# A Process Model for Human Resources Management focused on increasing the Quality of Software Development

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*Abstract* — **The lack of quality in the production process of software development isn't attributed only to the techniques and technologies, but also to the lack of attention and importance placed on its members. Thus, this paper presents a process model for Human Resources Management focused on improving the quality of software development. Its preparation was based on areas and expected results of the process of human resource management present in the Reference Model for Brazilian Software Process Improvement (MR-MPS)[1]. In order to contribute to its understanding and use, it is presented a comparative study with other models present in the literature and identify their benefits and problems with an application in two software development projects.**

*Keywords: Human Resources Management; Process Quality; Training Management; Performace Management; Human Factor.*

## I. INTRODUCTION

The high dependence of human resources for the development of a software project has demonstrated the importance of its management. This is due to the fact that some studies have demonstrated that they generate and strengthen innovation, produce, take decisions, lead, motivate, communicate, supervise, manage and direct the business [5], [8], [9], [13], [14], [15].

However, even nowadays, these resources are still losing focus on software development processes, which tend to give more importance to the technical and practical areas [2], [14]. Moreover, it has been ever more common to find members doing exhaustive tasks (working overtime, on weekends or vacation) which end up resulting in their exhaustion, dissatisfaction and demotivation.

Thus, the software development process is not only about the use of software and hardware to generate systems. The development and maintaining is its connected to people.

As a consequence, its success or failure is intimately related to the way in which they are allocated and controlled within your budget and time [15]. Professionals with the right skills to perform their tasks, execute them in a most efficient way, which reflect in the quality of the software development process and in the final product.

Considering what was previously exposed, the aim of this work is to present a model of process focused on the increase of the quality of the software development process. For its elaboration, we based on what Amâncio et al. [1] and Morais [11] suggested and on the expected areas and results of the human resources management process presents in the maturity level E of MR-MPS.

This article is divided in six elementary sections, including this introduction. In Section 2 it is presented the theory related to the paper. In Section 3 it is presented the research methodology that was used. Section 4 it is presented the process model for Human Resources management. In Section 5 it is presented the results of the research. Finally, Section 6 it is presented the conclusions and suggestions for future works.

## II. THEORY

### A. Human Resources Management on Software Development

Several studies demonstrate that holding the best technological tools, using the most efficient techniques and work models is not enough to guarantee the success of a software project [9], [14], [15].

It is necessary the existence, in parallel, of a human resources management able to develop skills and guarantee the effective allocation of its members, in order to increase the quality of its process [12].

However, several managers attribute more importance to the technical and practical areas rather than the human resources, which end up by losing the focus in software development processes [2]. A manager must act in order to encourage the developing staff to work together as a team, concentrating in the customers' needs and product quality.

This context made managers responsible not only for the leadership in planning, organization and control of the efforts expended during the project. They had to develop other skills like manage people, e.g. ability to lead and stimulate people's development, abilities to solve problems and excellent interpersonal competence [15].

Moreover, during the development of a software project, the dynamic in business processes and the high turnover of technologies and his members highlights the importance to

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[1] Modelo de Referência para Melhoria do Software Brasileiro (MR-MPS)

manage intellectual knowledge with creating mechanisms to collect, store and share within the organization [6], [12].

### B. Related Work

There are several authors working hard in new models and processes to improve people management. We have made a deep analysis to find the good and bad points of them.

Amâncio et al.'s work [1] presents the definition of a process model grounded on the Human Resources Management, area of knowledge of PMBoK. The author presents its application in the software factory of a public education institution which main focus is the development of its members in the academic and professional spheres.

This process is divided into four activities, two of them *Planning Needed Human Resources* and *Hiring or Mobilizing Project Team* were developed in the initial phases of the project, while the other two *Develop Project Team* and *Manage Project Team*, must be executed in parallel until its end.

According to the author, although partial, the institutionalization of the process, besides achieving its main objective, the decrease in turnover, managed to increase the quality of its services and products through training and continuous assessment of the skills and performance of the people involved.

A human resource management process was also suggested in De Carvalho's work [7]. This work is divided into three complementary areas: Planning, Monitoring and Assessment, in each one of them its work instructions, resources and roles present in its execution were carefully defined and detailed.

Moreover, the author also defines some "external" activities which must be accomplished in a more administrative sphere. Among them, we can cite *Effectivenes of Professionals Hiring*, that is not part of the IT manager competence and must be carried out by the human resources department.

Also, in this context, Morais [11] presents a human resources management process focused on the improvement of the knowledge identification, storage and sharing process within the organization.

Developed to be adherent to the MR-MPS, this process is composed by six activities that aim to work broadly the organization's needs, its trainings, manageable knowledge and performance, besides controlling the dismissal of its members.

Apart from this presentation, the author performed a preliminary validation of the process through its implementation in the human resources area of a system development organization. According to the author, the model demonstrated to be efficient in this context.

Unlike the three first models, People Capability Maturity Model (P-CMM) maturity model is a variant of Capability Maturity Model (CMM) which has as focus to help in human resources management. To do so, it offers a set of good manners to make provisions for the continuous growing of workforce abilities in the organization [6].

According to Curtis and Hefley [6], the workforce abilities are defined as knowledge level, ability and capability to perform activities within the project. In order to monitor and improve these competences, the model is divided in five maturity levels, so gradually each one of them will be identified, developed and worked. Thus, the advantages identified when implementing the P-CMM vary in function to the maturity level in which the company finds itself [6].

### C. Reference Model for the Brazilian Software Improvement Process[2]

Developed in 2003 by the SOFTEX[3] as part of the MPS.Br[4] program, the MR-MPS consists of a reference model with the definition of prerequisites for the improvement of the quality of the software process. Besides it, the program is composed by an Assessment Method (MA-MPS) and a Business Model (MN-MPS), each one of them described by guides and/or document models.

In accordance with Capability Maturity Model Integration for Development (CMMI-DEV) and following the described headlines in its main program, this model was divided into seven maturity levels. These levels define steps to improvement processes in the organization [10]. Moreover, this division aims to enable its implementation and assessment in micro, small and medium enterprises.

These maturity levels are composed by processes which define what the expected results are, and capabilities which express its institutionalization level and implementation in the organization. Thus, it is noteworthy that the development among these levels happens cumulatively and only when all demands were found.

## III. RESEARCH METHODOLOGY

The research methodology used in this article was a case study. According to Yin [17], case studies offer an empirical research that investigates a contemporary phenomenon and offers researchers an object of applied study in its natural context. And, in addition, new facts and research issues about this environment can be identified [17].

In order to work on the case study, we selected a project of a software factory in a public university. Their teams were composed by undergraduate and master's students. Because of this, the company suffers with the seasonality issues in periods of academic activity, lack of commitment, interest and a low rate of productivity in its members.

Another problem of this company is the lack of a process of preservation of intellectual capital generated during the projects. Figure 1 show the development process used in the factory.

As shown in the Figure 1, the process begins with the macro activity, *Initial Analysis*, when the project's scope is defined through meetings with the customer. Then, in the macro activity *Analysis and Planning* it begins with the project planning and the record of its information in the Project Plan.

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[2] Modelo de Referência para Melhoria do Software Brasileiro (MR-MPS)

[3] Associação para Promoção da Excelência do Software Brasileiro

[4] Programa para Melhoria do Processo do Software Brasileiro (MPS.Br).
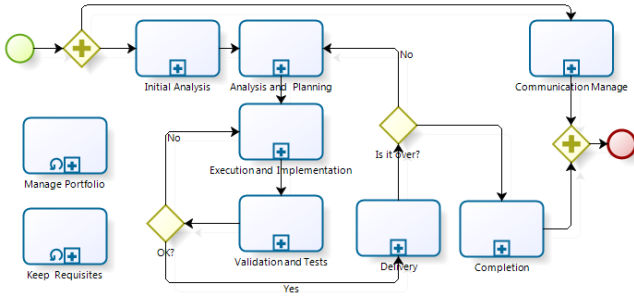
Fig. 1. Study Case Development Process

After this stage, it starts its execution and implementation and, subsequently, its validation and tests. During this stage, a direction is defined, either turning to the previous macro activity in order to correct inconsistencies and problems or, follow to the *Delivery* and *Project Completion*.

Unlike others, the macro activity *Keep Requisites* and *Manage Portfolio* occur in an asynchronous way and hold responsibility for ensuring the coherence of system's requisites and managing information between projects and top management, respectively.

Moreover, in each macro activities, a set of activities and artifacts, workflow of the works and tasks to be accomplished for each role of the process is defined.

## IV. PROCESS MODEL PROPOSED

Aiming the elaboration of the process model, we based on Amâncio et al. [1], Morais [11] and on the expected areas and results present on maturity level E of MR-MPS. The notation and elements used in the process modeling came from *Business Process Modeling Notation* (BPMN), since it is a notation language with standard icons for process design, which facilitates the understanding of the customer [4]. Figure 2 holds a more detailed model.
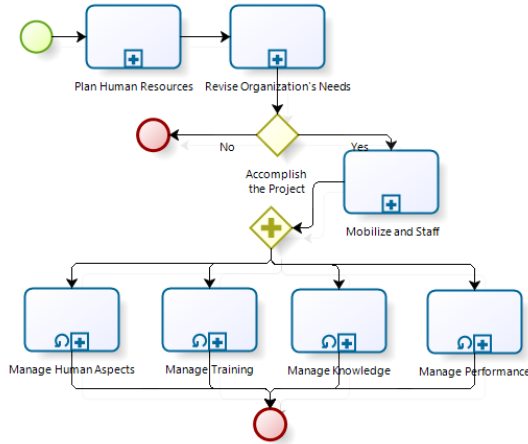


Fig. 2. Process Model for Human Resources Management

As shown in Figure 2, the process begins with the planning of the human resources. Then, it is conducted an analysis in domestic assets, in order to identify the partners who will be part of the project team. Based on this definition, it is carried out the recruitment and member's mobilization.

When the team is formed up and starts working on the accomplishment of the project, its members are constantly assessed towards knowledge, performance, training and human aspects, to minimize the problems and difficulties and maximize and improve the abilities. Next, we present each activity of the process.

### A. Human Resources Plan

Accomplishing the human resources planning, from the very beginning of the project, has a big importance for its manager. The reason is easy: this stage will be defined and planned to identify factors that could influence the human resources management.

Its workflow begins with the definition of the needed resources for the accomplishment of the project. Subsequently, based on this definition, a set of four management policies[5] must be defined. Then the organizational chart is elaborated.

After its definition, in parallel, we must work on the development of the career planning and on the detailing of the pre requisites for roles allocation. Completed these two stages, all this information will be grouped and will compose the Human Resources Management Plan (HRMP).

### B. Review the Business Needs

After planning, it is essential for the projects manager to work on the formation of their team. And, for that, they must base on the analysis of the organization's environmental factors (physical and social environments and people's attitude) and the organizational processes assets [1].

However, it is noteworthy that the revision of the organization's needs must encompass not only human needs, but also those needs connected to technical and support factors, such as: expenses with support people (e.g. accountants and administrators), travels, materials and trainings.

### C. Hire and Relocate Members

The goal of this activity consists in identifying, from an organizational chart, which roles and attributes will be needed to the execution of the project. Based on this, abilities and pre requisites can be defined and used to help in the selection of the member of the team.

In order to form the team, it is needed that, based on roles and attributes defined on the organizational chart, the manager is able to choose between hiring new members or relocating internal members. After this definition, the training needs must be identified, defined and recorded in the Tactical Training Plan (TTP).

During the development of this activity, the project manager must have access to artifacts that present which are the knowledge level, skills, experiences and availability of the members of the organization, so these information will help not only on the definition of whom is going to be part of the team.

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[5] Policies of Development, Knowledge, Availability and Communication Management.

### D. Manage Training

When any training needs in the team members are identified, they must be carried out according to the rules and specifications defined on TTP.

However, during their accomplishment, it is important to constantly monitor and assess their members. So that, improvements in teaching infrastructure and new training will be identified and implemented in order to guarantee the increase in the abilities and capabilities of their members.

### E. Manage Human Aspects

This activity has as purpose to identify the environmental and social factors which may influence the good development of the project.

For this, first of all, the needs of personal meetings, structural and geographical factors of the working environment and actions to minimize them must be defined. Subsequently, it must be defined the needs of personal meetings, exchange of staff and socialization needs.

All these factors must be constantly assessed, either through interviews or surveys, so the satisfaction and motivation levels of its members could be identified and improved. During this activity, a psychological can help to interpret data and collect information.

### F. Manage Performance

Managing performance consists in constantly assess, formally or informally, the member's performance, during the execution of their tasks, based on the assessment criteria pre-defined in the HRMP.

This assessment is important, because people are not always able to develop what is expected from them, resulting in a discrepancy between the planning and the accomplishment. Due to this, when identified, it's important that the manager adopts actions to correct or minimize them.

For that, with the definition of the criteria used for the performance assessment, the manager identifies if there were any discrepancy between what was planned and what was accomplished. Then, from this, he will be able to evaluate reasons and suggest corrective solutions for these problems.

### G. Knowledge Management

The knowledge management consists in adopting measures, techniques and tools to help the identification, retention and sharing of knowledge. This management focuses in to improve the quality and productivity in future projects or development [16].

This knowledge can be formed by a group of data generated throughout the projects, obtained from individuals, from the organization culture, organizational transformations and internal and external processes.

### H. Artifacts and Positions

During the application of the project, a set of **artifacts** must be elaborated and kept during the project. These must be generated either during the execution of the activities. The proper and constant update of these will serve as a help for other activities or for the development of future projects.

Moreover, it's important define the **management roles**, which throughout the completion of the model have to ensure the proper accomplishment of the activities. Besides this they have to identify possible improvements in the processes and suggesting corrective measures.

A summary of these artifacts and the roles related to the activities is presented in Table I.

TABLE I.          ARTIFACTS AND MANAGEMENT ROLES CONNECTED TO THE ACTIVITIES OF THE PROCESS MODEL

| | Consumed Artifacts | Generated Artifacts | Roles |
|---|---|---|---|
| **Human Resources Planning** | 1) Organizational Policies; 2) Scope Document. | 1) Human Resources Management Plan (HRMP); 2) Organizational Chart; 3) Plan of Positions and Functions; 4) Career Plan. | 1) Project Manager; 2) Human Resources Manager. |
| **Organization's Needs** | 1) Project Requisites; 2) Organizational Structure; 3) Economic Conditions. | 1) Organizational Chart; 2) Career Plan; (CP). | 1) Project Manager; 2) Human Resources Manager. |
| **Training Management** | 1) Tactical Training Plan (TTP). | 1) Report of Effectiveness of Team Training. | 1) Project Manager; 2) Human Resources Manager; 3) Course Coordinator. |

As shown in Table I, for each activity, besides a set of artifacts, there is a set of roles that must be associated and can be used during its execution.

However, due to the diversity in project's context, it is worthy to highlight that the acceptance and utilization of these roles must to attend to their needs. For more details about this process, access http://www.gaia.uel.br/gaia_rh/.

## V. RESULTS

In order to validate the process model, some performance indicators for information and data collection were defined and applied. Through the analysis of these sources, it was possible to identify its advantages and limitations. Next, the results obtained with this research are described.

The first indicator shows the variation in the rate of rework from the training sessions. This is because high levels of rework pose major problems during the development of a project.

Through training exercises, we try to eliminate them by improving the skills and knowledge of members. Thus, solving the rework, this metric helps the project manager to identify the level of effectiveness of training. Figure 3 show this indicator for the case study.
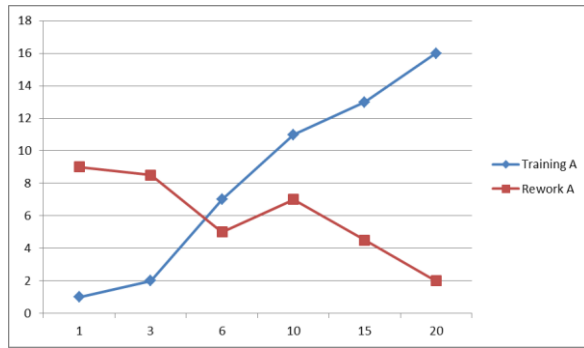
Fig. 3. Training Time vs. Rework Index

As can be observed in Figure 3, the training carried out with the team members have strong relationship with the improvement of your content to rework. After the implementation of the framework, this fact is evidenced by the decrease in 78% of this index in Project, that research contributes to the quality in the development process.

Besides this, the indicator for the analysis of improvement in the performance of members by conducting training, it is also important for improving quality in the development process. This is because the effectiveness of the performance actually contributes to the effectiveness of the members.

Thus, by conducting trainings, seeks to empower and qualify them so they can increase this indicator. Furthermore, through this measure, makes it possible to project manager to analyze the performance of its members and, if necessary, take steps to improve them. Figure 4 has the graphics prepared for analysis of this indicator.
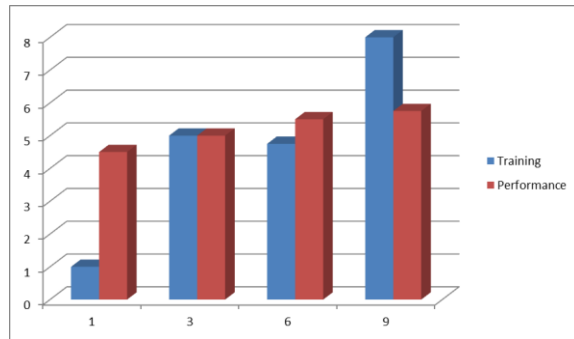


Fig. 4. Training Time vs. Performance Index

Also the rate of rework, the training carried out also maintains a strong relationship with the improvement in the performance index of members of the team. This fact strongly evidenced by analyzing the graphs shown in Figure 4.

Through them, it is noted that with the completion of training, implemented by the framework, an increase of 22% in performance of the project members. And that contributes not only to meet the deadline and measurement of the team, but also to improve the quality of coding, and especially the ease of maintenance.

Thus, in a general way, through the analysis of the performance indicators and collected information, the following advantages were identified:

• **Increasing member's motivation:** Main factor for the decrease in productivity and quality during the

accomplishment of the tasks. Their motivation is constantly analyzed during the project, and actions for his improvement be identified, suggested and worked;

• **Improvement in the development process:** The continuous process to analysis and monitoring the knowledge, performance and members' abilities, aims to guarantee the allocation of the appropriate member for each task and with this increase the development;

• **Improvement in selection and allocation of members:** These activities are improved by the selection and utilization of members based on their performance, knowledge and stored experiences in the History Database (HD);

• **Decrease of member's turnover:** Aiming to keep the integrity and consistency of the team, problems with respect, inclusion, motivation and alignment of member's personal objectives with organization's objectives are identified and worked during the development of the project;

• **Increase of the organizational memory of the organization:** The storage of experiences, estimates, knowledge and performance of team's members, during the development of the projects, in the suggested HD, has as objective to keep this information available in the beginning of every project in order to facilitate the definition of the workforce;

Moreover, through continuous monitoring of performance and human aspects in projects' teams, it can be stated that the mentioned advantages have contributed significantly for the decrease of its member's turnover and for the increase in motivation and improvement of its activities development.

All these factors, besides contributing significantly for the application of the process model, also collaborates to the establishment of a specialist's network within the organization.

### A. Comparative Analysis

In order to provide a comparative analysis between the models presented in Section 2a and the process model, Table II was elaborated with questions and activities from materials that generally cover staff management [3], as well as specific studies for the software development area [5], [12] [17], [18].

According to Table II, the process model is able to find all questions and activities defined for this analysis. We can observe the importance placed on the human resources present in the organization, the appreciation of the organization's intellectual capital from a specific level (individual) to a more organizational one (company) and the work of monitoring and evaluation performed on the human aspects of its members.

### VI. CONCLUSIONS AND FUTURE WORKS

Analyzing the results obtained during the case study development, we can evaluate the success in the implementation of the process model. It is highlighted, mostly, the increase in motivation of members, their skills and capabilities, resulting in a significantly improvement in its development process and decrease in member's turnover.

Thus, focused on increase these human factors, the process model presented was developed to attend, provide and add

TABLE II. COMPARISON BETWEEN THE EXISTENT MODELS AND THE PROCESS MODEL

| | Amâncio *et al*. | De Carvalho | P-CMM | Morais | Process Model |
|---|---|---|---|---|---|
| **Planning Human Resources** | Yes, during the initial phase of the project. | Yes, realized in the beginning of the project. | Yes, defined in the initial phase of the model. | No. | Yes, it is work in the beginning of the project. |
| **Revise Organization's Needs** | Yes, approached superficially during the planning. | Yes, it uses a repository of knowledge and abilities. | No. | Yes, revised based on organizational factors. | Yes, it uses organizational factors. |
| **Opt for Internal Mobilization to External Staffing** | N/A | N/A | N/A | N/A | Yes. |
| **Work the Mobilization and Staffing** | No, the model only defines functions and timesheets. | Yes, performed based on profiles of competences demanded for the project. | Yes, performed based on project's needs and availability in the organization. | Yes, use an interview database and a recruitment process. | Yes, performed based on setting of the organizational chart. |
| **Training Management** | High. It has a specific activity and an action and monitoring plan. | High. It defines and constantly monitors. | High. It is worked during the development of the model. | High. Proposes a continuous process of improvement. | High. Worked on according to the project's needs. |
| **Performance Management** | High. Definition and monitoring of indicators. | High. It monitors with project repository. | High. Its analysis is realized during the whole model. | High. Monitoring using predefined indicators. | High. Constant monitoring during the project. |
| **Organizational Knowledge Management** | No. | No. | No. | Yes, the knowledge is identified, storage and sharing with the company. | Yes, focused in the individual sharing with the company. |
| **Uses Historical Database** | No. | Yes, it has an organizational and a project one. | Yes, used in all phases of the project. | No. | Yes, used in all phases of the project. |
| **Human Aspects Management** | No. | No. | Yes. | No. | Yes, monitored during the development of the project. |

more value to human resources of software project through planning and continuous development of his team's members.

Finally, as presented in Table II, this process model differs from other existing process models in literature, with the appreciation of the intellectual capital of the organization and the work of monitoring and evaluation performed on the human aspects of its members.

As future study suggestion is to development a tool to help in planning, recruitment and selection, monitoring, development and analysis of human resources during the development and project planning.

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