



The Organisational Factors of Software Process Improvement in Small Software Industry: Comparative Study

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Abstract. Small and Medium Enterprises (SMEs) are a great contribution to the international economy and have also been considered an important component in today's world business. Thus, in order to be more competitive, it is necessary for these companies to deliver their products with high-quality. However, despite their importance, small software companies still face myriad challenges and barriers in producing high-quality products. The objective of this study is to identify the organizational factors that have a positive impact to enable Software Process Improvement (SPI) effort in the small software industry. A Systematic Literature Review (SLR) was conducted to achieve the main objective of this study. The findings from this study provide a roadmap to guide future research in order to enable SPI effort in the small software development industry. We believe that findings from this study will give interesting insights to encourage researchers in using compromise technique to analyze future empirical studies based on a specific region to validate the suitability of identified factors in the specific country.

Keywords: Small and Medium Enterprises (SMEs) · Software Process Improvement (SPI) · Systematic Literature Review (SLR) · Critical Success Factors (CSF) · Organizational Factors (OF)

1 Introduction

Nowadays, software development companies are prioritizing the release of top quality software products with suitable cost, resources, high productivity, and within the right scope. In order to develop a top quality software product, the software development process must be of a high standard and well organized [1, 2]. Hence, continuous improvement in the software development processes will ensure an optimal software

quality process. Consequently, there are several standards introduced to support organizations in steering their software development processes to achieve top quality software products. These international models are: (1) “the Software Process Improvement and Capability determination (SPICE)” [3], (2) “Bootstrap” [4], (3) “International Organization for Standardization ISO 9000” [5], (4) “Six Sigma” [6] and (5) “the Capability Maturity Model [7] and advanced version the Capability Maturity Model Integration (CMMI)” [8]. However, existing literature, including [9–11] emphasize that these models are not appropriate to be implemented in Small and Medium-sized software development Enterprises (SMEs) although they constitute most of the companies in the marketplace [12–14].

SMEs are a great contribution to international economic and it considered as an important component in worldwide business [15]. United Nations industrial development organization [16], reported that the majority of companies worldwide fall under SMEs category, with representing more than 90% of total existing enterprises. Altenburg and Eckhardt [16] stressed the important role of small enterprises in creating employment opportunities and for providing workout events alongside relevant services for deprived employees. However, despite their contribution to economic growth and employment opportunities, SMEs still face myriad challenges and barriers. For example, lack of awareness, time-consuming, lack of resources, and lack of support. Baharorn et al. [17] emphasized that the failure of implementing good software development practices could be a major factor contributing to quality problems in software products. Almomani et al. [18] also indicated that factors such as time-consuming, lack of resources, and lack of support are preventing SME software development companies from implementing SPI in their activities. Accordingly, studies conducted by Almomani et al. [18, 19] stressed that the utilization level of SPI activities in SME software development companies is below par.

Therefore, it is imperative to analyze relevant studies to identify organizational factors of SPI in SMEs. Understanding of organizational factors will help the SPI manager to gain a deeper understanding of process improvement. Hence, the main objective of this study is to identify organizational factors that have a positive impact to enable SPI in the SMEs software development industry.

This paper is structured to cover the follows sections: Background and motivation of the study will be presented in Sect. 2. Section 3 presents the research methodology of dataset selection. The result of the study will be presented in Sect. 4. Section 5 addresses the result discussion and research findings of the study. Finally, Sect. 6 presents the conclusion as well as direction for future work.

2 Motivation

Effective factors outline aspects which are essential to assuring the successful implementation of SPI amongst SMEs software development industry. It is defined by Bullen and Rockart [20], as a mechanism to identify information needed in specific areas and where more attention is needed. Knowledge of effective factors helps to develop process improvement successfully to achieve organizations’ objectives [20]. In fact, effective factors influence SPI from several dimensions [21]. Therefore, it is very

important to address them appropriately in order to enable SPI effort in SMEs software development industry. From the last decade, there have been several studies conducted to investigate and analyze these effective factors. For example, organizational size [22–27], environmental conditions [18, 25, 26], social capital and team dynamics [28, 29], or geographical locations [30–32]. However, with the use of standard methods and research findings from these studies, much focus was not placed on organizational perspective as an effective factor.

Organizational perspective is defined to include all those factors impacting organizational politics, structure, and culture [33]. The organizational factors have a direct impact on SPI and its sustainable growth. Hence, El-Emam et al. [34] pointed out that the organizational dimension is a factor that characterizes organization undergoing SPI and the characteristics of the initiatives itself. However, despite their importance, SPI, organizational perspective, and small software industry are rarely found together in recent literature studies.

Over the last decades, several scientific reviews have been conducted in software process improvement field. For example, Staples and Niazi [35] conducted a review to investigate the organization and their related motivations in adopting CMM SPI model. They identified 43 primary studies related to CMM-based SPI model. They found that business benefits are the primary motivation for companies. Also, they mentioned that “organizations reported customer reasons infrequently and employee reasons very rarely”.

Another review performed by Lavallée and Robillard [36], to identify the impact of SPI on software developers, 26 primary studies were found related to the context of review objectives. The lists of positive and negative SPI impact on software developers were the main findings. The positive impact such as an increase in morale, communication among the team, better requirements and documentation through a decrease in the number of problems occurring during the development process and the negative impact such as an increase in overhead through the production of documents that have no perceived value to developers. Almomani et al. [11], conducted a systematic literature review in 2014, to identify SPI efforts in SME software firms. Their results indicated that most of process improvement initiatives are carried out in America and Europe. Furthermore, there are few studies done in Asia context.

However, these aforementioned reviews do not clearly consider organizational factors that positive impact on SPI implementation and they are mostly conducted in large and medium-size companies. Furthermore, none of them observed clearly SPI efforts amongst SMEs software development industry. Therefore, the objective of this review is to identify and analyze existing literature to fill this gap.

Our systematic review differs from the previous systematic review from several perspectives. Firstly, the focus of this review to gain an in-depth understanding of the organizational factors that have a positive impact to enable SPI in SMEs software development industry. Secondly, previous systematic reviews investigated generic impacts factors while our review is solely focusing on the specific domain, therefore, it will be more specific than the reviews. Thirdly, our systematic review focuses on SMEs software development industry, while other reviews do not indicate the size of the organization, owing to the fact, large and small companies differ from a different perspective, therefore, their results cannot generalize to all companies' sizes.

3 Research Methodology

Systematic Literature Review (SLR) is defined by Kitchenham et al. [37] as “A systematic literature review is a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest”. The guideline template and systematic review protocol proposed by Kitchenham et al. [37] were adopted in this review. The Kitchenham’s protocol consists of three major stages as explained in the following subsections.

3.1 Planning for Review

During this stage, we developed a review protocol, defined research questions, identified and determined search strategy for data sources and search terms to retrieve relevant studies. Study selection criteria and filter were performed, relevant studies were retrieved based on paper title and abstract. Final selection of studies was performed for precise filtering based on information in the whole of research papers. Also, it is important to note that the first activity ‘identify the need for review’ of this stage has been discussed in the background and motivation section.

Formulate Research Questions: Developing significant research questions is considered an important part of any successful systematic literature review. In order to address the objective of this study, we have formulated the following research questions:

- (Q1) What organizational factors do small industry need to address in order to enable SPI effort in their activities?
- (Q2) Do the identified factors differ from developed to developing countries?

Development of Review Protocol

Sources of data: The search sources included two main categories to determine related work: publishers’ sites (Online Search Engines) and index engines (Online Databases). The sources were validated by experts in the respective software engineering areas. Several data sources have been used to determine related work such (Google Scholar, Research Gate, IEEE Xplore, Science Direct, ACM Digital library, ISI Web of Science, SCOPUS, Springer Link and The IEEE Computer Society Digital Library).

Search Strategy: The Search Strategy for this SLR consists of four main steps. **Step (1)** Derive keywords for the research questions by using Petticrew’s and Roberts’ method (Population, Intervention, Comparison, and Context - PICOC). **Step (2)** Identify terms derived from synonyms to perform searches in digital libraries. **Step (3)** Group synonyms and related words with the identifier “OR”. **Step (4)** Group each set of terms with the identifier “AND”.

After adopting Steps 3 and 4, the following results were determined for the search string (“Software Improvement OR Software Process Improvement OR Software Process Enhancement OR Software Process OR Improvement OR SPI”) AND (“Small and Medium OR SMEs OR Very Small entities OR VSEs, Micro”) AND (“Software Company OR Firms OR Enterprise OR Company OR Setting OR Businesses”) AND

("Element OR Component OR Constituent OR Item OR Feature OR Aspect OR Characteristic OR Influence OR Circumstance OR Determinant OR Parameters OR Indicator OR Practices OR Impact OR Catalyst") AND ("Organizational OR Structural OR Managerial").

Inclusion Criteria: Studies consisting of SPI effort that focuses on organizational perspective, Studies must be based on small software development industry, Studies should include a list of factors that effect to implement SPI effort, Studies those are largely related to the research content.

Exclusion Criteria: Studies are not written in English language, Studies are limited and short or the full text not available, Studies which are not relevant and related to the objective of this study, Studies out of research scope.

Quality Criteria: Using quality assessment during the data extraction process is important, to evaluate the quality of research studies and to determine the elaborate inferences strength. Therefore, quality assessment checklists were proposed to assess the quality of primary studies according to existing studies in software engineering field [37, 38]. The checklists were adopted by using questions from Kitchenham et al. [37] to reflect the review context questions and are accordingly adjusted: (1) Is the objective of the paper sufficiently explained? (2) Is the idea of paper clearly presented? (3) Is the problem of paper clearly stated? (4) Is the methodology used suitably to address the stated research questions? (5) Are the data collection methods adequately defined? (6) Are the findings of the research relevant to answer the research questions? (7) Is the knowledge claimed validated?

3.2 Conducting the Review

This stage involved four main activities which are the selection of primary studies after adopted exclusion and inclusion criteria, assessment of the study quality is performed through developed quantitative checklists, data extraction objective to accurately the information and final process in execution is data synthesis where the data collected and summarized the results of the primary studies.

Primary Sources: After applying the procedure to gather initial research studies, a total of 8002 articles was found. Removal of duplicate studies and applying previous inclusion and exclusion criteria, 1085 studies were selected as being relevant studies. After reading full-text papers of relevant studies, only 81 studies are related to research questions. The selected studies were published over the last decade. Table 1 presents the number of selected articles found in the literature.

Quality Assessment: The quality assessment checklists are rated according to Kitchenham et al. [37], as follows: "Yes", "No" or "Partially" scale where a score of one was allocated for "Yes", half for "Partially" and zero for "No". Based on the quality assessment checklists, the score was 84% and this percentage score indicated stronger evidence to the relevant context.

Data Synthesis: A list of Organizational factors from the 81 primary studies was formed. A primary reviewer has performed data synthesis on useful information to provide a foundation for phase 3 (report review). The syntheses of data are performed to identify the organizational factors that have a positive impact on implementing SPI

efforts in the SMEs software development industry, and a list of 11 factors was identified, as tabulated in Table 2.

Table 1. List of primary studies

DB. name	Found studies	Not. related	Primary studies	Selected studies
IEEE explore	2362	2154	208	19
ACM library	1238	1044	194	6
ScienceDirect	343	191	152	9
Wiley	360	244	116	9
Springer link	245	149	96	19
Emerald insight	241	234	7	1
Other	3213	2901	312	18
Total	8002	6917	1085	81

4 A Review Report

In this systematic review, research questions were developed to gain insight into the current state of organizational factors that have a positive effect to enable SPI in the small software development industry. In order to collect relevant articles that afforded the best answers for the research questions, a total of 81 articles were Selected and read in depth. The following subsections present the results based on our formulated questions:

RQ1: What organizational factors do small industry need to address in order to enable SPI effort in their activities?

In order to answer this research question, Table 2 shows the list of organizational factors identified through the SLR along with the frequency and percentage of the total number of selected studies.

Business Orientation: From the results, ‘Business Orientation’ is identified as the most critical factor in the SLR study, i.e. (78%, 63 articles). This indicates that understanding projects goals amongst every member of a software organization has a positive impact on implementing SPI effort in SMEs software development industry. Due to the importance of this factor, process improvement objectives should be associated directly with business orientations [P1]. Therefore, considering business orientation will provide the best way to enable the SPI strategy in small companies [P15].

Management Commitment: The results of this research study also indicated that ‘Management Commitment’ is the second most important factor (74.1%, 60 articles). According to Guerrero and Eterovic [P64], commitment from management helps throughout the project by providing resources and helping to obtain buy-in from developers. Several researchers emphasize that organization’s SPI efforts have a strong influence on management commitment [P3] [P4] [P36] [P50]. Therefore, senior management commitment is required to ensure that the improvement of the process is coordinated as a strategic project.

Table 2. List of identified factors

Factor	Studies	Total	%
Business orientation	[P1]; [P2]; [P3]; [P4]; [P5]; [P6]; [P7]; [P8]; [P9]; [P10]; [P11]; [P12]; [P13]; [P14]; [P15]; [P16]; [P17]; [P18]; [P19]; [P20]; [P21]; [P22]; [P23]; [P24]; [P25]; [P26]; [P27]; [P28]; [P29]; [P30]; [P31]; [P32]; [P33]; [P34]; [P35]; [P36]; [P37]; [P38]; [P39]; [P40]; [P41]; [P42]; [P43]; [P44]; [P45]; [P46]; [P47]; [P48]; [P49]; [P50]; [P51]; [P52]; [P53]; [P54]; [P55]; [P56]; [P57]; [P58]; [P59]; [P60]; [P61]; [P62]; [P63];	63	78.0
Management commitment	[P1]; [P3]; [P4]; [P5]; [P6]; [P7]; [P9]; [P10]; [P11]; [P12]; [P13]; [P14]; [P16]; [P17]; [P18]; [P19]; [P22]; [P23]; [P24]; [P25]; [P26]; [P27]; [P28]; [P29]; [P30]; [P31]; [P32]; [P35]; [P36]; [P37]; [P38]; [P39]; [P40]; [P41]; [P42]; [P43]; [P44]; [P45]; [P46]; [P47]; [P48]; [P49]; [P50]; [P51]; [P54]; [P56]; [P62]; [P63]; [P64]; [P65]; [P66]; [P67]; [P68]; [P69]; [P70]; [P71]; [P72];	60	74.1
Organizational culture	[P1]; [P4]; [P9]; [P13]; [P14]; [P15]; [P16]; [P20]; [P22]; [P25]; [P27]; [P28]; [P32]; [P35]; [P42]; [P47]; [P48]; [P49]; [P51]; [P64]; [P69]; [P76]; [P77]; [P78];	24	30
Organizational politics	[P4]; [P6]; [P16]; [P18]; [P24]; [P29]; [P30]; [P31]; [P42]; [P48]; [P49];	11	14
Organization structure	[P1]; [P6]; [P10]; [P13]; [P42]; [P48];	6	7.4
Resource allocation	[P4]; [P6]; [P10]; [P11]; [P13]; [P16]; [P18]; [P22]; [P24]; [P26]; [P28]; [P29]; [P31]; [P32]; [P35]; [P36]; [P37]; [P41]; [P42]; [P48]; [P50]; [P52]; [P53]; [P54]; [P69]; [P70]; [P79];	27	33.3
SPI benefit	[P6]; [P9]; [P13]; [P15]; [P16]; [P19]; [P22]; [P28]; [P31]; [P35]; [P36]; [P38]; [P42]; [P44]; [P46]; [P47]; [P48]; [P49]; [P50]; [P52]; [P57];	21	26
Roles and responsibility	[P5]; [P6]; [P11]; [P18]; [P22]; [P23]; [P25]; [P26]; [P28]; [P30]; [P31]; [P32]; [P41]; [P43]; [P46]; [P48]; [P51]; [P54]; [P55]; [P61]; [P77]; [P80];	22	27
Political stability	[P5]; [P42]; [P48]; [P49]; [P69]; [P78];	6	7.4
Effective management	[P4]; [P18]; [P17]; [P19]; [P22]; [P31]; [P37]; [P40]; [P44]; [P51]; [P53]; [P63]; [P76]; [P78]; [P81];	15	18.5
Organization vision	[P10]; [P15]; [P22]; [P31]; [P38]; [P44]; [P47]; [P48]; [P49]; [P60]; [P64];	11	14

Resource Allocation: ‘Resource Allocation’ was identified as effective factors, representing 33.3% of the selected studies. The researchers argued the importance of this factor [P22] [P24] [P28]. Therefore, in order to increase an understanding of resource allocation for the different roles, the minimum overhead resources should be allocated based on experience [P42] [P70].

Organizational Culture: our findings also showed that ‘Organizational Culture’ is an important factor (30%, 24 articles). According to GarzáS et al. [P22], one of the main reasons for small companies to tackle the improvement effort is to establish a culture of quality. Muñoz et al. [P15] argued that companies should analyze organizational culture properly in order to establish SPI efforts successfully. Furthermore, Albuquerque et al. [P16], conducted a study to understand the factors that can influence the success of SPI effort in small companies. The results indicated that factors of organizational culture could directly influence SPI implementation.

Roles and Responsibility: Almost a quarter of the selected articles in this systematic review point to the importance of ‘Roles and Responsibility’ factor for the success of the improvement process. Garcia et al. [P23], conducted a study with the aim to support small software development industry to adopt iterative approach by using SPI web tool. The results emphasize that responsibility was one of the factors that strongly contributed to support the web tool to achieve the main goal. Similarly, assigning responsibility and authority play important roles in increasing the capacity level of the process [P18] [P22]. Other research studies, including [P6] and [P26], emphasizes that clearly defined roles and their responsibilities in SPI efforts will lead SMEs companies to successfully implement the improvement strategy.

SPI Benefit: This factor was cited in 26% of the total articles as a critical factor in the organizational domain to enable SPI effort in the small software development industry. The awareness of SPI benefit amongst organization members will be a guarantee to implement efficient SPI strategy [P42]. According to Sulayman et al. [P49], management in small software companies needed to convince clients about SPI benefits in order to include the SPI related project cost in the overall project cost. Therefore, in order to convince small companies about the expected benefits in the business, it is necessary to recognize the importance of minimizing the costs of improvement to make SPI benefits visible in shortest time frame [P19] [P52].

Effective Management: 18.5% of the studies cited ‘Effective Management’ as an essential factor to deploy the process improvement over the small software development industry. According to Pino et al. [P44], “the process improvement is not an isolated activity, but is closely related to other activities of the software process management”. Therefore, having strong configuration management play a critical role in the SPI effort within small companies [P22].

Organizational Politics and Vision: The findings of this study also indicated that both ‘Organizational Politics and Organization Vision’ were cited by (14%, 11 articles) of the total selected papers. Other factors that were cited by articles in the review were Political stability and Organization Structure and they had the least significant percentage (7.4%, 6 articles) compared with other organizational factors.

RQ2: Do the identified factors differ from developed to developing countries?

In order to answer research question 2, Table 3 demonstrates the list of organizational factors identified based on various developed and developing countries. All identified articles through the SLR were classified into three clusters based on the condition of the country’s economy where the selected study was performed, namely, developed, developing and semi-industrialized. In total, 81 research articles were included in this review process, with 44 of the research conducted in developed

countries, while 10 articles were in developing countries and 27 of the articles were conducted in semi-industrialized countries. From the results, of the eleven factors, two factors were cited by more than 50% of the groups. The ‘Business Orientation’ factor was the most cited factor, with 84.1% percentage of articles in developed countries group. The second highest factor was ‘Management Commitment’ factor and it has 72.7% of total articles in this group.

The main objective of this question is to investigate if there is any difference between developed, developing and semi-industrialized countries in order to consider the identified factors in the particular country. To identify if there exists a significant difference across the groups, the Chi-square test linear-by-linear association was deployed. From the statistical test results, there was a significant difference in ‘organization structure’ factor only.

Table 3. List of identified factors across country-wise

Factor	Developed (n = 44)	Developing (n = 10)	Semi industrialized (n = 27)	Chi-square test (linear by linear association) $df = 1$; $\alpha = 0.05$	
				X^2	ρ
F1	37 (84.1%)	8 (80%)	18 (66.7%)	2.829	.093
F2	32 (72.7%)	9 (90%)	19 (70.4%)	.013	.910
F3	10 (22.7%)	4 (40%)	10 (37%)	1.783	.182
F4	5 (11.4%)	1 (10%)	5 (18.5%)	.665	.415
F5	0 (0%)	3 (30%)	3 (11%)	3.874	.049
F6	11 (25.0%)	4 (40%)	12 (44%)	2.929	.087
F7	9 (20.5%)	5 (50%)	7 (25.9%)	.442	.506
F8	13 (29.6%)	2 (20%)	7 (25.9%)	.142	.707
F9	3 (6.8%)	0 (0%)	3 (11%)	.339	.561
F10	6 (13.6%)	2 (20%)	7 (25.7%)	1.670	.196
F11	4 (9.1%)	3 (30%)	4 (14.8%)	.665	.415

5 Discussion

In this SLR study, we have identified SPI factors that are faced by SMEs software development industry in the context of organizational perspective. Extracted factors help SMEs companies to implement SPI strategy successfully. Therefore, for better understanding, we have classified and analyzed the identified factors into three clusters based on the condition of the country’s economy where the selected study was performed. These clusters help to represent the identified factors with respect to a particular country. Therefore, small software companies in those particular countries should consider identifying factors with a positive impact in the specific country.

To broaden the relevance of the identified factors, definite criteria were entrenched to deduce the level at which factors were recognized as influential to the

implementation of an SPI strategy with respect to the professional characteristics of the practitioners. The level of importance of each factor was considered in the assessment of such a factor. That is if a factor is cited more (greater than 50% of the identified articles), such factor will be recognized as important. Several research studies in same domain have used the same criterion [22, 39–41].

Therefore, to answer research question one, by using these criteria we have identified two organizational factors to be critical for SMEs software development industry. These factors are: ‘Business Orientation’ and ‘Management Commitment’. Similarly, to address research question two, the results showed that out of the eleven factors, ‘Organization Structure’ had a significant difference across developed, developing and semi-industrialized countries when compared country-wise.

The construct validity of this study is based on SLR study and its data extraction procedures were assessed by expert researchers. Furthermore, to arrive at the acceptable assessment of the investigated effective factors, this study adopted the results of the literature studies as highlighted in the research methodology section (See Sect. 3). The majority of our primary research studies were selected from recognized scientific research sources from authors with extensive experience in SPI.

6 Conclusion and Future Direction

This study was conducted to identify the effective factors that have a positive impact to enable SPI efforts in SMEs software development industry. The identified factors in this review were investigated based on organizational context perspective. Consequently, systematic review technique as mentioned by Kitchenham et al. [37] was adopted. In order to answer our research questions ‘What organizational factors do small industry need to address in order to enable SPI effort in their activities? And Do the identified factors differ from developed to developing countries?’. From a total of 1085 studies, 81 articles were found to have a significant contribution to the research context. List of eleven factors has identified as mentioned in Table 2. From the results, ‘Business Orientation’ and ‘Management Commitment’ factors were the most critical organizational factors that have a direct effect on the successful implementation of SPI in SMEs software development industry. The Chi-square test was used to identify if there is any significant difference in term of developed, developing and semi-industrialized countries. ‘Organization Structure’ factor has a significant difference amongst the three groups when compared country-wise and it is important to note that this factor (‘Organization Structure’) did not appear in the developed countries where the reviewed studies were performed.

In conclusion, the finding of this research will help SMEs software companies to understand and respond positively to organizational factors related to SPI efforts. In addition, the results and findings from this study will give interesting insights to encourage researchers in using compromise technique to analysis future empirical studies based on a specific region to validate the suitability of these factors in a specific country. For the next step, our future work is to investigate other possible perspectives; human, process, project management, knowledge management, external and internal support. The ultimate future goal to develop Malaysian SME Software Process Improvement

model (MSME-SPI). This research paper contributes only one part of the model. Identifying these factors will positively assist in developing the MSME-SPI model based on the specific context, especially for Malaysian SMEs software development industry.

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