Success Factors of Process Improvement in Small and Medium Web Companies

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ABSTRACT

Small and medium Web companies have emerged very rapidly in recent years and thousands of such companies are in existence around the globe. To cater for the unique needs of such companies, a new field of research 'Web engineering' was created. Web companies, when compared to traditional software companies, have unique needs due to their different nature. Software Process Improvement (SPI) is one of the greatest challenges that Web companies face. In order investigate the state of the art in SPI relative to Web companies a Systematic Literature Review (SLR) was conducted.

Results of our SLR as well as other relevant literature suggested that investigating SPI success factors relative for small and medium Web companies was a new avenue of research yet to be explored. We also conducted an exploratory study on 20 Web companies (with 72 participants) to assess the state of practice with regard to SPI success factors for small and medium Web companies; its results also supported the view that success factors for small and medium Web companies had not been investigated yet; hence this is the aim of this research. To achieve this aim we will employ mixed methods to identify and verify SPI success factors and their measurements from both qualitative and quantitative foci for small and medium Web companies. The comparison of the results of both approaches will be performed in order to achieve the most accurate set of SPI success factors and their measurements for small and medium Web companies.

1. INTRODUCTION

Software processes play an important role in helping project teams in software development organizations and motivate the use of similar and sound practices [1]. Formal processes emphasize the explicit command-and-control side of the organization due to their concrete nature, while informal team practices emphasize the mutual adjustment and explorations needed to accomplish the software project and associated process tasks successfully [2].

Almost all modern software organizations operate in a competitive market, under tight time and cost constraints [3] [34]. As an answer to their needs, organizations have started to undertake software process improvement (SPI) initiatives (see [4] for an overview of different approaches) aimed at increasing the maturity and quality of their software processes [5]. Investment in process improvement has had various business benefits i.e. improved product quality, reduced time to market, better productivity [5], increased organizational flexibility and customer satisfaction [6] [7] [35].

Many researchers have focused their attention to defining development processes and their relation to the quality of the products [8] [9]. While this remains important, many researchers are investigating SPI success factors [27] [41] and people issues that inherently play major roles in the adoption of new processes by software organizations [7].

According to a recent survey, 99.2% of the world's software companies are small and medium in context [10]. It is also observed that in recent years small and medium sized software development companies have emerged very swiftly and many of them are working in the domain of Web development [11].

SPI for small and medium organizations has emerged as a separate research area in modern era. Large SPI models are not suitable for small and medium companies due to their complex nature and expensive costs [40]. Corporate SPI giants like ISO and CMMI have also felt this need and have formulated focus groups for small and medium software companies. A number of researchers have proposed their own SPI frameworks for small and medium software organizations [41] [42].

Web development is inherently different from traditional software development [32] [41]. In order to deal with the specific needs of Web companies and software companies that develop Web applications [19] [29], a new research field, 'Web Engineering' [16] was created. It requires Web agile process models [36] [37] that uses RAD, SCRUM [12] [13] etc. which implies that the development methodologies are also different [14] [15] [36] [37]. Like traditional software, the engineering of Web applications are supposed to adapt to the Model Driven Agile Web Development approach [17] [36] [37]. The methodology for development is intended to be user centered due to the rapid change of content and flexible nature [18].

Web application developers are different in attitude and approach from the traditional systems developers and have a strong focus on hypermedia context and continuous evolutionary approach [19]. Some examples of Web development methods are OOHDM, SWM, OOWS and UWE & WebML as an extension of UML [20] [31] [21]. Web requirements Engineering is moving from task orientation towards goal orientation [22] based on NDT (Navigational Development Techniques) [23]. Researchers are also focusing on devising special project management initiatives like WIPSE (Web Integrated Project Support Environment), Action minutes and PAWS (Project administration Web Site) for Web development companies [23]. In addition testing of Web applications is also different from the traditional systems and revolves around different quality dimensions such as load, stress and volume. RIA (Rich Internet Applications) is using the above specified Web Engineering practices [24].

In this research, we initially identified some broad research questions and investigated them through our SLR in the domain of SPI for small and medium Web companies (mentioned in section 2) and research gaps were identified. One of the research gaps was the success factors investigation of SPI for small and medium Web companies which became our main research question. We replicated an existing general theoretical model of SPI success factors on our domain and performed quantitative analysis (see section 3). We further intend to investigate SPI success factors for small and medium Web companies qualitatively by applying

grounded theory methodology and eventually propose a comprehensive set of SPI success factors for small and medium Web companies based on our quantitative and qualitative assessments (see section 4 for details).

2. SYSTEMATIC REVIEW

In order to investigate the state-of-the-art on SPI for small and medium Web companies, we conducted a Systematic Literature Review (SLR) using Kitchenham's guidelines [25]. The details of the conducted SLR can be found at http://www.cs.auckland.ac.nz/~mria007/Sulayman/

Our SLR found no specific SPI success factors and their measurements that specifically exist for small and medium Web companies to the best of our knowledge. Also, the different context and nature of Web projects and therefore, Web companies, makes an interesting case to investigate as to how SPI should be tailored for them and what factors can be influential regarding their initiatives for SPI success. Hence, we have chosen to explore this avenue of research further and we will identify success factors and their measurements for the SPI activities within the domain of the small and medium Web companies.

3. REPLICATION STUDY OF SPI SUCCESS FACTORS

To investigate SPI success factors [26] [27] [28] in small and medium Web companies our SLR provided us the state of art and we further performed an exploratory study to investigate state of SPI practice in the mentioned domain.

One aspect of our SLR was the gathering of evidence about specific SPI success factors for small and medium Web companies. No evidence was found; however, one of the studies found in the primary search phase of the SLR had investigated SPI success factors within a broader context – that of small and medium Companies (software and Web companies) [30] but it did not explicitly discussed Web companies. Further research revealed other related publications of the same author that elaborated their investigation further [27] [32]. These studies proposed a theoretical model for the quantitative measurement and interdependence of SPI success factors [27] [30]. These studies laid the foundation for the replication study presented herein: to replicate [30] by employing the same theoretical model they proposed but targeting solely at small and medium Web companies.

The seven hypotheses investigated in the replicated study are the same one proposed in [27] [30].

The details of statistical results can be found at http://www.cs.auckland.ac.nz/~mria007/Sulayman/Repstudy/

As in [27], our study gathered data using a survey. For our survey 20 Web companies and 72 CEOs, managers and Web development professionals agreed to participate. The survey contained questions organized in three main sections. Sections I & II enquired general and demographics data regarding the company and the respondents. Section III investigated key factors of SPI success in the respondent's Web company. In section III 37 separate items measured the six independent variables and five items measured the dependent variable - SPI success. This section also enquired about the company's environmental conditions.

Before conducting the detailed analysis, reliability and validity tests for the measurement scales employed were performed. Reliability of the multiple item scales was evaluated using the Alpha Coefficient, also known as Cronbach Alpha [33]. The validity of the measurement scales relates to the accuracy of the measurement scales employed. In this study we validated the content, construct and criteria validity of the data using the same procedures previously performed in [32].

Similarly to [27], bivariate correlations were used to test hypotheses 1 through 6 and the results supported alternate hypothese. Both zero orders as well as partial correlations were performed on the data. For bivariate correlations *(r)* the moderating variables were considered constant. For partial correlations *(pr)* their exact values were considered.

As in [27], a regression analysis was performed to obtain results for overall SPI success. We have performed a stepwise regression analysis to find out which factors influenced SPI success more significantly. Results of the stepwise regression analysis showed that 'Leadership Involvement' was the factor that had highest value and demonstrated around 26% contribution to SPI success when considered alone. 'Employee Participation' along with 'Leadership Involvement' demonstrated 32% contribution. 'Concern for Measurement' also showed a significant value ($p < 0.05$) among excluded variables in both models of stepwise regression and contributed significantly. These three variables also exhibited the highest B, β and t values. The other three variables 'Business Orientation', 'Exploitation of Existing Knowledge' and 'Exploration of New Knowledge' were not found significant in our stepwise regression analysis.

Based on our results, alternative hypotheses 2 to 4 were supported as they contributed in stepwise regression analysis and bivariate as well as partial correlations were positive. Whereas hypotheses 1, 5 and 6 were partially supported as they did not contribute in stepwise regression analysis but bivariate as well as partial correlations were positive for them.

As in [27], to test hypotheses 7 we used Cohen's coefficient ($f^2 = R^2/(1-R^2)$) [39] to observe the variance in SPI success. The effect of variance is considered to be large when the coefficient is > 0.35 [39]. In our case the value of f^2 was 0.63, so demonstrating a very high effect of variables on SPI success and corresponding to multiple correlation coefficients. We also observed very high values and a normal distribution when we used Konishi's extension [40] to Fisher R to Z transformation, which also supported our hypotheses 7. These are the similar techniques employed by Dyba in [27].

Dyba [32] differentiated between small and large software development organizations; however, unlike [32], we differentiated between small and medium Web development companies within the context of this study. So far, to the best of our knowledge, no strict criterion for differentiation between small and medium Web companies has been proposed in the literature. However, based on the expert opinion of academics and industry practitioners in which they have differentiated between small and software large companies, we have used the variable 'Organizational size' for differentiation among small and medium Web companies [55] [19] [30] [56]. Web companies with less than 20 Web development professionals were considered to be small, and companies with more than 20 and less than 100 Web development professionals were considered medium.

As in [32], we have used a 2-tailed independent samples t-test to compare the means of the success factors for small and medium Web companies, setting $\alpha = 0.05$. There are no significant differences between the values of the independent variables

between small and medium companies, except for 'Employee participation'. Medium Web companies reported significantly high values for 'Employee participation' ($t = 2.045$; $p < 0.05$). The remaining independent variables were not significant and had a similar overall effect on SPI success.

There were differences between our findings and those presented in [27]. Contrary to Dyba's findings, which suggest partial support for 'Exploration of new knowledge' and 'Leadership involvement' [27], our results demonstrated stronger significance for 'Leadership involvement'. We observed partial support for 'Exploration of new knowledge' which is similar to Dyba's finding [27]. Similarly, Dyba's results showed a stronger support for 'Business orientation' as major success factor of SPI directly influencing overall SPI success; however our results suggested partial support for this variable as a predictor of SPI success. Our results also showed strong support for 'Employee Participation' and 'Concern for Measurement'.

4. OBJECTIVES & SCOPE OF THE RESEARCH

Based on our SLR and replicated study, the major objectives of this research are as follows:

- To develop a theoretical model of SPI success for small and medium Web companies.
- To identify and investigate SPI success factors for small and medium Web companies using both qualitative as well as quantitative foci.
- To compare the results obtained from the quantitative and qualitative studies in order to obtain a more general set of SPI success factors for small and medium Web companies.
- To obtain a comprehensive set of SPI success factors, their measurements and inter-dependence to help small and medium Web companies achieve organizational excellence.

As part of our research we have performed an SLR and a quantitative replication study to observe state of practice in SPI success factors. The next steps of our research are as below:

Step 1: Qualitative Investigation and Proposal of a Theoretical Model of SPI Success Factors. Rather than relying only on the results of quantitative replication study discussed in Section 3, we also want to investigate the SPI success factors for small and medium Web companies with a qualitative focus through inductive research. The methodology of Grounded Theory [48] will be applied for this purpose and a theoretical model of SPI success factors will be proposed along with the measurements of the success factors. This means that the quantitative research (see Section 3) will be complemented with qualitative research [47] in our case. The advantages of using both qualitative and quantitative methods in combination or in parallel are to validate, complement and add confidence to the findings of one another [47].

Qualitative research has its footings in the natural sciences; it progressed from natural to social sciences and is now also widely used in the field of information systems [45] due to the involvement of social or soft factors in this field [46] [53]. There are various approaches to conducting qualitative research including action research, case-study research, ethnography and grounded theory. Our choice of Grounded Theory [48] to conduct this step of the proposed research is based on the following reasons.

- Grounded theory allows formulating concepts and drawing logical connections and inter-relationships among them, and therefore enables the creation of a theory from experts' knowledge (immersed in data) [50], whereas the quantitative path proposes a theory first and then validates it.
- The State of the art results, obtained via our SLR, have identified very few studies and no explicit theory or set of SPI success factors for small and medium Web companies; therefore, a visible research gap to investigate SPI success factors exists and therefore we believe that to conduct inductive research for the purpose of theory development is as equally applicable as using quantitative methods.
- Grounded theory deals with the involved people in the investigated domain and provides a means for direct contact and gaining firsthand knowledge [49].
- There is proof of successful application of grounded theory in software, information and health systems in the context of processes and their improvement [54].

Step 2: Comparison of Results Obtained from Quantitative and Qualitative Approaches. This research involves the development of a theoretical model therefore, we believe that the model's measurement and validation using both quantitative and qualitative perspectives can be extremely useful [47]; parallel value can be acquired from both qualitative and quantitative approaches by triangulation, facilitation, complete picture, macro level investigation, etc [47]. In this step, the comparison of the models and findings of the replication study (Section 3) and grounded theory (Step 1) for the identification and measurements of SPI success factors for small and medium Web companies, will be performed.

Step 3: Proposal of Success Factors; and Measures, Categorization, and Interrelationships of Success Factors for Small and Medium Web Companies. Based on the comparisons performed in Step 2 and the commonalities and differences found by using the qualitative and quantitative approaches, this step will involve proposing a general model of SPI success factors for small and medium Web companies. This model will be based on a comprehensive set of SPI success factors, their measures and taxonomical categorizations as well as interrelationships, which will help Web companies in achieving organizational excellence with better commitment to SPI programmes.

5. CONCLUSIONS

From the SLR and surveyed literature, it is concluded that SPI for small and medium Web companies is a new area and there are definite research gaps available to extend future research. We have also conducted a replication study to validate an existing theory model within the context of small and medium web companies. We will investigate and measure SPI success factors for small and medium Web companies with both qualitative and quantitative methodologies. Grounded theory will be used for qualitative assessments. The theoretical model obtained from the grounded theory will be quantitatively assessed for further identification and measurements of SPI success factors. The intended outcome of this research, a theoretical model of SPI success factors will help Web companies in achieving competitive advantage and operational excellence.

6. REFERENCES

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