Resistance Factors in the Implementation of Software Process Improvement Project

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Abstract

Over decades, software model for improving the quality of software through management of the software process has become significant in the software industry. Many companies are now being assessed according to standards such as the CMM, SIXSIGMA or ISO 9000, which have brought substantial profit to the companies that utilize them to improve the quality of software product. Several companies in Malaysia have been carried out software process improvement projects. However, a software process improvement initiative is still sometimes delayed, costs are over budgeted and some of them surrender before the project ends. Therefore, this paper attempt to analyze and identify the resistance factors which influence the implementation of the software process improvement project initiated by the company. This paper will serve as reference to the professionals in the area. In the other hand, it may also helping the other companies to manage future projects through the use of preventive actions that will eliminate or at least lessening the resistance factors’ consequences during the implementation of the software process improvement projects. This paper present a survey with 8 Malaysia’s companies around Kuala Lumpur and Selangor which have an experience in initiating and conducting software process improvement project. A total of 117 respondents from various background have participated this survey.

1. Introduction

Inspired by the efforts of Deming 6] and Juran [12], the software engineering community has realized that high-quality software development processes will produce high quality products. It has been generally agreed upon that, ‘the quality of a product is largely governed by the quality of the process used to build it’ [22].

The current focus moved from the work products to the organizations that produced the work products. Various software process improvement (SPI) models such as Software Process Improvement and Capability determination (SPICE) [11], BOOTSTRAP [24], ISO 9000[20] and the Capability Maturity Model (CMM) [21] have been proposed to assist organizations to achieve more predictable results by incorporating proven standards and procedures into their software process. The research survey conducted in Brazil by Brietzke and Rabello in [3], there are many resistance factors influencing the implementation of a SPI project whereby some of the project implementations were delayed and cost overrun and some of them surrender before the project ends.

This paper will look into the factors that influence the implementation of SPI project. It concludes with existing research that there are various resistance factors influence the implementation of the projects and this paper attempts to rank the resistance factors.
based on the research survey conducted in the state of
Kuala Lumpur and Selangor, Malaysia.

This paper is divided into 7 sections. The first
section provides the introduction to the importance of
having standards in SPI. The second section
highlights some improvements of the implementation
of SPI projects based on the reported previous study,
while the third section discusses a set of hypothesis in
relation to resistance factors in the implementation of
the SPI. The fourth section states the methodology on
conducting this research survey. The fifth section
demonstrates the analysis of the survey result, while
the sixth section provides ranking for resistance
factors based on the analysis made on the previous
section. The last section summarizes the main points
of this research.

2. Software Process Improvements

Many companies are now being assessed
according to de facto standards such as the Capability
Maturity Model (CMM), SIX SIGMA or
International Standards Organization (ISO) 9000,
which have brought profit to the companies in
improve the quality of software products.

Organizations that make use of the standards
advocated in CMM, PSP, CMM-I, ISO usually show
excellent improvements. For example, by ‘improving
its development process according to CMM
“maturity”, Hughes Aircraft improved its productivity
by 4 to 1 and saved millions of dollars’ [23]. Besides,
Ferguson et al. reported in [7] that there is a schedule
estimation improvement and strong quality
improvements in the developed software when
software engineering groups from three different
companies, namely Advanced Information Services,
Motorola and Union Switch and Signal using
Personal Software Process (PSP) as their SPI model.
CMM-I helps organization such as IBM Australia
Application Management Services to help in reducing
a cost effectively. In Malaysia, the most common SPI
standards used by most of the software based
companies are CMM-I, CMM, ISO-9000 and Six
Sigma.

3 Resistance Factors in Software Process
Improvemements Projects

Based on software process improvement (SPI)
literature, there are various factors which are
influencing the implementation of SPI project. This
paper has categorized all those factors according to
Beecham’s research [2] as presented by Brietzke and
Rabello in their paper [3] and we broadly divided into
2 main categories which are organizational factors
and project factors.

3.1 Organizational Factors

These are the factors which are related within the
scope of the organization and are usually under senior
managers’ responsibility as presented by Brietzke and
Rabello [3] and others as stated in [1], [2], [5], [19],
[25], [26], [28], [29]. There are 5 factors which are
categorized under organizational factors namely 1)
human 2) political 3) cultural 4) goals and 5) change
management as mentioned in Table 5 in Appendix A.

3.2 Project Factor

These are the factors which reflects the resistance
factors on ongoing project which contributes and
gives impact during the software process and it
involves contribution from all level of personnel
management as described by Wiegers [28] and others
[2],[9],[27],[28]. There are 4 project factors namely
1) budget and estimates 2) documentation 3) quality
and 4) tools and technologies as mentioned in Table 6
in Appendix B.

4. Methodology

The main objective of this research is to replicate
the survey performed by Brietzke and Rabello [3],
but in a different country, Malaysia. There are two
main stage are implemented in order to conduct this
research survey. The first one is data gathering and
literature review and the second one is conducting a
survey. For the second one, the key resistance factors
are abstracted from Brietzke and Rabello [3] and
deriving the questionnaires. The resulting
questionnaires were distributed to software
companies which have been undergoing SPI project.
8 companies have been identified around the state of
Kuala Lumpur and Selangor, Malaysia. From 160 of
questionnaire that have been distributed, 117 of
professionals taking part in this survey.
5. Survey Results

Survey results are described according to the section divided below:

5.1 Demography Information

This section presents an analysis of the profile of the respondents and companies taking part in this survey. The demography information has been organized in the first section in the questionnaires. Table 1 demonstrates number of respondents according to their roles in the organization.

| Roles                                | Numbers |
|--------------------------------------|---------|
| Business Person                      | 5       |
| Project Manager / Quality Manager    | 13      |
| IT Consultant                        | 9       |
| System Analyst                       | 15      |
| Software Engineer / Developer        | 47      |
| System Administrator                 | 5       |
| Designer                             | 2       |
| Others                               | 21      |

Table 1: Number of respondents according to years of involvement in software development area

Figure 1 above shows the years of involvement of respondents in software development area, meanwhile, Figure 2 demonstrates the years of involvement of respondents in the SPI project. Respondents also were asked regarding their level of expertise in the SPI.

Figure 2: Period of time working in software process improvement project

5.2 Resistance Factors

This section in the questionnaires cover the resistance factors that may influence and contribute to the delay or failure for the implementation of Software Process Improvement. The questionnaire uses the ordinal scale of 1 to 5, ranging from the least influential to the highest influential factor.

5.2.1 Total Influence Level for the Organizational Resistance Factors. Table 3 summarizes the total of influence level score for each organizational resistance factor according to the formulae below:

\[ T(f_n) = \frac{1}{25} \sum_{n=1}^{n} R(f_n) \cdot W(f_n) \]  (1)

where \( T(f_n) \) is the total of influence level score attributed to factor (f). It is a sum of the score rated by the respondent multiplied by weightage score according to influence level.
$R(f_i)$ is the score attributed to factor ($f$) as rated by the respondent according to the influence level

$W(f_i)$ is the weightage score attributed to factor ($f$) according to influence level as assigned in Table 2

$f_i$ is refers to the factor number.

**Table 2 : Value of influence level and weightage score**

| Influence Level, $R$ | Weightage Score, $W$ |
|---------------------|----------------------|
| 1                   | 1                    |
| 2                   | 2                    |
| 3                   | 3                    |
| 4                   | 4                    |
| 5                   | 5                    |

**Table 3: Total influence level in SPI area for the organizational resistance factors**

| Influence Level | Total of Influence Level Score, $T$ |
|-----------------|------------------------------------|
| 1               | 407                                |
| 2               | 419                                |
| 3               | 293                                |
| 4               | 401                                |
| 5               | 404                                |
| F06             | 377                                |
| F07             | 368                                |
| F08             | 355                                |
| F09             | 378                                |
| F10             | 368                                |
| F11             | 418                                |
| F12             | 370                                |
| F13             | 372                                |
| F14             | 392                                |

**Legend:**

F01 Lack of commitment in all levels of the organizations
F02 Lack of adhesion and participation of all the individual involved in SPI project
F03 Lack of professionals experience and skill
F04 Lack of leadership and backup by top management level
F05 Lack of adequate training
F06 Lack of the establishment of organizational policies.
F07 Lack of the establishment of Quality Policy
F08 Lack of expertise in implementing cultural changes.
F09 Lack of consistency between software processes improvement project and the organization’s strategic objectives
F10 Absence of focus on the organization’s most urgent needs.
F11 Unrealistic expectation towards the SPI project.
F12 Insufficient and ineffective assessment of the current software process
F13 Existence of a software processes improvement project team not focused on orientation and technical support.
F14 Simultaneous focus on many improvement areas

**Figure 4: Total influence level score according to organizational resistance factors**

All the results gained in Table 3 are then plotted in a graph format as illustrated in Figure 4. It can be observed that the most top 3 organizational resistance factors are factor number 2 which is lack of adhesion and participation of all the individual involved in SPI project, followed by factor number 11 which is unrealistic expectation towards the SPI project and the third one is factor number 1 which is lack of commitment in all levels of the organizations. All these top 3 resistance factors are categorized under people factor as referred in Table 3. The three lowest of organizational resistance factors are absence of focus on the organization’s most urgent needs, lack of expertise in implementing cultural changes and
lack of professionals experience and skill. However, the total influence level score for all the factors are almost average with standard deviation of 32.2.

5.2.2 Total Influence Level for the Project Resistance Factors

Table 4 summarizes the total of influence level score for each project resistance factor according to the formula given in section 5.2.1. Then, the results gained are plotted as illustrated in Figure 5 below.

| Influence Level | Total of Influence Level Score, T |
|-----------------|----------------------------------|
|                 | 1  2  3  4  5                    |
| F15             | 7  14 39 38 19                   | 399 |
| F16             | 5  20 41 35 16                   | 385 |
| F17             | 1  17 40 45 14                   | 295 |
| F18             | 5  15 46 35 16                   | 393 |
| F19             | 7  28 35 37 10                   | 366 |
| F20             | 4  20 56 33 4                    | 364 |
| F21             | 5  13 49 37 13                   | 391 |
| F22             | 6  25 39 39 8                    | 369 |
| F23             | 6  20 53 27 11                   | 368 |
| F24             | 2  19 48 39 9                    | 385 |
| F25             | 0  14 50 40 13                   | 403 |

Legend:
F15 Current budget and estimates exceed planning.
F16 Lack of understanding by top management level that the software processes improvement project is a long-term return on investment process.
F17 Lack of visibility about the ongoing software processes improvement project activities.
F18 Excessive documentation and formality.
F19 Lack of infrastructure and of a documentation management.
F20 Lack flexibility in the use of the documentation in projects of different types and sizes.
F21 Lack of involvement of top management in the relationship between the project teams and the person or group of quality assurance.
F22 Lack of treatment to guarantee process conformity in instances of hiring and/or dismissal of skilled professionals.
F23 Automation of not well-defined processes
F24 Lack of training on the support tools and technologies defined as support.
F25 Pressure and absence of planning concerning the adaptation period.

As illustrated in Figure 5, the total of influence level score for each of the project resistance factor is very close to each other with standard deviation of 29.7, not much different with organizational factors. It can be observed that the most top 3 project resistance factors are factor number 25, pressure and absence of planning concerning the adaptation period. Then followed by factor number 18 which is excessive documentation and formality and then the third most is factor 21 which is involvement of top management in the relationship between the project teams and the person or group of quality assurance. Meanwhile, the three lowest of project resistance factors which are identify as factor number 17, 19 and 20 respectively.

6. Consolidation of the Results

Based on the analysis of the results reported in Section 5, total influence level score for both organizational and project resistance factors are being merged to gain overall results in order to determine the most and the least influence resistance factors.

According to the results survey, the most critical resistance factor is lack of adhesion and participation of the entire individual involved in SPI projects. This result is similar with the result gained by Brietzke and Rabello [3] and corroborates the research findings experience in SPI projects [1],[2],[25],[26],[27],[28]. The second most critical resistance factor is unrealistic expectation towards the SPI project. It is
essential that clear expectations and goals need to be specified earlier, so that progress towards those goals can be continually monitored, and so that revisions to either goals, of processes, or both can be made persistently. The third most critical resistance factor is lack of commitment in all levels of the organizations. This factor is directly influenced by the size or hierarchy of the company, the larger size or hierarchy of a company, the more time needed to get a commitment from all levels of the organization.

All these top 3 resistance factors are classified under organizational factor as described in details in Section 3.1 which are related within the scope of the organization and usually fall under senior managers’ responsibility. The results gained in this research is not much different with the results survey conducted by Brietzke and Rabello[3] whereby both human factors which are lack of adhesion and participation of all the individual involved in SPI projects and lack of commitment in all levels of the organizations give a big influence in determining the successfulness of the SPI project.

Meanwhile the 3 least resistance factors identified in this survey are lack of professionals experience and skill, lack of visibility about the ongoing software processes improvement project activities and lack of expertise in implementing cultural changes. However, the third least resistance factor which is gained in this research survey is opposed with results gained by the Brietzke and Rabello [3] where lack of expertise in implementing cultural changes is one of the top most resistance factors.

Besides, the respondents also mentioned that the schedule which is not planning-well and mix-up between software development schedule and SPI schedule is also affected the effectiveness of implementation of SPI project.

7. Conclusion

This paper has identifies and analyzes main resistance factors which influence the implementation of the SPI project specifically in Malaysian software companies. It concluded that organizational factors specifically human factors playing an important role in determining the successfulness of the SPI project. Participation and commitments from all individuals across the organization are very important and required in order to support this good initiative.

One of the limitations is that this survey is non-probabilistic, quantitative, and intentional and using a set of questionnaire in order to gather all data required. In this case, the degree of reliability and validity of the data is maybe applicable for only the companies taking part in this survey. However, it is believed that the instance of the scenario is not much different between the other states in the Malaysia. In further studies, the samples of the survey could be increased by conducting and repeating this research survey in other states of Malaysia, as a result, more overall picture and understandings can be gained about the implementation of SPI Project in the Malaysia.

Based on these findings, we expect that it may help other software companies to manage future projects through the use of preventive actions or proper planning which can reduce the resistance factors’ consequences during SPI projects implementation.
Table 5: Description of Each Organizational Factors

| Description | Key Resistance Factors |
|-------------|------------------------|
| Human       |                        |
| Lack of commitment in all levels of the organizations | Lack of adhesion and participation of all the individual involved in SPI projects |
| Lack of adhesion and participation of all the individual involved in SPI projects | Lack of professionals experience and skill |
| Lack of professionals experience and skill | Lack of leadership and backup by top management level |
| Lack of leadership and backup by top management level | Lack of adequate training |
| Human       |                        |
| According to Abrahamsson without commitment from all organizational levels (human) to support SPI, the initiative will most likely fail or the results are not far reaching [1]. The experience of senior management with an SPI project will give positive impacts to the improvement process. Consultation support such as advice and training of SPI action teams and staffs is one critical aspect in ensuring the success of SPI project. Beecham et al. in stated that organizational issues (especially the human element) are important contributing factors to the success of SPI initiatives [2]. | |
| Political   |                        |
| Lack of the establishment of organizational policies | Lack of the establishment of Quality Policy |
| Lack of the establishment of Quality Policy | |
| Cultural    |                        |
| Lack of expertise in implementing cultural changes. | |
| Cultural    |                        |
| Taylor and McGraw proved that in order to ensure success in a cultural change program, a champion who can build, deploy, drive, and own each initiative going forward must be properly decided [26]. However, every cultural change program requires good cooperation from both management and tactical technical staff; improvement programs will fail if either group is left out or underemphasized. | |
| Goals       |                        |
| Lack of consistency between software processes improvement project and the organization’s strategic objectives | Absence of focus on the organization’s most urgent needs. |
| Absence of focus on the organization’s most urgent needs. | Unrealistic expectation towards the SPI project. |
| Goals       |                        |
| Initial analysis needs to be conducted to determine whether the SPI initiative apt with the organization’ objectives and interests. This is also discussed and supported by Statz et al. in [25]. Wiegers in conceived that the SPI project’s team be used to actively facilitate the efforts toward changes on the part of the project teams rather than simply check the situation of the ongoing process in order to report a long and depressing list of findings [28]. Miler and Górski highlighted that in order to have a successful software process improvements, risk from configuration & change management which is not explicitly defined will lead to unsuccessful business process [19]. | Insufficient and ineffective assessment of the current software process |
| Insufficient and ineffective assessment of the current software process | Existence of a software processes improvement project team not focused on orientation and technical support. |
| Change Management | Simultaneous focus on many improvement areas |
### APPENDIX B

#### Table 6: Description of Each Project Factor

| Description                      | Key Resistance Factors                                                                 |
|----------------------------------|----------------------------------------------------------------------------------------|
| **Budget and Estimates**         | Current budget and estimates exceeds planning.                                          |
|       | Lack of understanding by top management level that the software processes improvement project is a long-term return on investment process |
|       | Lack of visibility about the ongoing software processes improvement project activities. |
| **Documentation**                | Excessive documentation and formality.                                                 |
|       | Lack of infrastructure and of a documentation management.                              |
|       | Lack flexibility in the use of the documentation in projects of different types and sizes. |
| **Quality**                      | Lack of involvement of top management in the relationship between the project teams and the person or group of quality assurance. |
|       | Lack of treatment to guarantee process conformity in instances of hiring and/or dismissal of skilled professionals. |
| **Tools & Technology**           | Automation of not well-defined processes.                                              |
|       | Lack of training on the support tools and technologies defined as support               |
|       | Pressure and absence of planning concerning the adaptation period.                     |
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