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Factors Influencing the Adoption of ISO/IEC 29110 in Thai Government Projects: A Case Study

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Abstract

This paper presents the views of four Thai government organizations who had been awarded ISO/IEC 29110 Basic Profile Certification. Team ideas as to the success factors and barriers involved in implementations are explored. In-depth interviews with closed- and open-ended questions were conducted. The data collected was analyzed using qualitative content analysis. The results show two reasons for choosing standard, first, to enhance software development process, and second, because the financial support from the SIPA. The success factors were supportive organizational policy, staff participation, availability of time and resources for the improvement of the software process, consultations with the SIPA and team commitment and recognition. The barrier factors were time constraints, lack of experience, documentation load, unsynchronized means of communication and improper project selection. The findings were based on four diverse organizations. Other countries may take into account the variations e.g. working culture or organizational structure when seeking to apply these results.

Keywords

Barrier, Executive Perspective, Government Agency, ISO/IEC 29110, Software Process Improvement, Standard Certification, Success Factor, Thailand Context, Very Small Entities (VSEs)

1. Introduction

ISO/IEC 29110 is a process lifecycle standard for very small entities (VSEs) targeted particularly at organizations developing systems having hardware and software elements and software, with up to 25 people (ISO, 2011) (O'Connor & Laporte, 2014). The objective of the standard is to control the quality of software and system and/or service processes, from the perspective of both administrative and technical support. The process used to develop ISO/IEC 29110 started with the ISO/IEC/IEEE 12207 and ISO/IEC/IEEE 15288 international standards. ISO/IEC/IEEE 12207 and 15288 process elements were selected to develop profile specifications (Laporte, Alexandre, & O'Connor, 2008; ISO, 2015a).

In ISO/IEC 29110-2-1 standard there is a definition of profile that states: "*Profile is set of one or more base standards and/or profiles, and where applicable, the identification of chosen classes, conforming subsets, option, and parameters of those base standard, or standardized profiles necessary to accomplish a particular function*" (ISO, 2015a). Four profiles

which are Entry, Basic, Intermediate and Advanced are proposed on ISO/IEC 29110. Also, management and engineering guides, such as ISO/IEC TR 29110-5-1-1:2012, were developed to facilitate the implementation of the profile specifications (ISO, 2012). VSEs have to be assessed by an assessor for standard certification. This VSEs standard is suitable to be applied to any development life cycle, for example waterfall, iterative, incremental, evolutionary or agile (ISO, 2015b).

Because this standard is suitable for application in the context of Thai VSEs, the Thai Government has agreed to promote ISO/IEC 29110 to entrepreneurs, practitioners and both public and private organizations. The Basic Profile is the profile selected to be implemented in Thailand. The ISO/IEC 29110 Basic Profile consists of two processes, project management (PM) and software implementation (SI) (ISO, 2011). The objectives of PM are to determine the project's beginning point, to establish the tasks of software implementation and to manage the project in order to achieve the goal of the project (O'Connor & Laporte, 2012). The objectives of the SI process are to analyze, design, construct, integrate, verify, and validate activities for new or modified systems following the specified requirements (O'Connor, 2014).

In 2011, three Thai ICT-related public organizations, namely, the Ministry of Information and Communication Technology (MICT), the Software Industry Promotion Agency (SiPA) and The Innovation Foundation signed a memorandum of understanding and started a project that aimed to encourage both the Thai government and the private sector to improve their software development processes using the ISO/IEC 29110 standard. Since then, the Thai Government and SiPA, as the project leader, have been providing full support for participants who are willing to adopt ISO/IEC 29110 as their software process standard. The Thai government has been promoting "The use of standards in software procurement for government" projects and hopes that this standard will be widely adopted in order to achieve continuous quality in process improvement, and the ISO/IEC 29110 standard has been adopted as a part of the strategic plan to empower the Thai software industry to meet international standards (Ministry of Information and Communication Technology, 2015).

A project to encourage software entrepreneurs to participate and achieve ISO/IEC 29110 certification was established by SiPA in 2012. The objectives of this project were to support the community of Thai software companies and government agencies to increase their software process quality, to expand the capability of the Thai software industry in international competition, and to build credibility, confidence and a good image with customers (SiPA, Project, 2013). This valuable project has been assisting participants who are interested in adopting the ISO/IEC 29110 standard since 2012 (SiPA, Project, 2014; SiPA, Project, 2015).

A total of 152 organizations achieved ISO/IEC 29110 Basic Profile certification in the first year that the project was implemented, including four government agencies. The total numbers of private and public organizations certified between 2012 and 2015, are 274 and 13 respectively. The total number in each year is shown in Table 1.

Table 1. ISO/IEC 29110 Basic Profile certified organizations in Thailand

Types of participant	2012	2013	2014	2015	Total
Private	148	40	57	29	274
Public	4	6	2	1	13
Total	152	46	59	30	287

ISO/IEC 29110 is starting to gain popularity because it seeks to reduce process complexity, implementation costs and time overheads, while promoting effective software processes and improved performance (Takeuchi, Kohtake, Shirasaka, Koishi, & Shioya, 2013). Another reason that makes this standard more useful is that it was specifically designed for very small entities (VSEs) with up to 25 people (Laporte et al., 2008; Ribaud, Saliou, O'Connor, & Laporte, 2010), and is therefore appropriate for many information technology development sections in government agencies (Siddoo, Wongsai, & Wetprasit, 2012). However, the standard is quite new and is less recognized within the industry than other well-known model such as CMMI.

Despite the problem of its unfamiliarity within the industry, the publication of articles related to the adoption and implementation of the ISO/IEC 29110 standard has steadily increased in the decade since this software process standard for VSEs emerged, (e.g. Ribaud, Saliou, & Laporte, 2010; O'Connor & Laporte, 2011). These studies show that there is a high potential for success in applying ISO/IEC 29110 in international software industries. Hence, compliance with ISO/IEC 29110 could be the first step, for many small organizations that want to standardize their software process, as part of their software process improvement (SPI) strategy. However, so far no studies have dealt with the factors, which lead to success or failure in the adoption of this standard in the public sector (Clarke & O'Connor, 2012b).

The authors, as the implementation team in one of the pioneer Thai government organizations who were certified in 2012 (Siddoo et al., 2012), found that the standard certainly enhances the software process in terms of documentation, processes and change management. Moreover, it not only increases the effectiveness of team communication, but it can also more easily deliver the results of the project implementation as planned to the organization's executives.

The main motivation of this study is to encourage government agencies with internal Information Technology/Software development departments to become, certified to an appropriate standard, even though, the main mission of most agencies is not related to business but to public service (Åkesson & Edvardsson, 2008; Sharma, 2015). The objective of this paper is to explore the factors which influence success and create barriers to success by investigating public organizations that have participated and achieved ISO/IEC 29110 Basic Profile certification. This study pays more attention to the perspective of executives/managers and their teams and how these factors affect them, because they are the people accountable for system/software development initiative programs in conventional Thai bureaucratic organizations. The contribution from this study could be valuable as a set of guidelines for government organizations considering the implementation of the ISO/IEC 29110 standard.

2. Suitability

2.1 Why do Thai government organizations need the ISO/IEC 29110 standard?

Thailand has had five main ICT master plans between 1996 and the present, namely, IT-2000 (1996-2000), IT 2010 (2001-2010), The first ICT Master Plan (2002-2006), The second ICT Master Plan (2009-2013), and The Third ICT Master Plan or Smart Thailand 2020 (2014-2018). All these plans have implemented a policy of encouraging government organizations to adopt information technology in their daily services and data management. In addition, these plans have also focused on encouraging information technology-related companies, which are mostly small or medium sized enterprises (SMEs), to gain advantage by using ICT to improve their business operations. The ultimate goal of the plans is to drive Thai society towards being a smart society.

A survey by the National Electronics and Computer Technology Centre (NECTEC) in 2002 (Malaiwong, 2003) reported that more than half of the enterprise software used in government organizations was developed in-house, and that applications produced in-house were able to satisfy user requirements better than those developed by hired software companies. This means that if government organizations have well-managed software projects and well-developed software products, then customers or end-users will be more satisfied. Although the government prefers each of its agencies to implement its own ICT policies, there are still some problems in developing in-house ICT services with relation to software process and delivery.

Lack of integration and good practices in employing ICT is a vital issue despite the government's master plans. Many organizations have been unable to define their policies and do not have a clear idea about how they could apply information technology (Abbott, 1997). Some do not realize the advantage of having information systems and do not really know their own requirements. These factors all influence the system development plans in the software development unit, causing resources to be occupied by unnecessary tasks.

Moreover, staff turnover is a major problem in government organizations because they cannot compete with the private sector in terms of remuneration. The combination of staff turnover and unsystematic software development documentation causes low development performance. New staff are not able to join teams immediately and to seamlessly take over the roles abandoned by staff leaving government organizations where recruitment is uncertain and involves compliance with many bureaucratic procedures.

Further, the local business culture is another factor which influences the adoption and implementation of software process models (Phongpaibul & Boehm, 2007). Thailand has a socialized culture where customer and user satisfaction in social terms is more important than the strict terms of the contract. Consequently, meeting the requirements set out in a contract does not guarantee satisfactory performance. This is aggravated because government organizations do not have staff with sufficient knowledge of software engineering to detect and correct such problems (Basri & O'Connor 2012).

ISO/IEC 29110 addresses these challenges in control and management in both project management and software development processes (ISO, 2011). ISO/IEC 29110 technical report provides guidelines for system/software development with minimum resource requirements required to solve all those difficulties and maintain the quality of the software produced.

2.2. ISO/IEC 29110 adoption

SPI is concerned with the utilization of process engineering to make software development more effective (Larrucea et al, 2016). A quality SPI will help development teams control processes and finish jobs on time and within budget (Solingen, 2004). There are differences between large and small companies in term of SPI implementation (O'Connor, Basri, & Coleman, 2010). Particular VSEs adapt the standard software process to suit their own characteristics and limitations. The management style (Coleman & O'Connor, 2008a), the background of the software development manager/company founder, the size of the company, the target market and the type of project and system influences the software development process (Coleman & O'Connor, 2008b). Deciding to apply any standard is important because it should be flexible in its application to VSEs and needs to take the differences in characteristics into consideration (Clarke & O'Connor, 2012a) (Jeners et al, 2013).

ISO/IEC 29110 is a system/software engineering standard designed for VSEs (Laporte et al, 2015). The processes included in this standard are sufficient and suitable for small organizations to be able to gradually evolve the quality of their development. The project

management process is designed to minimize the documentation to suit the scope of the project, within a reasonable budget using only as much time as necessary without sacrificing the quality of the software product. When the software development team carries out its tasks according to the project plan, the project manager can follow the standard process to monitor each step and efficiently control the progress of the project until the product is delivered. There have been a number of studies of ISO/IEC 29110 related to the perspective of the standard's adoption in many countries.

Basri and O'Connor (2010) studied the views of a number of Irish software companies, who were all VSEs, about the adoption of process standards, especially ISO/IEC 29110. The results showed that the companies have generally negative perceptions about the adoption of standards, the barriers identified being that standards were overly involved and complicated, there was a lack of detailed implementation guidance, substantial resources were required and there was low demand from customers for standards to be implemented. However, those companies were aware of the potential benefits of being accredited to quality standards, for example, that standards could lead to their products having higher quality, project teams producing consistent work quality and their processes being improved. Respondents gave recommendations about the criteria which standards should meet in making them more likely to be adopted. The expected standard should align with current business and development process styles, have clear and simple guidelines or templates, have training or workshops and mentors or consultants, require lower documentation and easy management, and should minimize costs and the use of resources.

O'Connor (2012a) also interviewed Irish senior managers about their opinions, attitudes and sentiments towards implementing ISO/IEC 29110 in their companies. The study looked at four core areas: acceptance of standards, interest in standards, awareness of standards and perceived needs. The managers interviewed thought that the standard was difficult to tailor to their processes and that they had to work hard to achieve certification. They felt that companies needed guidelines to follow and had to stretch their resources if they were to be involved in standard accreditation. In addition, it was again noted that there was no requirement from the market for software development companies to be accredited to standards. Customers were not interested in software process improvement but mostly focused on product delivery. Therefore, the standard had low acceptance in business and implementation was a low priority and it can be assumed that this forms a barrier to deploying the standard. However, even though the standard was not perceived as being a priority for software companies, the managers interviewed still had a positive perspective about its value. They were interested in the standard and concerned about having certification. The study concluded that there were six main benefits to be derived from implementing ISO/IEC 29110: (1) it would be likely to lead to a quality product, (2) it would create working team consistency, (3) it would create working process consistency, (4) it would improve the work process, (5) it would improve the company's image and (6) it would be good for business.

Finally, the researcher listed the criteria which the managers felt were necessary for ISO/IEC 29110 adoption which can be considered as forming success factors for a successful implementation. These were that the standard must align with the current development process, must provide detailed principles or guidelines for implementation and have sample templates. Training should be provided on how to apply the standard, and the implementation process should be easy to manage and not require excessive documentation, and the process should be easy to adapt to apply to existing business and other technical standards. Finally, the implementation of the standard should be low cost and not excessively demanding on the company's resources (O'Connor, 2012b).

In a later study conducted by the same researcher, two Irish based VSEs were adopted as case studies during their accreditation to the ISO/IEC 29110 standard. The study focused on project management design and development. The researcher provided training and helped the project teams by using a project management deployment package. The two case studies were successful in managing their projects by applying the package. After the accreditation process had been completed the researcher used unstructured open interviews to collect the views of the project managers, CEOs and CTOs involved. Overall, the managers agreed that the standard was beneficial but had some reservations about the accreditation process, namely that it took too long to complete, that excessive resources were consumed by the process, and that there had been no requirement from either the market in general or from their customers for accreditation to the standard. The critical features which the interviewees considered were necessary from the standard were that it should not be too difficult to adopt, that there should be guidelines or examples for teams who had no previous experience of the implementation of the standard to follow, and that when problems occurred, it would be useful to have a mentor or consultant who could help to resolve those problems. Finally, it was again stressed that the standard should be compatible with the organization's work and the current techniques used. (O'Connor, 2014)

Sanchez-Gordon, O'Connor and Colomo-Palacios (2015) interviewed project managers and staff working for software companies in both Ireland and Ecuador in relation to their opinions, attitudes and sentiments about adopting ISO/IEC 29110. They identified three categories and six sub-categories of quality standard acceptance level as follows:

1. Level of Interest and Awareness: high awareness of standard, standard benefit awareness
2. Level of Acceptance: low acceptance (overly involved/complicated, lack of detailed implementation guidance), less priority (low demand for accreditation to standards from clients)
3. Barriers Towards Adoption: perceived need, resource demand

They noted that companies are interested in the ISO standard because it is able to improve the quality of software products; software teams are able to come to agreements about working by using the ISO process, and the standard has created consistency in development work and reduced the time spent on the development process. Moreover, companies had a better image in terms of their marketing if they were certified to an ISO standard. The companies that were the subject of the case studies also considered the factors that would lead them to succeed in the implementation of a software quality standard. The factors identified were: *minimum overhead in terms of resources, guidelines or deployment packages and certification process scheme, time required or lessons learned, expert assistance, clear templates provided, and workshop and/or training provided on how to actually apply standard.*

In addition, the companies also pointed out some barriers in their ISO adoption. These were *lack of resources, difficult process in implementation, many documents to complete, and customer did not require the standard.* (Sanchez-Gordon et al., 2015)

A case study of an Information Technology start-up company in Peru found that VSE's skills were improved during the implementation of the standard, which did not waste much time based on a comparison with the overall budget (García Paucar, Laporte, Arteaga, & Bruggmann, 2015). The company were successfully certified to ISO/IEC 29110 and the process of becoming certified consisted of six steps: (1) preliminary assessment survey, (2) commercial-technical proposal and contract, (3) initial audit (phase1), (4) certification audit (phase2), (5) analysis by the certification body (CB), and (6) issue of certificate. The study noted that having a checklist was able to help VSEs to verify tasks and activities. It was useful in preliminary analysis

because the VSEs might have missed some entry conditions. Support tools were also significant in assisting the VSEs to control the project to completion. Computer-based and paper-based tools were able to support the team by handling version control, monitoring tasks, managing resources, tracking project progress as well as other functions.

Furthermore, the projects selected for standard certification were vital, particularly in the company studied, which was engaged in standard assessment for the first time. It was noted that it was particularly important to allow sufficient time for the standard certification process because all mandatory documents and a collaborative working environment were needed to prepare for the assessment. The study also found that the approach to software development was one of the main issues because the company which was the subject of the case study used agile methodology in their software development, but the SI process of ISO/IEC 29110 was obviously a sequential process. There is a noticeable difference between the steps in processes based on an iterative or incremental approach and a sequential approach (García Paucar et al., 2015).

A recent study on how to become certified to ISO/IEC 29110 noted that information technology businesses should have a standard process, adopt best practice and be certified by some international certification organization because this could make the company more productive and competitive at the international level, as well as ensuring the quality of work products delivered to the customer (Rodríguez-Dapena & Buitrago-Botero, 2015). The main roles in the certification processes were also presented in the study. Certification bodies and assessors were noted to be the main issue that VSEs should consider when they decide to implement ISO/IEC 29110. Certification bodies should understand ISO 170xx standards and be authorized by their national accreditation organization.

The certification schemas, "Process Assessment and Maturity Levels" and "Audit" were compared and presented in the study. The comparison highlighted nine issues: (1) knowledge of the two schemas, (2) criteria in evaluation, (3) assessors' training, (4) improvements for the VSEs, (5) certification bodies, (6) time consumption, (7) cost, (8) objectivity, and (9) repeatability. Some issues were assumed to be factors that affect the adoption of ISO/IEC 29110 and should be noted by all VSEs. Based on the detailed findings, of the study, the criteria indicators were essential to those being evaluated because they were able to prepare themselves by following existing guidelines. The experience and objectivity of certification bodies and assessors can help VSEs to clearly understand the process of assessment and save time and costs during the assessment period. Having qualified certification bodies is able to ensure a well-organized process, a good document system and efficient risk management. VSEs can have more confidence in the appraisal process if conducted by a qualified certification body. The time involved and the costs incurred in the certification process were also noted to have had an impact on the VSEs because, as a small entity, it had to economize on its expenses. (Rodríguez-Dapena & Buitrago-Botero, 2015)

3. Research Methodology

3.1 The Organizations

There are currently 13 Thai government agencies which are ISO/IEC 29110–Basic Profile certified as summarized in Table 1. Due to time and budget limitations, only the first group of four government agencies that were certified in 2012 were selected for the present study. The four organizations are, Learning Center, Prince of Songkla University, Phuket Campus (LC), the software development unit under the Faculty of Technology and Environment, Prince of Songkla University, Phuket Campus (TE), Information Technology Center, National Institute of Metrology (NIMT) and Information and Communication Technology Center, Ministry of Transportation (MOT). As the pioneers in this process, they did not have lessons to draw on, nor any previous

experience of software process standard certification. The organizations made commitments to participating, training their staff, implementing procedures and preparing for standard assessment. Their experiences and the mistakes that they made are precious knowledge for future implementers of standard certification. Thus, all four agencies were chosen as the sample of the study and were asked to participate through interviews and the collection of data. Fortunately, all the organizations responded positively and were ready to disclose their experiences to the public.

Table 2 details the characteristics of the organizations surveyed in relation to their experience of system/software development implementation, type of software development, and type of current development life cycle. The details of characteristics and missions are described in Appendix A.

Table 2. List of participating organizations

Participants/Characteristics	LC	TE	NIMT	MOT
Interviewee	Assistant to the President for Information Technology, and 2 Developers	Head of Software Development Division, and 1 Developer	Assistant Chief of the Technology Center, and 3 Developers	Assistant Chief of the Technology Center
Team experience in implementing any standard	None	None	ISO 9001	N/A
Type of software development	In-house	In-house	In-house	In-house /Possible outsourcing
System development life cycle (SDLC)	Waterfall	Waterfall	Waterfall	Waterfall
People involved in software development/ Total people in organization	5/>100	4/20-50	5/50-100	4/>100

3.2 Interview Questions and Data Collection Methods

Face-to-face interviews lasting between two and three hours were arranged in advance and conducted on site. The executive manager of each organization was sent a set of guidelines for the interview questions beforehand. The guidelines were separated into four broad themes based on the categories identified by Rainer & Hall (2002), which were *people*, *skill*, *process* and *leadership*. The brief questions are shown in Appendix B. The initial set of interview questions were aimed at establishing the background of the organization and aspects of its characteristics and performance. These were followed by several questions, which focused on the implementation team and its experience and knowledge. The next group of questions related to how well the team managed to follow the PM and SI processes defined in the standard. The questions addressed to the management interviewee were intended to gain an insider executive's views on the standard implementation. Both closed- and open-ended questions were used. The interviewees had adequate time to prepare their answers and to discuss them with their team, and the interviews with the executives/senior managers and the SPI implementation team members were conducted in a relaxed atmosphere.

The interview ended with a number of discussion type questions that were intended to elicit information relative to the objectives of this study. These were:

1. Why did they specifically choose the ISO/IEC 29110 standard for the improvement of their software development process?

2. What were the success factors that led to them completing the standard implementation and being certified?

3. What were the potential barriers they had encountered during the implementation process that could have led to the failure of the SPI initiative?

These face-to-face meetings served as a means of clarifying the objectives of the research, collecting data, exchanging knowledge and discussing the organization's policies, as well as eliciting the management's views about the SPI program. All the interviews were recorded and transcribed, and the authors then summarized the data collected immediately after the completion of each interview. The summaries were then sent to the interviewees to ensure the accuracy of the content and to avoid any misunderstanding of the interviewee's views.

3.3 Data Analysis Methods

The research objectives were to explore the factors that influenced success and the barriers that affected ISO/IEC 29110 Basic Profile achievement and to present the executives/managers perspective on the implementation of standard certification -. Content Analysis (Hsieh & Shannon, 2005) was used to analyze the interview transcripts by adopting the process from Niazi, Wilson, & Zowghi (2003) and O'Connor, (2012b) to establish themes and categories respectively. To avoid misunderstandings and bias, two researchers were assigned to code and analyze the interviews and broadly identified the same categories. It was significant that although the group of categories established by each researcher had a different name they bore the same meaning. Discrepancies were solved by discussion and the results were refined again. For example, "meeting schedule available" and "funding budget" were grouped into "time and resources available for SPI", and "mentor", "expert" and "expert training" were grouped into "consultation".

In the analysis process, the themes and categories were coded manually for two main reasons; firstly, there was a limited budget for investment in qualitative software, and secondly, there were only a small number of organizations included in the study. Therefore, it was decided to read the transcripts of the interviews on paper and to code them by hand. However, confidence in the reliability of the results was based on the researchers' knowledge of standard certification and their experience in implementing standards.

4. Results

4.1 Results of the Interviews with the Information Technology Development Teams

People category background

The four organizations have information technology teams of no more than five people. They serve numbers of users from 20 upwards. We noted that the teams are quite small compared to the number of users. Their users generally don't have any information technology experience. The projects are web applications. To develop projects, the teams follow the traditional approach which is known as waterfall methodology. The team hierarchies are top-down structures in which work will be delegated by the team leader to staff who will then carry out the work and send it to the team leader. This structure is characteristic of Thai bureaucracies. None of the participants in this research had any knowledge of ISO/IEC 29110 before the implementation. When they get new staff, they transfer knowledge to them by telling them the history of the project. They don't give physical documents or other materials to team members. One organization (TE) has a different approach to transferring knowledge to new staff. They have both a tacit and an explicit methodology. They discuss work in an informal way, such as talking over lunch or after working hours, which they call tacit methodology. They

also conduct formal meetings at which programs and documents are systematically explained. They call such formal transferring of knowledge explicit methodology.

Skill and knowledge category background

None of the teams had any experience of implementing any system/software development standard. One team had experience of ISO 9001. To understand system/software development standard better, they gained knowledge by self-study. The organization provided some training budget for them to attend conferences or classes outside of work.

Software development process background

All the teams used face-to-face communication. They sometimes sent files or forwarded related documents by email. To contact stakeholders, email is used because it is an official communication which can be collected as evidence. At meetings, the teams conferred informally rather than formally. Two teams usually conducted meetings monthly. Before implementing ISO/IEC 29110, no change management processes had been used and the developer was the person responsible for the change process. Only one of the agencies collected electronic files such as source codes, library files, and manual documents in a systematic way by using a file server. The other teams stored their data files only on their own devices.

Leadership background

The management style of the teams interviewed was participative. All members could express their own opinions. One agency had a different style, with coaching being used by management. It is notable that all the agencies work like a family team and support each other. Because the teams interviewed are from non-profit organizations, they need their work approved and were answerable to the users. The purpose of the team in the SPI was to work more efficiently and systematically. They knew the reputation of standards such as CMMI or SPIICE, but chose to not adopt them. Their perspectives on SPI adoption are presented in the following section.

Table 3 Summary of interview results

Team Development Information Background				
Question	LC	TE	NIMT	MOT
People				
Size of implementing team	5	4	5	4
Number of users	>100	20-50	50-100	>100
Type of information technology project	Mainly Web applications			Web /Windows application
Software development process	Waterfall			
User characteristics	Non information technology			
Team structure	Top-Down (2-3 levels)			
Knowledge of ISO/IEC 29110	None			

Knowledge transfer	Tacit (and explicit for TE)			
Skill and knowledge				
Team experience in any standard	None	None	ISO 9001	None
Team experience in system/software development methodology standard	None			
Knowledge learning in SPI	Self-study/training		Self-study	N/A
Process Development				
Communication tools (team)	Face-to-face and E-mail			
Communication tools (user)	Face-to-face, E-mail and Telephone			
Meeting style (formal/informal)	Informal			
Meeting frequency	Monthly		As necessary	
Change management	Only the responsible staff will take action			
Document repository	Individual hard drive (and File server for TE)			
Leadership				
Management style	Participative (only Coaching for NIMT)			
Teamwork style	Family team			
Focus on the quality of the software? Why?	Yes, to deliver effective product to user			
Objective of team in SPI	Need for team enhancement			
SPI standard background (including known but never used)	CMMI, SPICE (only CMMI for LC)			
The reason of choosing or not choosing any standard?	<ul style="list-style-type: none"> - Too complicated for team. - Don't have time. - Don't have resources. - Don't know the implementation approach well. - Don't have budget. 			
The reason of choosing ISO/IEC 29110	<ul style="list-style-type: none"> - Needed a simple system/software development methodology - Offered the senior managers an easily manageable project - Consists of uncomplicated PM and SI processes 			

	<ul style="list-style-type: none"> - Fulfils the basic executives' demands - SiPA offered full support
What are the important success factors that encouraged you in being Basic Profile Certified in ISO/IEC 29110?	<ul style="list-style-type: none"> - Organizational supportive policy - Staff participation - Time and resources availability to software development implementation - Consultation - Team commitment and recognition - Have professors offering software engineering courses (TE) - Have ISO 9001 standard certification (NIMT)
What are the barrier factors or barriers that concerned you in the implementation of the ISO/IEC 29110 standard?	<ul style="list-style-type: none"> - Limitation on time available - Lack of experience - Documentation load - Unsynchronised communication means - Improper project selection (NIMT)

4.2 Perspective on ISO/IEC 29110 Adoption

The response of the interviewees from all four agencies to questions regarding their reasons for adopting an SPI standard appeared to be similar. These reasons can be summarized as concerns about difficulty in understanding and the complexity of the standard processes and the time and budget involved in the team's learning the processes, which might affect the time spent on routine work. However, one of the interviewees who had experience of ISO standard implementation commented that every SPI standard has its own procedures which are comprehensible with expert guidance.

Two views were commonly expressed by the four government organization executives and their teams as to their reasons for participating in the ISO/IEC 29110 initiative program conducted by SiPA. The first comment was that the implementation teams and the software development processes needed to be improved. Generally, in-house software development teams in government organizations are relatively small and usually serve a lot of users from many departments. This represents a limitation on the time and resources available which can be devoted to the standard initiative and was a matter of vital concern. Interview extracts below illustrate this:

"We want our users to get a good impression when we first deliver a product and we do not want to have to fix many bugs after going live, which would create maintenance overheads and consume our limited resources when launching a new project."

"The main reason for adopting an ISO standard is to improve the performance of our current software development process. We hope that will help us to overcome resource allocation problems."

The standard selected for implementation must thus involve a tractable, visible, and understandable implementation approach. Moreover, it should offer senior managers the ability to manage any software project, as well as providing a comprehensive software engineering process for the development team. Thus, the ISO/IEC 29110 standard, which consists of uncomplicated PM and SI processes, fulfilled the executive's' basic demands. The following quote from an interviewee who had experience in other standard implementation explains this:

"We had implemented another ISO standard and felt that it was not really difficult to be assessed and certified for the standard as long as we strictly followed all the PM and SI processes and were well prepared for the assessment"

This view is supported by the two interview extracts which follow from one of the organizations which had never experienced any standard implementation:

"We think it as a good thing to have a straightforward standard for software development management. At least we have some common project management guidelines to follow"

"We cannot ignore the fact that there is high competition from the private sector. On behalf of a government information technology unit manager, we would like to create a good image in how we serve the public."

The second common view expressed by the interviewees related to the enormous support offered by the government for government organization wishing to adopt an SPI initiative program e.g. providing an expert mentor and budget for the program. SiPA, who conduct the programs, arranged for ISO/IEC 29110 experts to coach each participant at the beginning of the program, then provided continuous on-site mentoring. Moreover, SiPA also supported each organization in terms of the coordination of the project to its completion, without charging any fee. This provided a stimulus to SPI awareness and offered significant encouragement to the executives in the government organizations to embrace and willingly implement SPI and to seek standard certification. The following extract is illustrative of this point.

"The beauty of the SPI initiative program is that government agencies like us are not overlooked and get full support in the same way as the private sector. Even though, we are not the main target of this supportive policy and do not gain any market or competitive advantage from being certified, eventually, we have a quality working process which is exactly what we wanted."

4.3 Success Factors

Open-ended questions concerning internal and external influences on standard implementation were asked during the interviews to elicit the executive's ideas on the factors leading to successful standard implementation. The executives and their teams mentioned many policy and management issues. The success factors eventually identified can be, summarized and grouped into five main categories:

1. Supportive organizational policy: Within strong Thai government bureaucracies, any significant organizational action that may affect its daily process or needs internal collaboration must have official approval and support at the policy management level. Clear supportive policies understood by all stakeholders were a very important success factor because the implementation of the ISO/IEC 29110 standard involved a significant amount of time and effort from the software development team. For example, the team spent more than half of each day completing paperwork at the beginning of a project execution. The following extracts from the open-ended question section of the interviews highlight this issue:

"Understanding the necessity of certification and the need to give high priority to the adoption of the standard encouraged the team and made us confident in and dedicated to the implementation."

"Bureaucratic organizations, like us, typically have a top-down command line. If we have official orders from the top executives, we will be confident in dedicating our efforts towards completing the program and getting certified."

"In some organizations, top management thinks that workshops and training and the application of standards in the workplace are not necessary. If the executives have this kind of view, the organization will definitely not be able to participate in the program."

2. Staff participation: Another success factor for government organizations implementing ISO/IEC 29110 is the participation of the staff. They have to understand their roles if the organization decides to implement the standard. They need to be informed in order to appreciate the benefit of adopting the standard and they should realize that compliance with the standard can help them cope with the problems arising when other members of the team leave their jobs. Hence, either formal or informal communication among the team is essential which usually ensures the participation of the staff who are part of the ongoing project in the government agency concerned. The two quotes below comment on this factor.

"We are a small information technology department, the same as most of the units in government organizations. Communication within the team is mostly face-to-face and we all agree with this easy-going way of working. However, we also use email for formal contact with other people outside of our team."

"Our work stations are in the same room. While preparing artefacts for certification, we had to discuss the standard process. We can easily walk in and discuss the process or other issues. Therefore, face to face communication helped us gaining more understanding. "

3. Time and resources available for SPI: The adoption of SPI requires extra resources. These may include more team members from different units, individual overtime expenses, or even extra funds for necessary tools, all of which are essential for the learning and practice that influence the achievement of the award. All staff involved need to appreciate that the ISO/IEC 29110 standard is not complicated; it is not a waste a time to implement it and hence, it can be of practical use. The following interview extracts underline this situation:

"We were able to succeed in becoming certified to the standard because top management allowed us to join the training. Moreover, the team's unity is a big reason that we passed the evaluation."

The following quote is from a member of one of the two organizations that held monthly meetings to tracking the progress of the project:

"We had regular meetings. We used the time to discuss the standard particularly at the beginning of standard implementation."

Other organizations had irregular meetings but because the teams were very small, they could easily arrange ad-hoc meetings if needed.

"We think that the way we agreed to implement the standard is more important than arranging meetings. We don't mean that meetings are not necessary but we are so small that can talk together immediately"

4. Consultation: SiPA, the organization that promotes the software industry, provided a consultation team to mentor all the organizations that joined the certification project. ISO/IEC

29110 is quite a new standard compared with others such as CMMI and ISO 9001. Almost all the government organizations at the time of being interviewed had limited knowledge about ISO/IEC 29110. But the consultations and mentoring became one of the key success factors. All the interviews produced the same view that the ISO/IEC 29110 implementation teams appreciated the support of the SiPA consultation team, since they encouraged Thai VSEs to become certified to this standard, they were instrumental in preparing announcements, providing expert guidance and training courses, and fostering a practical approach to assessment. The interview extract below illustrates this:

"This was the first standard implementation, SiPA understood organizations like us which lacked experience. SiPA assigned a mentor to guide our steps towards becoming certified."

5. Team commitment and recognition: Mental support and recognition are another success factor. To be awarded certification involved improving the software process, and the development team needed to devote considerable time and effort from routine jobs to this end. For example, team worked eight hours per day, they had to allocate two or three hours in each day to do paper work. Small software development teams need to be very determined and committed to be able to perform the extra work necessary while continuing to perform routine tasks. Mental support and recognition from the organization are thus vital to the team. The following two interview extracts support this:

"The support of top management is a positive influence on the team. It fosters team spirit and helps us to resolve problems and overcome obstacles well."

"... after we got certified, our executive praised and encouraged us to keep up our performance. This made us proud."

Familiarity with other standards also assists in the achievement of certification. One of the organizations interviewed noted that because they were already ISO 9001 certified, their team was quite comfortable when implementing ISO/IEC 29110.

It was also helpful for the university concerned that they had professors who were involved in the certification process and who offered software engineering courses. The following quotes explain this:

"I was offered a software engineering course. It was an advantage for our unit to be able to understand the standard process quickly. I think other universities should become certified to the standard. Now I include this standard as one of the topics in my lectures because students might be able to use it in the future."

"This standard is significantly supported by the Thai Government and might have an effect on employment in the future."

4.4 Barriers

ISO/IEC 29110 is very new in Thailand. The public agency, SiPA, whose mission is to promote the Thai software industry, has urged both the public and private sectors to implement the standard by offering staff training, consultation, mentors, and the payment of the certification fee. In 2012, SiPA support was provided to projects for a period not exceeding one year, and participating organizations therefore had to carefully plan their standard implementation to be completed within that period.

The following are the barriers to implementation identified:

1. Time constraints: Consistent with other software standard implementations (Baddoo & Hall, 2003; Niazi et al., 2003), lack of time due to personnel being overloaded with work can become a significant barrier to SPI and ISO/IEC 29110 certification. This is particularly critical with a small team in VSEs, the context in which ISO/IEC 29110 is recommended. The team still has to perform its normal support functions for existing users as well as preparing work products during a project for accreditation. The following quotes explain this factor:

"Because we are a small team but have many users, we need to allocate our schedule to follow the standard process."

"Increasing the workforce in government agencies is more difficult than in the private sector. We have pre-planned our budget. If we want to recruit someone for a new position, we have to submit a formal application to our management. The process involved in recruiting staff is very complex."

Acquiring more staff on an ad hoc basis is rarely possible within Thai government organizations where plans have to be made some years in advance if more staff are needed.

2. Lack of experience: In general, Thai government organizations do not shown interest in software development standards because they focus on supporting users. Therefore, few government personnel ever gain experience in the certification process. This turns out to be a barrier in Thai government teams, particularly with recently established organizations. The following two extracts from the answers to the open-ended questions illustrate such obstructions to implementing the standard.

"We had virtually no experience in standard implementation. We work more slowly than organizations in the private sector which have experience."

"Staff at government agencies need to attend seminars related to software engineering because it can help them to understand the process better."

3. Documentation load: The ISO/IEC 29110 technical report describes 22 work products (ISO, 2011). Prior to the preparation of the work products, the different entities in an organization need to agree a common template for each product. Some issues, such as software and document version control tools and repositories need to be organized together. This is likely to be a large burden for a small software development team. The following quote illustrates this:

"We were quite confused by the documentation and procedures in the standard because normally we don't care much about formal documents. We mostly focus on terms of requirement (TOR) and user acceptance."

4. Unsynchronized means of communication: Teams need proper means of communication and communication tools, not only for acquiring the ISO/IEC 29110 certificate, but also for SPI generally. The interviewees indicated that lack of these tools and efficient collaboration between team members can be an obstacle to certification. The two quotes which follow describe these barriers.

"We think the problem of communication could lead to failure in implementing the standard. If we misunderstand during the assessment, the assessor might think that we don't have team consistency."

"We recommend communicating face-to-face because we can easily understand what is being said."

5. Improper project selection: In order to become certified to the ISO/IEC 29110 standard, each organization must select a project on the basis of which there will be assessed. Each team is allowed to propose the project that they are most confident and comfortable in performing, to give them the best opportunity of being awarded certification and demonstrating an improvement in the quality of their software process. Selecting the wrong project can therefore lead to failure to achieve certification. The following quote clarifies this:

"For agencies for which this is the first experience of certification, project selection is very important. You need to be clear about the requirements and have a working plan. If you choose an obscure project as the pilot project in the standard evaluation, you might not be able to answer the assessor's questions."

5. Discussion

This case study of four government organizations demonstrates that the success factors and barriers encountered are consistent with those reported in the literature relating to standard certification. However, there are some issues that appear to be unique in the Thai Government context. The topics on which the current research agrees with previous studies are the issues of *time and resources, documentation, project selection* and *consultants*.

Time and Resources

The time and financial resources available, are issues that can affect the success of certification. According to García Paucar et al. (2015), if companies such as "tech start-ups" have to devote more time and resources than expected, they may decide not to join an SPI initiative program. Such companies have limited resources and need to focus on product delivery and profit. However, ISO/IEC 29110 certification requires less time compared to other standards as reported by Sanchez-Gordon et al. (2015).

In this case study, all the government agencies had official approval to participate in the initiative. They all agreed to commit the time and resources available and this was a significant element in the teams' success. This included not only extra budget for overtime working if required, but also the support of top management in allocating time normally used for routine work to conduct the standard process and generate work products, and this was a major factor in the success of the certification projects.

Documents

The certification process is assessed based on proof of actual work of a project and organizations have to show the evidence such as project plan report, test case report for the assessor. The organizations studied in this research had never previously implemented this standard. Their concern was that work products needed to be created while following the steps of the certification process and that this would consume the limited time available to complete the project. However, in comparison to other well-known standards such as CMMI, ISO/IEC 29110 requires a smaller set of documents to be generated. The results of the present study are similar to those of García Paucar et al. (2015) who followed the progress of a Peruvian tech start-up which had no previous experience of standard documentation, where work product templates were able to considerably assist the company in becoming certified. The team was able to study, emulate and adapt the templates to be suitable for their own context.

Project selection

The findings of the present study agree with those of García Paucar et al. (2015) that project selection can have a major effect on the success of standard certification. The project should have as clear requirements as possible, as well as not being too complicated or not involving a too short or over long time span. Improper project selection can cause many problems in standard implementation, especially in VSEs that do not have previous relevant experience. The main risk is not being able to successfully manage the time to complete the required processes and work products due to frequent changes of requirements, a complex software development and underestimating the time needed to complete the project.

Consultants

The research results of García Paucar et al. (2015) and Sanchez-Gordon et al. (2015) agree with this study that having an expert and/or consultant and the use of a checklist or work product template make the accomplishment of the standard implementation possible. Particularly for VSEs who are considering their first standard adoption, the factors identified in this and previous case studies will allow them to set guidelines to comfortably carry out the implementation.

The success factors and barriers identified in the current work which differ from previous studies relate to four issues as follows:

Policy support

In traditional bureaucratic Thai government agencies, there is a strong line of command. Receiving prior authorization to initiate and conduct projects or activities from higher management is officially required. This working culture might be different from that of the private or public sectors in other countries. This presents both advantages and disadvantages. The advantages are that the team is able to work comfortably and purposefully in the knowledge of the support of the organizations' management and that the resources needed have been definitely allocated to the team's work. On the other hand, if the organizations' executives lack vision and do not support the implementation of the standard, such an SPI will not be possible, even if attempted purely as a learning experience.

Approach to software development

García Paucar et al. (2015) note the adoption of an agile methodology in their study of a start-up company in Peru. If the team uses methodology such as an 'agile' or 'scrum' approach to software development, they have to study and understand the technical report guide when implementing ISO/IEC 29110. The development method adopted in implementing the ISO/IEC 29110 standard in all four organizations in this cases study was based on the water fall model. They followed the technical guideline and delivered work products in accordance with the PM and SI processes standard. However, this point should not be overlooked since agile methodology is wildly used at present and the trend is for it to be used more in small start-up development teams.

A previous study which looked at the issue of compliance with the project management process with particular regard to how this was affected by different development methodologies found that organizations could apply the project management process with scrum, UPEDU and XP methodologies by having a clear understanding of the process and its application (Galvan, Mora, O'Connor, Acosta, & Alvarez, 2015). The latest version of ISO/IEC 29110 published in December 2015 (ISO, 2015b) has clearly clarified that the standard does not mandate a specific life cycle. A number of different methods have been identified including agile, evolutionary, incremental and test driven developments. Project teams who have their own approaches to software development can still apply this standard to their information technology projects.

Related documents, support tools and templates

As SiPA fully supported all the participants in this study, they also nominated a CB for each organization. The CB prepared related documents and examples of work products. They acted as consultants to the organizations and recommended the format for the evaluation process. According to the study of Sanchez-Gordon et al. (2015), good examples of documentation and related materials are important in achieving certification. In addition, in a study of a European Company Rodríguez-Dapena & Buitrago-Botero (2015) noted that being familiar with the criteria indicators (CI) was a critical factor, with the participants in their study suggesting that knowing the details of the CIs before the assessment process would have been of advantage to them, since they would then have understood the definition and adoption of each indicator. This is slightly different from the present case study, where the participants were not concerned about the evaluation measure process as this was explained to them by the CB who helped them to apply each CI during the implementation of the project.

In addition, Rodríguez-Dapena & Buitrago-Botero (2015) found that the company emphasized the ability to select their CB based on experience and objectivity. However, the organizations in the present case study did not choose their own CB. Therefore, this issue did not affect success in the context of the four Thai organizations studied. Nevertheless, organizations deciding to seek certification since 2013 have been allowed to choose their own CB with the condition that any CB selected should have the same standards of knowledge and ethics as the SiPA and operate under national standards supervision.

Customer needs

Sanchez-Gordon et al. (2015) were clear in stating that the issue of customer needs affects the attitude of the companies in relation to implementing standards if customers are not concerned about certification but focus on the product outcome in terms of the information technology system delivered. Previous studies have identified the important influence of customer and market needs on the attitudes of private companies to adopting the standard. Managers in a number of companies interviewed in those studies have indicated that if customers were more concerned with process quality rather than focusing on product delivery, they would consider implementing this standard (Basri & O'Connor, 2010; O'Connor, 2012a; O'Connor, 2014). This contrasts with the situation with Thai Government agencies, who are encouraged to become certified to standards because they need to enhance their SPI ability. This results in agencies having a good reputation within the public services, and certification is now regarded as a key performance indicator for the public sector. In 2015, the Thai government included reference to the ISO/IEC 29110 standard in its national procurement process by giving priority to organizations certified to ISO/IEC 29110 in tenders for outsourced software development contracts (Ministry of Information and Communication Technology, 2015). Thus, private software companies tendering for outsourced government contracts may need to consider becoming certified to this standard. This will be helpful to government agencies that outsource software development contracts, which can thus be certain that software developers are certified to the same standard.

6. Conclusion and Suggestions

This study looked at a group of four Thai government organizations that were certified to the Basic Profile of ISO/IEC 29110 standard at an early stage of the promotion of this standard in Thailand. Two common reasons were given by the four government organization executives for choosing the ISO/IEC 29110 standard and the success factors and barriers have been presented and discussed in detail. The results of this study provide lessons to be learned for other Thai government organizations that wish to adopt the ISO/IEC 29110 standard for their SPI. All the success and barrier factors found in this study should be fully investigated. The

decision to implement the standard must be taken based on the readiness of the team. This research, was based on four diverse government organizations which suggests that the findings are more widely applicable.

Overall we conclude that the ISO/IEC 29110 standard has significant utility for implementation in Thailand given the constraints that both Thai government organizations and private enterprise face in terms of the scale of their information technology departments. In reaching this conclusion we believe that the following qualifications are appropriate. Since the findings were based on the views of people working in the context of Thai government organizations and the factors and barriers found in this research might be different at other locations. If government organizations in other countries wish take account of the results reported herein, they should be aware of the following limitations.

Cultural diversity: Thai and, for example, U.S. cultures (and quite probably the cultures of other countries as well) are different, and constitute one of the key success factors for the adoption and implementation of software process models (Phongpaibul & Boehm, 2007). This study was conducted in the context of Thailand and the result were derived from Thai people and Thai culture. Organizations in other countries should be aware of the differences inherent in their culture and consider the applicability of our results carefully.

Human resource acquisition and financial planning: To secure funding and human resources, public agencies in Thailand need to make a proposal some years in advance. For government agencies in countries that have a more flexible process, this might not form a barrier for the implementation of the standard.

Limited number of organizations included in the case study: Ideally, this research would have covered more government organizations but at the time of data collection, there were only four organizations that had been awarded an ISO/IEC 29110 certificate of conformity. However, all Thai government agencies have the same budgeting and financial policies. Therefore, it can be more or less assumed that the results of the study can reasonably be applied to other government organizations.

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Appendix A

The Case Studies

The four government organizations which were chosen as participants in this case study were awarded the ISO/IEC 29110 standard in 2012 and were the very first group of Thai government organizations that adopted this standard as their means of improving their software process. They are all large organizations with hundreds of staff and have been implementing information systems for over 10 years. The software development team of each organization employs less than 10 people. They have the following characteristics and missions:

1. Learning Center, Prince of Songkla University, Phuket Campus (LC) (www.lc.phuket.psu.ac.th): The information technology unit in this center develops information systems for the campus. At the time of being awarded certification, they conducted only in-house software development, with no outsourcing. This team had never had experience in either software process improvement or any standard certification. The stakeholders of the systems they develop include the President's Office, as well as faculty members. The problems they usually face include high staff turnover, limited human resources, frequent changes of requirements from users who do not understand the benefit of computer systems, or know what they really want and lack of working templates in the software development cycle.
2. The software development unit under the Faculty of Technology and Environment, Prince of Songkla University, Phuket Campus (TE) (www.te.psu.ac.th): This unit is in charge of in-house software development for the faculty's internal use, but the systems must be able to conduct data interchange with the university's database for many reasons. No other software development standard had been implemented. The problems they faced were mostly the same as for case 1 above but had a lesser impact because of the smaller group of users/stakeholders, fewer systems developed, and the smaller size of the systems they develop.
3. Information Technology Center, National Institute of Metrology (NIMT) (www.nimt.or.th): This public agency develops the national measurement standards recognised internationally and disseminates accurate measurements to the Thai community. They also ensure the accuracy of measuring results as well as being the basis of accreditation activities for standards such as ISO 9001, ISO/IEC 17025, and ISO 14000. The information technology centre develops software to facilitate both internal and external services such as an application for collecting data from clients who use their instrument calibration services. The agency as a whole experienced ISO 9001 certification which allowed them some familiarity with the demands of certification when implementing ISO/IEC 29110.
4. Information and Communication Technology Center, Ministry of Transportation (MOT) (www.mot.go.th): The centre develops information systems to support other departments in the ministry. The systems may be developed in-house or may be outsourced.

Appendix B

Brief Questions

1. General organization information:
 - Name
 - Core business
 - Type of organization
 - What the software development unit is responsible for
2. People:
 - Team implementing ISO/IEC 29110
 - Number of users to support
 - Information technology project type
 - Software development process
 - What are your user characteristics?
 - How is your team structured?
 - Does the team have knowledge of ISO/IEC 29110?
 - How do you transfer knowledge to new staff?
3. Skill and knowledge:
 - Does your team have experience in any standard?
 - Does your team have experience in any system/software development methodology standard?
 - How do you improve your knowledge of SPI?
4. Leadership:
 - What is your management style?
 - What is your teamwork style?
 - Do you focus on the quality of the software? Why or why not?
 - Why does your team need SPI?
 - Do you know of any other SPI standard?
 - (Additional question) Why didn't you choose this standard?
 - What do you think about ISO/IEC 29110?
 - Why did you choose ISO/IEC 29110?
5. Process development:
 - What are the communication tools you use?
 - How do you store the software project documents?
 - How frequent are your team meetings and what is their style?
 - What are your actions when there are changes in a software project?
6. What were the important success factors that encouraged you in being certified in ISO/IEC 29110 Basic Profile?
7. What were the barrier factors or barriers that concerned you in the implementation of the, ISO/IEC 29110 standard?