The Influence of Human Aspects in Software Process Improvement: a Brazilian Public Company Study

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Abstract - This study discusses issues related to factors that can influence the success of Software Process Improvement (SPI) initiatives and seeks to contribute to the understanding of these factors, focusing especially on human aspects in the adoption of these initiatives. The study is quantitative, based on a survey approach, and was conducted at a public information technology (IT) company that aims at reaching Maturity Level G of the MR-MPS-SW Model (Reference Model for Brazilian Software Process Improvement). The results are analyzed taking into account four basic hypotheses, organized based on four human factor categories: inertia and resistance to negative experiences; lack of evidence of benefits; imposition; and, restricted resources.

Keywords: Human Aspects, Software Process Improvement, MPS.BR, MR-MPS-SW.

1 Introduction

Software development companies have focused their attention on SPI (Software Process Improvement). According to Vavpotic and Bajec [1], this interest is due to the fact that SPI includes a wide variety of approaches and practices that seek to improve the quality and reliability of software products, customer satisfaction and a return on investment in software development.

A number of standards and models with the best software development practices, such as the CMMI [2] and the reference models of the MPS.BR program [3] have been developed for these purposes. The CMMI family, composed of models that scale process improvements into maturity levels, is widely known and used worldwide. The MPS.BR (Brazilian Program for Software Process Improvement) was created in Brazil in 2003 and is widely used to improve software processes all over the country, with over 400 companies evaluated at different maturity levels. Its improvement principles are also based on maturity levels.

There are several studies that discuss the aspects involved in successfully adopting this kind of improvement program, including motivation, resources and professional training [4]. According to [5], observing previous experiences, identifying what went right and wrong, can be very useful for understanding which motives led to success and which led to the failure of a given approach. This information is important to managers of SPI programs in order to prevent possible problems and make adequate planning for a successful implementation.

In this context, it is important to understand the factors that can influence the success of improvement initiatives, especially human factors. The present study was conducted at a Brazilian public information technology company, analyzing human aspects in the implementation of the improvement program based on the MR-MPS-SW reference model [3]. The study is quantitative and the survey method was used to gauge the perceptions of the workers during the implementation of this program.

The article is organized as follows: Section 2 presents the theoretical framework of critical factors in the success of SPI; Section 3 presents the research method and structure; Section 4 shows the main results and also includes a discussion; and Section 5 contains the conclusions of this study.

2 Theoretical Framework

2.1 Main factors of the success of SPI program

Despite the development and availability of a series of standards and improvement models for over two decades, there are still problems and they remain difficult to adopt. For this reason, studies have been conducted in an attempt to identify and analyze factors that influence the implementation of SPI programs [6].

In [7], the authors conducted a study to investigate the factors and their impact on SPI programs in order to offer recommendations to professionals and researchers in this field. They analyzed the perception of SPI managers in companies with different maturity levels (evaluated maturity, evaluation of maturity and no evaluation) located in the United Kingdom and in multinational companies. The factors with the greatest impact, in the opinion of the managers, were: i) reviews; ii) standards and procedures; iii) training and mentoring; and iv) an experienced team. In more mature companies they found internal leadership, inspections, executive support and the quality of internal processes.

In [8], the authors presented the results of an empirical study on what demotivates software professionals from lending their support to SPI programs. The study used data derived from focus group discussions at 13 companies in the
United Kingdom involving 200 software professionals, providing the views of managers of this type of program and identifying problems that these professionals face when there is no motivation for SPI. These issues include some human factors such as: i) resistance to change; ii) lack of evidence of process improvement; iii) imposition; iv) restricted resources; and, v) commercial pressures.

In [9], the authors reported the results of a qualitative study using the procedures of Grounded Theory. The data were collected during open interviews with 21 participants from 11 different companies in Pakistan. The aim of the study was to identify the factors that were successful in software improvement in small and large companies with a web domain. The result was a set of success factors of SPI initiatives. In the view of the participants, these factors were: automated tools, client support, communication, company vision, cost benefit analysis, support from the staff, gradual approach, support from the senior administration, consultancy in SPI, function of the implementer, SPI measures, supportive policies, adaptation of processes, application of existing knowledge regarding SPI, SPI awareness programs, targets and benefits of SPI, success of the company, the most mentioned by the participants being the support of the senior administration, benefits and targets of SPI and the success of the company.

In [10], the authors reported the results of a study of 81 software development companies in Santa Catarina State, Brazil, comparing micro and medium size businesses to medium and large size companies, taking into account factors that might influence the adoption of SPI programs. The study showed that the group of medium and large size companies found the model bureaucratic, while half of the smaller companies cited a lack of financial resources as a reason for not adopting SPI programs. The study also found that each group had different interests in adopting SPI. While the smaller companies had less knowledge of the existing models, made less use of them and were more concerned with expanding their market, the larger companies were concerned with customer satisfaction.

2.2 The Importance of the Human Factor in the Activities of Organizations

Considering human aspects and seeking to understand and manage them can be a differential for the success of the activities developed by organizations. For this reason, they have become the object of study in recent years [11]. When analyzing SPI, one of the main characteristics is to understand and evaluate the needs and expectations of each user to organize them following a technical formality [12].

Software Engineering, according to [13], “is a domain that is highly driven and guided by knowledge, in which the factors of success are related to experience in accordance with the data collected from people involved in the following phases: project, construction, testing and implementation”. It is necessary to harness the knowledge of each collaborator and convert it into something that the organization can use, which according to [14] is knowledge management.

In this view of knowledge, according to [15] and [16], tacit knowledge is highly personal and depends on the action and commitment of each individual within a given context, including cognitive elements, where human beings create models and establish analogies. It is important to verify that in accordance with the authors in [14], it is necessary to understand how the creation of knowledge takes place within a work environment and also that “the creation of organizational knowledge is a spiraling process that begins at the individual level and keeps moving up, extending the communities of interaction that cross frontiers between sections, departments, divisions and organizations”.

In [8], the authors stated that many collaborators end up not accepting practices that even logic, evidence or experience suggest that they should. This can happen for a number of reasons, such as established personal practices (since people learn to develop programs that work and establish some personal practices) and previous bad experiences with new techniques or tools. Consequently, the workers end up thinking that new practices do not bring them any benefits.

According to some studies, software developers are resistant to initiatives when they feel they are being imposed. According to [8], improvement programs initiated at the corporate level are not conducted consultatively and do not involve the developers in decision making.

Furthermore, in the studies reported in [17] and in accordance with Rainer et al. [7], the developers wanted some evidence of the direct benefits of implementing the improvement processes before they would agree to take them on. Most of the studies showed that resources dedicated to implementing SPI were a critical factor to their success [18]. Moreover, according to [17], software developers of all the participating groups of the software development company are highly motivated by people, experience and the tools dedicated to the software improvement program.

Kitson and Masters [19] conducted a study in which they separated the practitioners of improvement processes into three hierarchical groups and saw that, due to having collected data from managers and developers, who had questions that were faced in a daily analysis, there was a high level of reliability in the range of accuracy and validity of data. This separation is important because, according to [13], this perspective enables differences to be detected in the perception of the participants from the companies in question.

3 Research Method

This is a quantitative study using the survey method. Forza [20] describes three types of survey-based research: exploratory, descriptive and confirmatory or theory testing. Using these definitions, this study could be classified as confirmatory because it has an understanding of the research
theme and aims to confirm hypotheses concerning the influence of the human factors listed in the previous section.

The study followed the script proposed by [20]: (i) related to a theoretical level; (ii) project the survey; (iii) conduct a pilot test; (iv) collect the data; (v) prepare data analysis; (vi) produce a report. The procedures for each state will be described in the following topics.

3.1 The Importance of the Human Factors in the Activities of Organizations

3.1.1 Phase I: Relate to a theoretical level

The aim of this study is to understand the different perceptions of workers at a public company during the implementation of Level G of the MR-MPS-SW. The MR-MPS-SW model is divided into 7 maturity levels, ranging from A to G; with A being the highest level of maturity. At each level, there are associated processes and expected results. Level G, the first level of the model, is composed of Project Management (PM) and Requirements Management (RM) processes.

The objective of the study was delineated in accordance with the Goal-Question-Metric paradigm and stated as: Analyze the implementations of an improvement program based on the MR-MPS-SW reference model for the purpose of investigating and understanding the factors involved in relation to human aspects from the viewpoint of the information technology manager, analysts and programmers in the context of a public software development company. From the theoretical context presented in Section 2 of this study, the human factors that served as a basis for the definition of four hypotheses were identified, for the purposes of achieving the goals of this study, as shown in Table 01.

<table>
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<tr>
<th>Human Factors</th>
<th>Hypotheses</th>
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<tr>
<td>Inertia and resistance to negative experiences.</td>
<td>H1: It is harder for workers who have been at the company for longer to accept the activities involved in the process.</td>
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<tr>
<td>Lack of evidence of benefits</td>
<td>H2: The workers can see no benefits from adopting the SPI.</td>
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<tr>
<td>Imposition</td>
<td>H3: The more technical workers in the organization believe that they are less involved in the software process improvement.</td>
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<tr>
<td>Restricted resources</td>
<td>H4: The workers believe that the resources allocated to SPI programs (training, staff and equipment) are insufficient.</td>
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3.1.2 Phase II – Designing the Survey

In this stage, the target public was defined, along with the sample and data collection method. The target public of the study was professionals in the field of software development who are involved in SPI. The size of the sample was approximately 300 people. The data collection method that was chosen was a questionnaire to be distributed locally.

3.1.3 Phase III – Conducting the pilot test

To validate the questionnaire, 14 questionnaires with 12 closed questions were distributed in the company’s development sector. All of these questionnaires were returned, with contributions from the management of the development sector and the management responsible for the implementation of the MPS.BR program. Following an analysis of the results of the pilot test, some questions suggested by the managers were added and two questions were altered because the respondents had difficulty in understanding them, which could compromise the results.

3.1.4 Phase IV – Collecting the data to test the theory

After the adjustments to the questionnaire, 90 of them were distributed during two workshops promoted by the managers in charge of implementing the MPS.BR program, of which 63 were returned completed.

3.1.5 Phase V – Analyzing the data

The first step of the data analysis was to verify whether all 63 questionnaires could be considered valid, i.e., with all the questions answered. All the questionnaires proved to be valid for the study and the responses were tabulated. A detailed analysis will be given in the following section.

3.1.6 Phase VI – Producing the report

Following the tabulation of the data, a report was produced with the perceptions gauged through data analysis, highlighting whether or not the hypotheses of the study were validated. The resulting graphs are included in this study.

4 Results and Discussion

In this section, the results are presented and discussed. They are organized into 4 factors: i) inertia and resistance to negative experiences; ii) lack of evidence of benefits; iii) imposition; and iv) restricted resources.

4.1 Inertia and resistance to negative experiences

To analyze the first hypothesis, H1, the respondents were asked to characterize their profiles according to how long they had been working at the company: the newer workers, who had been at the company for less than ten years, and the older workers, who had been there for over ten years. They were then asked about their experience in other SPI programs and what the respondents thought of this experience.

The results showed that 59% of the workers had been at the company for less than ten years and 41% are more experienced. Regarding experience in SPI, 30% of the newer workers had already been involved in such a program and 42% of the older workers. In both categories, the workers considered their experience in SPI as positive.
From these results, the conclusion is that hypothesis H1, in which the older workers of an organization find it more difficult to adapt to SPI programs is confirmed. Another finding is that resistance was not detected among the less experienced workers.

### 4.2 Lack of evidence of benefits

To analyze the second hypothesis H2, questions were asked about the direct and indirect benefits, motivation and the continuity perspective in the eyes of the workers in order to gauge whether they saw any benefits to be gained by adopting this type of program. It should be mentioned that this question generated many responses since the workers could see more than one benefit or motivation.

The results showed that only 2% of the respondents thought that the program would bring no improvements, while the others found some type of improvement, with the most outstanding benefits being: increased quality (79%) and the accuracy of estimates (68%). Regarding to the motivation perceived by the respondents for the organization adopting the MPS.BR program, the most expressive motivations were improved products/company projects (78%) and improved company management (57%). The continuity perspective of the improvement program has an expressive percentage of respondents who believe that the program will continue, as a result of its proven benefits (71%).

These results show that the influence of this factor does not apply to the implementation of the organization under study, as its workers see benefits, motivations and continuity perspectives because the benefits of this type of program have been proven to them. This becomes more evident in terms of the quality of products and project management. Therefore, hypothesis H2 was not confirmed.

Other factors that were highlighted by the respondents in their answers to this open question concerning the continuity of the program were: political issues, understanding of benefits, results obtain and the commitment of those involved.

### 4.3 Imposition

To analyze the third hypothesis, a question was asked that characterized the role of the respondent in the software development process of the organization in order to obtain the point of view of the more technical workers.

The workers were characterized as technical and managerial. The technical workers were those who worked as analysts, designers, developers and/or software development supporting staff. The managerial roles were business analysts, project managers and project leaders. The sample included 23 technical respondents, accounting for 37% of the total number of interviewees. There were 40 respondents employed in operational or managerial positions, representing 63% of the total number of interviewees.

It was observed that 52% occupy a technical position and had no opportunity to participate in the improvement program. This can be partially related to the fact that at G Level, the focus is on management practices.

Concerning the degree of knowledge of the MR-MPS-SW model, there is a low level of knowledge of the model in both groups. Among the technical staff, nobody had a high degree of knowledge of the model, a considerable number (78%) have low knowledge and 4% of these workers have no knowledge of the model. For the managerial positions, 3% have in-depth knowledge of the model and 73% have a low level of knowledge.

These results led to the conclusion that hypothesis H3 that workers with a more technical role in the organization believe that they are less involved in software process improvement is confirmed. However, it is important to point out that this is a result that is coherent with the level of the model that is being implemented. As mentioned above, Level G focuses more intensely on managerial practices. This is inevitable because it has a more direct effect on managerial rather than technical activities.

### 4.4 Restricted resources

For the fourth hypothesis H4, the respondents were asked two questions. The first dealt with whether the human resources made available were sufficient. The second had to do with possible obstacles that would be faced in this type of program. Multiple choices were permitted and an open field was provided for the respondents to include other obstacles that they felt deserved to be mentioned.

The results showed that 54% of the respondents claimed that the amount of resources allocated to the process was less than required and that the workers viewed this lack of resources as an obstacle to the implementation of the program. There were some factors that stood out: lack of tools (52%) and lack of training (44%).

The results showed that, in the opinion of the respondents, there were insufficient resources for the successful implementation of the SPI program. Therefore, the conclusion is that hypothesis H4 that workers believe that the resources allocated to the SPI program (training, staff and equipment), was confirmed.

Other obstacles to the MPS.BR at the company were identified by the respondents, such as organizational culture (6%) and resistance to change (5%).

### 5 Final Considerations

This article presented the results of a quantitative study concerning human factors that can influence the success of a software process improvement process in the environment of a Brazilian public information technology company, where the implementation process is progress, i.e., there is yet to be an official evaluation.
The factors that the study sought to explore were resistance, lack of benefits, imposition and restricted resources. These factors gave rise to four research hypotheses. An analysis of the collected data showed that the hypotheses related to resistance and evidence of benefits were not confirmed, while the hypotheses regarding imposition and restricted resources were confirmed.

The adoption of the MPS.BR by the organization in question is well regarded and eagerly awaited by the workers no matter how long they have been working at the organization or what position they hold. The study showed that a very important factor to the success of the adoption of this type of program, although it is often not given the priority it deserves, is the allocation and availability of resources such as training, number of staff involved, availability of adequate equipment and communication to all the participants throughout the implementation process.

Some other factors that could influence process improvement programs were obtained through responses to the open questions asked in this survey. These factors included political issues, understanding of benefits and results obtained/commitment of those involved regarding the continuation of the program and factors of organizational culture, in addition to resistance to change, which were identified as obstacles to successfully implementing the MPS.BR.

For future studies, this study could be expanded in the same organization, involving new variables identified during the course of this study in response to the open questions. This further study could examine whether this behavior applies after the official evaluation of the MPS.BR.

6 References


