Identifying high perceived value practices of CMMI level 2: An empirical study

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\section*{Abstract}

Objective: In this paper, we present findings from an empirical study that was aimed at identifying the relative “perceived value” of CMMI level 2 specific practices based on the perceptions and experiences of practitioners of small and medium size companies. The objective of this study is to identify the extent to which a particular CMMI practice is used in order to develop a finer-grained framework, which encompasses the notion of perceived value within specific practices.

Method: We used face-to-face questionnaire based survey sessions as the main approach to collecting data from 46 software development practitioners from Malaysia and Vietnam. We asked practitioners to choose and rank CMMI level 2 practices against the five types of assessments (high, medium, low, zero or do not know). From this, we have proposed the notion of ‘perceived value’ associated with each practice.

Results: We have identified three ‘requirements management’ practices as having a ‘high perceived value’. The results also reveal the similarities and differences in the perceptions of Malaysian and Vietnamese practitioners with regard to the relative values of different practices of CMMI level 2 process areas.

Conclusions: Small and medium size companies should not be seen as being “at fault” for not adopting CMMI – instead the Software Process Improvement (SPI) implementation approaches and its transition mechanisms should be improved. We argue that research into “tailoring” existing process capability maturity models may address some of the issues of small and medium size companies.

\section*{1. Introduction}

One of the major challenges in the software industry is to help organisations, especially small-to-medium size, to design and implement appropriate control structures for managing software development activities. That is why the software engineering community (researchers and practitioners) has been allocating a large amount of resources to Software Process Improvement (SPI) since the early nineties. There has been a proliferation of SPI standards and models all claiming to increase the likelihood of success of process improvement initiatives. Some of the most notable efforts in this line of research and practice have resulted in process capability maturity models such as Capability Maturity Model (CMM), Capability Maturity Model Integration (CMMI) [11] and ISO/IEC 15504 (SPICE). These SPI frameworks can be used for defining and measuring the processes and practices that can be used by software developing organisations that are improving and/or assessing their software development processes.

However, a large majority of software development organisations appear to be unwilling to follow the SPI initiatives based on process capability maturity models like CMMI [53], which is the successor to CMM and is consistent with the international standard ISO/IEC 15504. An SPI programme is quite an expensive undertaking as organisations need to commit significant resources over a long time period. Even organisations who are willing to commit the resources and time do not always achieve their desired results [16,24]. Hence, the significant investment required and limited success are considered two of the main reasons for many organisations being reluctant to embark on a long path of systematic process improvement [53]. Moreover, in the case of small and medium size organisations, there are more concerns about the relevance and applicability of the models like CMM or CMMI [8]. Case studies reporting small organisations’ experience with CMM [5] invariably discuss the difficulties that small organisations have of using and benefiting from CMM. Based on a systematic review of 45 studies reporting SPI experiences of 122 companies, Pino et al., have found that only two medium size companies (with 70 and 150 employees) could be formally assessed as CMM-SW level 2 [42].

Consequently, there is growing realization of the importance of gaining an in-depth understanding of the business drivers for SPI in order to make SPI approaches more widely and easily used [12]. Researchers have also been emphasising the important role of identifying the relative “perceived value” (i.e. the extent to which
a CMMI level 2 specific practice is perceived to add value to a project or an organisation based on the perceptions and experiences of practitioners) of different CMMI practices [61]. It is argued that a better understanding of the relative value of CMMI practices perceived by organisations and practitioners is expected to enable SPI program managers to concentrate more on “high perceived value” practices. Other researchers have also studied the relative “perceived value” of CMMI practices with the aim of helping practitioners [61]. This research purports to extend the findings of Wilkie et al. [61] by conducting a similar study in two different countries, i.e. Malaysia and Vietnam, which have been attracting a significant number of software outsourcing contracts from Ireland, where Wilkie et al. carried out their study. Wilkie et al. [61] have described the results of CMMI software process appraisal with six small-to-medium sized software development companies. They have identified “commonly practiced” or “not practiced” elements of the model that lead them to the notion of perceived value associated with each specific CMMI practice. However, we have decided to identify the relative value of different practices of CMMI level 2 process areas based on practitioners’ perceptions and experiences rather than based on process appraisal like Wilkie et al. [61]. We believe that software practitioners usually associate different values to different CMMI practices and the relative value of a practice may encourage or discourage them from fully supporting a particular practice.

This paper presents the results of an empirical study aimed at identifying the relative “perceived value” of CMMI level 2 practices, based on the perceptions and experiences of practitioners in developing countries Malaysia and Vietnam, we are involved in outsourced software development. Since we expected to have small and medium size companies [59], we limited our research to the practices of CMMI level 2 process areas as it has been observed that when small and medium size companies start process improvement based on the CMM model, they set out to achieve level 2 [42]. Our investigation has revealed several interesting findings which enabled us to identify and explain the relative "perceived value" of different practices of the CMMI level 2 process areas. We have also identified a set of research questions that need to be explored in this line of research. This paper makes the following contributions to the SPI discipline:

- It presents the design and results of a first of its kind study in developing countries to identify an important aspect of CMMI-based SPI practices.
- It provides information about how practitioners perceive different practices of CMMI level 2 process areas.
- It identifies further research areas that need to be explored to support an effective and successful SPI program.

The following section discusses the background and motivation of this research. Section 3 describes the study design and logistics. Section 4 presents and discusses findings. The research and findings are summarized in Section 5. Limitations of the study are described in Section 6. The concluding remarks and future work are presented in Section 7.

2. Research background and motivation

Research shows that the effort put into SPI can assist in producing high quality software, reducing cost and time-to-market, and increasing productivity [2,21,43]. Despite the different advances made in the development of SPI standards and models, the failure rate for SPI programs has been reported up to 70% in a report from the Software Engineering Institute (SEI) [31,47]. It can be argued that one of the reasons for this situation is lack of attention being paid to gaining fine-grained understanding of the relative perceived value of various SPI practices prescribed by well-known SPI/SPA standards and models. There is a growing realization that organisations and practitioners usually pursue a particular practice or activity based on the perceived value/benefit and required effort and cost [1,30]. From the value-based software engineering perspective [7], it can be argued that the relative value of a practice may be the key consideration in management's decision to implement a particular value. This is a particular issue for small and medium size companies who need to be value sensitive in order to remain competitive in a tough global market.

Recently, a large number of software development companies have started moving their software development jobs/centres to relatively low cost countries like Malaysia and Vietnam, an emerging paradigm called Global Software Development (GSD). However, this paradigm shift has created a wide variety of new challenges for software development process management researchers and practitioners. One of the main challenges is the vital need of gaining an in-depth understanding of different practices of the SPI frameworks (i.e. CMMI Level 2) in organisations involved in software outsourcing and/or off-shoring, which are parts of the GSD phenomenon. We have noticed that an SPI program in the context of GSD usually requires more initial investment than a similar program in a non-GSD environment. Moreover, managing an SPI program in the GSD context is expected to be far more complex and difficult because of the geographically distributed locations and lack of reliable infrastructure for GSD teams [9]. That is why SPI practitioners face new challenges such as developing global SPI practices, creating confidence and trust among the vendor and customer companies, managing the expectations of what can and what cannot be done in a distributed setting, and understanding the human and cultural specific aspects of SPI initiatives. To successfully address these challenges, SPI practitioners need to gain a solid understanding of the changing mechanisms of designing and implementing better SPI practices in the context of GSD.

Despite the increasing importance of an empirically tested body of knowledge on different aspects of successfully implementing SPI initiatives, little research has been carried out to identifying the relative “perceived value” of CMMI level 2 practices based on the perception of practitioners in developing countries which are fast becoming the prime destinations for outsourcing. However, implementing models like CMMI is considered quite difficult in such developing countries as many of the companies are not only small-to-medium but also have resource constraints; hence, SPI becomes quite challenging [5].

Previously we have published, using Malaysian data, a primary study of only three process areas of CMMI level 2 [34]. This paper is a revised and substantially extended version in which we present findings from an empirical study, with Malaysian and Vietnamese practitioners, that was aimed at further identifying the relative “perceived value” of practices of six CMMI level 2 process areas. In this paper we have critically analysed and discussed each practice of CMMI level 2 process areas with a detailed description of the research methodology used. In addition, we have used statistical analysis in comparing perceived values given by Malaysian and Vietnamese practitioners. Our long-term research goal is to provide SPI practitioners with a body of knowledge that can help them to design and implement successful SPI initiatives in developing countries.

Our research is aimed at not only extending the findings of existing studies [61] by conducting a similar study in a different culture; but also at expanding this type of research by identifying the relative value of each CMMI practice perceived by practitioners. Moreover, it is also possible that CMMI practices may vary from one geographical region to another. As part of a large project about SPI implementation, we have been carrying out a research.
3. Study design

3.1. Perceived value

In this study, we define ‘perceived value’ to mean the extent to which a CMMI level 2 specific practice is perceived to add value to a project or an organisation based on the perceptions and experiences of practitioners who have been working in the area of SPI in their respective organisations. This may be considered to be a subjective view as it relies on the self-reported data. However, the respondents of this study are considered to be active members of SPI teams within their organisations. Hence, we are confident that their perceptions are grounded in significant experience of designing and deploying CMMI-based practices in real world SPI initiatives.

In order to describe the notion of perceived value of CMMI practices, it is essential to decide on the “importance” of a perceived value. For this purpose, we have used the following definition:

- If the majority of respondents (> 50%) perceive that a CMMI practice has high value then we treat that practice as critical.

A similar approach has been used in the literature [39,46]. Rainier and Hall [46] identified important factors in SPI with the criterion that if the 50% or more practitioners perceive that a factor has a major role in SPI efforts then that factor should be treated as having a major impact on SPI. However, SPI practitioners can define their own criterion in order to decide the importance of a CMMI practice. Like Wilkie et al. [61], we assert that “perceived value” of a particular practice can be used as a judgement criterion for determining activities that organisations need to pursue. We believe that where respondents from different organisations perceive a practice as having a high perceived value then that practice should be considered for its importance in an SPI program. The information about relative “perceived value” can help practitioners and researchers to better understand various practices detailed within the CMMI for the purpose of developing more appropriate implementation strategies and appraisal procedures for small-to-medium sized organisations.

3.2. Research method

Considering the available resources, we decided to use a face-to-face questionnaire based survey sessions to identify and understand the relative “perceived value” of CMMI level 2 practices based on the perception and experience of Malaysian and Vietnamese practitioners. A survey research method can use one or more data gathering techniques such as interviews and self-administered questionnaires [26]. A survey research method is considered suitable for gathering self-reported quantitative and qualitative data from a large number of respondents [25]. We decided to use a questionnaire as a data collection instrument in face-to-face meeting sessions. Our choice of combining questionnaire and face-to-face meeting sessions as a means of collecting data was motivated by several factors such as collecting data from respondents whose native language is not English, possibility of clarifying the objectives of the research and different terms used in the questionnaire and explanation the purpose of different questions included in the questionnaire, and ensuring data validation just before finishing each survey session. The negotiated survey session duration was an hour.

3.3. Data collection

We collected data from 46 software development practitioners of 23 Malaysian and 8 Vietnamese software development organisations. Appendix A shows the demographics of participants’ organisations.

More than two dozen software development companies were identified in Vietnam with the help of the Vietnam Competitive Initiative (VNCI), a US-Aid funded organisation working to improve the competitiveness of Vietnamese companies. An email invitation to participate in our research was sent to the Directors of the identified companies. Our invitation letter included a brief description of the research project and the nature of the commitment required. In return, we offered to make the findings of the research available to the participating companies and, in addition, to offer their staff half-day training in software architecture evaluation methods and techniques. As one of the researchers was experienced in architecture evaluation this offer was intended to provide an incentive for the companies to participate. Eight Vietnamese organisations agreed to allow their practitioners to participate in the research project. Each of the participating companies nominated a person to liaise with the researchers to plan and execute the research. Potential participants of this research were identified with the help of the liaison people. One or more relevant practitioners in each company were identified based on their direct involvement in SPI implementation programs in their respective organisations. Twenty-three practitioners from eight Vietnamese companies participated in our research. The survey sessions were conducted in the participants’ offices.

More than 70 software development companies were identified in Malaysia with the help of Centre for Advanced Software Engineering (CASE), University of Technology Malaysia. A letter of invitation was sent to these companies for participation in this research project. In return, CASE has organised a free seminar on “software process improvement: a road to success” for these companies. Twenty-three practitioners from 23 Malaysian companies were agreed to participate in our research. The survey sessions were conducted after the SPI seminar in a hotel.

Based on the organisation size definition provided by the Australian Bureau of Statistics (SMALL: 0–19 employees, MEDIUM: 20–199 employees and LARGE: 200+ employees) [59], our Malaysian sample contains 2 practitioners from small sized organisations and 21 practitioners from medium sized organisations. Our Vietnamese sample contains 21 practitioners from medium sized organisations and 2 practitioners from large sized organisations. Each company nominated employees who were involved in tackling real SPI implementation issues on a daily basis in their respective organisations. It is important to acknowledge that the practitioners nominated within organisations are representative of practitioners in organisations as a whole. A truly representative sample is impossible to attain and researchers should try to remove as much of the sample bias as possible [13]. In order to make the sample fairly representative of SPI practitioners in particular organisations, different groups of practitioners from each organisation were nominated to participate in this research. The sample of practitioners involved in this research includes developers, quality analysts, Software Quality Analysis (SQA) team leaders, SQA managers, project managers, and senior management. Thus the sample is not random but a convenience sample, because we sought a response from a person with a specific role within a software development organisation. We consider that the practitioners who participated in this study fall into two main categories:

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• “Developers” consisting of programmer/analyst/SQA coordinator.
• “Managers” consisting of team leader/project manager, and senior managers.

Our sample of data contains 19 developers and 27 managers. We planned the data collection procedure and process to meet the ethics requirements set for this research, i.e. protection of subjects from harm, deception and loss of privacy. The dignity and interest of participants was respected at all times. Approval from the host companies was gained prior to conducting the research. In addition the participating companies gave us consent to publish the findings provided the confidentiality and privacy would be maintained.

3.4. Data collection instrument and analysis method

We used a closed ended questionnaire as an instrument to collect self-reported data. Our questionnaire was based on the CMMI level 2 practices of six process areas. The questionnaire was also designed to elicit the perceived importance of each identified CMMI practice (perceived value). In order to indicate the importance of CMMI practices, the respondents were supposed to rate each identified practice’s relative value on a five-point scale (i.e. high, medium, low, zero, or not sure). In this questionnaire we have precisely described all CMMI level 2 practices with their related process areas. The questionnaire was tested in a pilot study for clarity and the required time.

In order to analyse the perceived value of each identified CMMI level 2 specific practice, the occurrence of a perceived value (high, medium, low, zero) in each questionnaire was counted. By comparing the occurrences of one CMMI practice’s perceived values obtained against the occurrences of other CMMI practices’ perceived values, the relative importance of each CMMI practice has been identified. We have also used this approach to identify high and low valued requirements engineering practices and SPI de-motivators in our previous research [33,36]. For most of the data analysis, we used frequency analysis. We believe that the presentation of data along with their frequencies is an effective mechanism for comparing and contrasting within, or across groups of variables.

Though all the participants were well-versed in English and the questionnaire was in English, the research team had a Malaysian speaking researcher in Malaysian and Vietnamese speaking researcher in Vietnam, who provided necessary interpretation and explanation whenever required.

In order to find significant differences between the two data sets (i.e. Malaysian and Vietnamese practitioners) we have used the linear by linear association chi-square test. The linear by linear association test is preferred when testing the significant difference between two ordinal variables because it is more powerful than Pearson chi-square test [29].

4. Findings

The questionnaire was designed to gather data about the “perceived value” of practices of six of the seven CMMI maturity level 2 process areas:

1. Requirements management.
2. Project planning.
3. Project monitoring and control.
6. Configuration management.

We did not include “Supplier Agreement Management” process area in our study as our participants were not managing the acquisition of products from suppliers.

4.1. Requirements management

The requirements management process area is focused on the practices that are considered important to manage the requirements of the products and to identify inconsistencies between the requirements of project’s plans and work products [11].

Fig. 1 presents the specific practices for requirements management process area reported by the Malaysian and Vietnamese practitioners. The results show that the most common ‘high’ value practice (61%) is ‘obtain an understanding of requirements – SP1.1-1’. Research shows that if a system’s requirements are not fully understood, it can have a huge impact on the effectiveness of the software development process for that system [15,18,23,41,45,51]. When requirements are poorly defined, the end result is a poor product or a cancelled project [23,51]. An industry survey in the UK reported that only 16% of software projects could be considered truly successfully: “Projects are often poorly defined, codes of practice are frequently ignored and there is a woeful inability to learn from past experience” [58, p. 17]. Sommerville and Ransom [49] have reported that well defined requirements should lead to business benefits. The evidence is clear: problems in the requirements phase can have a large impact on the success of software development projects [18,23,45,48,49]. The majority of the participants of this study perceive this practice of ‘high’ value, which shows the critical importance of this practice for improving software development processes using SPI models like CMMI.

The requirements management practice ‘obtain commitment to requirements – SP1.2-2’ is also a frequently reported ‘high’ value practice by the Malaysia and Vietnamese practitioners. One can obtain commitment to the requirements from the project stakeholders by involving them in a systems development process [14,23,45]. Involving stakeholders in the development process can reduce their fear, for example, that development of a software system will have any negative consequences such as loss of job or loss of organisational power. It is also a common observation that if a new system is installed in an organisation without consulting the stakeholders, who would be affected by the system, then they may feel that the new system is unnecessary and therefore they should not co-operate in its successful execution.

The other frequently cited ‘high’ value practice is ‘manage requirements changes – SP1.3-1’. Our results have confirmed the previous findings of several researchers that highlight the importance of this requirements practice [18,32,36,37,49]. It is widely reported that requirements often change during the software/system

![Requirements Management Specific Practices](image-url)
development process. These changes are inevitable and driven by several factors including errors in original requirements, evolving customer needs, constant changes in software and system requirements, business goals, work environment and government regulation [4]. Volatile requirements are regarded as a factor that causes major difficulties during system development for most organizations in the software development industry [62]. Volatile requirements contribute to the problems of software project schedule overruns and may ultimately contribute to a software project failure [54,62,63]. Furthermore, ad hoc change management can lead to escalating requirements, uncontrolled scope creep and potentially uncontrolled system development [15,60].

4.2. Project planning

The project planning process area incorporates the practices considered important to establish and maintain project plans and activities [11]. There are 14 specific practices in the ‘project planning’ process area as shown in Fig. 2. Our results indicate that none of the specific practices of this process area has been singled out as having a ‘high’ value by majority of the participants of this study. These results show that limited attention is being paid to project planning activities in Malaysia and Vietnam. Given that the effective project planning is considered a key to the success for an information systems development projects [22,28,44,55], it is quite interesting to find that the majority of the participants do not appear to place much value on most of the practices of this process area. Different studies have reported the importance of project planning in project management activities: Zwikael and Sadeh [64] have found that improving the project planning is an effective tool in dealing with high-risk projects; Sun-Jen and Wen-Ming [55] have reported the impact of project planning on project duration; and Linda et al. [27] have described the lack of project planning as a risk to software projects.

Other studies have reported several problems due to the lack of project management activities: Taylor [57] reported that only 12.7% of IT projects were successful (130 of 1027 surveyed); a study conducted by a group of Fellows of the Royal Academy of Engineering and British Computer Society shows that despite spending 22.6 billions pounds on IT projects in UK during 2003/2004 a significant number of projects failed to deliver key benefits on-time and to targeted cost and specification [58]; the CHAOS Report shows that on average the percentage of software projects completed on-time and on-budget improved from 16.2% in 1995 [50] to 35% in 2006 [52]. Despite this improvement, nearly two-thirds of the projects examined in the 2006 CHAOS report were ‘challenged’ (i.e. only partially successful) with the authors observing that one of the main reasons for project failure is poor project management activities of which project planning an important part.

These findings provide useful information about different aspects of the SPI initiatives in Malaysian and Vietnamese organisations, which participated in this research. Lack of project planning is considered a risk to software projects [27,55]. Despite this we have found that majority of the participants of this study appear to be unconvinced of the importance of project planning practices. One explanation of this finding can be that Malaysia and Vietnam are developing countries, where a large majority of the software development companies are small-to-medium sized organisations, which may not be able to allocate sufficient resources for training their employees in good project management practices.

The majority of the participants of the current study perceived eight practices of project planning (i.e. SP1.1-1, SP1.3-1, SP2.2-1, SP2.3-1, SP2.4-1, SP2.5-1, SP2.6-1 and SP3.2-1) as “medium value” practices. If this situation prevails then it will help Malaysian and Vietnamese practitioners to successfully implement a project planning process area of CMMI level 2 in their respective organisations [40]. Hence, using the criterion described in Section 2, we have not identified any frequently cited (>50%), ‘project planning’ practice which has a ‘high’ perceived value.
4.3. Project monitoring and control practices

The purpose of this process area is to provide an understanding of the project’s progress in order to perform corrective actions when the project’s performance deviates from the original plan [11].

Fig. 3 shows that there are 10 specific practices in the project monitoring and control process area. It is clear from Fig. 3 that none of the specific practices of this process area has been singled out as having a ‘high’ value by majority of the participants of this study. Rather, four practices (i.e. SP1.1-1, SP1.2-1, SP1.4-1 and SP2.2-1) of this process area are frequently cited (52%) ‘medium’ value practices. Project monitoring and control is an important activity in any project in which project managers make sure that the team is making satisfactory progress to the project deliverables [10,27,28] and it is interesting to find that a majority of the participants do not place high value on the practices designed for ensuring satisfactory progress in project monitoring and control. Different studies have reported the need to monitor project progress: John [22] reported that “if you don’t take time to figure out what happened during a project, both the good and the bad, you’re doomed to repeat it”, Sun-Jen and Wen-Ming [55] have reported the impact of lack of project monitoring on project duration; and Linda et al. [27] have reported a lack of project control as a risk to software projects. We assert that if this situation prevails in Malaysian and Vietnamese software development industry, the significant numbers of future projects may fail to deliver key benefits on time and to targeted cost and specifications. Such a situation can also have negative impact on software development economy of their countries as it will be hard for Malaysian and Vietnamese practitioners to get CMMI level 2 certification for their respective organisations. Hence, using the criterion described in Section 2, this study has not identified any frequently cited (>50%), ‘project monitoring and control’ practice which has a ‘high’ perceived value. However, four practices (i.e. SP1.1-1, SP1.2-1, SP1.4-1 and SP2.2-1) of this process area are frequently cited (52%) ‘medium’ value practices in Malaysia and Vietnam.

4.4. Measurement and analysis

This process area is used to develop a measurement capability in order to support the information needs of the management [11].

Fig. 4 shows that none of the specific practices of this process area were perceived as ‘high’ value practices by our respondents. One reason for this could be that small and medium sized companies that have more contacts with their employees are less likely to use measurement and analysis. However, gathering and analysing data for a suitable set of metrics is considered an important activity in any project as it provides insight into issues and risks [44,45,56]. Such information is vital to enable project managers to detect and resolve problems as early as possible [17]. The measurement and analysis process area provides management with the visibility that organisations need to develop measurement guidelines in order to improve their project management efforts [19,44,45]. Goldenson et al. [17] have described the need to focus on measurement and analysis from the very beginning of a process improvement effort in order to provide value to both projects and organisations. Well designed measurements guidelines are expected to help project managers to identify the problems, size and scope of the problems, sources of problems and any alternative course of actions [17]. In other studies the majority of the project managers emphasised the need on the use of accurate estimation techniques for any project success [41,45]. Our results show that none of the measurement and analysis practice was perceived to be of ‘high’ value, however all practices were perceived as ‘medium value’ practices. The results show that the most common ‘medium’ value practices (61%) are ‘analyse measurement data – SP2.2-1’ and ‘store data and results – SP2.3-1’. Most of our respondents (59%) consider ‘specify measures’ (SP1.2-1) and ‘collect measurement data’ (SP2.1-1) as ‘medium’ value practices. The other measurement and analysis practices are also a frequently reported ‘medium’ value practice in Malaysia and Vietnam.

However, the majority of the study’s participants do not place high value on the practices designed for measurement and analysis. Based on these findings and using the criterion described in Section 2, this study has not identified any frequently cited (>50%), ‘measurement and analysis’ practice which has a ‘high’ perceived value.

4.5. Process and product quality assurance

The purpose of this process area is to provide staff and management with useful insights into process and product quality assurance activities [11]. There are four specific practices in the ‘process and product quality assurance’ process area as shown in Fig. 5. The purpose of this process area is to provide an understanding of the project’s progress in order to perform corrective actions when the project’s performance deviates from the original plan [11].

Fig. 4. Measurement and analysis.

Fig. 5. Process and product quality assurance practices.
in Fig. 5. Our results indicate that none of the practices of this process area were perceived as 'high' value practice by the Malaysian and Vietnamese practitioners. Less than 30% of the participants cited all practices of ‘process and product quality assurance’ as ‘high’ value practices. These findings can be interpreted as an indication of the limited attention being paid to process and quality assurance activities in Malaysian and Vietnamese software development organisations of the participants of this study. Other reasons could be limited resources and limited technical expertise as most of the participants of our study belonged to small and medium sized companies and this is a particular issue for such companies [5]. Given that organisations need to demonstrate the ability of implementing process and product quality practices in order to achieve a certain level of CMMI maturity, it is an interesting revelation that the majority of our study's participants do not place a high value on the practices designed for ensuring process and product quality. We argue that quality issues should be fixed as early as possible in any project because “by the time you figure out you have a quality problem, it is probably too late to fix it” [22]. Process and product quality assurance is very important for companies that either develop software or buy software. This is because the process and product quality assurance is the activity which provides evidence that the methods and techniques used are integrated, consistent and correctly applied [20].

However, the bar chart in Fig. 5 shows that more than half of the respondents perceived all practices of ‘process and product quality assurance’ process area as having ‘medium value’. It will be interesting to find out the detailed reasons for this situation. This finding may also be considered as an indicator of an increasing realization of the critical role of the practices of this process area in achieving CMMI maturity level 2.

Based on these findings and using the criterion described in Section 2, this study has not identified any frequently cited (>50%), ‘process and product quality assurance’ practice which has a ‘high’ perceived value. However, this study identified (>50%) all practices of ‘process and product quality assurance’ process area as ‘medium’ value practices.

4.6. Configuration management

The configuration management process area is used to establish the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits [11].

Fig. 6 shows that there are in total 7 specific practices in the configuration management process area. Fig. 6 also presents the percentages of the participants' responses about the relative ‘value’ of each of the specific practices of this process area. It is clear that like all specific practices of the process and product quality assurance process area, that none of the specific practices of this process area has been singled out as having ‘high’ value by the majority of the participants of this study. However, a large majority of the participants perceived that each of the practices of this process area has either ‘high’ or ‘medium’ value in their process improvement program. That means there were only a small number of participants who perceived that the practices of this process area were of ‘low value’.

Such findings can be considered as a problem specific to Malaysia and Vietnamese companies as many companies in Western countries with relatively longer history of software development have been found not being able to adequately control their configuration items [61]. Other reason could be that a configuration management may not be so relevant to small and medium sized organisations. With the passage of time, the importance of the configuration management practices may grow among Malaysian and Vietnamese practitioners as they will learn from their Western colleagues.

However, more than half of the Malaysian and Vietnamese practitioners have cited four practices as ‘medium’ value practices as shown in Fig. 6. Hence, based on the criterion described in Section 2, we have not identified any practice in this process area that has been perceived as of ‘high’ value by more than 50% of the participants of our study.

4.7. Comparing Malaysian and Vietnamese perceptions

We have also decided to analyse the findings based on the participants’ country, i.e. Malaysia and Vietnam. We contend that an understanding of the similarities and differences found among practitioners’ perceptions, from different countries, about the relative value of the CMMI practices can help managers to design better SPI strategies as they can place more focus on the practices that are considered of ‘high’ value by practitioners in both countries. We believe that when respondents from different countries consider a practice of ‘high’ value, that practice tends to have a significant impact on the success of a SPI program. Tables 1–6 show the relative ‘perceived value’ of the CMMI practices reported by Malaysian and Vietnamese practitioners. Table 1 shows the list of requirements management practices along with their respective relative ‘value’ cited by Malaysian and Vietnamese practitioners. It is evident from Table 1 that four practices were considered as having a ‘high’ value by the majority of the Malaysian practitioners (>50%), while majority of the Vietnamese practitioners considered three requirements management practices as having a ‘high’ value. Out of five requirements management practices two are common between Malaysian and Vietnamese practitioners (i.e. obtain an understanding of requirements – SP1.1-1 and obtain commitment to requirements – SP1.2-2). This shows that the Malaysian and Vietnamese practitioners give importance to stakeholders’ participation in the systems development process as this is one of the motivations to obtain commitment and understanding to requirements from project participants [14]. More than 50% of the Malaysian practitioners also believe that an understanding of the requirements is important.
consider ‘maintain bidirectional traceability requirements – SP1.4-2’ as a ‘high’ value practice while only 30% of the Vietnamese practitioners consider this practice as a ‘high’ value. However, 65% of the Vietnamese practitioners consider SP1.4-2 as a ‘medium’ value practice. Our results show that there is no significant difference (i.e. \( p < 0.05 \)) between two the data sets.

### Table 1
Requirements management practices.

<table>
<thead>
<tr>
<th>Requirements management practices</th>
<th>Malaysia (n = 23)</th>
<th>Vietnam (n = 23)</th>
<th>Linear by linear association chi-square test ( \chi^2 ), df, ( p )</th>
</tr>
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<tbody>
<tr>
<td>SP1.1-1</td>
<td>H 14 8 0 0 1</td>
<td>H 14 8 0 0 1</td>
<td>0.000, 1, 1.000</td>
</tr>
<tr>
<td>SP1.2-2</td>
<td>12 9 2 0 0</td>
<td>12 8 1 0 2</td>
<td>0.610, 1, 0.435</td>
</tr>
<tr>
<td>SP1.3-1</td>
<td>12 6 5 0 0</td>
<td>11 11 1 0 0</td>
<td>0.388, 1, 0.534</td>
</tr>
<tr>
<td>SP1.4-2</td>
<td>12 6 3 1 1</td>
<td>7 15 0 0 1</td>
<td>0.000, 1, 1.000</td>
</tr>
<tr>
<td>SP1.5-1</td>
<td>10 11 2 0 0</td>
<td>12 11 0 0 0</td>
<td>1.023, 1, 0.312</td>
</tr>
</tbody>
</table>

H = High, M = medium, L = low, Z = zero, NS/NR = not sure/no response.

### Table 2
Project planning practices.

<table>
<thead>
<tr>
<th>Project planning practices</th>
<th>Malaysia (n = 23)</th>
<th>Vietnam (n = 23)</th>
<th>Linear by linear association chi-square test ( \chi^2 ), df, ( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1.1-1</td>
<td>8 12 0 1 2</td>
<td>12 11 0 0 0</td>
<td>3.624, 1, 0.057</td>
</tr>
<tr>
<td>SP1.2-2</td>
<td>12 6 3 0 2</td>
<td>7 15 0 0 1</td>
<td>0.021, 1, 0.886</td>
</tr>
<tr>
<td>SP1.3-1</td>
<td>7 14 0 1 1</td>
<td>9 10 2 0 2</td>
<td>0.020, 1, 0.887</td>
</tr>
<tr>
<td>SP1.4-1</td>
<td>7 14 1 0 1</td>
<td>13 5 1 0 4</td>
<td>0.132, 1, 0.717</td>
</tr>
<tr>
<td>SP2.1-1</td>
<td>8 9 3 0 3</td>
<td>9 9 0 0 5</td>
<td>0.010, 1, 0.920</td>
</tr>
<tr>
<td>SP2.2-1</td>
<td>6 11 2 0 4</td>
<td>5 13 3 0 2</td>
<td>0.334, 1, 0.266</td>
</tr>
<tr>
<td>SP2.3-1</td>
<td>7 10 4 0 2</td>
<td>6 15 2 0 0</td>
<td>1.296, 1, 0.255</td>
</tr>
<tr>
<td>SP2.4-1</td>
<td>7 11 3 0 2</td>
<td>9 13 0 0 2</td>
<td>1.501, 1, 0.221</td>
</tr>
<tr>
<td>SP2.5-1</td>
<td>7 12 3 0 1</td>
<td>6 15 1 0 1</td>
<td>0.028, 1, 0.867</td>
</tr>
<tr>
<td>SP2.6-1</td>
<td>6 9 5 0 3</td>
<td>3 15 2 0 3</td>
<td>0.014, 1, 0.906</td>
</tr>
<tr>
<td>SP2.7-1</td>
<td>9 11 3 0 2</td>
<td>12 10 0 0 1</td>
<td>1.314, 1, 0.266</td>
</tr>
<tr>
<td>SP3.1-1</td>
<td>9 11 2 0 1</td>
<td>8 11 1 0 3</td>
<td>0.388, 1, 0.533</td>
</tr>
<tr>
<td>SP3.2-1</td>
<td>7 12 2 0 2</td>
<td>5 13 3 0 2</td>
<td>0.066, 1, 0.797</td>
</tr>
<tr>
<td>SP3.3-1</td>
<td>7 12 1 0 3</td>
<td>7 10 2 0 4</td>
<td>0.172, 1, 0.678</td>
</tr>
</tbody>
</table>

H = High, M = medium, L = low, Z = zero, NS/NR = not sure/no response.

### Table 3
Project monitoring and control.

<table>
<thead>
<tr>
<th>Project monitoring and control</th>
<th>Malaysia (n = 23)</th>
<th>Vietnam (n = 23)</th>
<th>Linear by linear association chi-square test ( \chi^2 ), df, ( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1.1-1</td>
<td>10 8 3 0 2</td>
<td>5 15 0 0 3</td>
<td>0.225, 1, 0.635</td>
</tr>
<tr>
<td>SP1.2-2</td>
<td>8 9 4 0 2</td>
<td>5 16 0 0 2</td>
<td>0.066, 1, 0.798</td>
</tr>
<tr>
<td>SP1.3-1</td>
<td>10 8 2 1 2</td>
<td>10 11 2 0 0</td>
<td>1.526, 1, 0.217</td>
</tr>
<tr>
<td>SP1.4-1</td>
<td>7 11 2 0 3</td>
<td>7 13 1 0 2</td>
<td>0.357, 1, 0.550</td>
</tr>
<tr>
<td>SP1.5-1</td>
<td>5 9 5 0 4</td>
<td>8 12 0 0 3</td>
<td>1.682, 1, 0.195</td>
</tr>
<tr>
<td>SP1.6-1</td>
<td>9 10 1 0 3</td>
<td>9 12 1 0 1</td>
<td>0.763, 1, 0.382</td>
</tr>
<tr>
<td>SP1.7-1</td>
<td>10 8 3 0 2</td>
<td>8 11 0 0 4</td>
<td>0.192, 1, 0.662</td>
</tr>
<tr>
<td>SP2.1-1</td>
<td>10 8 2 0 3</td>
<td>10 9 1 0 3</td>
<td>0.047, 1, 0.829</td>
</tr>
<tr>
<td>SP2.2-1</td>
<td>9 12 1 0 1</td>
<td>10 12 1 0 0</td>
<td>0.734, 1, 0.392</td>
</tr>
<tr>
<td>SP2.3-1</td>
<td>10 10 2 0 1</td>
<td>8 12 1 0 2</td>
<td>0.162, 1, 0.688</td>
</tr>
</tbody>
</table>

H = High, M = medium, L = low, Z = zero, NS/NR = not sure/no response.

### Table 4
Measurement and analysis.

<table>
<thead>
<tr>
<th>Measurement and analysis</th>
<th>Malaysia (n = 23)</th>
<th>Vietnam (n = 23)</th>
<th>Linear by linear association chi-square test ( \chi^2 ), df, ( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1.1-1</td>
<td>8 12 2 0 1</td>
<td>7 14 1 0 1</td>
<td>0.023, 1, 0.879</td>
</tr>
<tr>
<td>SP1.2-2</td>
<td>7 13 2 0 1</td>
<td>6 14 2 0 1</td>
<td>0.000, 1, 1.000</td>
</tr>
<tr>
<td>SP1.3-1</td>
<td>6 14 2 0 1</td>
<td>6 12 2 0 3</td>
<td>0.418, 1, 0.518</td>
</tr>
<tr>
<td>SP1.4-1</td>
<td>6 12 4 0 1</td>
<td>6 13 3 0 1</td>
<td>0.089, 1, 0.765</td>
</tr>
<tr>
<td>SP2.1-1</td>
<td>7 14 1 0 1</td>
<td>8 13 0 0 2</td>
<td>0.000, 1, 1.000</td>
</tr>
<tr>
<td>SP2.2-1</td>
<td>8 13 1 0 1</td>
<td>6 15 1 0 1</td>
<td>0.024, 1, 0.876</td>
</tr>
<tr>
<td>SP2.3-1</td>
<td>7 13 2 0 1</td>
<td>7 15 0 0 1</td>
<td>0.218, 1, 0.641</td>
</tr>
<tr>
<td>SP2.4-1</td>
<td>4 16 2 0 1</td>
<td>10 9 1 0 3</td>
<td>0.065, 1, 0.798</td>
</tr>
</tbody>
</table>

H = High, M = medium, L = low, Z = zero, NS/NR = not sure/no response.
Table 2 shows the list of project management practices along with their respective relative 'value' cited by Malaysian and Vietnamese practitioners. We have identified only one practice (SP1.2-1) in Malaysia that has been perceived as of 'high' value by more than 50% of the practitioners. However, we have identified three practices (SP1.1-1, SP1.4-1 and SP2.7-1) which have been perceived as of 'high' value by more than 50% of the Vietnamese practitioners. Other practices have been perceived as of 'medium' value by most of the Malaysian and Vietnamese practitioners. We have identified only one practice (track change requests) of this process area has been frequently cited (≥ 50%) as a 'high' perceived value practice by Malaysian and Vietnamese practitioners. However, the majority (≥ 50%) of the Malaysian and Vietnamese practitioners consider all practices as a 'medium' value practice. We have already provided some of the possible explanations for such situation in Section 4.5. Moreover, we did not find any significant difference between two data sets.

Table 3 shows the list of project monitoring and control practices along with their respective relative 'value' cited by Malaysian and Vietnamese practitioners.

We have not identified any practice in this process area that has been perceived as of 'high' value by more than 50% of the Malaysian and Vietnamese practitioners. However, Table 3 shows that most of the practices were perceived as 'medium value' practices by the Vietnamese practitioners. However, Malaysian practitioners are far behind in realizing the importance of project monitoring and control practices. Our results show that there is no significant difference (i.e. \( p \leq 0.05 \)) between the two data sets.

Table 4 shows the list of measurement and analysis practices cited by the Malaysian and Vietnamese practitioners. It is clear that none of the specific practices of this process area was perceived as a 'high' value practice by more than 50% of the Malaysian and Vietnamese practitioners. The measurements and analysis is an important activity in any project. However, Table 4 shows that most of the practices were perceived as 'medium value' practices by the Malaysian and Vietnamese practitioners. The results show that the most common 'medium' value practice (16 out of 23) cited by the Malaysian practitioners is SP2.4-1 (communicate results). Table 4 also shows that the most common 'medium' value practices (15 out of 23) cited by the Vietnamese practitioners are SP2.2-1 (analyse measurement data) and SP2.3-1 (store data and results). Our results show that there is no significant difference (i.e. \( p \leq 0.05 \)) between two data sets.

Table 5 presents the relative 'value' of each of the practices of the process and quality assurance process area reported our respondents. It is interesting to note that no practice in this process area has been frequently cited (≥ 50%) as a 'high' perceived value practice by Malaysian and Vietnamese practitioners. However, the majority (≥ 50%) of the Malaysian and Vietnamese practitioners consider all practices as a 'medium' value practice. We have already provided some of the possible explanations for such situation in Section 4.5. Moreover, we did not find any significant difference between two data sets.

Table 6 shows the specific practices of the configuration management process area along with their respective perceived 'value' as cited by our respondents. Our results show that no specific practice of this process area has been frequently (≥ 50%) cited by Malaysian and Vietnamese practitioners as being a 'high' value practice. We argue that this is due to the fact that Malaysia and Vietnam are developing countries and it will take them some time to learn from their Western colleagues. Only one practice (track change requests – SP2.1-1) was considered as a 'medium' value practice by more than 50% of the Malaysian practitioners. However, all practices of configuration management process were considered as a 'medium' value practices by majority of the Vietnamese practitioners. These results show the level of commitment Vietnamese practitioners are going to have in developing configuration management practices.

5. Summary

Our research has been motivated by the challenges faced by companies, especially small-to-medium sized, in implementing CMMI-based process improvement programs. Moreover, there have also been calls to understand business drivers and relative 'perceived value' of different practices of a process improvement model such as CMMI in order to make SPI methods and technologies widely used [12]. We believe that a better understanding of the relative value of SPI practices perceived by practitioners should be taken into consideration while designing and implementing an SPI program.

Other researchers have also conducted a study to identify the relative value of the each of the practices of CMMI level 2 process areas with the aim of helping practitioners to pay more attention to the 'high perceived value' practices [61]. The relative "perceived value" of CMMI practices can act as a guide for SPI program man-
High SP1.1-1, SP1.2-2, SP1.3-1
Medium SP1.1-1, SP1.3-1, SP2.2-1, SP2.3-1, SP2.4-1, SP2.5-1, value
Perceived
Comparing Malaysian and Vietnamese perceptions and experiences of CMMI level 2 practices.

Table 8
Summary of perceived values of CMMI level 2 practices in Malaysia and Vietnam.

<table>
<thead>
<tr>
<th>Perceived value</th>
<th>Requirements management</th>
<th>Project planning</th>
<th>Project monitoring and control</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>SP1.1-1, SP1.2-1, SP1.3-1, SP2.1-1, SP2.2-1, SP2.3-1, SP2.4-1, SP2.5-1, SP2.6-1 and SP3.2-1</td>
<td>SP1.1-1, SP1.3-1, SP2.1-1, SP2.2-1, SP2.3-1, SP2.4-1, SP2.5-1, and SP2.6-1</td>
<td>SP1.1-1, SP2.1-1, SP2.2-1, SP2.4-1 and SP2.6-1</td>
</tr>
<tr>
<td>Medium</td>
<td>SP1.1-1, SP1.2-1, SP1.3-1, SP1.4-1, SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1</td>
<td>SP1.1-1, SP1.2-1, SP1.4-1, and SP2.2-1</td>
<td>SP1.1-1, SP2.1-1, SP2.2-1 and SP3.1-1</td>
</tr>
</tbody>
</table>

However, our study has not identified any frequently cited 'high' value practice for other process areas of CMMI level 2.

We have also analysed the responses based on the participants' country. We suggest that understanding the similarities in SPI practices across practitioners from different developing countries can help to develop effective SPI implementation strategies in these countries. This is because, where respondents from different countries consider a practice of 'high' value, that practice is likely to have a significant impact on the success of a SPI program in developing countries. Based on this analysis, we have found (as summarized in Table 8):

- three 'requirements management' practices as having a 'high' perceived value;
- a number of medium value practices in different process areas of CMMI level 2.

Four specific practices of the 'requirements management' process area have been reported as 'high' value practices by Malaysian practitioners. However, three practices of this process area have been reported as a 'high' value by Vietnamese practitioners.

We have identified only one practice (SP1.2-1) of the 'project planning' process area which has been perceived of a 'high' value by more than 50% of the Malaysian practitioners. However, we have identified three practices (SP1.1-1, SP1.4-1 and SP2.7-1) which have been perceived of 'high' value by more than 50% of the Vietnamese practitioners.

We have not identified any practice in project monitoring and control process area that has been perceived as of 'high' value by more than 50% of the Malaysian and Vietnamese practitioners.

- None of the specific practices of the 'measurement and analysis' process area was perceived as a 'high' value practice by more than 50% of the Malaysian and Vietnamese practitioners. However, most of the practices were perceived as 'medium' value practices by our respondents.

- None of the practices of the 'process and product quality assurance' process area has been perceived as a 'high' value by Malaysian and Vietnamese practitioners. However, all of the practices were perceived as 'medium' value practices by our respondents.

- None of the practices can be considered as having a 'high perceived value' in configuration management process area.

These findings indicate that our respondents are aware of the importance of 'requirements management' process area as most of the practices in these process areas were perceived as 'high value' practices by more than 50% of our respondents. Our results indicate that Vietnamese practitioners have started realizing the

Table 8
Comparing Malaysian and Vietnamese perceptions and experiences of CMMI level 2 practices.

<table>
<thead>
<tr>
<th>Perceived value</th>
<th>Requirements management</th>
<th>Project planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>Vietnam</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>SP1.1-1, SP1.2-2, SP1.3-1 and SP1.4-2</td>
<td>SP1.1-1, SP1.2-1, and SP1.5-1</td>
</tr>
<tr>
<td>Medium</td>
<td>SP1.4-2</td>
<td>SP1.1-1, SP1.2-1, SP1.3-1, SP2.1-1, SP2.2-1, SP2.3-1, and SP2.4-1</td>
</tr>
</tbody>
</table>

Project monitoring and control

| Malaysia | Vietnam |
| High | SP2.2-1 | SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1 |
| Medium | SP2.2-1 | SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1 |

Process and product quality assurance

| Malaysia | Vietnam |
| High | SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1 | SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1 |
| Medium | SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1 | SP2.1-1, SP2.2-1, SP2.3-1 and SP2.4-1 |

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importance of other process areas of CMMI level 2 as most of the practices in these process areas were perceived as ‘medium value’ practices by the majority of the Vietnamese practitioners. Our results also indicate that Malaysian practitioners are not fully aware of the importance of two process areas of CMMI level 2, i.e. ‘project monitoring and control’ and ‘configuration management’. This may be due to the fact that often in organisations practitioners are under enormous time pressure (i.e. time pressure is often in the form of meeting project deadlines) [35]. Hence, they may have little time in which to participate in project monitoring and control, and configuration management activities. These findings enable us to suggest that Malaysian organisations should design SPI awareness initiatives for their practitioners in order to fully understand the benefits of these two process areas. These SPI awareness initiatives can be organised in the form of training and coaching programs. In addition, Malaysian organisations should establish some procedures to avoid their developers from time pressure.

Our long-term research goal is to build an empirically tested body of knowledge of different aspects of SPI initiatives and assessment. We are approaching this by firstly focusing on complementing and/or extending the current understanding about practitioners’ attitudes toward and opinions of different aspects of SPI models and programs. We plan to develop appropriate support mechanisms and tools to facilitate the design and implementation of suitable SPI strategies. In this study, we have gained important insights into the relative “perceived value” of each practice of the six process areas of the CMMI level 2 maturity. We found that practitioners view certain practices as of ‘high’ value and should be paid more attention in any SPI program initiative.

6. Limitations

Construct validity is concerned with whether or not the measurement scales represent the attributes being measured. Our survey instruments were based on the specific practices of the six process areas of CMMI level 2 [11]. During the survey sessions, the researchers observed that the participants were able to recognize each of the practices without any difficulty. Hence, their responses provided us with the confidence that all the practices included in the survey instrument were relevant to the participants’ workspace.

Another issue is that the questionnaire surveys are usually based on self-reported data that reflects what people say they believe or do, not necessarily what they actually believe or practice. Hence, our results are limited to the respondents’ knowledge, attitudes, and experiences regarding the relative ‘value’ of each of the specific practices of different process areas of CMMI maturity level 2. However, the participants’ perceptions and experiences have not been directly verified through another mechanism such as appraising their organisational practices like Wilkie et al. [61]. This situation can cause at least one problem – practitioners’ perceptions and experiences may not be fully accurate as the relative ‘values’ assigned to different practices may actually be different. However, like the researchers of many studies based on opinion data [3,6,38], we also have full confidence in our findings because we have collected data from practitioners who were directly involved in SPI efforts in their respective organisations and their perceptions and experiences were explored without any direction from the researchers.

Sample size may be another issue as 46 practitioners participated in this study. In this respect, our research was limited by available resources and the number of companies that could be convinced to participate in the reported study. However, to gain a broader representation of developing countries practitioners’ views on this topic, more practitioners and companies need to be included in a study.

Another limitation of the study is the non-existence of a proven theory about human and organisational aspects of SPI efforts to guide a research similar to ours. That is why we considered our research as an exploratory approach, aimed at gathering facts in the hopes of drawing some general conclusions. We expect that the findings from this research can help us and the wider SPI community to identify a research direction to develop and validate a theory of mechanics of SPI based on a certain maturity model.

7. Conclusion and future work

Small and medium size companies should not be seen as being “at fault” for not adopting CMMI – instead the SPI implementation approaches and its transition mechanisms should be improved. We argue that to achieve broader impact, SPI approaches must target small and medium size software developing companies and require very little cost and time to adopt. Radically different approaches to SPI may be required. One size may not fit all, and it is possible that research into “tailoring” existing process capability maturity models may address some of the issues of small and medium size companies.

Our results indicate that practitioners usually support a specific SPI practice on the basis of the relative value of that practice perceived by them. Based on these findings we can suggest that the relative perceived value is often grounded in relevant experiences of real world and practitioners roles in different organisations. The information about the perceived value can provide organisations with new opportunities for targeting the areas which need real attention. By paying attention to weak areas of SPI initiatives, we can develop a finer-grained framework, which can help organisations to better implement SPI initiatives.

We encourage independent studies on this topic. This could increase confidence in our findings and also track changes in attitudes to SPI over time. We encourage further research into the extent and nature of variation of business context, needs, and constraints of small and medium size software developing organisations, and their differences to larger organisations. We believe that a good understanding of these issues is vital in improving and creating effective SPI approaches. From the findings of this study, we have identified following goals that we plan to follow in future:

- Collect additional data on the perceived value of different SPI practices by exploring the basis of practitioners’ perceptions and experiences through more in-depth interviews and case studies.
- Conduct empirical studies to determine the relationship between the relative “perceived value” of each practice and how its implementation is justified by return on investment.
- It is also important to determine the mechanics of encouraging practitioners to support those practices which have been perceived of “low value” but are required to achieve a certain level of process maturity.
- Conduct a comparative study to compare the Malaysian and Vietnamese practitioners’ views on SPI practices with their counterparts’ views in the UK [61]. This comparative study will provide insight to SPI managers by knowing the views of practitioners in a developed country (i.e. UK) and a developing country (i.e. Malaysia and Vietnam).

Acknowledgements

We are grateful to the participants and their companies for participating in this study. Lero is funded by Science Foundation Ireland under Grant Number 03/CE2/I303-1.
Appendix A. Demographics

<table>
<thead>
<tr>
<th>ID</th>
<th>Company age (yrs)</th>
<th>Number of employees</th>
<th>Primary function</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Business systems and telecommunications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Business systems and real time systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Software systems and windows based systems</td>
</tr>
<tr>
<td>2</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Safe time systems</td>
</tr>
<tr>
<td>3</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house and outsourced development</td>
<td>Windows based systems and embedded systems</td>
</tr>
<tr>
<td>4</td>
<td>3–5</td>
<td>20–199</td>
<td>In-house and outsourced development</td>
<td>Data processing and systems software</td>
</tr>
<tr>
<td>5</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Real time systems</td>
</tr>
<tr>
<td>6</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Windows based systems</td>
</tr>
<tr>
<td>7</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house and outsourced development</td>
<td>Safety critical</td>
</tr>
<tr>
<td>8</td>
<td>3–5</td>
<td>20–199</td>
<td>In-house and outsourced development</td>
<td>Windows based systems and embedded systems</td>
</tr>
<tr>
<td>9</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Data processing and systems software</td>
</tr>
<tr>
<td>10</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Real time systems</td>
</tr>
<tr>
<td>11</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Windows based systems</td>
</tr>
<tr>
<td>12</td>
<td>&gt;5</td>
<td>20–199</td>
<td>In-house development</td>
<td>Safety critical</td>
</tr>
<tr>
<td>13</td>
<td>&gt;5</td>
<td>&lt;20</td>
<td>In-house development</td>
<td>Software systems</td>
</tr>
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References


