2014

The Adoption of Software Process Improvement Programs in the English-Speaking Caribbean

Delroy A. Chevers
The University of the West Indies, delroy.chevers@uwimona.edu.jm

19P. The Adoption of Software Process Improvement Programs in the English-Speaking Caribbean

Delroy A. Chevers
The University of the West Indies
delroy.chevers@uwimona.edu.jm

Abstract

Managing and improving the processes used to develop software products is widely accepted as one of the remedies to overcome the problem of poor quality systems being delivered. As a result, the IS community has adopted several software process improvement (SPI) programs. The tenets of these programs are grounded in the belief that a mature development process can increase the likelihood of producing high quality software products with the requisite requirements which should add business value. However, small firms in developing countries like the English-speaking Caribbean (ESC) are not aware nor adopting these SPI programs because they are seen as costly, time consuming and disruptive; hence, not realizing the potential benefits. This study examined the awareness, adoption and benefits of SPI programs in ESC software development firms. The result found that a slight majority (54.5%) of firms in the region are aware of SPI programs, with only 20% of those who are aware using any form of SPI programs in the development of software. These findings reinforces the need for SPI training in the ESC to articulate the compelling need for a change towards the adoption and use of SPI programs in software development.

Keywords

Adoption of software process improvement, Capability maturity model integration, Information systems quality, English-speaking Caribbean

1. Introduction

Many software development firms strive to improve the quality of the software they deliver, as well as seek to improve the productivity of key IS professionals in the developmental process (Niazi, 2012). One approach for achieving these two goals is to improve the maturity of the software development process (Rodriquez-Repiso, Rossitza, & Salmeron, 2007; SEI, 2010). This concept of software process improvement can give firms a competitive advantage (Srinivasan & Murthy, 2010). As a result, the IS community has adopted several software process improvement (SPI) programs like the capability maturity model integration (CMMI) for development.

The underlying principles of these programs are grounded in the belief that a mature development process will increase the likelihood of producing high quality software products with the requisite quality dimensions like functionality, reliability, usability, efficiency and maintainability (ISO/IEC, 2001). Not only are the quality dimensions enhanced but SPI programs can improve firms' performance in areas such as reduced project cycle time,

reduced development cost, improved staff productivity and improved customer satisfaction (Clarke & O'Connor, 2013). Thus adding business value and enhance the performance of firms.

Research conducted in developed countries have revealed the benefits stated above, but small firms in developing countries like the English-speaking Caribbean (ESC) are not aware nor adopting these SPI programs (Chevers & Duggan, 2010) because they are seen as costly, time consuming and disruptive (Niazi, Babar, & Verner, 2010). As a result, these firms are not realizing the potential benefits and the opportunities that exist; as more and more, the software development global market is opening its doors to developing countries (Kituyi & Amulen, 2012). Brazil responded to this opportunity with a nationwide program for software process improvement in Brazilian organizations in an effort to enhance their global competitive advantage (Montoni, Rocha, & Weber, 2009). But the ability for small software development firms in the ESC to respond to these opportunities and become competitive is low. However, it is important that they adopt and use internationally accepted SPI programs (Kituyi & Amulen, 2012). A move which can increase the likelihood of earning scarce and needed foreign exchange (Chevers & Duggan, 2007) for nation building, in a region where there are severe resource constraints (Niazi, 2012).

To be competitive in the global market and win contracts, firms must demonstrate that their software delivery processes are capable and mature (Niazi et al., 2010; Sulayman, Urquhart, Mendes, & Seidel, 2012). It is assumed in this study that small firms in the English-speaking Caribbean would like to compete in the global market and make IT a factor in economic development. Furthermore, there are increasing pressure from clients for software developers in developing countries to produce high quality software products (Chevers & Duggan, 2007). In addition, small organizations in developing countries have less capacity to absorb and recover from failed projects (Kituyi & Amulen, 2012). Based on these challenges and assumptions this study examined the following research questions:

- What is the level of SPI awareness in the ESC?
- What is the rate of adoption of SPI programs in the ESC?
- What benefits are being derived from SPI programs in the ESC?

The motivation to conduct this study is based on the fact that there is little research in this domain in the English-speaking Caribbean (Chevers & Duggan, 2007), coupled with an appeal in the literature (Chevers & Duggan, 2010). The expected contribution is for IS professionals in the region to gain deeper insights regarding the reasons for the lack of awareness, use and benefits of SPI programs. If the reasons are understood and properly managed software development firms in developing countries could strive to bridge the digital gap between themselves and the developed world (Heeks, 2002).

2. Literature Review

Managing and improving the processes used to develop software products is widely accepted as one of the remedies to overcome the problem of poor quality systems being delivered (Kituyi & Amulen, 2012). A large percent of IS projects are considered failure due to budget overruns, time overruns, and abandonment (Bulatovic, 2011; Li, Huang, Luftman, & Sha, 2010; Luftman & Ben-Zvi, 2010; Nauman, Aziz, & Ishaq, 2005; Standish Group, 2013). However, the main contributor of project failure as suggested by some scholars is poor quality software products being delivered (Brooks, 1987; Walia & Carver, 2009).

It is generally accepted in the information systems community that people, technology and process maturity are major determinants of IS quality (SEI, 2010). However, many scholars believe that a mature IS delivery process is the most influential of all the factors (Humphrey, 1989; Paulk et al. 1995). This view has led to the popularity of software process improvement (SPI) programs. Software process improvement is a systematic approach to improve the maturity of the developmental processes in firms (Kituyi & Amulen, 2012). Advocates of the process paradigm (SEI, 2005) states that "everyone realizes the importance of having a motivated workforce, quality work force and the latest technology, but even the finest people can't perform at their best when the process is not understood or operating at its best." (p.9).

There are several SPI models which seek to assist firms in assessing process maturity and then suggest a development path towards gradual process improvement. Some of these models include: (1) The capability maturity model integration (CMMI), (2) ISO/IEC 12207, and (3) ISO/IEC 15504, (4) Personal software process, (5) Team software process, and (6) Bootstrap (Oktaba, Garcia, Ruiz, Pino, & Alquicira, 2007; Pino, Garcia, & Piattini, 2008).

The capability maturity model integration (CMMI) for development a popular and well established process improvement framework (Agrawal & Chari, 2007; Beecham, Hall, & Rainer, 2005; Jiang, Klein, Hwang, Huang, & Hung, 2004) was used to guide the direction of this study. It is a major contributor in the area of process maturity. Maturity is defined as the extent to which a process is defined, managed, treasured, controlled and effective (Dooley, Subra, & Anderson, 2001). The CMMI is described as a methodology used to develop and refine firms' software development process (Dooley et al., 2001). The model entails a five-level evolutionary path of increased maturity which details a list of prescribed practices at each level. It is used to assess the maturity of firms, as well as prescribe practices to improve process maturity (Kituyi & Amulen, 2012). These prescribed practices if understood, followed and institutionalized during the development cycle can increase the likelihood of producing high quality software products.

However, small firms in developing countries find many of the CMMI practices irrelevant and hard to implement (Mondragon, 2006). Many small firms cannot afford the steep initial investment, high implementation cost, heavy human resource burden and time commitment in SPI implementation (Kituyi & Amulen, 2012). As a result, the uptake of SPI programs like the CMMI is low in these small firms. Small firms are defined as having ten to forty-nine employees or with annual turnover between EU$2 - 10 million (European Commission, 2005). Based on this definition, most or all software development firms in the ESC would be classified as small.

In general, the objective of most small firms in developing countries is to survive (Kituyi & Amulen, 2012) due to resource constraints, and so the adoption and implementation of these programs are secondary. Some of the constraints are lack of core competences, lack of finance, existence of flat organizational structures where roles and responsibilities are not clearly defined, heavy reliance on imported IT solutions and foreign exchange shortage (Avgerou, 2008; Berisso & de Vries, 2010; Bhatnagar, 2000; Kodakanchi, Kuofie, Abuelyaman, & Qaddour, 2006; Niazi, 2012). Another major constraint and hurdle to overcome is the attitude and belief of most employees in small organizations. They tend to believe that they are skilled and competent, and cannot afford training both in terms of time and money, rules do not apply to them and rules just get in the way of doing the job and so they do whatever needs to be done (Abrahamson, 2000). These attitudes and beliefs simply

make it more difficult to embrace SPI programs in which they are established practices to be followed during system development.

These constraints have pushed developing countries away from the competitive global business community (Johnson & Brodman, 1997). The issue of poor quality software being delivered in developing countries needs urgent attention because these countries have less capacity to absorb such failures due to their limited resources in finance, human capital and infrastructure (Heeks, 2002; Nauman et al., 2005), coupled with the need to earn scare foreign exchange (Chevers & Duggan, 2007).

Based on the above stated constraints and culture, it is reasonable to expect different results in SPI adoption studies in developing countries in contrast to similar studies in developed countries (Kamhawi, 2007). This expectation is equally supported by the discovery in a study conducted in the English-speaking Caribbean (ESC) which found that a large majority of software development firms in the region are not aware of software process improvement (SPI) and its benefits, nor are they using or intend to use any forms of SPI programs in the near future (Chevers & Duggan, 2010).

In this study, it is assumed that small software development firms would like to make information systems a factor in economic development by competing in the global market (Duggan, 2006). However, because SPI programs are not well established in this region, it is recommended that a gradual approach be taken to adopt these programs. In his paper (Kandt, 2003) made mention of four critical steps to successful SPI adoption. These include (1) constructing the vision of the new organization, (2) obtaining executive-level commitment (3) involving practitioners in the development of the software process improvement initiatives, and (4) communicating the change effort – the vision, its benefits, its differences to the entire workforce. Such a gradual approach can increase the likelihood of successful SPI implementation which can increase the delivery of higher quality software products. This can improve the competitiveness of firms, which can enhance the possibility of winning global contract, which by extension can increase the desire of earning scare foreign exchange.

3. The Survey

Both online and self-administered survey methods were used in this study. The survey (both online and self-administered) was conducted in five ESC countries namely Barbados, Guyana, Jamaica, St. Lucia and Trinidad. These five countries accounted for 85% of the population in the ESC and they constitute the major software development countries in the region.

The unit of analysis in this study was IS projects and the scaled items in the survey instrument ranged from 1-7, with 1 being strongly disagree and 7 being strongly agree. A similar 7-point likert-type scale was used by (Wixom & Todd, 2005) in their technology acceptance study. The targeted respondents/participants were IS project managers, analysts, developers and programmers.

For the online survey method, one hundred and seventy-six invitations were sent via email addresses to potential respondents in the five countries. Of this total, only thirteen were received and analyzed. On the other hand, the self-administered survey method took the form of focus group sessions being held in the five countries with the targeted participants – IS project managers, analysts, developers and programmers. Contacts were made by the researcher and invitations extended to each participant prior to the focus group sessions.

Sixteen, fourteen, six, five and one participant attended the sessions in Jamaica, Guyana, Barbados, St. Lucia and Trinidad respectively. This gave a total of forty-two attendees at the five sessions in which participants were given the survey instrument to complete. All 42 instruments were completed at the focus group sessions. Hence the total completed survey instruments (both online and self-administered) was fifty-five (13 + 42 = 55). This gave a 25% response rate (55/218 = 25%).

The profile of the fifty-five respondents was forty males and fifteen females. This included 27, 14, 6, 5 and 3 respondents from Jamaica, Guyana, Barbados, St. Lucia and Trinidad. The completed instruments were coded by the researcher and statistical package for the social sciences (SPSS) was used as an analytical tool to conduct the analysis. SPSS was selected due to their popularity (Hair, Black, Babin, Anderson, & Tatham, 2006).

Awareness	Number of Respondents	Percent (%)
Yes	30	54.5
No	25	45.5

Table 1: Awareness of SPI

4. Analysis and Discussion

The results from Table 1 indicate that a slight majority of respondents (54%) were aware of software process improvement, in contrast to 45% who were not aware. Jamaica recorded the highest awareness at 40.7% followed by Guyana at 22.2% (see Table 2).

Country	Yes (%)	No (%)
Jamaica	40.7	29.4
Guyana	22.2	47.1
St. Lucia	18.5	11.8
Barbados	14.8	11.8
Trinidad	3.7	0.0

Table 2: Cross-tabulation of countries and awareness of SPI

In reviewing the reasons given for not being aware of SPI programs, these included little or no exposure, not utilized and other types of development methods being used in place of SPI as outlined in Table 3.

Reasons	Percent (%)
Little or no exposure to SPI	50.0
Not utilized	22.7
No experience in software development methods	13.8
Other types of development methods used in place of SPI	13.5

Table 3: Reasons for non-awareness of SPI

On the other hand the reasons given for non-adoption of SPI programs included lack of resources, company at beginning stage, time consuming, too costly and cumbersome (see

Table 4). These findings were expected as most software development firms in the ESC are small.

Reasons	Percent (%)
Other (lack of resources, company at beginning stages, will implement in the future, etc)	82.6
Time consuming	8.7
Too costly	4.3
Cumbersome	4.3

Table 4: Reasons for non-adoption of SPI

In addition, only 20% of those who are aware of SPI are using these methods during software development (shown in Table 5). These findings are consistent with prior studies in small firms and confirmed the notion that SPI adoption is low (Sulayman et al., 2012) due mainly to its implementation being time consuming, costly and cumbersome.

Use of SPI	Percent (%)
Yes	20
No	80

Table 5: Use of SPI programs in software development

Six scaled survey items (1-7 scale) were included in the instrument regarding SPI benefits. In analyzing these survey items regarding SPI benefits, it was discovered that the mean scores were at the mid-range on the 1-7 scale, with the lowest being 3.200 and the highest at 4.400 (as shown in Table 6). The highest ranked benefit was SPI model being able to improve software product quality. Again this finding is consistent with prior studies in developed and developing countries.

Factor	Mean (n = 55)	Standard Deviation (n = 55)
SPI model used in all IS projects	3.200	1.924
SPI model improved software product quality	4.400	2.074
SPI model reduced project cycle time	3.400	1.517
SPI model reduced development cost	3.600	1.342
SPI model improved staff productivity	3.600	1.140
SPI model improved customer satisfaction	4.200	0.447

Table 6: Analysis of SPI Benefits

5. Conclusion

Information systems project success and firm's competitiveness can be improved through the use of SPI programs. However, before these benefits can be realized, SPI awareness and adoption needs to be increased from the current level in the ESC. Firms in the ESC need to adopt SPI programs, be appraised to determine their maturity level and then embark upon implementation plans to increase their capability.

These suggestions are made based on the range of the mean scores in Table 6. These scores indicate that firms in the ESC who use SPI programs are realizing moderate benefits in areas such as reduced project cycle time and development cost, improved staff productivity and improved customer satisfaction. It is hoped that the findings of moderate benefits being realized might increase the curiosity of IS professionals in the English-speaking Caribbean to become more aware and knowledgeable of SPI programs. Thereby increasing the desire to attend seminars in which the focus should be on SPI and its benefits.

However, a finding of the study reveal that of those information systems managers who have expressed a desire to embrace SPI, 67% are seeking guidance on how to implement SPI activities, rather than which SPI activities to implement (Herbsleb & Goldenson, 1996). Based on this discovery, the focus of these seminars should be centered on the 'how' of SPI implementation.

It is also being proposed that emphasis should be given to a phased approach to successfully implement process change as distilled by (Gallivan, 2001; Heijstek & van Vliet, 2006). The stages are (1) contact, (2) aware, (3) understanding, (4) adoption, (5) institutionalized, and (6) internalized. During the contact stage prospective users of the new process get in contact with the new process, and then become aware of what the new process can do, at which point they obtain a deeper understanding of its benefits. With this knowledge prospective users will fully adopt the process, which will be embedded in the culture and become institutionalized and after sufficient passage of time will become internalized (Heijstek & van Vliet, 2006). The achievement of this suggested evolution can create a culture of continuous improvement, which by extension can lead to the institutionalization of SPI practices and ultimately higher quality software products being produced.

A limitation of the study was the small sample size. As a result, more extensive data analysis could not be done. Future research could include a larger sample for the quantitative analysis and this could be complemented with interviews to ascertain deeper insights in this area of SPI adoption in the ESC. In addition, a longitudinal study could be conducted to assess the progress being made in the areas of SPI awareness and adoption in ESC software development firms. If such progress is made these firms could win global contracts and earn needed foreign exchange, which by extension can increase the economic development of countries in the English-speaking Caribbean.

Reference

Abrahamson, E. (2000). Change without pain. *Harvard Business Review, 78*(4), 75-79.

Agrawal, M., & Chari, K. (2007). Software effort, quality, and cycle time: A study of CMM level 5 projects. *IEEE Transactions on Software Engineering, 33*(3), 145-156.

Avgerou, C. (2008). Information systems in developing countries: A critical research review. *Journal of Information Technology, 23*, 133-146.

Beecham, S., Hall, T., & Rainer, A. (2005). Defining a Requirements Process improvement Model. *Software Quality Journal, 13*, 247-279.

Berisso, Z. A., & de Vries, W. T. (2010). Exploring characteristics of GIS adoption decisions and types of induced changes in developing countries: The case of Ethiopia. *The Electronic Journal on Information Systems in Developing Countries, 40*(2), 1-16.

Bhatnagar, S. (2000). Social Implications of Information Communication Technology in Developing Countries: Lessons from Asian Success Stories. *The Electronic Journal of Information Systems in Developing Countries, 1*(4), 1-9.

Brooks, F. (1987). No Silver Bullet: Essence and Accidents of
Software Engineering. *Computer Magazine*, 1-13.

Bulatovic, J. (2011). Key issues in information systems management: A Serbia's perspective (Delphi study). *Global Journal of Computer Science and Technology, 11*(19), 34-50.

Chevers, D. A., & Duggan, E. W. (2007). A Modified Capability Framework for Improving Software Production Processes in Jamaican Organizations. *The Electronic Journal on Information Systems in Developing Countries, 30*(4), 1-18.

Chevers, D. A., & Duggan, E. W. (2010). *A preliminary study of the use of software process improvement initiatives in Jamaica.* Paper presented at the 3rd International Conference on Information Resources Management (Conf-IRM), Montego Bay, Jamaica.

Clarke, P., & O'Connor, R. V. (2013). An empirical examination of the extent of software process improvement in software SMEs. *Journal of Software: Evolution and Process*, 1-18.

Dooley, K., Subra, A., & Anderson, J. (2001). Maturity and its impact on new product development project performance. *Research in Engineering Design, 13*(1), 23-29.

Duggan. (2006). Tranquilizing the Werewolf that Attacks Information Systems Quality. In (pp. 253-281): Idea Group Inc.

European Commission, T. (2005). The new SME definition: User guide and model declaration. *Enterprise and Industry Publications*, 1-51.

Gallivan, J. (2001). Organizational adoption and assimilation of complex technological innovations: Development and application of a new framework. *Database for Advances in information Systems*, 51-85.

Hair, Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate Data Analysis*. New Jersey: Pearson - Prentice Hall.

Heeks, R. (2002). Information systems and developing countries: Failure, success, and local improvisations. *The Information Society, 18*, 101-112.

Heijstek, A., & van Vliet, H. (2006, May 10-12, 2006). *Measuring the adoption of software processes.* Paper presented at the 3rd Software Measurement European Forum, Rome, Italy.

Herbsleb, J., & Goldenson, D. R. (1996, March 25-29). *A systematic survey of CMM experience and results.* Paper presented at the 18th International Conference on Software Engineering - ICSE, Berlin, Germany.

ISO/IEC. (2001). *Product Quality - Part 1: Quality Model - ISO/IEC Standard 9126-1*.Unpublished manuscript.

Jiang, J. J., Klein, G., Hwang, H. G., Huang, J., & Hung, S. Y. (2004). An exploration of the relationship between software development process maturity and project performance. *Information & Management, 41*(3), 279-288.

Johnson, D. L., & Brodman, J. G. (1997). Tailoring the CMM for Small Businesses, Small Organizations and Small Projects. *Software Process Newsletter, 8*, 1-16.

Kamhawi, E. M. (2007). Critical factors for implementation success of ERP systems: An empirical investigation from Bahrain. *International Journal of Enterprise Information Systems, 3*(2), 34-49.

Kandt, R. K. (2003). *Ten steps to successful software process improvement.* Paper presented at the 27th Annual International Computer Software and Applications Conference, Hong Kong, China.

Kituyi, G. M., & Amulen, C. (2012). A software capability maturity adoption model for small and medium enterprises in developing countries. *The Electronic Journal on Information Systems in Developing Countries, 55*(1), 1-19.

Kodakanchi, V., Kuofie, M. H. S., Abuelyaman, E., & Qaddour, J. (2006). An economic development model for IT in developing countries. *The Electronic Journal of Information Systems in Developing Countries, 28*(7), 1-9.

Li, D., Huang, W. W., Luftman, J., & Sha, W. (2010). Key issues in information systems management: An empirical investigation from a developing country's perspective. *Journal of Global Information Management, 18*(4), 19-35.

Luftman, J., & Ben-Zvi, T. (2010). Key issues for IT Executives 2010: Judicious IT investments contunue post-recession. *MISQ Executive*, 1-16.

Mondragon, O. A. (2006). *Addressing infrastructure issues in very small settings.* Paper presented at the International Research Workshop for Process Improvement in Small Settings, Pittsburgh, PA.

Montoni, M. A., Rocha, A. R., & Weber, K. C. (2009). MPS.BR: A successful program for software process improvement in Brazil. *Software Process Improvement and Practice, 14*, 289-300.

Nauman, A. B., Aziz, R., & Ishaq, A. F. M. (2005). *Information Systems Development Failure: A Case Study to Highlight*

the IS Development Complexities in Simple, Low Risk Projects in

Developing Countries. Paper presented at the 2nd International Conference on Innovations in Information Technology, Dubai, UAE.

Niazi, M. (2012). An exploratory study of software process improvement implementation risks. *Journal of Software: Evolution and Process, 24*, 877-894.

Niazi, M., Babar, M. A., & Verner, J. M. (2010). Software process improvement barriers: A cross-cultural comparison. *Information and Software Technology, 52*, 1204-1216.

Oktaba, H., Garcia, F., Ruiz, F., Pino, F. J., & Alquicira, C. (2007). Software process improvement: The Competisoft Project. *IEEE Computer Society*, 21-28.

Pino, F. J., Garcia, F., & Piattini, M. (2008). Software process improvement in small and medium software enterprises: A systematic review. *Software Quality Journal, 16*(2), 237-261.

Rodriquez-Repiso, L., Rossitza, S., & Salmeron, J. (2007). Modelling IT projects success: Emerging methodologies reviewed. *Technovation, 27*(10), 582-594.

SEI. (2005). Capability Maturity Model Integration (CMMI) version 1.1 Overview. Retrieved February 9, 2007. *www.sei.cmu.edu/cmmi/adoption/pdf/cmmi-overview05.pdf.*, 9.

SEI. (2010). CMMI for Development, Version 1.3. *Carnegie Mellon University, Software Engineering Institute, CMU/SEI-2010-TR-033*.

Srinivasan, S., & Murthy, M. A. N. (2010). Process maturity model can help give a business an edge. *SixSigma Newsletter, 1*, 1-7.

Standish Group, T. (2013). Chaos Manifesto 2013: Think big, act small. *The CHAOS Manifesto*, 1-48.

Sulayman, M., Urquhart, C., Mendes, E., & Seidel, S. (2012). Software process improvement success factors for small and medium Web companies: A qualitative study. *Information and Software Technology, 54*, 479-500.

Walia, G. S., & Carver, J. C. (2009). A systematic literature review to identify and classify software requirements errors. *Information and Software Technology, 51*, 1087-1109.

Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information System Research, 16*(1), 85-102.