ISSN: 2286 - 6213

INTERNATIONAL JOURNAL OF BUSINESS DEVELOPMENT AND RESEARCH

Volume 2, Issue 1, 2015

IJBDR

FOREWORD

It is my great pleasure and honor to present the second volume of *International Journal of Business Development and Research* (IJBDR). It has been created to provide academics and practitioners a platform for exploration of new ideas, concepts, systems and practices in the areas of business innovation, applied technologies, and industrial & organizational management right across the world. The world is changing; there is a continuation of needs in exploring new ideas. For this, we must hear from individuals who are dynamic in professional management, business development and research. Theory and practice are interrelated, and we want to bridge the gaps.

This issue covers the areas of real situations of business development and existing practices in a numerous areas such as: Knowledge Management, New Product Development (NPD), Performance Management, Project management, Research and Development (R&D), Reengineering, Risk Management, Software Testing, and Test Automation.

We hope that the research featured here will set up new milestones. We have had an overwhelming response from very eminent editors and researchers globally to support as editorial team. I look forward to make these endeavors very meaningful. Let me take this opportunity to express my appreciation and indebtedness for the contribution of authors and editorial board members to the journal. Their work, either by contributing articles, reviewing them or by working as a board member, has framed the journal leading to accomplishment of its goal.

Editor-in-chief

ISSN: 2286-6213
Volume 2
Issue 1
2015

International Journal of Business Development and Research

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Stakeholder Involvement in NPD Project Phases

Jukka Majava* *(jukka.majava@oulu.fi)*
Harri Haapasalo *(harri.haapasalo@oulu.fi)*
Industrial Engineering and Management, University of Oulu
P.O. Box 4610, FI-90014, Finland

*Corresponding author

ABSTRACT

Multiple stakeholders affect new product development (NPD). Despite rich literature, the previous studies have inadequately addressed stakeholder involvement in different NPD project phases. This study assesses the key stakeholders for product management and research and development (R&D) in an NPD project in ICT industry, the stakeholders' roles, and their involvement in project phases. The literature part of the study addresses product development stakeholders and their requirements, while the empirical part explores industry views through a single case study. The results include an analysis of key stakeholders, their roles, and their involvement in different project phases. The results highlight the importance of appropriate stakeholder involvement in NPD projects and the need to manage this involvement. In addition, the timing of stakeholder involvement must be carefully planned. The study indicates a need for systematic way of working and good internal co-operation between product management, R&D, and other stakeholders. Managers can utilise the findings to improve decision-making and prioritisation in NPD projects.

Keywords: New Product Development (NPD), Project, Product management, Requirement, Research and Development (R&D), and Stakeholders.

Article classification: Case study

1) INTRODUCTION

New product development (NPD) is vital for companies to meet their business objectives. If organised properly, NPD can improve revenues, market shares, net results, and share prices (Cooper, 2011). Over the years, product development has been studied from different viewpoints (e.g. Kinnunen et al., 2013; Krishnan and Ulrich, 2001; Tolonen et al., 2015).

NPD is typically influenced by multiple stakeholders, i.e. groups or individuals who can affect or are affected by the achievement of the organisation's goals (Freeman, 1984). Stakeholders have been discussed in academic literature from many perspectives (e.g. Mitchell et al., 1997). Because NPD is cross-functional in nature, many internal stakeholders contribute to it (Kinnunen et al., 2014). Furthermore, various external stakeholders need to be considered by using methods such as customer value chain analysis (CVCA) (Donaldson et al., 2006). In some cases the conflicting requirements of different stakeholders make the management of product development very difficult (Bendjenna et al., 2012).

Stakeholders affect decision-making in organisations and the outcome of NPD projects. The previous literature on stakeholders has addressed many important topics (Aaltonen and Kujala, 2010; Freeman and Reed, 1983; Mitchell et al., 1997) including requirement engineering (e.g. Glinz and Wieringa, 2007). However, the previous studies have not adequately addressed how stakeholders contribute in different phases of NPD project and what is the dynamics between different stakeholders during the development. This study aims to provide new viewpoints by assessing the key stakeholders in an NPD project from product management and research and development (R&D) perspectives. The two aforementioned have been found to be core functions in product development context (Majava et al., 2015). This case study focuses on the roles of the stakeholders and clarifies the dynamics of stakeholders' involvement during the project phases. Accordingly, the research questions are set as follows:

1. Who are the key stakeholders for product management and R&D in an NPD project in ICT industry?
2. What are the roles of these stakeholders?
3. In which project phases stakeholders are involved?

This paper addresses the research questions both through literature and empirical study. The literature review focuses on product development stakeholders and their requirements, while the empirical part explores industry views at managerial level through a single case study.

2) LITERATURE REVIEW

Product development transforms market opportunities into production, sale, and delivery of completely or partially new products (Krishnan and Ulrich, 2001). Product development projects are initiated based on various drivers; the projects can be classified into research and development (R&D) projects, breakthrough projects, platform projects, derivative projects, incremental improvements, and fundamentally new products (Majava et al., 2013; Schilling and Hill, 1998; Ulrich and Eppinger, 2012). Small change projects entail acquiring tacit knowledge about customer needs and current product deficiencies. In NPD to existing markets customers' tacit unmet needs are translated into product features without having an existing product. In NPD to new markets, customer involvement typically takes place only when a prototype is available (Un and Cuervo-Cazurra, 2009).

Various definitions for stakeholder have been presented in academic literature. Broadly defined, stakeholder can be considered as "any group or individual who can affect or is affected by the achievement of the organisation's objectives" (Freeman, 1984). According to narrow definitions, in turn, stakeholders are groups or individuals on who the organisation is dependent for its continuous survival (Freeman and Reed, 1983). These narrow views define stakeholders in terms of their direct relevance to the company's core economic interests (Mitchell et al., 1997). In product development context, stakeholders can be considered as the parties that can affect or are affected by the "transformation of a market opportunity and a set of assumptions about product technology into a product available for sale" (Krishnan and Ulrich, 2001; Lehto et al., 2011).

Stakeholders can be categorised in many ways including primary or secondary, owners and non-owners of the company, those in a voluntary or involuntary relationship with the company, resource providers to or dependents of the company. Internal stakeholders are formal members of an organisation or a project. External stakeholders are not formal organisation or project members, but can affect or be affected by it (Aaltonen and Kujala, 2010; Aapaoja and Haapasalo 2013; Mitchell et al., 1997).

Stakeholder salience describes how managers prioritise competing claims. Both internal and external stakeholders can be key stakeholders, if the issue is salient to them (Aapaoja and Haapasalo 2013; Savage et al., 1991). The salience is based on three attributes: the stakeholder's power to influence the firm, the legitimacy of stakeholder's relationship with the firm, and the urgency of stakeholder's claims. However, it is ultimately the firm's managers who decide which stakeholders are salient and will receive attention. (Kinnunen et al., 2014; Mitchell et al., 1997).

Stakeholders can affect the product demand, and they enable product delivery to the final users and the support throughout the life cycle of product (Ulrich and Eppinger, 2012). Appropriate stakeholder participation in NPD projects is needed to ensure correct requirements and avoid problems during the development (Aapaoja et al., 2013; McManus, 2004; Razali and Anwar, 2011). Stakeholders must be prioritised in decision-making, as their interests conflict, resources are often limited, and requirements have to be balanced (Bendjenna et al., 2012). Methods for stakeholder identification in NPD include Design for Excellence (DfX) (Bralla, 1996; Kinnunen et al., 2014), the stakeholder identification framework by Razali and Anwar (2011), and Customer Value Chain Analysis (CVCA) (Donaldson et al., 2006). Stakeholder prioritisation techniques include ordinal scale (ranking) and ratio scale methods, such as Analytic Hierarchy Process (AHP), Cumulative Voting (CV), and Hierarchical Cumulative Voting (HCV) (Berander and Jönsson, 2006; Contreras et al., 2008; Saaty, 1980).

The amount of requirements from identified and prioritised stakeholders can become very high, which has major impacts in projects (Gorschek and Wohlin, 2006). Systematic stakeholder and requirement prioritisation can be considered to involve four phases. First, the purpose of prioritisation must be clear to ensure the right decisions. Leffingwell (2010) sees these purposes as investment themes, and Lehtola et al. (2004) considers them business strategy attributes. The second phase involves stakeholder identification by using tools, such as checklists and DfX philosophy (e.g. Bralla, 1996). It is important to identify key stakeholders in different situations and prioritise their needs accordingly (Barney et al., 2008). Third, requirement classification is needed; the dependencies, urgencies, and categories are clarified. Requirements classification is vital to organise requirements into certain clusters (Sommerville, 2007). Several ways exist to make this classification, either based on stakeholders or requirement types (Leffingwell and Widrig 2000; Sommerville, 2007; Wiegers 2003). Value

Based Requirements Engineering (VBRE) aims to ensure business value and focus all activities on value creation rather than feature development (Azar et al., 2007). This calls for effective product management due to the need to serve various stakeholders. In the fourth phase, the requirements are prioritised using appropriate methods (e.g. Berander and Jönsson, 2006).

Finally, it should be emphasised that stakeholders are industry-dependent. For example, complex product systems, such as telecommunications systems, aircraft engines, and weapon systems differ from mass-produced products such as cars and consumer electronics (Dedehayir et al., 2014; Kinnunen et al., 2014). In the complex product systems, key stakeholders typically include governments, standardisation and regulatory bodies, whereas in the consumers electronics end-user needs play a very significant role.

3) RESEARCH PROCESS

The research process applied in this study is presented in Figure 1. The study started with a literature review on product development and stakeholders to form a theoretical basis for the empirical study. Then, an empirical study was planned and conducted. Finally, the empirical data was analysed and conclusions were made.

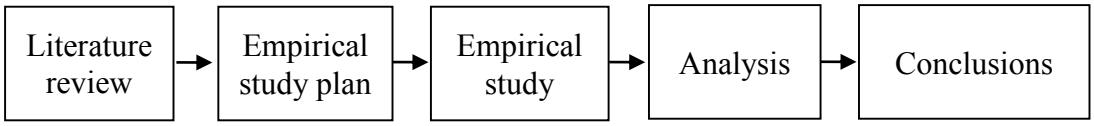

Figure 1: Research process

The empirical study included a case study of a product development project. In the case study, six mid-level managers involved in the NPD project were interviewed regarding their views on the project stakeholders. The managers interviewed included two product managers, concept manager, software product owner in R&D, programme manager, and project manager. The case company was chosen from ICT industry and it was based in Northern Europe.

Semi-structured interviews were conducted to gain insights of the case project and respondents' views regarding the studied topics. The first phase of the interviews included questions on product development in the company, the case project, and its stakeholders. In the second phase, two

interviewees, a product manager and software product owner in R&D, who were most actively involved in stakeholder collaboration, were selected for an in-depth interview on stakeholder roles and involvement in the project. The interview questions used in the second phase of the interviews are presented in Appendix 1.

The interviews were recorded and transcribed for analysis. The data was analysed by using a qualitative approach of reading the interviews several times, each time going deeper into the data to identify connections, patterns, and juxtapositions. Emerging patterns were structured, and the key concepts and issues were defined.

4) RESULTS

4.1) Case project

The studied project was a software project of a global ICT company in a business-to-consumer market. The most important driver of the project was the company's strategy; the product offering had to be renewed rapidly due to competitive pressures. In addition to a new software release creation, the user interface and architecture of the software platform that was used in the final products were renewed. The final products were targeted to a specific consumer segment in developing markets, but also wider market, distribution partners, and geographical requirements were considered. In terms of size and newness, the project can be considered a large-scale, radical development project.

The project included hundreds of people, and the development took place in two R&D sites, one in Europe and the other in China. Development work in the project was iterative according to agile software development principles. During the project, short sprints were used to create bigger software entities, and new feature definition and development were simultaneous. Due to the nature of the development, interfaces and cooperation between product management and R&D were aimed to be transparent and smooth as possible.

Project phases included concepting, minimum content definition, minimum content implementation, full content implementation, maturation, and sales start. The high-level project objectives and minimum content requirements were created by product management in the concepting phase. R&D received these high-level objectives in autumn 2012, and started to work on

development and resource plans for minimum content implementation. Since then, the work proceeded in turns; product management defined the next most important features, and the development continued until the implementation-stop decision was made. The software was built piece by piece in continuous interaction with stakeholders, and both technical and business changes were discussed carefully with them. The implementation phases were followed by the maturation phase including error correction to achieve sales quality. From maturation phase onwards, project management approval was needed for any requirement and priority changes. The project schedule was driven by time-to-market objectives; the sales start took place in summer 2013.

4.2) Project key stakeholders and their roles

Various stakeholders, both internal and external to the company, were identified for the project. Table 1 lists the key internal stakeholders and their roles.

Table 1: Key internal stakeholders and their roles.

Stakeholder	**Role(s)**
Software product management	Defined the content, high-level objectives, and feature priorities Guided and "protected" R&D Managed customer and business related stakeholder interfaces The most important internal customer for R&D
R&D	"Turned what into how" Planned technical implementation Turned business and customer needs into technical features Implemented the content in priority order
Management	Defined strategy (the project driver) Provided resources for the project Accepted project milestones
Sales teams	Provided regional and country specific requirements Provided feedback on the software content Informed which errors should be corrected Accepted the software for sales
Marketing	Participated in content definition Represented consumer view Implemented marketing activities

Table 1 (Continued)

Stakeholder	Role(s)
Consumer research team	Conducted research that helped defining target segments Conducted studies on products in the market
User interface and experience teams	Provided usability related data Conducted internal and external usability tests
Product programs	Acted as an internal customer Developed product hardware and set related requirements (e.g. operations and logistics) Provided information on sales arguments, important features, and priorities
Service development team	Created product related services
Application enablers team	Developed technical enablers for application development
Testing and certification	Acquired certification and country specific type approvals
Parallel business unit	Affected content definition

The first key internal stakeholder, software product management, had a central role in the project. It defined the software content, high-level objectives, and feature priorities. Product management provided guidance to R&D and protected the engineers from issues outside their core expertise. This "protection" included managing customer and business related interfaces, such as sales and marketing interfaces, during the project. Overall, product management was seen as the most important internal customer for R&D. R&D, in turn, was responsible for technical implementation in the project and "turned what into how". In addition to technical planning and objective allocations to teams, R&D turned business objectives and customer requirements into technical features. However, implementation order followed the priorities set by product management.

The third key internal stakeholder in the project was management. Management defined the strategy that was the driver for the project initiation. Management also provided the project with resources needed, and

accepted the project milestones. By accepting the milestones, management committed to upcoming investments in the project.

Sales teams, which included local sales units and customer teams, provided the project with regional and country specific requirements. The sales teams also provided feedback on the software content at the time when the content was known. Their feedback was also utilised in deciding whether certain software errors should be corrected. Finally, sales teams accepted the software for sales, and by doing that, committed to sell the end product in their regions.

Marketing was also considered to be a key internal stakeholder in the project. Marketing participation in content definition was important to ensure the marketability of the product. Marketing also represented consumer view and implemented marketing activities in the project. Marketing related work was supported by a consumer research team, whose role in the project was to help defining product target segments. In addition, the consumer research team conducted studies on products in the market, which were utilised at the beginning of the project.

User interface (UI) and experience (UX) teams provided usability related data at the beginning of the project, which helped to identify the focus areas in UI renewal. Furthermore, the teams conducted internal and external usability tests with end-users to find out improvement areas during the project.

Product programs were considered an important stakeholder, since they acted as an internal customer for the project. The product programs developed hardware for the final products and set related requirements including, for example, operations and logistics requirements. They also provided information on the important features, sales arguments, and feature priorities from end product perspective.

The rest of the key internal stakeholders included service development team, application enablers team, testing and certification, and parallel business unit of the company. The service development team provided services that were part of the product offering. Application enablers team, in turn, developed technical enablers for both company-internal and external application development, whereas testing and certification had an important role in

acquiring certifications and country specific type approvals. Finally, parallel business unit's product offering affected the project content definition.

In addition to internal stakeholders, many important external stakeholders were identified for the project (Table 2).

Table 2: Key external stakeholders and their roles

Stakeholder	**Role(s)**
End-users	Set needs and requirements for content definition Participated in usability tests Participated in project end-phase tests
Key direct customers	Provided customer specific requirements Provided a distribution channel in some markets Accepted the product for sales in their portfolio
Application developers	Developed 3rd party applications to complement product offering
Standardisation and regulatory bodies	Set requirements for needed approvals
Governments and legislators	Set legal requirements
Subcontractors Competitors	Provided resource flexibility for development and testing Set requirements to "keep up with the competition" Competing offerings provided information to concepting phase
Suppliers and technology vendors	Provided components and technology for the company's larger offering

The first key external stakeholder, end-users, was considered to include both external consumers and internal end-users (company employees). The end-users set needs and requirements that greatly affected the project content definition. The end-users also participated in usability tests. Furthermore, internal end-users were involved in the project end-phase tests, where the end product was used daily to identify problems and evaluate sales start readiness.

Key direct customers were considered less important than consumers in the project. However, the direct customers had specific requirements that had to be fulfilled to ensure distribution in certain markets. Direct customers approvals were needed to get the end product into their portfolios, and thus, increase sales.

The third key external stakeholder, application developers, had an important role in the project. Some 3rd party applications were seen as necessities in certain markets, and the applications complemented the company's product offering.

The roles of standardisation and regulatory bodies and governments and legislators were somewhat similar. These stakeholders set requirements that had to be fulfilled; either to receive needed approval or to satisfy market-specific legal requirements for the products.

The rest of the key external stakeholders included subcontractors, competitors, and suppliers and technology vendors. Although the development work was mostly carried out internally in the company, subcontractors provided resource flexibility for development and testing activities. Competitors, in turn, set benchmark for "keeping up with competition" and information on their offerings were utilised in the project concepting phase. Finally, suppliers and technology vendors were not seen to be directly involved in the project, but provided components and technology for company's larger offering affecting the project.

4.3) Key stakeholders' involvement in the project phases

In addition to the roles of key stakeholders, their involvement in different project phases was analysed. Figure 2 illustrates the key internal stakeholders' involvement in different project phases including concepting, minimum content definition, minimum content implementation, full content implementation, maturation, and sales start.

As can be seen in Figure 2, software product management participated in all project phases from concepting to sales start. R&D was responsible for technical implementation, and the cooperation between product management and R&D took place throughout the project from minimum content definition phase onwards. Management's involvement, in turn,

started already prior to concepting phase and continued in the project milestones.

Sales teams were strongly involved in concepting, full content implementation, maturation, and sales start phases. The sales teams were also involved in minimum content definition and implementation phases, but to a lesser extent.

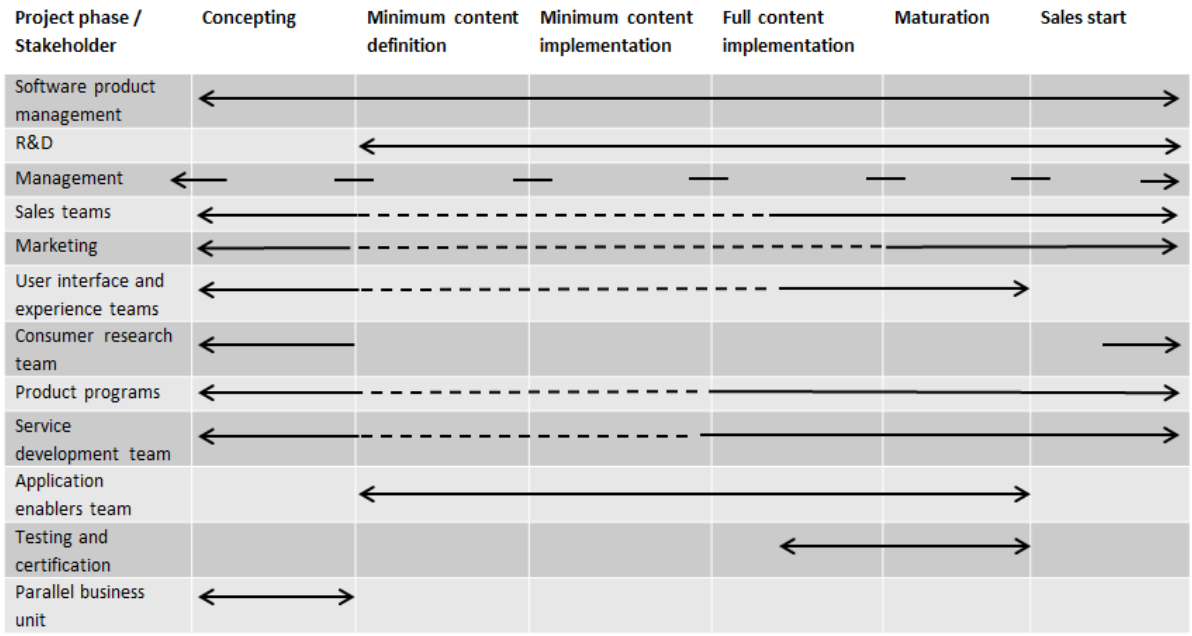

Figure 2: Key internal stakeholders' involvement in the project phases

Marketing was most actively involved in concepting, maturation, and sales start phases. However, information exchange with marketing also took place in other project phases. The involvement of consumer research team and UI and UX teams focused on project beginning and end phases. All of these teams were involved in the concepting phase, and UI and UX teams involvement continued throughout the project until sales start phase. Consumer research team became actively involved in the project again at sales start.

Product programs, as well as service development team, were involved throughout the project. However, the most active phases were concepting, full content implementation, maturation, and sales start. Application enablers team, in turn, was most actively involved from minimum content definition to maturation phase.

Testing and certification became involved in the project in full content implementation phase, and the involvement continued in the maturation phase. Finally, parallel business unit affected the concepting phase, but it was not involved in other project phases.

In addition to internal stakeholders, the involvement of key external stakeholders was analysed (Figure 3).

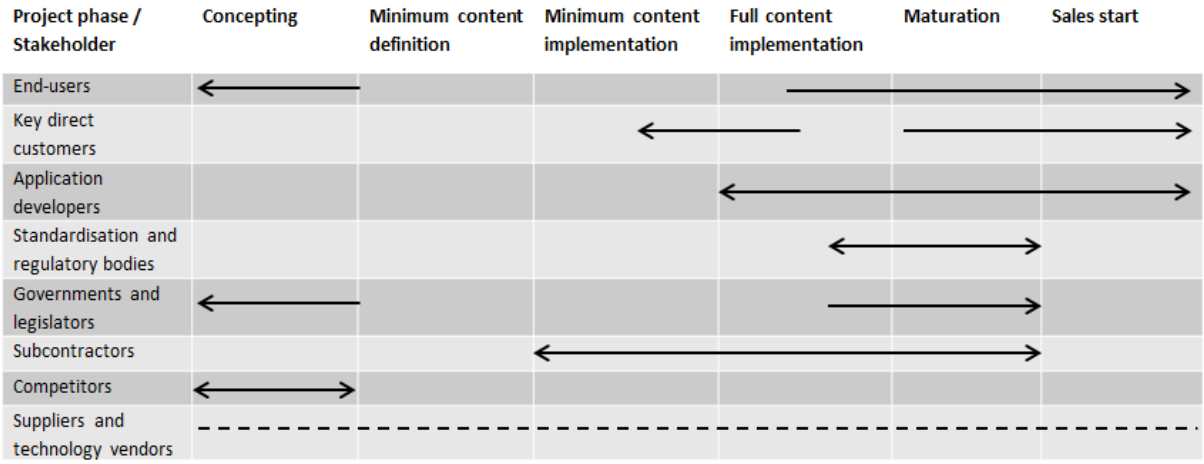

Figure 3: Key external stakeholders' involvement in the project phases

Figure 3 illustrates that end-users were involved in the project in concepting, full content implementation, maturation, and sales start phases. Key direct customers, on the other hand, became involved in the project later, in minimum content implementation phase. The late involvement of the direct customers differed significantly from earlier projects; in the studied project the most important customer group was consumers.

The third key external stakeholder, application developers, became involved in the project in full content implementation phase. In this phase, the software was considered to be stable enough for application development.

The involvement of standardisation and regulatory bodies and governments and legislators was most visible in full content implementation and maturation phases. However, country specific legal issues were considered already in concepting phase, and they were processed as minimum requirements in the project.

Finally, subcontractors were involved in project implementation and maturation phases, whereas competitors mostly affected the concepting

phase. Suppliers and technology vendors' involvement was seen indirect; they affected all the project phases by providing components and technology for company's larger offering.

4.4) Stakeholder cooperation

Stakeholders largely defined the project objective-setting, and the success measures included how well the project met its targets in terms of profits and technical requirements. One measure for the success of stakeholder cooperation was the number of change requests. The amount of change requests was only a few percentages of the total software features; this was considered very low compared to earlier projects. Thus, it can be concluded that stakeholder cooperation worked well in project beginning, which reduced the need for changes in the end phases. Although development was iterative, the stakeholder interaction focused more on the beginning and end phases. In beginning phase, stakeholders had a vital role in requirement definition, and in the end phase stakeholders' role turned into acceptor of the project outcome.

In terms of importance of stakeholders, the exact priority order was considered difficult to define. Product management and sales units had the biggest roles, because they had the business responsibility in the project. However, based on the interview analysis, all stakeholders can be considered important due to their different and complementing roles. Product management was responsible for stakeholders related to business, sales, and marketing. In R&D, the software product owner was responsible for stakeholders related to technical implementation, such as certification, subcontracting, and product development steering group. Both product management and software product owner actively contacted sales units and marketing to provide information on project status and to receive feedback and guidance. The cooperation was seen as a dialogue aiming for the project's success.

The organisation interfaces towards stakeholders were seen quite stable. For example, sales units had named persons who were involved in concepting phase. Existing processes and organisational networks were used to define the project stakeholder map. The aim was also to identify areas where stakeholder cooperation had to be extended to understand customer needs and requirements better.

Stakeholder cooperation worked especially well with a few of the sales units that were closely collaborating with the project team already at the beginning. People from the project team visited the sales units, and cooperation was smooth also in critical project phases despite heavy time pressures. On the other hand, business environment and organisation changes sometimes posed challenges in stakeholder cooperation. The project lasted many months, and changes in personnel responsibilities complicated cooperation, especially if the changes were made fast. Dependency on individual persons was seen as one of the key challenges. In addition, the target customers and markets were rather far away from the development site. Despite know-how and information existed inside the company, processing the information and selecting the right things to focus on was considered difficult.

5) DISCUSSION

Stakeholders have been discussed in academic literature from many perspectives (e.g. Freeman, 1984; Glinz and Wieringa, 2007; Mitchell et al., 1997). Yet, the stakeholder roles and involvement in different NPD project phases have not previously received sufficient attention. This study aims to provide new viewpoints by assessing the key stakeholders in an NPD project in ICT industry, their roles, and the project phases stakeholders' involvement is most important.

Stakeholders are very important in NPD projects; stakeholder co-operation and appropriate involvement is vital for the project success. While stakeholders are project specific, the results of this study indicate that external stakeholders are more involved in the beginning and end phases, whereas internal stakeholders' involvement is more constant during the project.

Early stakeholder involvement and systematic stakeholder and requirement prioritisation are considered important in literature (Aapaoja et al., 2013; Barney et al., 2008; Leffingwell, 2010; Sommerville, 2007). In ideal situation, all stakeholders and their requirements are identified and prioritised before development work starts in the project. However, this study suggests that stakeholder involvement takes place during various project phases. Yet, not all the stakeholders have to be involved in all the phases, and, for some stakeholders, early involvement is not needed. For example, the target customers in the case project, consumers (consumers),

participated already in the project concepting phase, whereas the channel partners (direct customers) were involved only in the later project phases. The study results indicate that in addition to stakeholder identification, the involvement timing must be carefully planned. Project resources are typically limited; thus, the resources that must be focused appropriately in order to maximise business benefits. Appropriate stakeholder participation is needed to identify the most critical product features, and the information from the stakeholders must be systematically processed to create a product that is competitive in the market. In the end phase, stakeholders' role is typically the acceptor of project outcome.

Planning the timing of stakeholder involvement is very important, because it is impossible to involve all stakeholders in the project all the time. This study indicates a need for stakeholder involvement prioritisation in different project phases. Having said this, the stakeholders' mandatory requirements should already be known at the beginning. If early external stakeholder involvement is not possible, their requirements should be clarified via internal stakeholders to identify the most critical needs, requirements, and priorities.

The results of this study indicate a need for systematic way of working and good internal co-operation between product management, R&D, and other internal stakeholders. Stakeholder cooperation in NPD projects should be open and involve regular interaction; this means that the parties present things, give feedback, and work together to help the project to proceed and succeed. The cooperation calls for trust, transparency, and sticking to the agreed issues. Common agreements should be documented and acted accordingly.

This study complements the previous research (e.g. McManus, 2004; Razali and Anwar, 2011) by pointing out that appropriate stakeholder participation is important for project success, and this seems to apply also in ICT industry. Furthermore, the results indicate that the involvement of stakeholders must be managed. In addition, this study contributes to existing body of knowledge by clarifying the roles of the key external and internal stakeholders in different NPD project phases. Practicing managers can utilise the findings to improve decision-making and to reduce unnecessary complexities in NPD projects. It should be noted, though, that stakeholders are industry-dependent (e.g. Dedehayir et al., 2014). This study included

only one case project in ICT industry, so further research is needed to compare and validate the findings.

6) CONCLUSIONS

Product development is increasingly complex to manage. Various external and internal stakeholders affect decision-making in organisations and the outcome of NPD projects. This study assesses the key stakeholders in an NPD project in ICT industry, the roles of the stakeholders, and the project phases stakeholders' involvement is most important.

Academic literature has discussed stakeholders and product development from many perspectives. However, the previous studies have not adequately addressed how stakeholders contribute in different phases of NPD project. The results of the empirical study describe the key internal and external NPD project stakeholders, their roles, and contribution in different project phases. The results highlight the importance of appropriate stakeholder involvement in the project and the need to manage the stakeholder involvement. External stakeholders are most actively involved in project beginning and end phases, whereas internal stakeholders are also actively involved in mid-phases. The results indicate that in addition to stakeholder identification, the involvement timing must be carefully planned.

The study demonstrates a need for systematic way of working and good internal co-operation between product management, R&D, and other internal stakeholders. Stakeholder cooperation in NPD projects should be open and involve interaction at the right times. The cooperation requires trust, transparency, and sticking to joint agreements. In spite of project specific differences, NPD managers can utilise the study findings to improve decision-making, prioritisation, and reducing unnecessary complexities in projects.

The limitations of this paper include typical limitations of a single case study, which makes the generalisation of the findings difficult. As stated in the literature review, stakeholders depend on the industry. This study was carried out in only one global ICT company in a business-to-consumer market. Thus, further research is needed to address these limitations; this involves conducting similar studies in different types of projects, companies, and industry sectors.

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8) APPENDIX

Appendix 1. Interview questions.

1. Tell about the product development project and your role in it.
2. Tell about the development model used and the project phases.
3. Tell about the internal and external stakeholders that you interacted with in the project.
4. Tell about external and internal stakeholders that were involved in project.
5. Tell about the phases in which each stakeholder was involved in the project.
6. Tell about each stakeholder's role in the project.
7. Tell about stakeholder cooperation in the project.
8. How do you see the importance of stakeholders from project success point of view?
9. How do you see the importance of project stakeholders compared to each other?
10. Do you have any additional comments on the topics discussed?

Improving the Effectiveness of Project Management: Roles of Knowledge Management

Kongkiti Phusavat*, Ph.D. *(fengkkp@ku.ac.th)*
Paiboon Leelanoi *(paiboon.leelanoi@gmail.com)*
International Graduate Program in Industrial Engineering
Faculty of Engineering, Kasetsart University, Thailand

*Corresponding author

ABSTRACT

A typical dairy company has to deal with several projects annual for production and operation improvement. Due to various sources of supplies, technology improvement, and regulatory requirements; improving operational processes is needed to ensure high quality and needed quantity in a market. In the case company, a lack of effective project management has resulted in delays and cost overrun. The root-cause analysis identifies scope clarity, scope change, cost management, and project management skills of a project manager as the key contributors. Therefore, the objective of the study is to develop a project management guideline which can reduce project management risk and subsequently improve the effectiveness in how a project is managed in this company. The study's methodology includes a review of the company's project-management process, an examination into standard practices in project management (e.g., PART and PRINCE2), and verification and test of a proposed guideline. The findings indicate the guideline's perceived usefulness. The study's implication highlights the importance of knowledge and risk management and organizational learning in the improvement of project management practices.

Keywords: Knowledge management, PART, Performance management, PRINCE2, Project management, and Risk management.

1) INTRODUCTION AND PROBLEM BACKGROUND

The company under study operates in food and nutrition businesses. This dairy company has been operating in Thailand for more than 40 years. It is considered as a multi-national company. Currently, the company employs more than 500 people and manufactures a full range of products under different brands for children, children with special nutrition needs, and children with cow's milk allergy. In the early 2000s, the company opened a new milk-powder Plant in Thailand which aims to produce milk-powder products for both domestic and international markets.

Usually, the company takes up many annual capital projects for production line improvement such as building improvement, tools replacements, purchase new equipments, etc. Unfortunately, almost 80% of all capital projects are faced with delays and cost overrun. Often, a lack of scope and requirement clarity is cited as a problem contributor. Project management skills are also mentioned as a project manager is not able to address the delay and cost-overrun problems.

For instance, it is widely recognized that the unclear scope and requirements from the users usually result in 20-25% of cost overrun and 30-40% delays from an original schedule. These problems also contribute to the planning of future capital investment in the following year. The delays have caused the transfer phase from project to operation/ process management. After a project completion relating to equipment overhaul, a project manager could not hand over equipment due to miscommunication of what was needed by maintenance supervisor (i.e., loss of test records as project members were not aware of the need to store them).

The transfer was delayed by four months after the re-test which also contributed to cost overrun. In other words, the problems of ineffective project management impact on the plant's performance and the company's competitiveness. The linkage between project management and performance of an organization is critical and needs to be managed well (Peng et al., 2011, and Perrenoud et al., 2014).

In fact, top executives at the company deemed ineffective project management as one of the risk areas that require immediate improvement intervention. Project management is viewed as an influential factor in determining the performance and competitiveness of the company (Shimizu

et al., 2012). The agreement was made earlier in 2013 to examine the possible applications of popular project management tools. To determine their applicability, the mistakes and common problems from the previous company's projects had to be part of this improvement initiative (Bowers and Khorakian, 2014). This underlines the importance of risk management in learning and improvement (Besner and Hobbs, 2012).

After the extensive discussion, the two project management frameworks were chosen together with project manager, plant managers, and section supervisors (i.e., maintenance, production, and storage). The improvement team would gain insight knowledge about these two frameworks and determined what to be adapted for the company's project management. The first one is Program Assessment Rating Tool (or PART) while the second one is PRojects IN Controlled Environments (or PRINCE2). Several past projects which negatively impacted the plant's performance were selected to identify the lessons that could be learned for improvement.

PART was originally developed by the U.S. Office of Management and Budget in late 2002 and had been applied actively until the end of the Bush Administration (See www.georgewbushwhitehouse.archives.gov/omb/expectmore/part.html). PART aims to ensure that all Federal agencies in the U.S. government would fulfill the requirements of the Government Performance and Results Act of 1993 by providing a standardized tool for monitoring and evaluation. PART deployment is linked with the budgeting process the federal level. PART highlights the importance of project life cycle which is essential in successful project management today (Ho, 2008, and De Marco et al., 2012)

PART is designed to provide a consistent approach to review an overall program/ project effectiveness- from how well a program/ project is designed to how well it is implemented and what results it achieves. PART recognizes the factors that the program or agency may not directly control but may be able to influence. PART is essential to the US government's Performance Improvement Initiative. It serves as the concrete step in fulfilling the Executive Order on Improving Government Program Performance.

Altogether, PART consists of 25 questions. They are based on critical success factors derived from previous federal programs deemed to be effective and efficient. PART covers four areas: 1. Program Purpose &

Design, 2. Strategic Planning, 3. Program Management, and 4. Program Results. For instance, for the first section, Program Purpose and Design consists of the following. See Appendix A.

- Question 1.1: Is the program purpose clear?
- Question 1.2: Does the program address a specific and existing problem, interest, or need?
- Question 1.3: Is the program designed so that it is not redundant or duplicative of any other governments, or private effort?
- Question 1.4: Is the program design free of major flaws that would limit the program's effectiveness or efficiency?
- Question 1.5: Is the program design effectively targeted so that resources will address the program's purpose directly and will reach intended beneficiaries?

PRINCE2 is a structured project management method based on the premise that a project management represents interrelated processes which have to simultaneously planned, executed, and monitored (see www.prince-officialsite.com/AboutPRINCE2/AboutPRINCE2.aspx). PRINCE2 is a process-driven project management method. PRINCE2 is based on seven principles (continued business justification, learn from experience, defined roles and responsibilities, manage by stages, manage by exception, focus on products and tailored to suit the project environment), seven themes (business case, organization, quality, plans, risk, change and progress) and seven processes. The PRINCE2 processes cover the complete route from the startup of a project through controlling and managing process, to the conclusion of the project. Also see Figure 1.

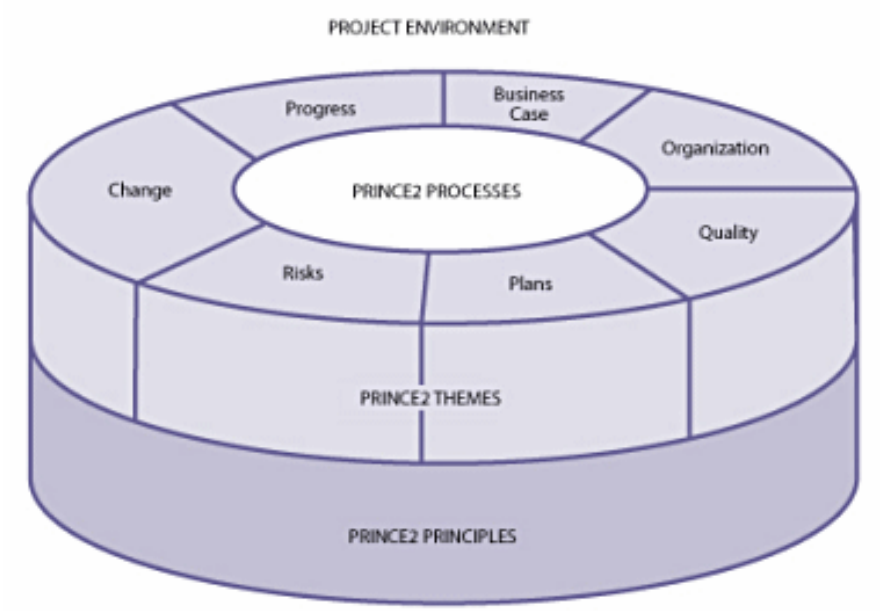

Figure 1: PRINCE2 Background
(Source: www.prince-officialsite.com/AboutPRINCE2/PRINCE2Method.aspx)

2) OBJECTIVE

The primary objective of the study is to develop and apply the guideline for project management practices. This proposed guideline is expected to solve ongoing problems relating to a lack of scope and requirement clarity, cost overrun, delays, transfer and closing. The study will highlight the need to continuously learn and improve from both external (i.e., PART and PRINCE2) and internal (i.e., past mistakes and problems) sources. For the scope, the study focuses on technical- and capital-related projects which exclude routine initiatives such as training project, etc.

3) METHODOLOGY AND RESULTS

Several steps have been taken to develop and test the guideline. The first step is to conduct a review session with relevant members of the company's plant and project managers. The aim is to learn more from past project mistakes. The second step is to examine and adapt the key issues from PART and PRINCE2 relating the common mistakes from the first step. The third step is to develop and propose the project-management guideline for the company. The weight assignment (as a preliminary baseline) and the result interpretation are also completed in this step. Then, the remaining step is to test and confirm the guideline's usefulness. See Figure 2.

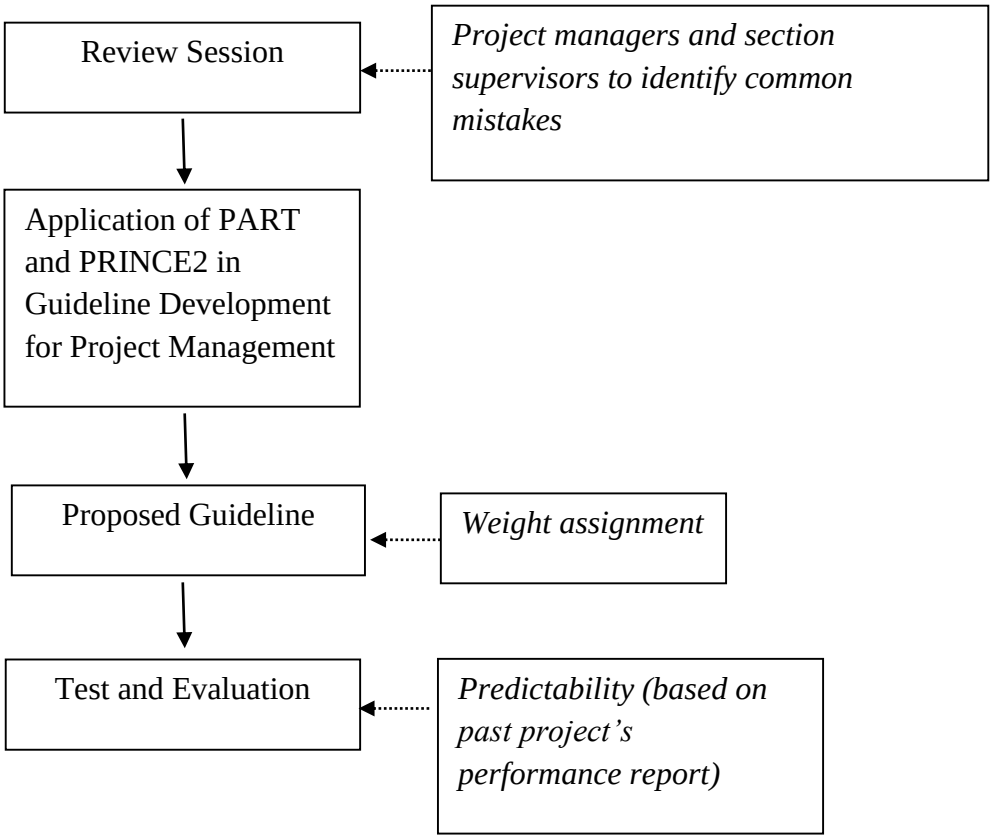

Figure 2: Study's Methodology

The review sessions, with eight project managers and engineers, together with all three section supervisors in a plant as well as plant managers and assistants to the manager, identified key tasks and activities that had greatly contributed to ineffective project management. There are altogether six most common areas that received the consensus of the session participants:

1. A lack of control mechanism such as checklist to avoid mistakes, especially during project planning, implementation, test and transfer or closing.
2. A lack of proper training on project management to newly-recruited members of a project team.
3. A lack of control during document (e.g., specification and requirement) revisions.
4. A lack of awareness of record keeping on request of quotations, request for specifications, bidding, tests, and drawings.

5. A lack of preparation during the transfer or closing stage of a project (due to the deadline pressure and the demands by the user- production, maintenance, and storage to wrap up the project work).
6. A lack of effective supplier/ subcontractor management during the project's installation and test.

The next step is to examine the potential usage of PART and PRINCE2 to address the six common areas that have been brought up earlier. Due to its simplicity, PART is picked to be the basis for the guideline development while the issues which pertain to PRINCE2 will be later selected to compliment the guideline to be based on PART. In addition, PART emphasizes the use of the life-cycle management which underlines the linkage between project design until the transition to the operations.

It is important to note that the company has classified its project management practices into four stages. These four stages can correspond to PART- purposes/ design, planning, management, and results/ accountability. In addition, the weight for each of the four stages which are consistent with PART will be similar to what has been used previously. They are as follows:

Stage 1: Initiation
Stage 2: Requirement Development
Stage 3: Implementation
Stage 4: Transfer

It is also determined at this discussion that the guideline will be developed as the checklist. The reason is that this checklist can help ensure more uniformity and consistency in project management, train new project managers, and strengthen internal communication. See Appendix B for the partial illustration of the remaining three sections.

Section 1: Initiation Stage

Question 1.1: Is the project problem or project background clear? (Note: adapted from PART)

- Evidence to be prepared: problem or business requirement report

Question 1.2: Is the project scope and description clear? (Note: adapted from PART)

- Evidence to be prepared: scope report with user participation and agreement

Question 1.3: Does the project manager identify key risk areas such as single subcontractor, imported items, etc.? (Note: adapted from PART).

- Evidence to be prepared: project risk description.

Question 1.4: Does the project contribute to specific problems or policy initiatives at the plant? (Note: adapted from PART).

- Evidence to be prepared: regulatory requirement document, organizational business plan, etc.

Question 1.5: Has the project been examined from the users and other stakeholders? (Note: from the review session).

- Evidence to be prepared: review meeting with users and stakeholders

Question 1.6: Has the project been grouped with others which share similar functionality? (Note: Adapted from project manager)

- Evidence to be prepared: project group and unique code assigned

Question 1.7: Does the project have a specific timeline which can impact the plant's operation? (Note: adapted from PART, project manager, and section supervisors)

- Evidence to be prepared: project timetable and business plan (e.g., production schedule)

Question 1.8: Has the project's cost been estimated (which is not the same as the project's budget which represents the ceiling amount that can be spent)? (Note: from project manager and section supervisors

- Evidence to be prepared: cost information from previous projects, past quotations from suppliers/ subcontractors, and etc.

For the weight assignment, the voting method from the Nominal Group Technique is applied. This technique is regarded as a process involving a group for problem identification, solution generation, and decision making. The voting method deals with prioritizing the recorded ideas in relation to the original problem statement. For this study, this voting method was applied to determine the weight for individual questions within each stage.

In other words, there were four voting sessions. Table 1 illustrates the results.

Table 1: Weight Assignment for Each of the Four Stages

	Weight for Each Question (%)								**Weight for Each Stage**
Project Management	1	2	3	4	5	6	7	8	
Stage 1	3%	3%	2%	5%	3%	2%	1%	1%	20%
Stage 2	5%	3%	2%	5%	3%	4%	5%	3%	30%
Stage 3	3%	5%	4%	2%	2%	4%	-	-	20%
Stage 4	10%	5%	5%	5%	5%	-	-	-	30%
								Total	100%

For the result interpretation, it was deemed by the project managers and section supervisors that the outline from PART was suitable for testing the applicability of the proposed guideline for project management. The interpretation can be described as follows:

- Effective project management: Score between 85-100
- Moderately effective project management: Score between 70-84
- Adequate project management: Score between 50-69
- Ineffective project management: Score between 0-49

The last step involves the evaluation of the proposed guideline's applicability. To test its usefulness, ten previous projects were randomly selected. These projects were allocated the budget between $1-5 millions. To test the proposed guideline indicates whether it can predict the level of project management's effectiveness. The first five projects began in 2010 and were completed before 2012. They were delayed with cost overrun. Scope and requirement changes also took place. The second set consists of five projects which were deemed as effective. They were completed on-time and did not exceed the budget. There were not required to amend their requirements after the transfer to operational processes.

For the projects that were perceived to be poorly managed, they are as follows:

1. New air compressor and room expansion
2. Sugar- mill improvement
3. Conveyers for bag stripping improvement
4. End-close depalletizer
5. V-Blender

The evaluation session was conducted for each of the five projects. The evaluation was performed by eight project managers and three section supervisors. See Tables 2 and 3 for the results from one project evaluation and the summary with the rating status.

Table 2: Results from New Air Compressor and Room Expansion Project

	Yes/No								**Score**
Project Management	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	
Stage 1	3	3	2	0	0	0	1	1	10
Stage 2	5	3	2	0	0	0	5	0	15
Stage 3	0	0	0	2	2	4	-	-	8
Stage 4	0	0	0	0	5	-	-	-	5
								Total Score	**38**

Note: If yes, then the question will receive the assigned weight due to the score of one. If no, then the score of zero is assigned.

Table 3: Summary of the Results from Project Believed to Be Managed Poorly

Project Name	**Total Score**	**Rating Status**
New air compressor and room expansion	38%	Ineffective
Sugar- mill improvement	36%	Ineffective
Conveyers for bag-stripping improvement	26%	Ineffective
End close depalletizer	30%	Ineffective
V-Blender	48%	Ineffective

For the projects that were perceived to be managed well, they are as follows:

1. Chemical laboratory expansion
2. Environment Health and Safety (EHS) improvement
3. Building improvement

4. Vitamin weighing room renovation
5. Cocoa preparation room

The evaluation session was again conducted for each of the five projects. Also, the evaluation was performed by eight project managers and three section supervisors. . See Tables 4 and 5 for the results from one project evaluation and the summary with the rating status.

Table 4: Results from Chemical Lab Expansion Project

	Yes/No								**Score**
Project Management	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	
Stage 1	3	3	2	5	3	2	1	0	19
Stage 2	5	3	2	5	3	4	5	0	29
Stage 3	3	5	4	2	2	4	-	-	20
Stage 4	10	0	0	5	5	-	-	-	20
								Total Score	**88**

Table 5: Summary of the Results from Project Believed to Be Managed Well

Project Name	**Total Score**	**Rating Status**
Chemical lab expansion	88	effective
EHS improvement	90	effective
Building improvement	85	effective
Vitamin weighing room renovation	95	effective
Cocoa preparation room	85	effective

4) DISCUSSION

The initial results from having applied the proposed guideline appear to be consistent with the company's report on individual projects' performance. In other words, based on past project's performance report, the proposed guideline is viewed to be predictable project managers and section supervisors. Key missing actions/ tasks for the well-managed projects are agreed by project managers. Critical collaboration between a section supervisor and a project manager is also underlined. The document or record to be prepared for each question is available. This guideline can help boost their usage. The next phase in improving the effectiveness of the company's

project management will focus on the guideline approval for formal use. Then, it is important to communicate and explain how to use the guideline to related personnel, especially other project managers and members.

Despite its usefulness, there are a few limitations of the guideline development that need to be pointed out. There have been a few large-scale projects that exceed $5 million as well as smaller-size projects which consume less than $1 million. Given the different complexity and length of a project, the guideline could be revised from its current shape and form to fit with small and large-scale projects. It is important to note that the 10 projects selected to test the applicability of the proposed guideline are considered to be medium.

Finally, the development of this proposed guideline coincides with the company's policies on both knowledge and risk management. The guideline development highlights the importance of acquiring new knowledge from outside, so called external knowledge while learning from the past mistakes will help minimize risk for future tasks. Knowledge management has been an integral part of improvement efforts in project management (Laitinen, 2009, and Jafari *et al.*, 2011). The use of PART and PRINCE2 represents the first concrete decision in addressing the ineffectiveness of project management. It helps change the paradigm in the company's project management practices which have not focused on project life-cycle, especially during the design and transfer. Given the pressure of time and cost management, minimizing potential risk is needed for project management. Learning and transfer knowledge from past mistakes are crucial for successful business operation (Wong and Lu, 2005). In addition, they are also essential to strategic management in an organization (Sahlman and Haapasalo, 2011). Without an awareness of risk, the impact on operational processes cannot be underestimated or overlooked. Subsequently, the company's performance will be affected.

5) CONCLUSION

The study focuses on improving the effectiveness of project management by developing the guideline in one dairy company. This development is based on adapting PART and PRINCE2 as part of external knowledge while learning from past common mistakes to underline to need to integrate risk management into the proposed guideline. After having tested with ten previous projects, the guideline appears to be consistent with their

performance report at the company. Importance of knowledge and risk management is also highlighted.

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7) APPENDICES

Appendix A: PART Questions for Sections 2, 3 and 4
(See www.ExpectMore.gov)

Section 2: Strategic Planning

Question 2.1: Does the program have a limited number of specific long-term performance measures that focus on outcomes and meaningfully reflect the purpose of the program?
Question 2.2: Does the program have ambitious targets and timeframes for its long-term measures?
Question 2.3: Does the program have a limited number of specific annual performance measures that can demonstrate progress toward achieving the program's long-term goals?
Question 2.4: Does the program have baselines and ambitious targets for its annual measures?
Question 2.5: Do all partners commit to and work toward the annual and/or long-term goals of the program?
Question 2.6: Are independent evaluations of sufficient scope and quality conducted on a regular basis or as needed to support program improvements and evaluate effectiveness and relevance to the problem, interest, or need?
Question 2.7: Are budget requests explicitly tied to accomplishment of the annual and long-term performance goals, and are the resource needs presented in a complete and transparent manner in the program's budget?

Question 2.8: Has the program taken meaningful steps to correct its strategic planning deficiencies?

Section 3: Program Management

Question 3.1: Does the agency regularly collect timely and credible performance information, including information from key program partners, and use it to manage the program and improve performance?
Question 3.2: Are agency's administrators and program partners held accountable for cost, schedule and performance results?
Question 3.3: Are funds (allocated to an agency) obligated in a timely manner, spent for the intended purpose, and accurately reported?
Question 3.4: Does the program have internal and/or agency-wide procedures (e.g., competitive sourcing/cost comparisons, IT improvements, and appropriate incentives) to measure and achieve efficiencies and cost effectiveness in program execution?
Question 3.5: Does the program collaborate and coordinate effectively with related programs?
Question 3.6: Does the program use strong financial management, as indicated by relevant audit agencies within the Royal Thai Government, practices?
Question 3.7: Has the program taken meaningful steps to address its management deficiencies?

Section 4: Program Results and Accountability

Question 4.1: Has the program demonstrated adequate progress in achieving its long-term performance goals?
Question 4.2: Does the program (including partners) achieve its annual performance goals?
Question 4.3: Does the program demonstrate improved efficiencies or cost effectiveness in achieving program goals each year?
Question 4.4: Does the performance of this program compare favorably to other programs, including government, private, etc., with similar purpose and goals?
Question 4.5: Do independent evaluations of sufficient scope and quality indicate that the program is effective and achieving results?

Appendix B: Partial Illustration of the Results for Guideline Development
Note: It is important to point out that all stated evidences to be prepared have existed or are available in the company.

Section 2: Requirement Development
Question 2.1: Does the project verify and use all requirements for project development (e.g., regulatory compliance and user needs)? (Note: adapted from PART)
Evidence to be prepared: Company' state of requirements

Question 2.2: Does the project have the milestones and baseline to ensure the progress can be determined (Note: adapted from PART and project managers)
Evidence to be prepared: Microsoft Project's report

Question 2.3: Does the project start the initial work and planning with suppliers/ subcontractors (Note: adapted from project managers)
Evidence to be prepared: Bill of Quantity or BOD report, minutes of the review meeting, etc.

Question 2.4: Do all partners (including owner, engineering team, consultants, suppliers/ subcontractors, and other related parties) commit towards the overall project objectives? (Note: adapted from PART and PRINCE2)
Evidence: Stakeholder Analysis, minutes of the review meeting, etc.

Question 2.5: Has the project included relevant regulations and standards into planning? (Note: adapted from PART, PRINCE2, and section supervisors)
Evidence to be prepared: Company's Health and Environment Procedures

Question 2.6: Has the project updated the requirements (when there is a request to amend or revise the requirements)?
Evidence to be prepared: request for a revision due to requirement's inadequacy

Section 3: Implementation
Question 3.1: Does the project regularly review in accordance to the milestone? (Note: adapted from PART)
Evidence to be prepared: Review report

Question 3.2: Does the project work with Hazard analysis and critical control points or HACCP which is part of Good Manufacturing Practice or GMP team? (Note: adapted from section supervisors)
Evidence to be prepared: Minutes of the meeting

Question 3.3: Has the suppliers or subcontractors been determined in accordance to the company's qualification
Evidence to be prepared: Supplier audit report

Question 3.4: Has the budget been disbursed to related parties (especially suppliers/ subcontractors) in the timely manner (Note: adapted from PART)
Evidence to be prepared: Accounting report

Question 3.5: Has the project been coordinating within its group to help avoid the duplication of resource utilization? (Note: adapted from project managers and section supervisors)
Evidence to be prepared: Minutes of schedule review, e-mail exchanges, etc.

Section 4: Transfer
Question 4.1: Have the key items, tasks, and features to ensure project transfer been developed together with the users?
Evidence to be prepared: Transfer items as a checklist (See Appendix C for a sample of the company's checklist which has not been utilized across all projects)

Question 4.2: Has the budget been disbursed (to avoid the project delay) as scheduled or planned? (Note: Adapted from PRINCE2 and project managers
Evidence to be prepared: Accounting report

Question 4.3: Has the report on the project's progress and completion (including test report, installation report, calibration report, etc.) been compiled and summarized? (Note: Adapted from project managers and section supervisors)
Evidence to be prepared: Project close-out report

Question 4.4: Have the lessons learned from the first stage to project completion been recorded, documented, and submitted? (Note: adapted from PRINCE2, project managers, and section supervisors)
Evidence to be prepared: Project Knowledge Management or KM report

Appendix C: Partial Illustration of the Checklist Used during Project Transfer

Project Title:
Project Code: **Project Transfer Checklist**
Revision No: (if any)
Date: _____

Documents/ actions required for the Project Transfer	Yes/No	Not Applicable
Construction and Equipment		
Spare parts received	■	☐
Equipment lists submitted to the Asset Care Unit	■	☐
Permits received and forwarded to Site Engineering Unit	■	☐
Inspection stickers received and filed	■	☐
Commissioning		
Verification/qualification checked	■	☐
Turnover checked	■	☐
Startup tested	■	☐
Document recorded	■	☐
Drawings received and handed over to Site Engineering Unit	■	☐
O & M manuals received and handed over to Site Engineering Unit	■	☐
HAZOP items confirmed (Hazardous operations assessment/mitigation)	■	☐
IQ/OQ document approved and filed	■	☐
Punch list items closed	■	☐
Training manual completed and handed over to Site Engineering Unit	■	☐
Warranties and Guarantees		
Management of Change (MOC) recorded and documented	■	☐
Official Certificate of Guarantees received	■	☐
Official Certificate of Warranties received	■	☐
Bank guarantee received	■	☐

Roles of Knowledge and Risk Management during the Reengineering Effort: Lessons Learned from Electricity Generating Authority of Thailand

Kongkiti Phusavat*, Ph.D. *(fengkkp@ku.ac.th)*
Prasit Thepsuwan *(Prasit.T@egat.co.th)*
International Graduate Program in Industrial Engineering
Faculty of Engineering, Kasetsart University, Thailand

*Corresponding author

ABSTRACT

The study focuses on the reengineering effort undertaken by Electricity Generating Authority of Thailand or EGAT at the Factory Operation Permit or FOP phase. The aim is to learn and describe how KM and RM interacts with this effort. The FOP is selected since EGAT could redesign this process without the participation from external stakeholders. After the completion of the process redesign, it appears that both KM (e.g., root causes of the delays) and RM (e.g., the impacts on national and organizational risk as a result of the delays) have played a crucial role in the reengineering initiative. There have been no conflicts among key internal stakeholders. From the observation, KM and RM play a catalyst role in soliciting the consensus and maintaining the focus during the reengineering initiative. Another important finding from the study includes the transition in the electricity market from the monopolistic or competitive status. For instance, when operating as a single operator in the market, completing the form with another public agency was regarded as a legal affair. The investigation into international operators during the transition to the competitive market represents a potential study in the areas of business and organizational development.

Keywords: Knowledge management, Reengineering, and Risk management.

1) INTRODUCTION AND PROBLEM BACKGROUND

Reengineering represents process improvement which is necessary for today businesses. It focuses on redesigning the workflows and business processes within an organization through in-depth root cause analysis. Reengineering addresses the bottleneck issue within a business process which can negatively affect the performance of an organization. Therefore, reengineering essentially helps the organizations review, rethink, and rework how their processes are carried out (Burke, 2004). The primary goals of undergoing the reengineering effort include better service delivery, lower operational cost, more productive operations with less time and resources, less project delays (Ho, 2008; and Dobni, 2011). The attempt to reengineering a process or work reflects the recognition that a drastic change is needed to ensure the long-term improvement is achieved (Bartlett, 2003; and Lee et. al., 2008).

Traditionally, the ability to implement reengineering depends on several factors, including administrative and technical aspects (Marjanovic, 2000). For instance, leadership and budgetary support is considered as a success factor from the administrative viewpoint. On other hand, the knowledge on crucial management tools such as process flow diagram and fishbone diagram is part of the technical aspect. Effective knowledge management is viewed as the critical practice in ensuring continuous process improvement in an organization. The challenge in many organizations today planning to use the concept of business process reengineering is the insights into the roles of knowledge management (KM) and risk management (RM) and how they contribute to the success of the reengineering effort.

For Electricity Generating Authority of Thailand (EGAT), due to the threat to the country's power shortage and the need to follow the National Power Development Plan, the delays for the commercial operation date or COD will have significant impacts on the economic and social development. The stability in power supply is one of many requirements for business investment while the electricity is essential for the daily life. See Table 1 for the future increase in the country's national supply.

Table 1: Total Capacity for Year 2012 – 2030

Item	Description	MW
1	Total capacity (as of December 2011)	32,395
2	Total added capacity during 2012 – 2030	55,130
3	Total retired capacity during 2012 – 2030	-16,839
4	Grand total capacity (at the end of 2030)	70,686

Source: EGAT (Thailand Power Development Plan 2012-2030 Revision 2)

Given the need to comply with the regulatory process outlined by the Energy Regulatory Commission which essentially ensure public participation and to assess the two environmental studies (i.e., Initial Environmental Examination and Health Impact Assessment), the delay appear inevitable, especially the tasks dealing with external stakeholders. For instance, the new power project needs to be submitted and approved by Energy Policy and Planning Office. The endorsement is needed for EGAT to conduct the two environmental-related studies which need to be in cooperation with Ministry of Environment.

The bidding process for the power plant construction is subject to the procurement process which is under the jurisdiction of Office of the Prime Minister (e.g., Regulation of the Prime Minister Office on the Thai Government Procurement of 1992 and Regulation of the Prime Minister's Office on e-Auction of 2006). Some of the estimated duration for key tasks relating to the power plant's commercial operation can be illustrated as follows (See Table 2 for the details).

Table 2: Estimated Time for Power Plant Development (in Months)

No.	Activities	Power Plant Type	
		Thermal	*Combined Cycle*
1	Site Selection	8 - 10	8 - 10
2	Land Procurement	24 - 36	20 - 36
3	Feasibility Study	6 - 12	6 - 10
4	Environmental/ Health-related Study	28 - 26	26-36
5	Public Participation	25 - 41	25 - 41
6	Project Approval		
	EGAT Board Approval	2 - 4	2 - 4
	Government Approval	27 - 32	27 - 32
7	Bidding		
	Bid Preparation	6	6
	Bidding Period	5	5
	Evaluation, Negotiation and Approval	7	7
8	Design, Manufacturing and Delivery	36 - 42	27 - 30
9	Site Preparation and Civil Works	36 - 48	27- 36
10	Installation and Erection	24 - 36	18 - 24
11	Test and Commissioning	6 - 9	6 - 9

Source: Knowledge Management System for Power Plant Development, EGAT

The priority is therefore given to the task that EGAT can improve internally. For the construction and operation phase, the critical step involves the document preparation and submission to Department of Industrial Work (DIW) under Ministry of Industry. This step is referred to as the Factory Operation Permit (FOP). Due to the treatment of the power plant as a facility for production and manufacturing, DIW requires the completion of the paperwork and documentation to ensure that the operations at the plant can be operated while meeting occupational health and safety's requirements. This is essential before the construction can take place. In other words, EGAT's power plant development has to deal with the concern over the public safety (i.e., environment and health of surrounding communities) and occupational safety and health of the workers in the plant. The FOP step has been viewed as one of the key bottlenecks that can be addressed by the improvement in EGAT's internal work processes. Table 3 shows the delay information during the FOP step.

Table 3: Delay Stemmed from the FOP Form Completion

Project code	Expected Duration (Months)	Actual Time (Months)	Delays (Months)
CC-01	5	13	8
CC-02	5	25	20
CC-03	5	40	35
CC-04	5	34	29
CC-05	5	20	15
CC-06	5	22	17
CC-07	5	10	5

Remark: Expected duration is the combined time required by the DIW for the document submission and EGAT's document preparation.

The past delays have had profound negative impacts on EGAT's financial and operational performance. In addition, the country's power supply is at risk (i.e., reliability and security) which has been viewed as one of the decision criteria for direct foreign investment. In the past, EGAT has had to revise the power generation plan and needs to obtain other energy supply from neighboring countries. The higher energy purchasing cost has led to several initiatives to help maintain EGAT's required the debt- service-coverage and debt-equity- ratios. The delays have also caused bad publicity and reputation for EGAT since business and community leaders openly question the nation's power reliability and security.

2) LITERATURE REVIEW

The project deals with several key literatures, including reengineering, knowledge management (KM), and risk management (RM). The FOP is also to be discussed. Reengineering (or often referred to as Business Process Reengineering) represents an effort to analyze and improve the operations (e.g., work processes) in all areas perceived to be critical. This criticality deals with bottleneck which negatively impacts the quality, safety, productivity, and other performance areas within an organization. Reengineering requires effective planning and teamwork since it involves with understanding of an existing problem within an operation and redesigning a solution to solve this problem. Traditionally, there are several approaches and tools that have been applied during reengineering. They are,

for instance, process flow diagram, fishbone diagram, and other quality tools within the process and root-cause analyses.

There are two primary reasons for applying the reengineering initiative. The first one is to reduce costs and cycle time. The positive outcome from reengineering is the elimination of non- value-added activities which result in delay, error, and rework. Improving the quality level of work (such as products, services, and work-in-process) is often cited for the reason to undergo reengineering in an organization. Reducing the work duplication by simplifying the tasks and changing the work sequence is often completed with effective teamwork, and commitment and acceptance by the workforce.

For KM, it is widely accepted that traditional production factors such as land and financial capital are to be replaced by the intangible assets which consists primary of knowledge and intellectual capital (Melton *et al*., 2006). The ability to utilize organizational knowledge (e.g., data and information, expertise, skills, and experiences) represents the strategic advantage the globalized market (Nonaka and Takeuchi, 1995). Also, applying the knowledge created through the KM process enables a firm to achieve a sustainable competitive advantage on the market. These emphasize the importance of knowledge management in the organization which are different depend on their knowledge management model and processes.

For RM, EGAT has developed the enterprise risk framework since 2009. RM is critical for planning and communication within an organization (Besner and Hobbs, 2012). RM is viewed as a key factor in managing organizational changes and raising the level of innovation (Bowers. and Khorakian, 2014). This framework deals with the four factors which are strategy, finance, operation, and compliance. Some of the key decisions and policies relating to RM can be briefly described as follows. EGAT has effectively managed the strategic risks in order to maintain security and reliability of the Thailand's power supply system. EGAT has maintained its agreed share of the generation capacity in order to preserve the state management capability over the power supply and price. From the strategic risk standpoint, EGAT needs to maintain its generation share not less than a half of the entire country's capacity.

In addition, risk management covers all key EGAT functions, including generation, transmission, administration, human resource management, and so on. Staff retirement and technology update through investment for power

generation and transmission are the key contributes to EGAT's operational risk. As a final point, non-compliance by EGAT which is a state enterprise is not acceptable by the general public. Given the concern over the safety, health, and environment; understanding and complying with the laws and regulations are critical for EGAT.

The Energy Industry Act B.E. 2550 is a Law issued in response to the government policy on the national energy industry management restructuring. The law aims to ensure that EGAT becomes an effective operator in the energy industry. Within this context, EGAT is required to operate as one of many power producers in the market; therefore, needs to comply with many regulatory requirements, including occupational safety and health, labor laws, etc. Fairness is embedded into the development of the new regulatory requirements so that EGAT and other small power producers operate under the same framework.

According to Factory Act, B.E. 2535 (1992), Section 7; the factory, including the energy plant, belongs to Group 3 which requires the permission to be granted prior to the plant construction. For EGAT's FOP, for the Ministerial Regulation No. 5 B.E. 2535 (1992), the application of a factory new and/or expansion permit will use the form, called Ror.Ngor.3. Then, this permit will result in a license to operate the plant. The entire process for the FOP should take approximately 90 days.

3) OBJECTIVE

Given the delay, a team to undertake the reengineering task is formed for process improvement. Therefore, this study aims to outline how this team has improved EGAT's internal process for obtaining the FOP. Then, how the reengineering effort has interacted with KM and RM will be examined and described.

Receiving the FOP will reduce the delay in the power plant construction and commission. This objective deals with the development of a guideline based on past mistakes and experiences and the process improvement through the reengineering in how a project is currently managed. Simply put, the reengineering initiative will result in the guideline for obtaining the FOP. It is important to note that this initiative is limited to the thermal power projects and a combined cycle power projects. The FOP is required for this

operation. Other types of the power generation (e.g., renewable energy sources) are not included.

4) METHODOLOGY

There are four key steps for the EGAT reengineering efforts. They are: (1) problem analysis, (2) codification and refinement, (3) guideline development, and (4) validation. The first step is to analyze the problem relating to the FOP which involves the compliance and the review over the past mistakes in the document submission to DIW. A team appointed by EGAT management team is formed for the reengineering initiative. The application of KM is critical for this step. The second step is to reengineer the workflows which are derived to overcome these past mistakes. The third step includes the development of the guideline which is consistent with the process improvement. The fourth step is to confirm the process reengineering efforts and the guideline development. Based on the reengineering initiative, the implications for KM and RM within EGAT are presented. These implications are based on the discussion sessions and the comparison with past practices. The study is expected to contribute to the areas of planning for reengineering within the context of KM and RM. At the same time, the EGAT demonstration should highlight how KM is applied even in a state enterprise (or the public sector in general).

5) RESULTS

For the reengineering effort, It is important to note that the review over past memos, email exchanges, and minutes of the meeting are reviewed with the discussion from EGAT management and staffs. It shows that the knowledge (especially data/ information, problems, mistakes, and experiences) is personalized and fragmented. With effective KM, the problem analysis can be performed with better-coordinated efforts. Based on the reviews and discussion sessions, the delays in obtaining FOP are derived from the preparation of the DIW's Ror.Ngor.3. The mistakes are classified as the incomplete documents and incorrect information. They can be summarized as follows:

<u>Preparation- information and teamwork</u>

- Preparation is not performed in parallel with other tasks. There is a wait for the construction project management structure to be

established. There is no need for these two tasks in be in a sequence format.
- EGAT lawyer is assigned to lead the FOP team.
- Progress monitoring of the preparation step is not performed.

Filling out the Ror.Ngor.3 Form for the FOP

- The required data contains both general and technical background. It is often difficult to have a lawyer capable of refining available technical data into what is required by the form. For instance, the machinery list and the respective specifications in the power production plant are required to be translated from English to Thai. There is also a need to ensure that the list of different machineries and the proposed or original drawings are consistent.
- The sources of data required are various. A lawyer is often unable to immediately locate and identify where the technical data is kept.
- EGAT lawyer usually has to deal with a contractor for technical specifications of the machineries. However, the contractor is reluctant to work with the lawyer until the bidding process is finalized with the winner is announced. In the past, after the delay occurs, EGAT technical staffs and engineers are asked to prepare these specifications instead.

More in-depth analysis shows that the FOP preparation task is fragmented. Altogether, there are several sources needed to complete this FOP form. For instance, the project engineering team is responsible for the initial project feasibility study and development. The engineering team is assigned to deal with the stakeholders relating to the environmental-impact assessment study. The civil engineering team is responsible for working with the contractor for the construction and commissioning of a power plant. The common mistake is the information accuracy on completing the FOP form. It is unlikely that a lawyer alone can complete the FOP application. In addition, the FOP deals primarily with the technical data and does not require the writing skills needed from a lawyer (as perceived by EGAT executives). Simply put, the document control for the one submitted for the environment-impact- assessment study and the information for the FOP have to be consistent.

Due to the various group of EGAT staffs who involve with the project feasibility, the assessment study, and the FOP submission; it is often that the information is neither consistent nor updated. Several reworks and

document revisions to the Provincial Office of Industry (a branch of DIW) have taken place- contributing to unnecessarily prolong the submission process. In summary, for the FOP application, there is no clear working structure, no clear responsibility assigned to other staffs except for a lawyer (who is not familiarized with the technical terms) from the beginning, a lack of authority for a lawyer, and a lack of planning in how to collect needed data for the FOP form, and lack of data verification prior to the form submission. Lastly, a proposed power plant relies on the technology from abroad. The information is documented in English while the FOP form is completed in Thai. The translation is also cited as problem.

For the second step, the attempt to complete the FOP without rework is proposed. Based on the past mistakes, the entire ten sections of the form should be completed by a team from different areas of expertise. To complete the ten sections by a lawyer has taken too much time. The recommended changes can be described as follows:

Section 1: Details about the plant (In this case: Power plant)

For this section, EGAT needs to provide the plant name and type, operation (e.g., electricity generation), horse power of machinery, number of workers, etc. This section should be completed by the engineering team.

Section 2: Details of the plant location and facility space

For this section, EGAT needs to provide the plant address, factory building space, and plant area space (include all related buildings). This section should provide should be completed by civil engineers.

Section 3: Details of normal operation hours

The normal operation hours is required and needs to be in compliance with the environmental impact assessment. This section should be completed by the engineering team- who has worked on this impact assessment.

Section 4: Details of the registered capital and other financial arrangement

In case of EGAT, this information is not strictly required. Nevertheless, the finance and accounting staffs should help complete the section.

Section 5: Details of the funds for construction and operation

For EGAT, an amount of funds or capital needed for construction and operation is referred to from the initial project submission. Therefore, this section should be completed by a project engineer(s) who are earlier assigned to work on a project proposal and development.

Section 6: Details of the factory workforce

For EGAT, the required details are similar to that of Section 5. In case of factory expansion, the number of additional employee work must be consistent with the size submitted during the environment impact assessment. This section needs to be completed by a project engineer(s) who are earlier responsible on project proposal and development.

Section 7: Details about production

This section requires the details relating to the raw material shall be indicated only really use in production process such as fuel oil, natural gas, water, etc. Again, these details must be worked out together between a project engineer(s) and a contractor who will be given a contract to build a power plant.

Section 8: Details of construction plan

The details relate to the equipment installation, and commissioning respectively. The construction period prior to the operation needs to be stated. This section is often completed by the work between a project engineer(s) and a contractor.

Section 9: Map of power plant location

This section requires the map of a planned power plant location to be exactly the same as the one submitted to environmental impact assessment. The engineering team needs to complete this section.

Section 10: Details of machineries

The details must contain machinery functions. It is very important that the submitted details must be consistent with the drawings. The engineering team which has worked since the environmental-impact-assessment stage needs to provide the needed details.

For the third step, the guideline (which shows the process redesign for the FOP application) is developed. Altogether, there were three group discussion sessions with all EGAT staffs who have involved in this application. Based on their experiences, there is a consensus that project-management knowledge is needed to ensure the process redesign would be credible and acceptable to EGAT executives. This knowledge highlights the systematic thinking which considers the following factors- organization, risk, planning, control, and quality.

EGAT executives should revise the current practices of appointing a lawyer to be solely responsible to complete the FOP form. This practice is based on the belief that this form has the legal implications. In addition, the FOP form is from the DIW which is also a public agency. So, it is viewed as more or less document work which requires no active involvement from engineering staffs. At the same time, EGAT executives presume that the study on environmental-impact assessment will not likely result in any drastic change in the power plant's machineries. This premise is not accurate based on past experiences. A change in machinery will lead to a recalculation of manpower needed and other wastes from a plant's operations. Updating the data becomes a challenge for a lawyer who is not part of the project and engineering teams dealing with the project feasibility and environment—impact assessment studies. Given the described circumstance, completing the FOP form has taken longer time which caused delays and increased the risk in all spectrum considered by EGAT. See Table 4 for the guideline and the comparison with current practices.

The last step deals with the validation of the proposed redesign for the FOP form completion. First of all, the discussion with a group of lawyers who had filled in the form indicates the support of the redesign. Despite their knowledge in how the data should be written on the form, the lawyers expressed their frustration with the inability to track the data and documents needed as well as to seek a timely response from engineering staffs (as they are occupied with other projects and work). Secondly, the discussion with engineering staffs about the proposed redesign also shows their support. This is due to the fact that they have to eventually involve with the task to complete the FOP form. Participating early without the rush due to the deadlines for the FOP submission is better. Finally, EGAT executives can grant the authority to apply the guideline by allowing a project management team to be formed by a lawyer.

Table 4: Proposed Guideline (after the Process Reengineering)

Consideration Factor	Proposed Practice	Current Practice	Benefits
Organization	• To set up Project Management Team	• Lawyer solely responsible for application completion.	• Involving key staffs early
	• Role clarity for data gathering and application completion	• Requesting assistance from other related staffs when needed.	• Clear sense of ownership in completing the FOP application
Risk	• Awareness of the impacts from the delays to EGAT risk spectrum	• No consideration of risk	• Becoming more proactive in working together
Planning	• To set up the timetable for responsible staffs in individual sections (of the FOP form)	• Ad hoc based on how a request from a lawyer is viewed and relied	• Better time estimation for the completion of the FOP form
Control	• Checklist • Progress report	• Ad hoc depending on a lawyer assigned to complete the FOP form	• Ensure the correct information is used to complete the FOP form and a timely manner
Quality	• Checklist (the same as planning)	• Focus primarily on the description from the legal perspective-whether it has any legal impacts	• Ensure data accuracy

6) DISCUSSION AND IMPLICATIONS

This project highlights the interrelationships among process reengineering, KM, and RM. Reengineering initiative from the EGAT case is based on the repeated delays in commissioning the power plants, the awareness of the impacts on organizational risk, and the common knowledge on what have contributed to these delays. Without KM (from the staffs' experiences and data/information on the past problems with the completion of the FOP form,

it is not likely that any significant change leading to the internal-process redesign can take place. The data (in reference to Table 3) confirms the severity of the delays which lasts in months or even in years in some projects. Initially, it was feared that a lawyer(s) might neither agree nor support a change for process improvement. At the end, it was not the case as the lawyers were seeking this change as much as engineering staffs.

Using the root-cause analysis to help gather the knowledge from the key staffs is also helpful. Raising the awareness on the complexity level (when attempting to complete the FOP form) is critical to gain the attention from top management. The linkage with RM when attempting to reengineer a process improvement is proven to be useful as the group members are aware of organizational risk factors and how these delays contribute to higher risk facing EGAT. The risk to national security (due to the threat of blackouts) and financial impact (due to the need to operate the obsolete machines and generators) need to be specific and clarified.

In the past, any process redesign or reengineering would progress very slowly. It is likely due to the monopolistic status in the electricity market. By allowing private operators and possible entry to the country's energy market by international operators requires the paradigm shift in how the delay in commission a new power plant is viewed, the urgency of process improvement and of the need to work as an effective team. Another important paradigm shift is on how EGAT (as a state enterprise) deals with other public agencies (such as DIW). The document is no longer about the legality. Since EGAT is perceived to be one of many energy operators in the market which have to comply with the regulatory requirements, the roles of engineering and technical staffs have become more important. In addition to the need to simultaneously consider KM and RM when undertaking the reengineering initiative, the paradigm shift from a monopolistic operator is also a key lesson learned from this study. It is important to note that EGAT was playing the roles of a regulator and an operator in the electricity market until the late 1990s.

7) CONCLUSION

The study focuses on how KM and RM interacts with the reengineering efforts. After the completion of the process redesign, it appears that both KM and RM have helped sort out potential conflicts among the relevant staffs and groups. KM and RM are helpful in clarifying the problems and

the potential impacts if these problems (especially the FOP delay) remain unresolved. From the observation, KM and RM play a catalyst role in soliciting the consensus and maintaining the focus during the reengineering initiative. Other lessons learned from the study include the need to involve all key stakeholders during process improvement. In this case, EGAT executives, engineering teams, civil engineers, lawyers, and staffs from the finance and accounting are involved. Dealing between the organizations within the domain of the public sector represents an issue which could be investigated later in the future. For the EGAT experiences, when operating as a single operator in the market, completing the form with another public agency was regarded as a legal affair. The investigation into other operators in the international markets during the transition to the competitive market represents a potential study in the areas of business and organizational development.

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The Test Automation Adoption-A Case Study

Anyanitha Distanont * *(anyanitha@citu.tu.ac.th)*
Orapan Khongmalai *(orapan@citu.tu.ac.th)*
College of Innovation, Thammasat University

Kacharuk Marukpitak *(Kacharuk@gmail.com)*
Reuters Software (Thailand) Limited

Harri Haapasalo *(harri.haapasalo@oulu.fi)*
Department of Industrial Engineering and Management, University of Oulu, Finland

*Corresponding author

ABSTRACT

The aim of this research is to identify key success factors of test automation adoption in the context of software development company. The research is qualitative by nature. The data collection was conducted through both qualitative and quantitative method. The qualitative data was collected through in-depth interviews and the quantitative data was collected through a questionnaire. The findings present that there are 26 factors from 4 main categories: (1) people, (2) process & approach, (3) technology, and (4) management support that influence the success of test automation adoption. The results would contribute valuable knowledge to both researchers and practitioners in software development fields as well as can be used as a guideline for developing or improving the test automation system.

Keywords: Software development process, Software testing, Test automation.

1) INTRODUCTION

Each time before the practical use of the software, the software has to be processed in software development life cycle so that it can be launched with the highest quality and efficiency. The software development process consists of the stages as requirements analysis, design, coding, and testing. Among these stages, it can be seen that software testing is considered the most crucial one which directly affects the overall quality of the software (Ahamed, 2009). For illustration, it is the stage for detecting any problems and defects of the system before the software developed is handed to the customer (Tuteja & Dubey, 2012). With this stage, we can be certain that the software is qualified and response to the need to the customer. On the contrary, in case that the software delivered possesses some mistakes, it can further affect the increase of work budget for fixing that failure software as can be seen from Figure 1. This has also been called "snowball" effect (Haapasalo, & Ylihoikka 2004), when costs accumulate when the errors are found later. In addition, it will lead to the negative trust of the customer and image of the organization. However, we need to bear in mind that the stage of software testing is very costly and can consume 50% of the total amount of time and labor of the entire of software development process (Budnik, Chan & Kapfhammer, 2010; Damm, Lundberg, & Olsson, 2004). Usually companies reason their testing activities "because it is cheaper to test than not to test" (Davis, 1994). The value of testing can be analyzed from the entity point of view, and the value added can be seen as the difference between incoming monetary flow and out going monetary flow, which is the value added inside the company in question. Because of profound testing, the product price can be set higher (increase the incoming monetary flow, due to higher reliability) and therefore increasing the value for the customer. This can be seen as the definition of the value added for testing from the business point of view. (Määttä *et al.*, 2009).

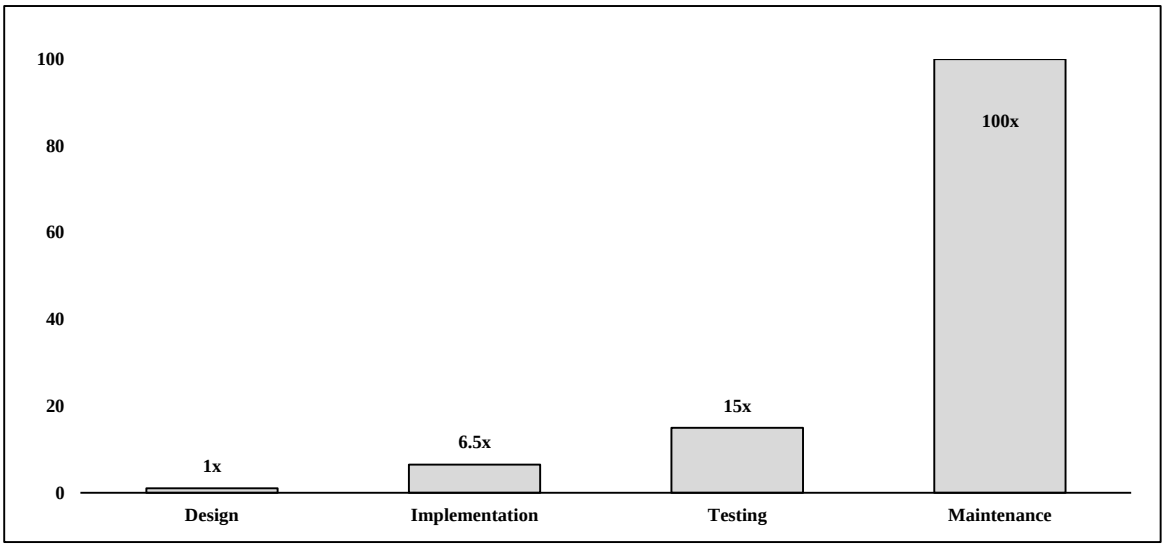

Figure 1: The cost to fix an error in each development phase (Soni, 2006).

Nowadays, there are more software developers paying attention on the test automation for software testing process. It is believed less cost consumed and can enhance software development quality as well as reduce the risks that may lead to any software defects (Collins, Dias-Neto, & Lucena, 2012). Moreover, test automation can be viewed as the main element in software development of agile methodologies which is now very popular in many organizations (Collins, Dias-Neto, & Lucena, 2012). It is considered very responsive to the requirement changes of the organization, flexible, and can reduce time consumed for software development so that the software can be launched to the market faster (Singh & Singh, 2010). Rafi et al (2012) state about the benefits of test automation as ((1higher quality of software, ((2test coverage, ((3reduced test time consumed, ((4 trustworthiness, ((5software trustability, ((6reusability, ((7less human labor consumed, ((8less cost consumed, and ((9more defects can be detected. Nevertheless, looking from the counterpart side of test automation, there still various problems hidden which can lead to the failure in the practical use of the process. Pettichord (1999) claims that although test automation can reduce the problems of software development, it can bore several problematic issues at the same time. Rafi et al (2012) therefore identified certain problems and limitations of test automation as follows: (1) test automation cannot completely replace manual test, (2) organization cannot achieve the goal by totally relying on test automation benefits, (3) maintenance issues, (4) need for development, (5) inapplicable expectation, (6) inappropriate development strategy and (7) lack of skillful human resources.

With these issues raised, it is therefore justified to study relevant issues affecting the success and best practices of test automation in order to gain the insight of test automation principles and development dealt in the case company that has high diversity in working environment and aims to use test automation in software development process of the case company. Also, the study is aiming to explore management methods and limitation solving issues for obtaining the model for test automation as the guidelines for future users and researchers.

2) SOFTWARE DEVELOPMENT PROCESS AND TEST AUTOMATION

Software development process is to translate the ideas and requirements into the physical system (Birrell & Ould, 1985). The software development life cycle comprises five stages: 1) requirement analysis, 2) design, 3) coding, 4) testing and 5) installation and maintenance (Kumar, Zadgaonkar & Shukla, 2013). It can be grouped into three categories as follow: 1) planning, 2) implementation, testing, and documenting and 3) deployment and maintenance (Distanont, 2012). Testing is a critical part of software development and it is important to the successful of software development project. It is the process of finding, identifying and correcting undiscovered errors during the software development process before it is released into production. (Tuteja & Dubey, 2012). However we have to keep in mind that quality must be built, not tested, into a system (Koomen & Pol 1999). The output of the testing phase is the input of the actual production of the software therefore early detection of defects can greatly reduce costs of production.

One view to illustrate testing in software development process is the so-called V-model illustrating how requirements are turned into product features and how testing is used to verify that the goals are reached. The V-model shows how different testing levels are situated in the software development process and each development activity has a corresponding test activity. The tests at each level exercise the corresponding development activity. The same principles apply no matter what software lifecycle model is used. (Fewster & Graham 1999).

Software testing generates over half of development costs (Beizer, 1990; Budnik, Chan & Kapfhammer, 2010; National Institute of Standards and Technology, 2012). Many main causes for these costs are poor test strategy,

underestimated effort of test case generation, delay in testing and subsequent test maintenance. The impacts from poor testing have been already found, including increased failures due to poor quality, increased software development costs, increased time to market due to inefficient testing, and increased market transaction costs. Therefore nowadays a number of companies apply test automation approach for software testing since it can improve the overall efficiency of testing including, increase software quality, improve software reliability and reduce the cost, time and risk of software errors (Colin, Dias-Neto & Lucena, 2012; Rafi et al, 2012).

The overall maturity of the test process is a critical factor in terms of value of testing. The literal meaning of the word maturity is "ripeness", conveying the development from some initial state to some more advanced state. Implicit in this is the notion of evolution or ageing, suggesting that the subject may pass through a number of intermediate states on the way to maturity. To increase their maturity, organizations need framework or model for improvements. An expected finding with the testing maturity approach is the fact that optimal total costs and test coverage decrease while maturity increases. (Määttä et al. 2009).

3) RESEARCH PROCESS

The research was conducted as a case study: the success factor of test automation adoption in a software development company. This case study organisation is the leader in the software industry in Thailand. It offers financial software in the financial and risk, legal, tax and accounting, intellectual property and science and media markets profession. The case study has long traditions of software development.

The research process had two phases. The first phase is the literature study which has been executed in order to understand test automation concept and the critical success factors for test automation. Then the empirical study was conducted. The data collection method is interviews. Interviewees include eight persons that were working in the software development project. The roles of informants are tester and developer in operation and management level (Table 1). The aim of the interviews was to identify the key success factors of test automation in practice through priority index analysis. The scale of priority index was from 1 to 5, (1-corresponding to not considerable important, 5- corresponding to very important).

Table 1: The characteristics of the informants

Informants	The job title of informants	Level	Years of work experience
1	Developer	Operation	3 Years
2	Developer	Operation	3 Years
3	Developer	Operation	1 Years
4	Developer	Management	7 Years
5	Tester	Operation	7 Years
6	Tester	Operation	7 Years
7	Tester	Operation	8 Years
8	Tester	Management	6 Years

4) RESULTS AND DISCUSSIONS

4.1) The list of critical success factors of test automation

The critical success factors of test automation have been summarized in Table 2. A total of 26 success factors were explored and grouped into four categories, namely people, process and approach, technology and management support. The goal of this summary was to list all the main success factors for test automation occurred in practice.

Table 2: Critical success factors for test automation (Research findings)

Category	Success factors
People	1. Developer's attitude
	2. Tester’s attitude
	3. Collaboration
	4. People skill
Process and approach	1. Selective automating
	2. Measurement
	3. Test prioritization
	4. Test driven development usage
	5. Adding test case for defects

Table 2 (Continued)

Category	Success factors
	6. Tool evaluation
	7. Multi layered automation approach
Technology	1. Ease of learning
	2. Ease of use
	3. Maintainability
	4. Independence
	5. Incremental delivery support
	6. Reviewability
	7. Reliability
	8. Execution speed
	9. Software change
	10. Software testability
	11. Software complexity
	12. Need of domain knowledge
Management support	1. Goal Setting
	2. Initial Investment
	3. Dedicated Resource

4.1.1.) Characters of success factors in people category

1) Developer's attitudes:

Most of the interviewees agree in term that developer is the main person responsible for the quality of the software. He or she needs to pay attention to testing process including test Automation. The interviewees notice that there are certain parts of developers who dislike or do not comfortable in testing process. Therefore, it is the good idea to build mindset of software quality to company's developers.

2) Tester's attitudes:

Every interviewee agree that testers can get involved in the part of testing design particularly in the level of end-to-end for making it more covered and trusted. However, there are still some testers who are not skillful for writing the program. Therefore, it is necessary that the testers need to have to positive attitudes for being enthusiastic learner in order to develop test automation of the team more effectively.

3) Collaboration:
It is considered very important for driving test automation being successful. Every party involved must see software quality as the shared responsibility of the team. Therefore, every individual in the team must support and share knowledge to each other. In addition, the collaboration must take place since the very initial stage as requirement setting process so that the whole team can see the overall picture of the work and plan the work effectively.

4) People skill:
This is one of the important factors in this context. However, it is very difficult to find people with all skills including program writing, test, and software knowledge. Hence, most of the interviewee found that the collaboration, knowledge exchange, and skill support between developers and testers can develop and fulfill this gap.

4.1.2.) Characters of success factors in people category process and approach

1) Selective automating:
It is suggested that the test should be done only in the important part or the part that can return the high benefits or the part that requires consecutive test. In addition, it is the good idea to rank the priorities of automated test because to conduct the test as 100% of the whole system is very unpractical and not worth investment.

2) Measurement:
This is also viewed as the very important part of the process by most of the interviewees for Test Automation in the angle that it must be clear, usable and significantly show the benefits and importance of Test Automation.

3) Test Prioritization:
The information obtained from the interviewees in this part show the information that is different from the review of literature. Most of them differently view from the literature in this part in terms of the priorities of the test and the management methods. For elaboration, they think that the important part of the test is actually at UI only because the test at the level of unit test and be totally run and fast. Nevertheless, some of the interviewees think that the selection method for the component and module is considered the most crucial thing because it is the main module and most practical.

4) Test driven development (TDD) usage:
Every interview agree that TDD can help Test Automation having high quality and robust. For illustration, TDD can ease code to be more testable and beneficial for unit test. However, in practical, this is not very easy to be done especially when the requirements of the projects keep changing during the development because new things have to be tried through the time. Also, this can lead to the delay of project delivery timeframe.

5) Adding test case for defects:
All interviewee agree that this is the appropriate way to be followed but not all bugs in automated test need to be taken to this process. Only some bugs that have been found defective should be selected.

6) Tools evaluation:
This is considered one of the other main important factors. All tools need to be evaluated as appropriate to the type of the project and technology to be applied in. This can be done by searching the source of information that provides the weakness and strengths of test automation tools so that any decision to be made can be more reliable. However, one of the interviewee reported that according to his personal experience, sometimes the tools to be selected must depend on the desire of the executives and this may in turn bring about the tools that are not exactly matched the need of the users.

7) Multi layered automation approach:
Regarding this part, all interviewees agree that it should be done in all parts by specifically focusing on uni test because it helps increasing ROI and very easy to be accomplished. Good uni test can also help detecting defects or bugs more effectively and reducing the problems occurred in GUI.

4.1.3) Characters of success factors in technology category

1) Ease of learning:
Most of the interviewees also agree that this factor is very important. If the tool is too complicated or difficult to learn or to apply, it will demotivate people's mindset to use test automation in the process. For example, if the tester has no basic skill in programming, he or she may take longer time to learn how to use the tool than those having programming skill. In any cases, the selection of the tools should be focused on the appropriateness as the group of people developing Automated Test.

2) *Ease of use*:
Similarly, every interviewees think that Test Automation should be easy to use because if not so; for example, many setup involved, more program required, complicate preparation, it will lead to lack of motivation of the users in using Test Automation.

3) *Maintainability*:
All interviewees agree that this factor is very important and suggest that the function that is used frequently should be set as the main library. In addition, this factor is considered one of coding practices in order to prevent code duplication. They suggest that at the initial stage of script writing, this point may not be necessary to be much focused; rather any relevant codes must be done practically first. Then, the other elements should be developed to reduce code duplication.

4) *Independence*:
Every interviewee agrees it as the important factor because if the test has domino effect, more time might be wasted in the process of problem detecting. Therefore, to solve domino effect that may occur, Test Automation must be setup and teardown before restarting the test.

5) *Incremental delivery support*:
This factor is agreed by all interviewees that it should be involved in Test Automation because Test Automation must be done by the selection of the crucial part and gradually increased.

6) *Reviewability*:
Most of the interviewees found that this is not the problem in processing Test Automation because if the tools or the language used in reviewing it is comprehensive, it will be used widely by more people. Moreover, this is the result of the tool evaluation as well.

7) *Reliability*:
This is considered very important factor because with the lack of trustworthiness in Test Automation, False Alarm will happen. OR, if bugs are failed to be detected during the test process, Test Automation will automatically viewed useless rather manual test will be more effective. To solve this problem, it is suggest that automated test script should be set as flexible as possible in order to prevent any unexpected incidents may occur:

8) *Execution speed*:
Also, this is one of the factors agreed by every interviewee that it is very important. The sooner the results of the test can be reported, the better the process it is. In addition, it will be even far more effective, if the test can be run parallel. However, one of the interviewee notices that though this factor is considered very important, trustworthiness is still considered more important. For illustration, he points out that Test Automation must possess trustworthiness value firstly then the other factors as the timing of the test should be run afterwards.

9) *Software change*s:
Every interviewee agree that the changes in the software will lead to more loads in maintaining Automated Test. However, software and changes are unavoidable. It is believed that the principles of Test Pyramid and the focus on uni test can help solving problems in this part

10) *Software testability*:
Every interviewee thinks that this factor is very important because if the software has low testability, its ROI will be low as well. More elaborated, it will take more cost for testing each of its part. On the contrary, if the software is designed supportive for Test Automation for example there is ID setup for all objects, Automated Test will be very easy to be done.

11) *Software complexity*:
This is considered one of the obstacles preventing the success of Test Automation. The interviewees state that the complication of software can lead to high degree of false alarm. For example, if the dependency or network has some problems, the investigation can be more difficult to be done. On the contrary, the more we can control variables or environment, the more Test Automation can be achieved.

12) *Need of domain knowledge*:
Most of the interviewees think that this factor negatively affect Test Automation. One of them points out this issue by raising the example case of the component he is being in charge that it is the software that requires high level of knowledge in finance. Those involving in his project must understand about the working process and flow of all types of markets such as finance market and bond market. This increases the difficulties in developing Test Automation. However, some of the interviewee point out that each test case itself can tell how the software should be tested.

According to them, all requirements and difficult issues are clearly explained in the requirement document. Therefore, this issue is not as difficult as seen.

4.1.4) Characters of success factors in management support category

1) *Goal setting:*
Most of the interviewees view that it is important that everyone in team must have the same goal because naturally every individual such as tester and developer has their own point of view and hence the work process can be done differently and far from the actual goal unless the goal is clearly and definitely set. However, one of the interviewees said that Test Automation is the work process that is quite clear in itself except when there is very limitation in time which the priorities need to be clearly set. For example, in case that there is the time constraint, workloads should be focused rather than the time spent.

2) *Initial investment*:
Regarding this factor, every interviewee thinks that it affects the success of Test Automation because besides the issue of the cost invested, the more important issue is timing. Executives need to understand and be ready to provide support. Moreover, the interviewees think that the investment in Test Automation consumes very long time period to reach the worthiness point.

3) *Dedicated resources*:
This factor is very important for Test Automation development. The interviewees found that the normal workloads already consume high demand of time. If there is no special slot of time provided for this process, Test Automation is very difficult to be done. In addition, one of the executives suggest that they can actually use push and pull method to reserve some special time for Test Automation if it is proven beneficial and needed by all team members.

4.2) Priority of key success factors of test automation in practice

		ALL	DEV.	TESTER	
People		2	1	2	Developer's attitudes
		3	2	3	Tester's attitudes
		1	3	1	Collaboration
		4	4	3	People skill
Process and approach		1	1	2	Selective automating
		5	5	5	Measurement
		4	4	6	Test prioritization
		6	7	4	Test driven development usage
		7	6	7	Adding test case for defects
		3	2	3	Tool evaluation
		2	3	1	Multi layered automation approach
Technology	Part of Test Automation Framework and Design	6	7	5	Ease of learning
		3	2	4	Ease of use
		2	2	2	Maintainability
		6	2	7	Independence
		4	6	3	Incremental delivery support
		8	8	8	Reviewability
		1	1	1	Reliability
		4	5	5	Execution speed
	Part of Software Testing	2	1	3	Software changes (-)
		1	1	1	Software testability
		3	3	1	Software complexity (-)
		4	4	4	Need of domain knowledge (-)
Management Support		1	2	1	Goal setting
		3	3	3	Initial investment
		2	1	2	Dedicated resource

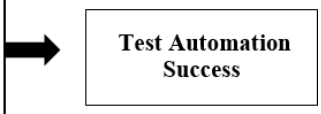

Figure 2: Prioritizing success factors

4.2.1.) People Factor

The interviewees who are the developers mainly focus on the importance of the attitudes of the developers. They consider themselves as the key part responsible for the quality of software. However, there are some developers who have no skills in running the test or do not realize on the importance of the test. Therefore, for these people, there is an urgent need to change their attitudes so that they can learn and be aware of software test process. In

doing so, the executives can help building the value awareness of the test among the developers by stating it as the goal or assessment factor for software quality and link it as part of working performance. Regarding the interviewees who are the testers, they heavily focus on the importance of work collaboration. They see that in running test automation, there must be the collaboration from developer, tester, and even product manager. They need to brainstorm and prioritize the parts in test automation since the very initial state of the process so that the work plan can be set effectively. After that, they think that both developer and tester need to help each other in designing Automated Test so that the test obtained can cover all working parts and be trusted. This can be occurred by continuing communication. As can be seen, the factors in part of collaboration are different in terms of the weight of work involvement between developer and tester. The executives should be aware about this issue and help driving developer, tester, and product manager realize on the importance of work collaboration in Test Automation development so that the work can be run smoothly and effectively.

4.2.2) Process and Approach Factor

In this part, the views from the developers and testers are highly correlated. They both focus on (1) the selection of the parts for Automated Test (2) Multi-layered Automated type of test and (3) tools evaluation. However, they somehow have the different view in the part of TDD usage. Developer finds some problematic issues in the practical use of TDD such as work delay and frequent change of requirement. Looking at working context, the unstable requirement will negatively affect developers rather than testers. For illustration, after the code has been set, if there is any change in requirement, developer needs to fix the code in the program which is more difficult than designing the test or testing the case. Therefore, with the issue of TDD usage, the executives should be aware of it and support the team to provide the solution regarding the use of TDD. One of the possible solutions is that they need to build the collaboration from product manager for the setting the requirement as clearly as possible. In addition, there should be the collaboration both from developers and testers in studying through the requirement, setting proof of concept or prototype before actual work running in order to reduce the chances of requirement changes in the process of code writing and TDD at least.

4.2.3.) Technology

According to the information gained from the part of Test Automation Framework and Design, the interviewees and priorities assessment show that the interviewees who are the developers and those who are the testers give considerable similar results; for example, trustworthiness (first ranked), maintenance (second ranked), testing timing (fifth ranked), review (eighth ranked). However, regarding the information in the part of independence, the developers rank it as the second place while the testers ranked it at the seventh. This can be explained that normally developers are the person responsible for checking and fixing when the test shows any failed sign. Therefore, if the test case has lack of independence, more time for problem detecting will be consumed. As a result, the executives should emphasize that both developers and testers must be aware when writing or developing Automated Test in order to reduce workloads for developers. As for the issue of development support, the developers ranked it as the sixth while it was ranked at the third by the testers. This can be explained by the fact that developers are more expertise in programming than testers. Therefore, they can fix Test Automated Framework more easily. On the contrary, testers think that to increase the new cases, it can be done right away without fixing Test Automation Framework. For this issue, the executives may create pairing between developers and tester so that testers can have more skill in fixing framework or the developers can develop framework for more flexible and supportive test case as appropriate to the need and make it easier for testers.

Regarding technology factor in term of the software to be tested, the interviewees from the part of developers and testers gave quite similar information. They both focus on testability of software as the first priority while specific skill of software is ranked at the last. As for the part of software complication, the testers rated them at first ranked which is different from developers who rated them at third rank. This can be seen that the developers are more skillfull and specialise in coding of the program than the testers. They can write stub or mock to help testing. Also, they tend to consume less time in investigating the problems occurred from software complication. In this issue, the executives can support the team to have knowledge transfer from developer to tester more especially in the part of problem checking. On the contrary, developers look at the importance of software changing at the first priorities while the testers look at it at the third rank. This is because developers are the group that most affected when there

is any change in software occurred. They need to fix, adapt, or even restart Automated Test as they are the code writers. For this issue, the executives must emphasize the team to set the plan and the direction for developing software as carefully as possible. For example, if the team acknowledge that some functions will be changed at the higher rate in the near future and will then affect Automated Test being run by fixing it or restart it, team must take these issues to the consideration if it is worth working. Or, the team may take these issues to the play since the process of the selection of technology to be used in software. For illustration, if the technology tends to be cancelled in the very near future, it should not be used.

5) CONCLUSIONS

The aim of this research is to identify key success factors of test automation adoption in the context of software development company. The research is qualitative by nature. The data collection was conducted through both qualitative and quantitative method. The qualitative data was collected through in-depth interviews and the quantitative data was collected through a questionnaire. The findings present that there are 26 factors from 4 main categories:(1) people, (2) process & approach, (3) technology, and (4) management support that influence the success of test automation adoption which are presented in table 2. The most important factor in the people and process & approach group are collaboration and prioritized automated test, respectively. While most discovered important factors in the technology and management support category are reliability and goal setting.

Given the findings in this research, they can lead to suggestions that, for a software development company which is looking to start building test automation system, or to improve its existing test automation process, the aforementioned factors, especially the highly ranked ones, should be taken into its consideration since the very beginning of the software development life cycle. Its executives need to ensure that the goals and expectations from its investment in test automation are clearly set and are very well understood by all involved in the development process, as well as provide sufficient resource and time for them. Managers should encourage collaboration between developers and testers to create synergy and close the knowledge gaps between the two different roles. Developers, testers, and product managers, should take automated test as priority and work on it together since the requirement analysis phase to ensure that the product design will ease the implementation of automated test. The team also needs to identify tests which need to be

automated from those which are not worth to put the efforts on. Last but not least, persistent efforts in making the test automation reliable is one of the most important keys to the success of test automation.

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