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An Empirical Study of Barriers in the Implementation of Software Process Improvement Project in Malaysia

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Abstract: This research attempted to identify and analyze main resistance factors which influenced the implementation of the software process improvement project specifically companies operated in Malaysia including local and multi-national companies. The findings helped other software companies to manage future projects through the use of preventive actions or proper planning which intended to lessen anticipated problems during software process improvement projects implementation. This research used a survey instrument to gather data from 29 companies operated across Malaysia with the total of 174 business and software professionals responded. Average of 4 to 8 questionnaires were distributed to each company with the objective of getting wider views on each SPI project. The questionnaires were mainly distributed to professionals who are directly involved in SPI projects. The results showed that the most critical resistance factor is lack of adhesion and participation of the entire individual involved in SPI projects.

Key words: Resistance factors, companies in Malaysia, qualities management standards, quality assurance, software process

INTRODUCTION

Software has become common and essential in our everyday life. As such, software development turns out to be a critical issue not only for present organizations but also the society as a whole. With the current requirements of having more complicated and complex domain and the higher expectations towards technology, software industries are burdened with increasing obstacles such as budget overshoot and frequently behind schedules. Many believe that the problems were caused by undisciplined, chaotic and unpredictable software process used. These awareness have led to the increasing efforts by organizations to establish and increase their software process maturity by adopting certain de-facto standards such as Software Process Improvement and Capability determination (SPICE), BOOTSTRAP (Cheng, 1995), ISO 9000, (Apolloni *et al*., 2005), Six Sigma (Macke and Galinac, 2007; Pan *et al*., 2007), Capability Maturity Model (CMM) (Staples and Niazi, 2007) and the Capability Maturity Model Integration (CMM-I) (Lee *et al*., 2007). Organizations that make use of the standards advocated in CMM, PSP, CMM-I, ISO usually show excellent improvements. Besides, Ferguson *et al*. (1997) reported 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 software process improvement model as mentioned by Ferguson *et al*. (1997). CMM-I helps organization such as IBM Global Australia Application Management Services to help in reducing a cost effectively.

However, a study of organizations that have undergone CMM evaluation shows that progression through CMM Maturity levels is very time consuming and difficult. Study conducted by Noor *et al*. (2007) reported that Pakistan's IT industry is still moving gradually towards adopting the CMMI framework even after attractive incentives have been introduced by Pakistan Government to encourage more IT company to adopt this framework. Not much guidance and knowledge are available in assisting organizations for their efforts. This finding has led researchers to explore and identify factors which are obstructing to the success of SPI implementation. Study conducted by Jung and Goldenson (2008) for example, attempted to identify the dimensions underlying a set of SW-CMM KPAs and to estimate the internal consistency of each dimension of the capability maturity concept which gave the result in a clear path way for the organization to follow. Meanwhile, Karlstrom *et al*.

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(2005) have introduced minimal test practice which involved 12 software companies that helps minimizing the resistance factors. Colla and Montagna (2008) presented a systemic model which assist organizations in implementing the SPI and provide an understanding behavior of the small organizational to make them understand the business context.

Brietzke and Rabelo (2006) conducted a survey in Brazil to identify resistance factors influencing the implementation of a software process improvement projects. Essentially 36 respondents from 29 companies were collected and analyzed by them. The research contributes in identifying main resistance factors perceived as critical to the implementation of SPI. Since the survey has been conducted only in Brazil, it is obviously useful to replicate the study in other part of the world. The replication will aid to verify the factors as well as to compare whether there is any major difference in other country such as Malaysia.

Subsequently, this research extracts the identified factors from Brietzke and Rabelo (2006). A set of survey question was developed and distributed to 29 software companies which have been involved in SPI projects. 4 to 8 questionnaires were distributed to each company with the objective of getting wider views on each SPI project. The questionnaires were mainly distributed to software professionals who are directly involved in SPI projects.

Based on Software Process Improvement (SPI) literature, there are various factors which are influencing the implementation of SPI project. This study has categorized all those factors according to Beecham *et al.* (2003) research as presented by Brietzke and Rabelo (2006) in their study. All those factors have been broadly divided into 2 main categories which are (1) Organizational factors and (2) Project factors.

Organizational factors are the factors which are related within the scope of the organization and are usually under senior managers' responsibility as presented by Brietzke and Rabelo (2006), Cheng (1995), Taylor and McGraw (2005) and Wheeler and Duggins (1998). There are 5 factors which are categorized under organizational factors namely (1) human (2) political (3) cultural (4) goals and (5) change management. Table 1 shows a description states the key resistance factor for each one identified.

Meanwhile, project factors reflect the resistance factors which stems from the ongoing project. The factors are concerned about the way the projects are planned,

Table 1: Description of each organizational factor

Description	Key resistance factor
Human	
Without commitment from all organizational levels (human) to support SPI, the initiative will most likely fail or the results are not far reaching 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.* (2003) stated that organizational issues (especially the human element) are important contributing factors to the success of SPI initiatives. As mentioned by Barreto *et al.* (2007), project staffing is the factor that affects the cost of the software project and the alignment of their characteristics which determine the software development organization.	Lack of commitment in all levels of the organizations. Lack of adhesion and participation of all the individual involved in SPI projects. Lack of professionals experience and skill. Lack of leadership and backup by top management level. Lack of adequate training.
Political	
According to Wheeler and Duggins (1998) the political factor is important to the construction for a department to SQA. The establishment of quality policy which is one of the political issues comes after the commitment of senior management. Quality policies and standards for SPI efforts describe the organizational goals and objectives related to the quality	Lack of the establishment of organizational policies Lack of the establishment of Quality Policy.
Cultural	
Taylor and McGraw (2005) 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. 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. Shachaf (2008) described how culture diversity plays an important role in order to enhance the creativity on the wider prospective for producing the effectiveness on the output product.	Lack of expertise in implementing cultural changes.
Goals	
If the goals, deadlines and expected results by the managers are impractical, the effort towards SPI may be unsuccessful. It is essential that clear 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.	Lack of consistency between softwareprocesses improvement project and the organization's strategic objectives Absence of focus on the organization's most urgent needs Unrealistic expectation towards the SPI project.
Change management	
Initial analysis needs to be conducted to determine whether the SPI initiative apt with the organization' objectives and interests. SPI project's team being 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.	Insufficient and ineffective assessment of the current software process.

Table 2: Description of each project factor

Description	Key resistance factors
Budget and estimates	
Lack of progress in improvement plans is frustrating to those who really want to achieve progress and this put down the importance of time and costs in the process evaluation. In study described by Cortellessa *et al.* (2008), there are some correlation between the cost and the non-functional attributes for the software development. It shows how important the cost management for the software related project. For a successful management of cost, schedule and quality or the certain project can determine successful software projects. The first year is the most difficult period for a SPI program. Resistance to change will be at its peak, the costs are likely to be higher than in the 17 following years and due to the steep learning curve, the first year goals and targets can easily be missed. Staples *et al.* (2007), discussed on how small organization adopted a cost and other resources in implementing the CMM-I for the SPI.	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	
In SPI project, documentation is a must in order to provide proof and dissemination throughout the organization in a formal way. Therefore, it is helpful to have an infrastructure for documentation, since it is a mandatory practice throughout the organization to Beecham *et al.* (2003) the documentation is also gaining importance in the list of problems associated to SPI. It includes data measurement, proceedings register, coordination and management of the documentation, data collecting the operational framework forms the relationships and dependencies between what is to be done, by whom, and how to do it.	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	
Quality refers to the state of the software as it was released or delivered to customers. Ordonez and Haddad (2008) stated that how important to ensure the quality for all aspects of software projects with the goal of achieving high quality products. In order to achieve higher level of quality assurance is by creating consent about how all the requirements definition processes has to be performed and which information should be provided to ensure the successfulness of the SPI project.	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 and technology	
The problem associated refers to the implementation of new tools and technologies, amount of work and pressures that hinder the use of new tools. According to Umarji and Seamen (2005), complexity of SPI tools and technologies need to ease with which developers can adapt to changes in work practices caused by SPI. However it has several acceptance issues because, it often involves learning new technology, changes in work practices and an additional workload. Also, SPI involves collecting data about projects, resources and deliverables and often practitioners are not keen on sharing this type of data. Savolainen *et al.* (2007) have pointed out some problems related to the SPI which need a support of new tools for the workflow in implementing SPI.	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.

executed and monitored. The factors also may originate from all level of managerial personnel as described by Beecham *et al.* (2003) and Umarji and Seaman (2005). There are 4 factors which are categorized under project factors namely (1) budget and estimate (2) documentation (3) quality and (4) tools and technologies. Table 2 shows elaboration on each project factor.

MATERIALS AND METHODS

The main objective of this research is to replicate the survey performed by Brietzke and Rabelo, (2006) in a different country. The survey has been carried out from June 2007 until March 2008. The survey involved 29 companies which are located in 9 states in Malaysia. This study focuses on verifying the relevance of the identified resistance factors as well as comparing the similarities and difference between the studies. Essentially, we perform the initial literature review on SPI, looking at the broader context of SPI, key success factors and the difficulties highlighted in various studies. In order to acquire the overall picture of software process improvement standards, some subjects related to the software process aspects, software qualities and software process improvement standards itself are reviewed. Mostly, the review is focused comprehensively on the past published experience on the implementation of software process improvement project by the industries as well as the resistance factors during implementing such project. All the information above is collected using on-line search via the internet specifically on the online databases namely ACM, IEEE, academic textbooks, magazines, online articles and others.

Secondly, we focus on abstracting key resistance factors from Brietzke and Rabelo (2006) and deriving the questionnaires. The resulting questionnaires were distributed to software companies which have been undergoing software process improvement project. Twenty nine companies have been identified around of the 9 state in Malaysia. There are 174 professionals taking part in this survey.

RESULTS AND DISCUSSION

Demography information: The demography information has been organized in the questionnaires which comprises several multiple choice questions. The respondents' profiles captured in this first section are role in the

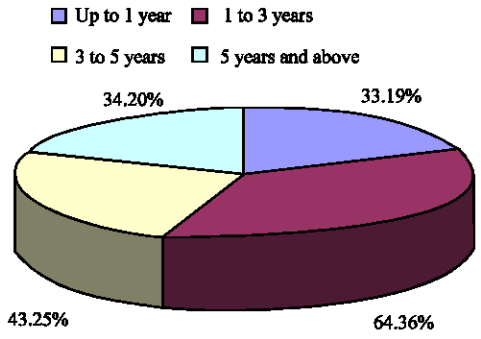

Fig. 1: No. of respondents according to years of involvement in software development area

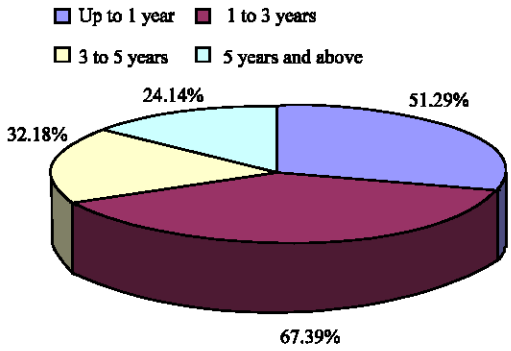

Fig. 2: Period of time working in software process improvement project

Table 3: Number of respondents according their roles in their organization

Roles	No.
Business person	13
Project manager/quality manager	19
It consultant	15
System analyst	26
Software engineer/developer	64
System administrator	6
Designer	3
Others (technical background)	28

organization, education level and academic area, working duration in software development area, period of time working in software process improvement project and expertise level on the area of software process improvement.

Table 3 shows number of respondents according to their roles in the organization which represent the individual who is taking part in the survey.

Figure 1 shows the years of involvement of respondents in software development area whereby 64 respondents (36%) have involved in software development area between 1 to 3 years, 43 respondents (25%) have involved between 3 to 5 years and 34 respondents (20%) have 5 years and above involvement in software development area. 33 respondents (19%) have only up to 1 year involvement.

Figure 2 shows from 174 respondents, 51 of them have of up to 1 year experience in SPI. Moreover, 67 out of 174 respondents have an experience between 1 to 3 years; meanwhile 32 respondents have an experience between 3 to 5 years. Also, there are 24 respondents who have more than 5 years experience in this SPI area.

Figure 3 shows that 85 from the respondents have an average of expertise level, 57 rated themselves have high level of expertise and 13 respondents rated themselves as an excellent level. On the overall, the results signify that the respondents have a good and sufficient knowledge of SPI and can provide reliable input to this survey.

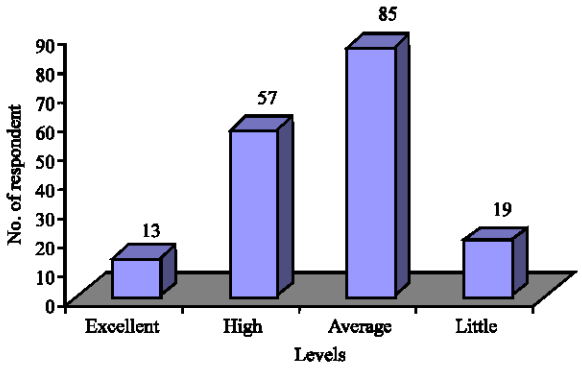

Fig. 3: Expertise level in software process improvement

Resistance factors: Here, 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 scale of 1 to 5, ranging from the least influential to the highest influential factor. Ordinal scale is used whereby the user need to choose to rate the influence level of resistance factor from 1 until 5. Then, the total of influence level score for each organization resistance factor is determined according to the following formulae:

$$T(f_n) = \sum_{25}^{n=1} R(f_n).W(f_n) \quad (1)$$

$T(f_n)$: 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

$R(f_n)$: The score attributed to factor (f) as rated by the respondent according to the influence level

$W(f_n)$: The weightage score attributed to factor (f) according to influence level

f_n : Refers to the factor number

Table 4: Total influence level in SPI area for the resistance factors

Resistance factor	Influence level 1	2	3	4	5	Total of influence level score (T)
F01	9	21	43	47	54	638
F02	5	17	42	68	42	647
F03	8	24	57	57	28	481
F04	4	31	40	66	33	615
F05	2	12	75	64	21	612
F06	6	35	59	56	18	567
F07	9	45	56	43	21	544
F08	11	38	63	53	9	533
F09	4	32	61	56	21	580
F10	10	24	61	56	23	580
F11	3	26	67	55	29	621
F12	3	26	55	75	15	595
F13	4	31	80	45	18	576
F14	6	22	62	66	18	590
F15	7	20	49	57	41	627
F16	6	30	61	54	23	580
F17	3	24	55	70	22	496
F18	6	20	61	54	33	610
F19	9	36	52	54	23	568
F20	5	28	82	52	7	550
F21	8	23	65	56	22	583
F22	7	36	55	63	13	561
F23	8	27	69	51	19	568
F24	4	23	62	64	21	597
F25	0	22	70	59	23	605

F01: Lack of commitment in all levels of the organizations, F02: Lack of adhesion and participation of all the individual involved in SPI projects, 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, F15: Current budget and estimates exceeds 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

For each corresponding influence level (R), a similar weightage score (W) is assigned.

From Table 4, 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 1 which is lack of commitment in all levels of the organizations and the third one is factor number 11 which is unrealistic expectation towards the SPI project. All these top 3 resistance factors are categorized under people factor as referred in Table 2. The three lowest of organizational resistance factors are and lack of professionals experience and skill, lack of expertise in implementing cultural changes and Lack of the establishment of Quality Policy.

As shown in Table 4, 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 15, current budget and estimates exceeds planning. Then followed by factor number 18 which is lack of training on the support tools and technologies defined as support and then the third most is 25, pressure and absence of planning concerning the adaptation period. Meanwhile, the three lowest of project resistance factors is lack of visibility about the ongoing software processes improvement project activities, followed by lack flexibility in the use of the documentation in projects of different types and sizes. The third least is lack of treatment to guarantee process conformity in instances of hiring and/or dismissal of skilled professionals which are identifies as factor number 17, 20 and 22, respectively.

Based on the survey findings reported earlier, 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 Rabelo (2006) and corroborates the research findings experience in SPI projects. The second 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. The third 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.

All these top 3 resistance factors are classified under organizational factor as described in details under analysis and Table 1 which are related within the scope of the organization and usually fall under senior managers' responsibility. The results gained in this research is in accordance with the survey findings conducted by Brietzke and Rabelo (2006) 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 are perceived to be the main determinants in the success of SPI projects. Moreover, all the three factors which have been perceived to be critical are obviously considered to be the most difficult elements which can be taken out of organizational staff. Participation, commitment and reasonable expectations are the end result which should be manifested by the organizational staff, if they are willing to contribute to the SPI project. This finding strongly indicates that organizations implementing SPI projects should spend more effort to create awareness and gain full participation and commitment from their staff to ensure successful implementation of SPI project.

Meanwhile the 3 least resistance factors identified in this survey are lack of visibility about the ongoing software processes improvement project activities, lack of professionals experience and skill and lack of expertise in implementing cultural changes. These 3 factors might have been considered as less critical due to the background of most of the respondents. Sixty seven percent of them have at least 1 to 3 years experience in SPI projects. Based on these, they might perceived that having experience, expertise and vision are not the most critical components which may contribute to the successful implementation of SPI. However, one of the top most resistance factors identified in survey performed by Brietzke and Rabelo (2006) is lack of expertise in implementing cultural changes. The difference in the perceived importance of this factor might be due to the background of the respondents as well. More than 80% of the respondents of this survey are from non-managerial background. These may indicate that they are not really considering the managerial views of getting people to understand and absorb the SPI practices to implement a cultural change. Rather, the views are focusing more on understanding how the typical staff in the organization should react and cooperate to ensure successful implementation of SPI projects.

Furthermore, several respondents mentioned that the SPI project implementation result is also defectively affected if SPI schedule mix up with the ongoing software development project in their companies. The respondents are suggesting that proper and synchronized planning should be done to ensure that the SPI implementation schedule can be carried out harmoniously with the ongoing software development project.

CONCLUSION

This study has identified and analyzed crucial resistance factors which influence the implementation of the software process improvement (SPI) project specifically software companies operated in Malaysia. The top three and the bottom three least resistance factors have been listed and discussed. It concludes that organizational factors specifically human factors playing an important role in determining the success of the SPI project. Participation and commitments from all individuals across the organization are vital and imperative to ensure success for SPI initiative.

One of the study limitations is in only using a set of questionnaire to gather all data required. Moreover, the data sample only covers 29 companies in 6 states of Malaysia. In this case, the degree of validity of the data maybe limited and may not be applicable and reflect all companies operated in Malaysia. However, it is believed that the characteristics of the IT companies in Malaysia are quite alike. Our future work intends to increase the number of participating companies and uses additional data gathering techniques with the objective of getting wider and more accurate picture of the implementation of SPI.

Based on these findings, we hope to facilitate other software companies to consciously manage future projects through the use of protective actions or proper planning which can reduce the anticipating problems during SPI projects implementation.

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