. Communication was identified as one of the primary reasons for the success or fail of projects. Plan, manage and standardizing the way how the communications are done in a project is a key factor.

There are several standards and methods for project management, for this particularly case, ISO 21500-2012 and PMBOK were the most relevant of choice.

Communication is the way of sending something from one person to another, no matter if it's verbal or non-verbal.

On an ongoing project, within an organization, has been detected some problems related with managing and communication.

To surpass the detected problems it was presented a solution that consists in redefine the manager role, adopt PMBOK standard and implement a communication model based in the model from PMBOK

The proposal was evaluated through interviews at project team members and Moody & Shanks framework enabling assess the solution validity.

Keywords

Projects; management; standards; methods; communication; PMBOK.

1. INTRODUCTION

Planning, strategy and management are important since the beginning of times. [1]

Nowadays project management involves people and companies from all sectors and activities. Technology is a very important factor, for some companies it's even crucial.

Hardware, software, communication and multidisciplinary teams changed the work environment of companies, totally. [2]

Leveraging business, working as a facilitator or disruptive nature, the technology is not only for technical teams it is also on the board rooms. Companies must have the ability of transformation themselves and have a great time to response. [3]

With that in mind good planning to better execute is very important. Standards and methods on project management are needs that a company should suppress with lessons learned as the result of this process. [4] [5]

In way to enable implement what was planned we have to use communication, this is not only mandatory, but do it well in an assertive and clear way is key. [6]

Due to his evolution, the industry, creates levels of complexity where the communication is not always easy to understand. The project manager role is vital to establish how the communication is taken and understood, leading to less failures, more innovation and success on adopting new technologies, improving the quality of the delivery and the support in decisions. [6] [7]

1.1 Problem

In a complex business environment, in the area of information systems, with teams based across different locations is necessary to work in a unified way and where the communication flows clearly and in an objective way, unfortunately this not always happen due to a wide variety of factors, the company organizational culture, the project manager's way of leading or even the unknowing of standards or methods that supports a communication model.

A Portuguese company, with several years in the market, working on different countries, have detected some problems in an ongoing project for a financial institution:

- Lack of responsibility for each member of the project team;
- Internal unknowing of milestones, dates and even project plan;
- Nonexistent communication between the team members;
- Project documentation not reachable across all members of the team.

We find a problem how the information in the project is passed on and accessed, resulting in the absence of a well-defined communication model that supports knowledge sharing and collaboration between the various elements of the project team.

1.2 Problem Goal

The use of standards and methods in project management allows support common forms of work, foresee critical paths and provide performance indicators immediately on the status of a project by adding a model of communication known to all stakeholders in the project.

The objective of this study was:

- Apply to a project already running, a project management standard, PMBOK, focusing on communication model that advocates and evaluate whether there were improvements in the way information is accessed by the various elements of the project team.

1.3 Problem Scope

The assumption that the general formulation the problem can theoretically be very complex is therefore necessary to surround it and focus on it to make the work feasible and consistent. So to carry out the work of this thesis was identified a project that would serve as an object of study and which would bring together the following conditions:

- Being in execution;
- Having a project team consisting by more than 3 elements and more than 2 business units within the company;
- Do not have in use any standards in project management;
- Need to redefine the project manager responsibilities;
- Being identified by the company as a project in poor execution and poor management.

PMBOK was applied, focusing on Chapter 10 [8], on the project communication management, as we can see on Figure 1 the business processes that support him.



Figure 1 - Project Communication Management Overview [8]

2. RELATED WORK

In order to characterize the problem and propose a solution to the same first we need to study the basic concepts in software development project management: a project, requirements, the project management and methodology. There are also different types of methods, some more relevant to the proposed solution ISO 21500: 2012 and PMBOK.

The definition of communication and what is meant by an effective and efficient communication model are also themes.

2.1 Project management main references

A project is something that occurs in a temporal space in order to create something unique as a product, service or result. By having a timeline that indicates that they have a defined beginning and end. The end is reached when the requirements to which the project is proposed were implemented or when they cannot be satisfied, or because the need that originated the project no longer exists. [8]

The project requirements can be defined as a high-level description of the information or for having an existing restriction on the system [9] or on the other hand a well-defined formal description of a system function [10]. The latter is the one that best fits the type of projects that we are working with.

The information systems project management is complex and with many variables. Project management is an essential component of software engineering. [11] To be something that takes place in the business environment it has various constraints such as time, people and costs, which is that there must be a professional management. [9]

The project management is the application of knowledge, skills, tools and techniques around project activities to meet requirements. This application of knowledge requires an effective process management. [8]

A methodology is a set of practices, techniques, procedures, and rules used in the context of the work in a given discipline. [8] Methodologies outline the path and provide the required steps, design, order and timeframe of tasks to undertake to complete the work. In theory, the benefit and goal of following specified methodologies is that it will improve and maximize overall efficiencies.

Standard is a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. [12]. It just tells us what to do.

There are several methods for project management and standards such as, P2M, ICB, PRINCE2, APMBOK and SCRUM, [13] but for this thesis the focus will be only two, ISO 21500: 2012 and the PMBOK.

2.1.1 ISO 21500:2012 – Guidance on project management

ISO 21500: 2012 consists of a guideline for project management and can be used by any organization, there is no domain restrictions, size or types of project. This international standard provides a high-level description, on the concepts and processes that allows to create best practices in project management. Projects can be grouped in the context of programs and portfolios. The latter are not part of this standard. [14]

Defined as 5 the processes group of a project, Initiating, Planning, Implementation, Monitoring and Closing, as we can see on Figure 2.

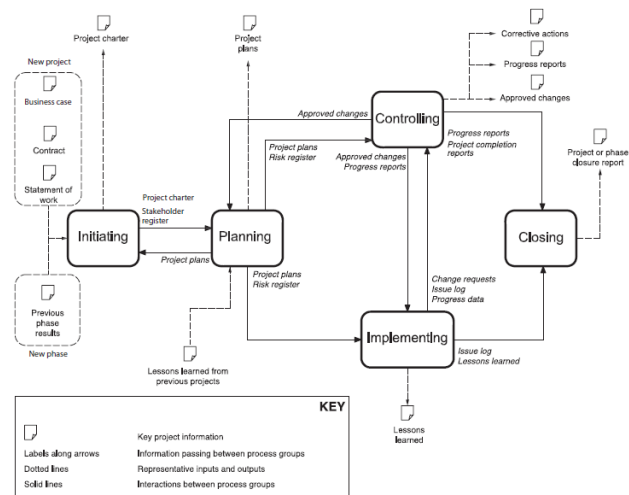


Figure 2 - ISO 21500:2012 – Processes group [14]

2.1.2 PMBOK – Project Management Body of Knowledge

The PMBOK, created by PMI in 1969 in order to serve the interests of the project management community is a standard formalized by ANSI, the version of ANSI / PMI 99-001-2013 [8] [15] is the one used in this thesis.

The PMBOK is currently in the 5th edition [8] and defines as 5 the processes group of a project, Initiating, Planning, Executing, Monitoring and Control and Closing.

These groups are formed by 47 project management processes and 10 knowledge areas:

- Project Integration Management
- Project Scope Management
- Project Time Management
- Project Cost Management
- Project Quality Management
- Project Human Resource Management
- Project Communication Management
- Project Risk Management
- Project Procurement Management
- Project Stakeholder Management

2.2 Comparison between ISO 21500:2012 and PBMOK

ISO 21500: 2012 and PMBOK are two standards for project management and both define as 5 the process group of a project. [14] [8] As we can see on Table 1.

The 10 areas of knowledge that the PMBOK define are in equal number to the subjects defined by ISO 21500: 2012 and they even called almost the same with minor change for Resources on ISO and Human Resources on PMBOK. [14] [8]. As we can see on Table 2.

However, there are differences between this two standards and it is in structure definition of the phases. ISO 21500:2012 does not provide a description of the tools used in the process, just what are the inputs and outputs and a brief description of the process. On the other side PMBOK beyond the detailed description and the inputs and outputs of each process define the tools and techniques to use in the processes.

The PMBOK have 47 project management processes and ISO 21500: 2012 have 39.

Table 1 - ISO 21500:2012 and PMBOK, processes group

ISO 21500: 2012	PMBOK
Initiating	Initiating
Planning	Planning
Implementing	Executing
Controlling	Monitoring and Controlling
Closing	Closing

Table 2 - ISO 21500: 2012 subjects and PMBOK areas of knowledge

ISO 21500: 2012	PMBOK
Integration	Integration
Scope	Scope
Time	Time
Cost	Cost
Quality	Quality
Resource	Human Resource
Communications	Communications
Risk	Risk
Procurement	Procurement
Stakeholder	Stakeholder
Integration	Integration
Scope	Scope

2.3 Communication in project management

Communication is transmitting something from one person to another, one or more, either verbal or non-verbal, for example, body posture or images. [16]

Communication was identified as one of the main reasons for success or failure in the execution of a project. An effective communication between the various elements of the project team, the project manager and the various external stakeholders is essential. Ensure a form of open communication is part to achieve a good working team and high performance in work execution. [8] It can be understood by open communication the way it communicates in the project, both internally and externally, with transparency, assertiveness and with the purpose of reducing the risk of false information. The information must be complete still ensuring it is actual and available at the right time. [17] [18]

Communication is the glue that keeps a project united and prevents this from falling apart. [19].

Typically there are five types of information flows in a project, [20] [21] as we can also see in Figure 3:

- **Downward** – From the project manager to the team members and typically serves for the manager to pass job details and what is to do;
- **Upward** – From the team members to the project manager. This flow is important to give feedback on how the project is running, and allow team members feel committed to the project, to be able to express their views and opinions on the implementation of the project;
- **Horizontal** – Between the various team members. It allows to create team spirit;
- **Diagonal** – Communication with other units and teams. Feedback from subject matter experts helping on solving a problem;
- **External** – Typically this kind of communication, is held by the manager, with the outside, with external stakeholders of the project or possible new actors or other organizations.

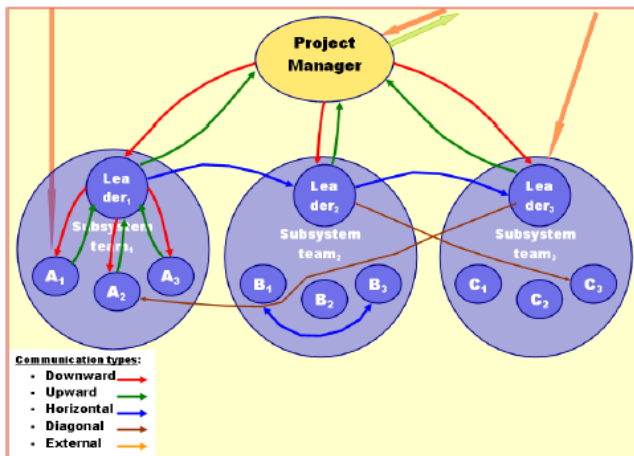


Figure 3 - Information flow in a project [21]

2.4 The PMBOK communication model

In PMBOK the communication model defined in the Project Communication Management knowledge area contains processes needed to ensure that timely information is accessible and shared correctly by all those involved in the project.

There are 3 defined processes [8]:

- **Plan Communications Management** – The process of developing an appropriate approach and plan for project communications based on stakeholder’s information needs and requirements, and available organizational assets.
- **Manage Communications** – The process of creating, collecting, distributing, storing, retrieving and the ultimate disposition of project information in accordance with the communications management plan.
- **Control Communications** – The process of monitoring and controlling communications throughout the entire project life cycle to ensure the information needs of the project stakeholders are met.

Each of these processes are composed by inputs, tools and techniques and outputs.

The inputs are information, whether existing artifacts or new ones of the environment where the project unfolds to serve as a starting point for communication processes.

The tools and techniques are artifacts that act over the project information.

The outputs are the production of new artifacts or update of existing ones.

The Communication Management Plan process’s benefit is to identify and document the most effective and efficient communication approach with the various project stakeholders. Effective communication is the one in which the information is provided in the right format at the right time for the intended audience and the proper impact. Efficient communication is one where only the necessary information is provided. [8]

In most projects, the communication planning is done at an early stage, typically in the definition of the project plan, i.e. to have the benefits of avoiding problems in the delivery of information and making timely allocation of resources such as time and budget for these activities.

3. PROBLEM ANALYSIS

To better understand the consequences of what poor definition of the role of the project manager, the lack of adoption of a project management standard and not setting a communication mode, causes on a project lifecycle we need, first, of focusing on our problem, an ongoing project in a business environment.

3.1 Problem context

The work object is a project that is already ongoing in a company providing consulting services in the area of information systems and the development of software solutions. With over 25 years of experience developing solutions to the financial sectors in more than 60 customers in 8 countries. It is headquartered in Funchal and with offices in Lisbon, Luanda, Maputo and Praia. With great focus and experience in banking core systems, where has begun its development and which currently have a wide range of solutions from core systems to web and mobile apps.

The company pyramid has a much broader base, with several units and segregation skills therefore a project team often formed by elements of 3, 4 or 5 units and subunits.

Not having a team 100% dedicated on project execution makes the project management a very demanding task for the management team. Different agendas, for each unit, with some of them in clash with the project dates and agreed milestones.

The software development company follows the traditional method, the waterfall model [22], that is, there are 6 sequential phases, requirements analysis, system design, software design, development, testing and acceptance.

The target project work of this thesis is the implementation of a solution that supports the business process of granting credit, in a major financial institution in Angola.

The scope of the project is the implementation of 14 credit products in the institution operation portal, using a BPM tool integrated with the existing systems.

The developments are performed in Lisbon and Funchal, with the installation to be carried out through remote connection in Lisbon, and the support and training being given locally, in Luanda.

3.1.1 Project team

The project team, during the problem analysis phase, was formed as follows, 4 units of the company that worked as independent companies between themselves, as we can also see in Figure 4.



Figure 4 - Project Team (AS-IS)

- **Unit X - Development FX (Funchal)** - Unit responsible for the creation and evolution of the company's products and the technological parts that development teams in Lisbon can use. This unit is considered the software development factory and has about 80 people;
- **Unit A – Development LX (Lisbon)** - Unit that performs all custom developments under the scope of projects and implements technological parts in alignment with unit X. Composed of sub-teams, they also have some little problems in communication. It is considered the custom development unit and contains about 30 people, including skills for developing integration solutions systems and graphical user interfaces, both desktop and mobile applications;
- **Unit B - Banking Consulting LX (Lisbon)** - Unit with the functional and technical knowledge of bank's central systems. Highly specialized senior elements, in all day to day banking operations and their technical components (central systems, RPG) and with some more junior members. It is the company's consulting unit, with nearly 120 people;
- **Unit C - BPM LX (Lisbon)** - Unit for processes implementation on various BPM tools, only have technical knowledge. Need help from unit B elements. Unit with 4 people.

Still in problem analysis phase, the project manager was at the same time the account manager, i.e., one person had the project management responsibility for the delivery and also the commercial responsibilities. Having to keep track of all requests made as well the state of the various projects on the client.

The total number of elements that made up the team during the analysis phase of the problem is not possible to indicate.

The commitment of the units was not with the project, the commitment was to the work priorities that each had. Did not exist a clear view of the project, scope, dates and customer expectations.

3.1.2 Existing communication model

With the structure of the project team presented in the previous section the existing communication between the various elements of team is illustrated in Figure 5.

If there was a need were sent individual emails without visibility by the project team of what was going on the whole and what was the impact it had on the client.

The mails were often sent to the heads of each unit, which have other responsibilities had no availability and promptness in response, leading to constant delays. Between sending and reply to an email could spend weeks, all this within the same company.

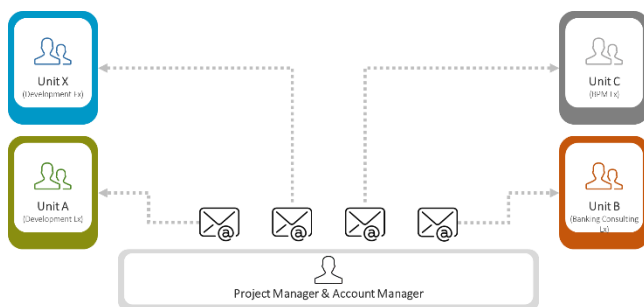


Figure 5 - Communication Model (AS-IS)

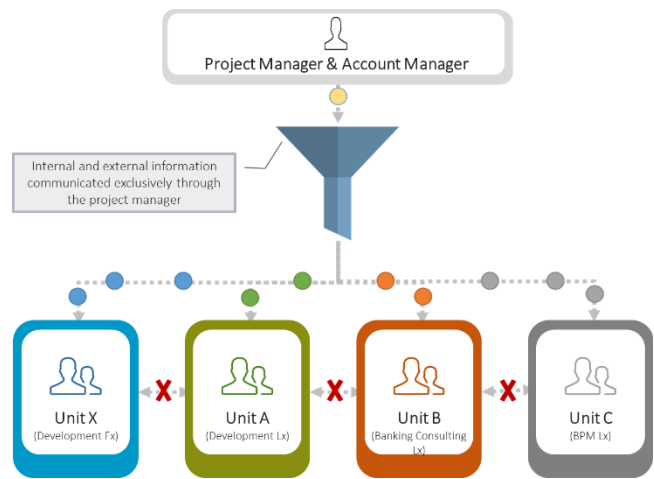


Figure 6 - Communication model in the project

There were no meetings with all project team members. The various elements participating in the project did not know all the other team members.

As shown in Figure 6 the project manager had the exclusivity of relations and communications, which is often verified result in an embarrassment to the efficiency and effectiveness of the flow of information required between the elements of the project.

There was no kind of internal interaction between the elements of the project team, lacking horizontal communication. Only downward communication exists. [21]

3.1.3 Problem state

With a year and a half after project adjudication and with a year delay in delivery compared to the original plan the status of project deliverables was:

- Functional analysis delivered and validated by the customer but without awareness of the various elements of the project, especially the Unit C - BPM LX. Risk of falling with customer expectation or not be possible to implement;
- GUI development already initiated by the Unit B - Development LX due to project manager request but without reflecting on all what was specified in the functional analysis;
- Nonexistent project plan.

With all that was described in this section it became necessary:

- Redefine project manager's role;
- Adopt a project management standard or method;
- Establish a way that communication become more effective to all project members

3.2 Project manager's role redefinition

The first step in the proposed solution is to assign the project manager responsibility to an employee of the company, different from the one that performs account manager role.

3.3 Project management standard or methods adoption

The second step in the proposed solution is the adoption of a project management standard that is accepted by the company where the project is ongoing.

This standard should be well documented and be a reference between standards and project management methods. It should indicate what to do and what tools and techniques to use to assist the project manager.

3.4 Establishment of an effective communications model

The last step in the proposed solution is the uniform and effective way to communicate in the project, the communication model. Being an integral part of the standard management adopted in the previous step, the communication model requires, creation of a communication plan and the implementation of control and maintenance mechanisms.

The project manager and the PMO's office are at the center of information and project control. It is project manager's responsibility develop not only the organizational structure of the project but also the plan and the lines of communication that support the communication model.

The communication plan should identify [8]:

- **Who** – are the lines of communication, transmitter, receiver;
- **What** – is the scope of communication and form;
- **When** – what is cadence;
- **How** – what is the format, e.g. mail, electronic documents;
- **Support** – create ways of recording, archiving and prevention mechanisms in the event of failure;
- **Feedback** – implement understanding confirmation and receipt of the message, documentation validation.

4. SOLUTION PROPOSAL AND SOLUTION APPLICATION

Because it's a project taking place in the business environment, the time restriction was high, leading to 3 clearly actions, redefine the project manager role, the adoption of PMBOK as the standard for project management, and implementation of the communication model defined in this standard.

4.1 The project manager

It was necessary to change responsibilities of stakeholders in the project before adopting any rule or method of communication.

The project manager who played at the same time account manager responsibilities began to be focused only on customer business aspects and project manager functions were taken over by another person, a company employee who did not have any liabilities on that client to put concerned project delivery due to other issues on the agenda. This redefinition of roles it's illustrated in Figure 7.

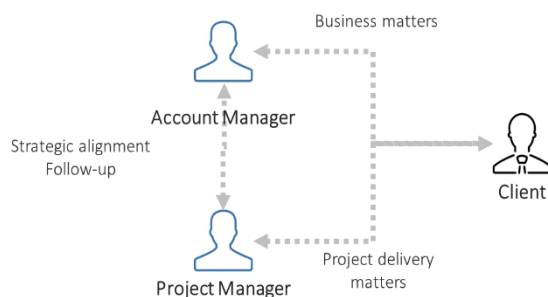


Figure 7 - Redefining project manager responsibilities

4.2 Project management adopted method

The implementation of the previous point was required to be able to proceed with the adoption of a standard or method in project management.

First was investigated the existence of any ISO standard on project management. ISO 21500: 2012 was the choice because indicates how to create the best practices in project management.

After the study of the ISO and verify the similarities and differences with the PMBOK, with the latter having the definition of tools and techniques to use as opposed to the ISO and this being the standard that is recommended by the company's PMO, it was decided to apply the PMBOK in project management.

With the project management standard defined a project kick-off meeting was convened. Until this meeting never the various elements involved in the project, with a year and a half of execution had been together in the same meeting room.

The purpose of this meeting was to clearly define the scope of the project, the role of each in the project, known limitations and internally present the work plan to further communicate it to the customer and get a validation.

In addition to the information to be provided was intended that the various elements involved in the project began to form a project team, as illustrated in Figure 8.

The project team, in the implementation phase, has in some moments up to 16 elements assigned.

The project manager plays a key role in this field, working as a facilitator for the various elements can perform the necessary work, communicate in a timely and constructive manner the next steps related to the project plan and help create a sense of belonging to the project.

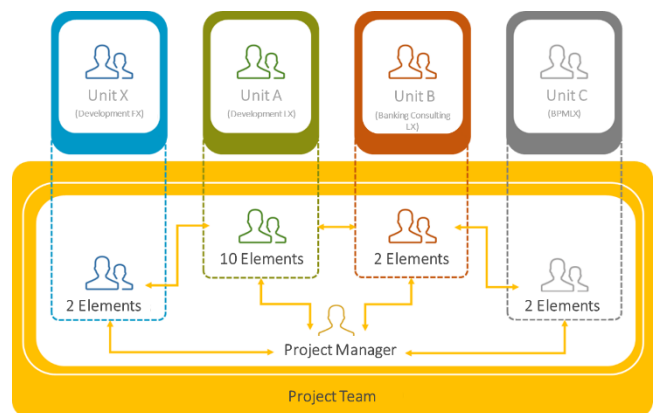


Figure 8 - Project Team (TO-BE)

4.3 Implemented communication model

The communication model, the main objective of this work can only be achieved after the redefinition of the role project manager and the adoption of a project management standard.

The goal was to create a support for an effective communication between the various elements of the project team and allow access to relevant information anytime anywhere.

It was necessary to define a communication plan and was followed PMBOK's Project Communication Management. [8]

This PMBOK knowledge area defines three methods for implementing a communication management model, each consisting of inputs, tools and techniques and outputs. Being the desired end result to have a more effective form of communication between the various members of the team.

4.3.1 Plan Communications Management

In this process the goal is to define and create a plan for project communications.

Using as inputs, the project plan, the existing stakeholders and the enterprise environmental factors, it was possible, through tools and techniques, like the analysis of the communication requirements, the technology available and meetings create an effective communication plan:

- Definition of the periodicity of meeting, internally biweekly, external and for controlling monthly;
- Site for the sharing of all information, the online repository. Supported on Microsoft technology, Microsoft SharePoint, which enables collaboration of the various elements of the project;
- Profiles to access information and information loading responsibilities, only the most senior elements could carry initial versions, the most junior members could give contribution to existing documents;
- Definition of communication with the customer, always through the project manager;
- After an external meeting a report for validation by the various stakeholders in the meeting is always sent;
- The emails about the project on the subject should respect the following taxonomy,[Client Country] [Project Name] - <subject to address>;
- Just treat a subject by mail, except for emails after meetings that had the effect of minutes;
- Team leader's identification, one by each specific area, 1 team leader for BPM, 1 team leader for integration, one team leader for the interfaces and 1 team leader for analysis and documentation.

4.3.2 Manage Communications

With this process the concern was to ensure that the information stored in the repository were updated as much as possible, and that the information sent to the client it was the only one he needed.

4.3.3 Control Communications

With this process it was possible to control the communication plan and at the same time carry out his monitoring.

Sending emails to the heads of each unit for decision making about the project decreased.

The number of documents produced in project increased.

5. EVALUATION

The evaluation of the results was performed using the statistical data for the communication plan, the project manager and tools used in the project. The communication model also questioned, it

was evaluated based on the quality's criteria of Moody & Shanks framework [23].

5.1 Practitioners interviews

For the evaluation of the work done, interviews were conducted to various elements of the project team.

The interviews can be divided into three types [24]:

- **Structured interviews** – When the researcher has fixed questions for every interviewee. The list of questions has a specific order;
- **Semi-structured interviews** – When the researcher uses a questions and topics guide to be covered;
- **Unstructured interviews** – When the researcher has a predefined plan, but the control on the interviewee's answers is minimum.

Interviews carried out were the structured type.

The choice of design team members for interviews was due to the fact that virtually all (9) have been present in the problem analysis phase (AS-IS) and in the implementation phase of the solution (TO-BE). Table 3 identifies who the project team was interviewed.

Table 3 - Interviewees

Interviewed	Unit
Information systems architect	Unit A
GUI Senior Consultant	Unit A
GUI Programmer	Unit A
Integration Senior Consultant	Unit A
Integration Senior Programmer	Unit A
Outputs Senior Consultant	Unit A
Senior Consultant	Unit B
Junior Consultant	Unit B
BPM Senior Consultant	Unit C
Integration Senior Programmer	Unit X

5.2 Results evaluation

The evaluation of the obtained results from the interviews was made in statistical form for the communication plan, the project manager, and tools.

To evaluate the communication model we rely on Moody & Shanks framework.

5.2.1 Communication plan

Looking to the results we may conclude that the proposed solution in terms of the communication plan was found positive.

- 100% answered that it is now easier access to the information, compared with the previous process management (AS-IS);
- What contributed most to the easier access to information, was the oral communication form (meetings and conversations, with an average of 4.4 on a scale of 1 to 5. In second place was the electronic communication form (email

and documents) with 4.2, and finally the visual form (slides) with 2: 8;

- According to the interviewees the most effective form of communication model in project management was also the oral 4.5 on a scale of 1 to 5. In second place was the electronic communication form (emails and documents) 4, 2 and finally the visual form (presentations) with 3.1;
- 100% of the interviewees believe that now they perceive better the project scope;
- 90% answered yes when asked about the existence of a feedback policy in the project. The remaining 10% replied that only sometimes, because the organization is not mature enough to have multidisciplinary teams;
- Related with the number of artifacts produced in the project 90% of interviewees says it increased and considers it positive. The remaining 10% consider that declined, referring to the number of emails exchanged between the teams in the analysis phase, which was higher, despite the response they consider the change as positive as well.

5.2.2 Project Manager

In this section of the questionnaire evaluates the role of the manager, explained in the implementation of the solution as compared to that found in problem analysis:

- 90% of the interviewees consider that the role of the previous project manager was not clear. The other 10% did not participate previously in the project;
- 100% of the interviewees consider that the current role of the project manager is clear and understandable.

The take on responsibility, the existence of recurrently meetings to follow-up with all team members and exists the concern in how the message is passed and understood by all led to the conclusion that the current role of the manager project is preferable to the former.

5.2.3 Tools

In this section we evaluated if the creation of forms to access information has contributed to an improvement in the communication process of the project.

A 100% agreement rate, where all interviewees agreed that the use of new forms of support, such as a single repository for all project information contributed to the improvement.

One of the interviewees when asked if the sharing of information and documentation, in collaboration between the various elements of the project contributed to a better understanding and monitoring of work to be performed under the project answered no, for him what contributed was the follow-up meetings. The remaining interviewees agreed with the question asked.

5.2.4 Communication model effectiveness

In this section was evaluated the effectiveness of the selected communication model. The main objective of this thesis.

It was chosen Moody & Shanks framework [23] for assessing the quality of the produced artifact, the communication model.

This framework proposes 8 criteria for evaluating the quality:

- **Completeness** - the artifact has all the information required to support the function of the system;
- **Simplicity** - the artefact achieved with the minimum possible interactions support the function in the system;

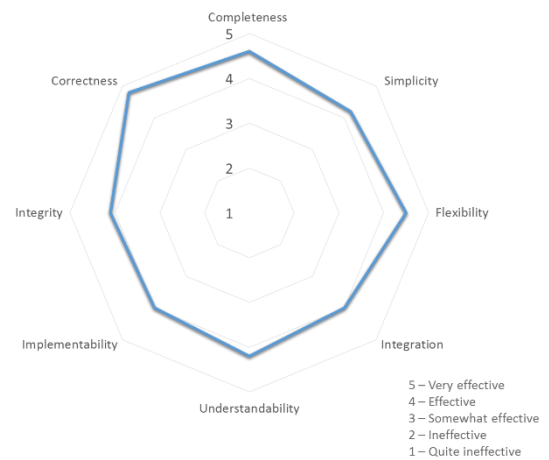


Figure 9 - Moody & Shanks Framework evaluation results

- **Flexibility** - the ability of the artifact to adapt to new requirements;
- **Integration** - the artifact integration in the organization;
- **Understandability** - the level of complexity to understand the artifact;
- **Implementability** - the effort for the artefact implementation;
- **Integrity** - the quality that the artefact produces or saves;
- **Correctness** - the compliance of the artifact.

The questions were asked to be evaluated on a scale of 1 to 5, with 1 for quite inefficient, 2 for ineffective, 3 for somewhat effective, 4 for effective, and 5 being very effective. This assessment was made without indicating to the interviewees the method we were using. The obtained results are illustrated in Figure 9.

After analyzing the results obtained from the questionnaires we can infer that related with Mood & Shanks framework criteria's the model of communication was:

- **Completeness** - the communication model is quite complete, allowing when needed full access to information. It is one of the dimensions best evaluated;
- **Simplicity** - the communication model is considered simple to use;
- **Flexibility** - the communication model is quite flexible, allowing, for example, maintain a follow-up meetings but switching between days or hours without major constraint for project team members. This was one of the best evaluated dimensions;
- **Integration** - after a habituation phase of the various elements of the project team began to adopt the model of communication, especially the information repository;
- **Understandability** - the communication model required a relatively low level of complexity. Possible to the oldest elements explain the new elements into the project how we were organized and which supporting tools we used;
- **Implementability** - the effort to implement the communication model was very low, the mailboxes already exist, the calendar also, as well as the repository tool, the rest was procedural;
- **Integrity** - by most of the artifacts produced in the communication model being electronic and we are using updated tools the integrity level of the communication model is quite high;

- **Correctness** - the communication model allows information to be available only to those who should access them. For example, the documents to produce, only the more senior elements may set up thus allowing that the loaded and shared information have a correct basis. This was the highest ranked dimension.

We conclude that the effectiveness of the communication model achieves very positive results on the criteria of Moody & Shanks framework.

6. CONCLUSIONS

The importance of communication in the software development management project was presented in the related work, showing that others have addressed the issue and it appears to be relevant in the project management area, through a real case presented in problem analysis and solution proposal and solution application.

We present the limitations of the work and also indicate what may be the future work on this subject.

We began this thesis by pointing out that the project management in a business environment is complex and must follow standards and methods in order to have more control and be a continuous improvement process. We mentioned that are useless these standards and methods if you do not know how to communicate. Communication is one of the key factors for success in project management.

In the related work we began by identifying references in project management and we found that there are an extensive range of methods and standards in this area. Due to its importance for this thesis we have deepened knowledge in the PMBOK and in his communication model. Communication can have different flows and ways to share information. Knowing what flow to use and when to use is not only an empirical work and involves methods, models and tools and techniques.

We define the problem of this thesis, a project taking place in the business environment with questions about the management and communication.

Our proposed solution consisted of three steps:

- I) Redefining the role of project manager;
- II) Adopt a standard or method for project management;
- III) Establish an effective communication model.

With the proposed solution set we moved for its implementation and for this purpose with the project identified as being in serious trouble by the PMO's office the project manager has been redefined, the PMBOK was adopted and a communication model based on the knowledge area for communication of this standard created.

The work was evaluated through interviews with project team members who participated in the problem analysis phase and in the implementation phase of the solution. The communication model was evaluated based on the quality's criteria of Moody & Shanks framework

6.1 Limitations

Since this work were being realized on a project that takes place at a business environment there are some limitations, such as scope and resources.

As the project was running at the same that the work of this thesis only one area of PMBOK can be implemented, the

communication. The remaining areas, such as risk or quality might not even be addressed.

One other limitation were the project team members. Being a project with a year and a half running the team is not the same which started making it difficult to make comparisons between the analysis phase of the problem and the phase of solution.

Another limitation is the end result, the communication plan, having just been applied and tested in a single project.

6.2 Future work

The application of the resulting communication model of this work to more projects in the same organization and other may be also future work. This suggestion comes following the feedback obtained by the company's PMO office on the execution of internal surveys carried out to their employees participating in this project. For this a survey was made of all employees who reported their hours into the project, in the company's internal control tool.

Calculating ROI in the communication process as complement to the work done by Angela Sinickas [18] is also a possibility for future work. Measure the cost, e.g. calls, with teams geographically dispersed versus after the feedback message, how is the clarity in the work being undertaken and the net result of the project compared to the initial estimation of costs. This work should be carried out with the financial area of the company, allowing us to understand the impact that communication have, not only in people but also in the financial aspect of a project and therefore in the company.

With the study of the literature we identify other potential innovation to complements this work such as measuring the existing communication in the project using the ICAM, [21] an original model from New Zealand created through a data mining tool called Weka [21]. This model uses several machine learning algorithms to analyze existing communication flows in the project, downward, upward, horizontal, and diagonal. It performs the measurement of information exchange internally in project teams allowing further analysis and presentation of results through graphics

7. REFERENCES

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