Designing a knowledge management system architecture for Abyor

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MASTER THESIS REPORT

Designing a Knowledge Management System Architecture for Abyor

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ABSTRACT

This master thesis project aims to propose a Knowledge Management (KM) System architecture for Abyor. This thesis project was started with the identification of Abyor's KM problems and Abyor's KM processes performance by using the KM Scan. Next, the KM system architecture was designed based on the COMET methodology that was adapted based on the guidance from Desta et al. (2014) study. This methodology produced the business model, the requirements model, the proposed KM system components, and the proposed KM system architecture model. Last, the validation of the proposed KM System architecture was performed by assessing the user acceptance and the organizational capacity.

Keywords: Knowledge, Knowledge Management (KM), KM Scan, KM system, KM system architecture.

PREFACE

This master thesis was the result of a graduation thesis project fulfilled to gain the degree of Master of Science in Innovation Management at the TU Eindhoven. This master thesis project was performed in Abyor's Europe BV in High Tech Campus, Eindhoven incorporation with Abyor International in Jakarta, Indonesia.

Firstly, I would like to thank Rik Eshuis for his dedication to this thesis through significant input and continuous feedback. Your support and help throughout the execution of this project were necessary for me to be able to finish this project with a satisfying result. I also want to thank Thijs Peeters for his dedication as my second supervisor. Your input and feedback helped in improving the quality of my thesis.

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Above all, I would like to thank my family for supporting and helping throughout my study. Your support is the biggest motivation for me to finishing this master study so that I can come back home.

Lastly, I would like to thank my friends that I met in Eindhoven, especially to all Indonesians student in Eindhoven. Thank you for fulfilling my days with smiles and laugh. Thank you for always help me, give support, and above all give me proper foods when needed. You all are considered as my new family while far-away from home.

Ully Yunita Nafizah P.

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MANAGEMENT SUMMARY

Research Background

As a consultant company, Abyor realizes the increased importance of knowledge management (KM) implementation in their organization to manage their knowledge as the company's key asset, to reduce the knowledge loss, and to foster the knowledge utilization across divisions. To do so, Abyor intends to develop a Knowledge Management (KM) system that is expected to support the application of KM processes within Abyor. The KM system development is executed by the human resource division and the delivery service division as the KM system architect and the KM system developer. However, due to the current situation, Abyor experiences the limitation of resources to develop the KM system. Therefore, the assistance from an external party is needed in the KM System development process.

Research Objectives

The primary purpose of this master thesis project is to propose a KM system architecture that aligns with the current performance of the KM processes within Abyor, solves Abyor's KM problems, and applicable to all employees. Furthermore, currently, Abyor has already implemented an ERP system in their organization. Therefore, it is expected that the proposed KM System is coherent with the existing ERP system.

To achieve the objective, this master thesis project is driven by four research questions:

1. What are Abyor's current problems regarding the KM processes?
2. What kind of KM system components should exist within the proposed KM system?
3. What is the best KM system architecture model, especially by considering the existence of the ERP system?
4. How valid is the proposed KM system architecture to be implemented in Abyor?

Data Analysis and Result

Research Question 1

For the first research question, the adapted Knowledge Management (KM) Scan proposed by Weggeman (1997) was used to identify Abyor's KM processes performance and Abyor's KM problems. As suggested by Hoff, Vijfers, and Ridder (2003), the KM Scan consists of both interviews and surveys. As a result, the current Abyor's KM problems are identified as follows.

- The inexistence of a procedure to facilitate the needed knowledge identification process, especially in the long terms.
- The lack of formal and well-documented procedures in the knowledge development process.
- The limitation of a formal communication facility to support the knowledge communication process.
- The inexistence of a central knowledge repository to support the knowledge storing and retrieval processing
- The limitation of a formal procedure to facilitate the knowledge transfer process.
- The inadequate access to find the knowledgeable and available expert

Further, the technology problems encountered are expected to be solved by implementing the proposed KM System.

Research Question 2

The COMET methodology that was guided by Desta et al. (2014) study was applied in the KM system development process. Firstly, the business model and the requirements model were developed to act as the basis to design the specific KM system components and the KM system architecture. The business model provides the detailed analysis regarding Abyor's organizational situation where the proposed KM system will be applied. The business model consists of the business context analysis, the goal model, and the KM process & resource model. The requirements model describes the functional and the non-functional requirements that are expected to exist in the proposed KM system. The requirements model, specifically the functional requirements, is modeled in the form of a use case model. Next, the KM system components are suggested by mapping the use case model into the reference structure analysis based on the KM system function as shown in Table M1.

Table M1 The Proposed KM System Components

KM System Use Case	KM System Function	The Proposed KM System Components
1. Searching information	Knowledge Portal	• Knowledge portal • Knowledge search tools
2. Searching Template		
3. Searching document		
4. Searching expert		
5. Input real-time data	Document Management	• Knowledge repository (content database, expert database, and reference database)
6. Input document		
7. Input new version document		
8. Retrieve document	Information Retrieval	• Knowledge portal • Knowledge search tools
9. Real-time update knowledge retrieval		• Publishing tools
10. Evaluate knowledge	Analysis	• Data Mining Tools
11. Communicating internally	Communication	• Communication and Collaboration Tools
12. Communicating externally		
13. Internal knowledge transfer	Workflow Management	
14. External knowledge transfer		

Further, to facilitate the integration between KM system and the ERP system, the knowledge interfaces that act as the application broker are proposed for both the KM to ERP process and the ERP to KM process.

Research Question 3

Based on the proposed KM system components, the KM System architecture model was designed. It is suggested that the knowledge portal acts as the primary KM system interface that has the call functions to the knowledge search tools and the communication & collaboration tools. Next, it is also proposed that the ERP modules can have a call function to the publishing tools, while the ERP portals can have a direct link with the communication and collaboration tools. Further, it is suggested that the KM system database and ERP system database are connected by using the ERP-KM system interfaces tools. The proposed KM system architecture for Abyor is shown in Figure M1.

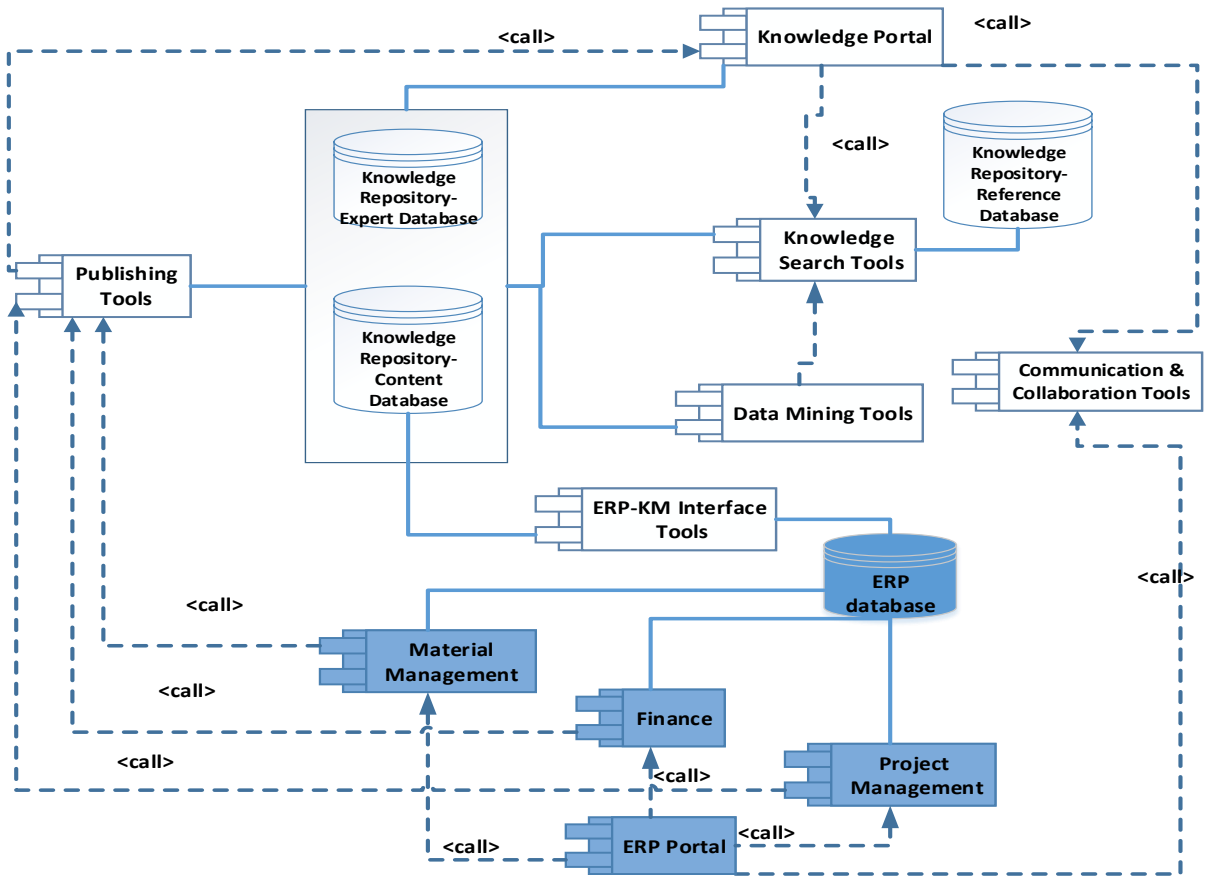


Figure M1 The Proposed KM System Architecture Mode

Research Question 4

The validation of the KM system architecture was performed based on the descriptive evaluation method by assessing the user acceptance and the organizational capability to the KM system architect and developer. As a result, it is found that both respondents confirmed the employee's high acceptance on the proposed KM system and validated the fulfillment of each Abyor's KM problem that was identified, specifically related to the technology problems. Further, both respondents also ensured Abyor's capability to embody the proposed KM system architecture. Therefore, it is summarized that the proposed KM system could solve the KM problems related to technology and enhance the KM processes within Abyor.

Limitations

Several limitations exist in this study process related to the research's validity. Firstly, the geographical distance might reduce the internal research validity. Secondly, the external research validity (generalizability) is considered low due to the case study design. Thirdly, the master thesis project focuses on designing a KM system architecture. Therefore, further study for the KM system embodiment and the KM strategic decision are needed to enhance the KM processes implementation in Abyor.

GLOSSARY

Data	The raw information with no meaning that is resulted from the input process (Ackoff, 1989)
Explicit knowledge	The type of knowledge which is easily stored, retrieved, shared, and disseminated (Cavusgil, Calantone, & Zhao, 2003)
Information	The processed data that has a meaning and a purpose (Ackoff, 1989)
Knowledge	The organization resource that is used to recognize the value of information, assimilate it, distribute it and apply it in the business process (Gold & Arvind Malhotra, 2001)
Knowledge Management (KM)	The organizational process for acquiring, organizing and communicating knowledge to increase efficiency and productivity of the knowledge utilization (Alavi and Leidner, 2001)
KM Process	Process for managing the knowledge as the organization's intellectual capital assets that consists of knowledge creation & acquisition process, knowledge organization & retention process, knowledge dissemination process, and knowledge application process (Supyuenyong and Islam, 2006)
KM System	The collection of the information system application and technology that can improve the efficiency of knowledge flow and the utilization of knowledge assets through the KM processes, particularly for the knowledge that defines the company's core competence (Newell, Huang, Galliers, & Pan, 2003)
KM System Architecture	The blueprint or the reference model for the KM system that defines KM system components' components' interdependencies, interactions, and interfaces (Maier, 2007).
KM System Components	The KM tools/ technologies that compose the KM system. The KM system components are ready and available in the self, thus need to be configured and adjusted based on each organization's needs (Desta, Garfield, & Meshesha, 2014)
KM System Functions	The KM capabilities which facilitate the KM processes by providing specific tools/technology (Park & Kim, 2006)
Tacit knowledge	A hidden, a non-verbalized intuitive and an unarticulated knowledge which resides in the individual (Cavusgil, Calantone, & Zhao, 2003)

CONTENTS

CHAPTER 1
INTRODUCTION

1.1. Introduction

During the past years, knowledge has been considered as the most critical driving forces for business success (Xu, Wang, Luo, & Shi, 2006); (Metaxiotis, 2009). Due to the stated fact, knowledge management (KM) has rapidly become an integral business activity in the organization (Grover & Davenport, 2001). Furthermore, there is a growing exploitation of technological capability in the pursuing of knowledge-driven competitiveness by implementing a knowledge management (KM) system (Alavi & Leidner, 2001). KM system itself is arguably composed of a group of technologies that has readily available in the self (Desta, Garfield, & Meshesha, 2014). However, the design process of the KM system is considered still disorganized with limited availability of theoretical framework and conceptual framework to ensure the system's components integration. Next, it is proposed that the KM system is not preferred to be implemented in isolation, but rather in parallel with other enterprise systems (Xu, Wang, Luo, & Shi, 2006). Nonetheless, only a limited number of studies have suggested the integration framework between KM system and another enterprise system, specifically ERP system, which the most common used system (Li, Chaudhry, & Zhao, 2006). Furthermore, the proposed frameworks have not been validated and proved yet to be implemented successfully within the company. Therefore, there is a need to perform an empirical case of KM system development, specifically, the case that requires the validation of the KM system integration with the ERP system.

This master thesis project focusses on the development of a KM system in Abyor International BV, which is an international IT service company based in Jakarta, Indonesia. As a consultant company, Abyor realizes that knowledge is a key asset to gain their competitive advantage and to ensure their survival, especially to keep up with client's need. Therefore, there is an increasing awareness of the importance of the KM processes implementation within Abyor. Related to that situation, Abyor has a plan to develop their internal KM System. This plan, which is still in the early stage of development, is executed by the human resource development and the delivery service divisions as the KM system architect and developer. In line with Abyor's situation, this study aims to provide in-depth analysis regarding the KM processes and the KM problems within Abyor. Next, the KM system architecture is proposed based on the current KM processes and problems. Furthermore, due to the current implementation of an ERP system in Abyor as their enterprise system platform, it is suggested that the proposed KM System should be aligned with the existing ERP system.

This master thesis report presents an explanation of the project related to the development of the KM system in Abyor. The primary objective of this master thesis project is to design a KM system architecture within Abyor that applicable to solve the current KM problems related to technology, to enhance the application of KM processes, and to be implemented seamlessly with its existing ERP system. To achieve the goals, several qualitative and quantitative methods were conducted to gather the basic requirements to design the proposed the KM system architecture model.

1.2. General Information about Abyor

In this section, the background information of Abyor International is presented by describing Abyor's business areas, vision, and organizational structure. Next, the background of KM system development is defined based on Abyor's current situation.

1.2.1. Abyor International

Abyor International is an international Information Technology (IT) service company based in Jakarta Indonesia which delivers transactional services, consulting & technology services, system integration, and managed services. Abyor is listed as an official SAP Gold Partner, which focuses its business on optimizing SAP Operations and Supports. Currently, Abyor International has several multinational branches which reside in Europe and Australia, of which one is located in High Tech Campus, Eindhoven. Functionally,

Abyor International acts as the main company since all IT consultants and developers reside there, while Abyor branches function as the sales promoter and the public relation representatives internationally. Due to the nature of the project, the study is mainly held in Abyor's headquarter in Jakarta, Indonesia, while Abyor's branch in Eindhoven acts as the representative to correspond with the university.

Abyor is known as one of the best SAP partners in Indonesia by getting platinum partner license and by becoming United Vars member (Iskandar, 2016). Different industries are explored by Abyor, such as mining, transportation, construction, manufacturing, oil and gas, retail, plantation, utilities, and others. Abyor International has the vision to become the most trusted partner for both local and international clients by providing the best integrated IT solutions to meet customer specific requirements through sound and reliable technical expertise. To do so, Abyor International defines its organizational values that act as the corporate backbone, namely, people development, continuous improvement implementation, optimal resource utilization, client integrity, and partnership.

Structurally, Abyor's organization consists of five main divisions, namely the delivery service division, the solution architecture division, the business improvement, and control division, the corporate service division, and the marketing and sales division. The delivery service division acts as Abyor's consultant who delivers the product to the client on the project-based. The delivery service division consists of several sub-divisions based on specific SAP modules, such as financial module, BASIS module, project manager module, HCM module, and logistic module. The solution architecture division is responsible for preparing the project, by which this division provides the necessary document, arranges modules, and organizes deliverables to be offered in project's tender. The business improvement & control division has two main tasks, namely, control the on-going project based on budget and develop a new offering product. The corporate service division consists of three main divisions, which are the legal division, the finance & general affairs division, and the human resource division. Finally, the marketing and sales division is responsible for searching the possible projects and offering Abyor's product to the potential clients. The following Figure 1 depicts Abyor International's organizational structure.

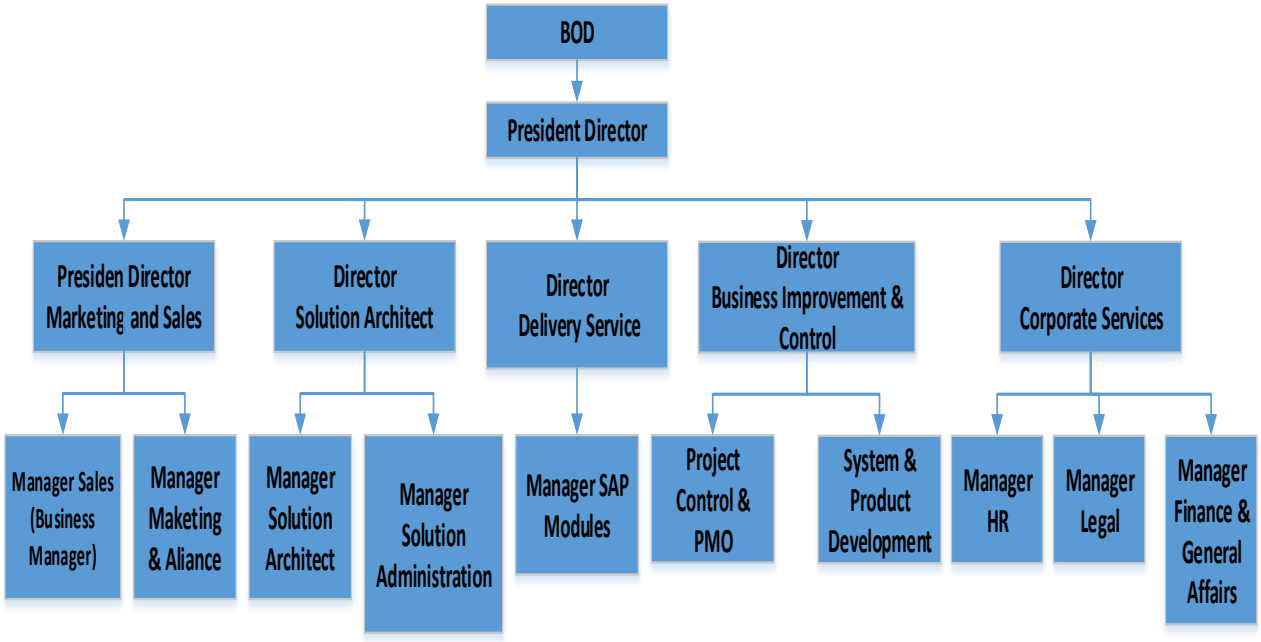


Figure 1 Abyor's Organization Structure

As a consultant company, Abyor realizes that employees act as the organization's backbone, thus managing employee's knowledge become necessary to ensure Abyor's survival. This idea is reflected within Abyor's people development program. Abyor's people are claimed to have a high value, thus increasing the possibility to be hired by competitors. This condition is reflected in Abyor's high turnover rate which reached 21% in 2014. As a result, in the long run, Abyor will suffer knowledge loss through its employee resignation despite its investment in people.

Despite the urgency of managing knowledge, Abyor is still considered lacking in managing their KM processes. In fact, currently, Abyor does not have explicit KM activities, procedure, nor infrastructure that applicable within Abyor. Several divisions, though, have unconsciously initiated several KM efforts, such as having internal database documents, having implicit agreement on project's documentation procedure and providing a supportive culture to facilitate the transfer of knowledge.

1.2.2. The Development of KM System in Abyor

Based on Abyor's current situation, it is clear that there is a high urgency of managing the knowledge. On the other hand, the existing KM implementation has not yet covered all of Abyor's KM processes. Aware of this matter, Abyor's board of director has instructed the human resource division to improve Abyor's KM processes. These improvements are shown through several new explicit strategies, several documentation procedures, a mechanism to knowledge transfer process since early 2016. Further, the project to develop a KM system for Abyor has been initiated since mid-2016 by its human resource division and solution architecture division.

By the time this master thesis project was started, the internal KM system development project was still in the planning stage, specifically in the stage of identification needs. The project is handled by the human resource division in cooperation with the solution architecture division. However, both divisions realize that they still lack knowledge and experience. From the human resource division perspective, they realize that they lack the knowledge to identify the existing KM processes within Abyor. From the solution architect division perspective, they find the difficulties in mapping the KM processes into the KM system specification. Another important thing is that both divisions experience a lack of resources, both employees and time, to proceed with the project due to a significant amount of client's project that Abyor faced. Furthermore, by considering that the ERP system has already been well implemented within Abyor, it is clear that the KM system will be carried out in parallel with the current system.

Based on Abyor's current situation and plan, this project was held to help Abyor in developing its KM System, specifically at the system architecture level. The primary goal of the project is to develop a KM system architecture as a blueprint to realize a KM system that enhances the implementation of KM processes, solve the current KM problems, and align with the existing ERP system.

1.3. Objectives and Research Questions

Based on the proposed problem statement, the research's goal is defined along with four research questions.

Research Goal

"To propose the KM system components and the KM system architecture model that applicable to Abyor by considering the current KM processes performance, the current KM problems related to technology, and the ERP system."

Research Questions

RQ1 What are Abyor's current problems regarding knowledge management process?
RQ2 What kind of knowledge management system components should exist within the proposed KMS?
RQ3 What is the best KM system architecture model, especially by considering the existence of the ERP system?
RQ 4 How valid is the proposed knowledge management system architecture to be implemented in Abyor?

The following Figure 2 represents the overview of each research questions deliverables.

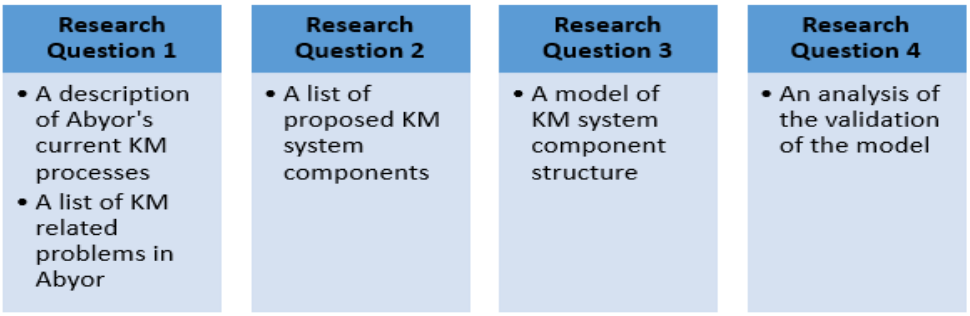


Figure 2 The Overview of Research's Deliverables

1.4. Research Scope and Boundaries

The research intends to propose a Knowledge Management (KM) system architecture that applicable to Abyor thus the technical level of analysis is not covered in this study. Further, by considering the existence of a well-implemented ERP system, the information regarding the ERP system was used as the baseline thus no significant changes should be applied to the ERP system to apply the proposed KM system. Overall, the proposed KM system architecture is expected to be relevant to Abyor's general strategy and Abyor's specific objective regarding KM, understandable for every level of employees, and valid to be implemented in Abyor. Moreover, the KM system should be able to foster Abyor's KM processes and to solve KM problems related to technology.

1.5. Outline of the Report

This chapter includes the introduction of Abyor International and the description of problems' background. This chapter also defines the research goals, the research questions, and the research scope that guide this master thesis project. In Chapter 2, the summary findings from a literature study that act as the basis of this project are presented. Chapter 3 presents a comprehensive research methodology. In Chapter 4, the KM scan result is performed to diagnose the current KM processes implementation to answer the first research question. Chapter 5 defines the design process of the KM system architecture which includes the answer to the second and the third research questions. This chapter also presents the validation of the proposed KM system architecture model to answer the fourth research question. Last, Chapter 6 presents the summary of the result and the discussion for possible further works. The outline of this report is shown in Figure 3.

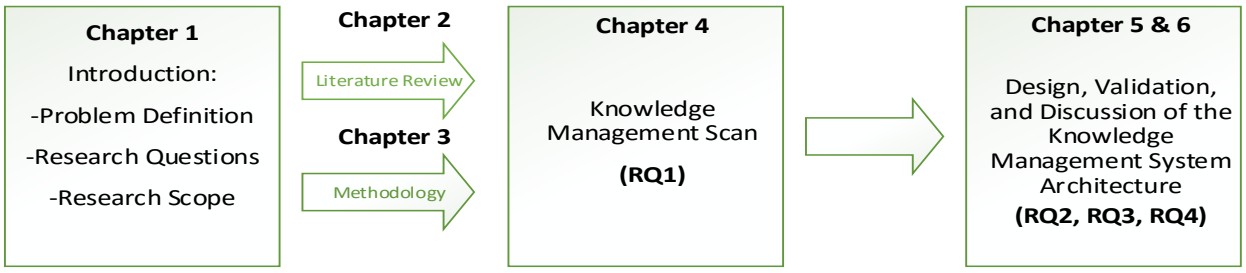


Figure 3 Outline of the Report

CHAPTER 2
LITERATURE REVIEW

This chapter covers the main findings of the related concepts in the literature review that act as the basis of this master thesis project. The first section defines the different views and types of knowledge exist. Further, the second section introduces the related theories regarding KM. The third section discusses the relevant concepts regarding the design process of the KM system. Next, the fourth section presents the existing proposed integration models between the KM system and the ERP system. The fifth section introduces the success dimensions of the KM system. Last, the conclusion of the literature review is presented.

2.1. Knowledge

Knowledge can be viewed from several perspectives, namely, a state of mind, an object, a process, a condition of having access to information, and a capability which lead to different implication strategy for managing knowledge (Alavi & Leidner, 2001). In this research, the perspective of knowledge as a process is used since it is widely applied as the research basis in the knowledge management area (Liu & Deng, 2015). In the process perspective, knowledge is defined as an organization resource that is used to recognize the value of information, assimilate it, distribute it, and apply it in the business process (Gold & Arvind Malhotra, 2001).

In accordance with the knowledge definition, there exist several classifications of the knowledge based on the different categorization ways, for example, based on its type, its function, and its source (Maier, 2007). The most common categorization is explicit knowledge and tacit knowledge (Nonaka & Takeuchi, 1995). Explicit knowledge is defined as the type of knowledge which is easily stored, retrieved, shared, and disseminated, while tacit knowledge is defined as a hidden, a non-verbalized intuitive and an unarticulated knowledge which resides in the individual (Cavusgil, Calantone, & Zhao, 2003).

There is a need to distinguish knowledge from data and information, especially for the system development purpose (Chen, et al., 2009). The data-information-knowledge-wisdom (DIKW) hierarchy proposed by Ackoff (1989) was used to differentiate the three terms. In the proposed hierarchy, it is argued that the data acts as the raw information with no meaning that is resulted from the input process. Meanwhile, the information is defined as a processed data that has a meaning and a purpose. Last, the knowledge is the application of data and information in the cognitive process (Ackoff, 1989).

2.2. Knowledge Management

In the previous studies, knowledge management (KM) was introduced in several disciplines with various definitions (Gupta, Sharma, & Hsu, 2008). The most comprehensive definition is proposed by Alavi and Leidner (2001) that defines KM as the organizational process for acquiring, organizing, and communicating knowledge to increase efficiency and productivity of the knowledge utilization. Further, the existence of KM processes implementation in the organization is arguably necessary, especially by considering the organization's transformation into a knowledge-intensive and knowledge-aware organization (Maier, 2007). According to Alavi and Leidner (2001), there exist three different KM implementation's aims in the organization: 1) to make the knowledge's resource, flows, and role in the organization visible, 2) to foster a knowledge intensive culture in the organization, 3) to build a KM infrastructure that facilitates people's collaboration and interaction. This three KM aims were used further as one of the bases for designing a KM system architecture.

The implementation of KM within one company should also be fostered by organization capabilities. Gold and Malhotra (2001) introduces the KM infrastructure capability framework that consists of culture, structure, and technology. The culture infrastructure focuses on the relation between the company's vision, values, and working environment with the knowledge management. Next, the structural infrastructure refers to the existence of norms, procedure, and mechanism that support the KM processes. Meanwhile, the technology infrastructure focuses on the presence of a technology-enabler within the company (Gold &

Arvind Malhotra, 2001). In this master project, the KM capability framework was used as the background information for the KM implementation and as the method for classifying the KM problems.

Related to the KM theory, two pillars of KM are introduced by Park and Kim (2006), namely, KM activities and KM functions. The KM activities define the process perspective of KM, while the KM functions define the KM capabilities which facilitate the KM processes by providing specific tools/technology (Park & Kim, 2006). Related to the proposition, the terms of KM processes and KM system are found to be more used and discussed in the previous study. Furthermore, based on their definitions, it is argued that the KM activities are a part of KM processes, while the KM functions are one component of the KM system. Therefore, the KM processes and the KM system are discussed further as the two pillars of KM.

2.2.1. Knowledge Management Processes

KM processes play a critical role in defining the knowledge type of intervention that is needed in the organization (Davenport, 2010). Various classifications and terms exist in the previous study to differentiate the KM processes. In this master thesis project, Supyuenyong and Islam (2006) classification was used since it is considered as one of the most comprehensive classifications as shown in Figure 4.

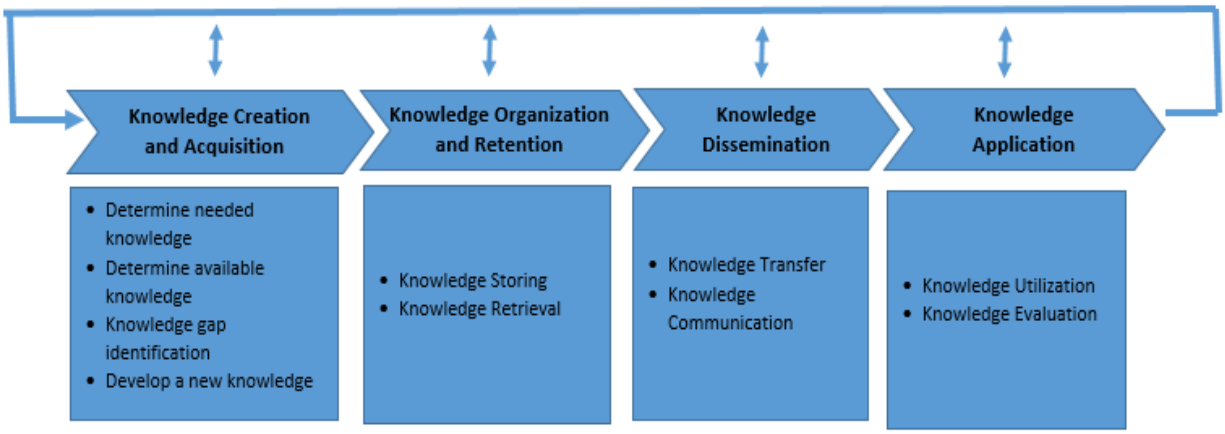


Figure 4 Knowledge Management Process based on Supyuenyong and Islam (2006)

As can be seen, the four main KM processes are identified in the proposed model by Supyuenyong and Islam (2006). The first process, namely the knowledge creation and acquisition, consists of the needed knowledge identification process and the available knowledge identification processes. Next, knowledge gaps are found and further analyzed to determine the appropriate knowledge development strategies. The second process, namely the knowledge organization and retention, focuses on the knowledge repositories process and the knowledge retrieval process within the organization. The third process, namely the knowledge dissemination, is the process to distribute and to communicate the knowledge for internal and external parties The last process, namely the knowledge application, aims to generate value from the knowledge and to assess the knowledge utilization process (Supyuenyong & Islam, 2006).

2.2.2. Knowledge Management (KM) System

KM system is necessary to be implemented to support and to enhance the KM processes (Alavi and Leidner (2001). KM system is defined as the collection of the information system application and technology that can improve the efficiency of knowledge flow and the utilization of knowledge assets through the KM processes, particularly for the knowledge that defines the company's core competence (Newell, Huang, Galliers, & Pan, 2003). Furthermore, Desta et al. (2014) argue that the KM system components are ready and available in the self, thus need to be configured and adjusted based on each organization's needs. The related concepts for designing the KM system are comprehensively presented in the next section.

2.3. Designing Knowledge Management System

Based on the existing studies, it is found that no best practice for designing the KM system exists (Desta, Garfield, & Meshesha, 2014). The comprehensive understandings regarding the KM processes and the KM system functions are necessarily required to design KM system in a particular organization (Deve & Hapanyengwi, 2014). Related to the design process of KM system, Ma and Hemmje (2002) identified three main issues, namely the KM system function, the information processing techniques a.k.a. KM tools and the KM system architecture. The following subsections present the comprehensive concepts of those three essential issues.

2.3.1. Knowledge Management (KM) System Functions

The KM system functions ensure that each critical KM process has been supported by the KM System. This KM system functions, further, are used as the basis for proposing the KM system components (Ma & Hemmje, 2002). In their meta-analysis study to the various KM processes and KM technologies, Park and Kim (2006) generate six main classes of the KM system functions and its sub-functions. The following Table 1 presents the classification of KM system functions proposed by Park and Kim (2006) that have been added from Chua (2004). In this master thesis project, this classification was utilized in designing the KM system components.

Table 1 The Classification of KM System Function adapted from Park and Kim (2006) and * *added from Chua (2004)*

KM Function	Sub-functions	Descriptions
Communication and Collaboration	Chatting	Facilitating direct communication
	Mailing	Facilitating indirect communication channel
	Conferencing	Real-time conferencing
Information Retrieval	Search agents	Searching and recalling data/information
	Visualization	Presenting data in more sophisticated ways
	Finding expert	Providing expert information
Document Management	Document repository*	Storing data in a central database
	Document versioning	Managing of multiple version of files
	Document metadata	Changing the managed documents
	Document indexing and retrieval*	Searching data and information in either content or index
	Document security	Controlling access to the data
Workflow management	Process definition	Identifying business process
	Task assignment	Assigning task based on process
	Authority	Delivering work items to appropriate users
Analysis	User analysis	Analyzing system usability
	Market analysis	Analyzing market trends
	Decision support	Supporting decision
Knowledge Portal	Integrated knowledge interface	Providing personalization facilities
	Navigation management *	Providing information categories, link, and navigation

2.3.2. Knowledge Management Tools

As stated in the previous section, KM system is composed of the various system applications and tools. Numerous KM tools are introduced in the literature, by which each literature defines different KM tools classification (Davenport, 1998). To name a few, Schmaltz, Hagenhoff, and Kaspar (2004) classified KM tools to seven categories, Tiwana (2000) distinguished KM technologies into five meta-components, while Chua (2004) clustered the KM technology into three main classes.

In this master thesis project, the various KM tools/technology found in the literature study are classified and presented based on the KM system functions classification proposed by Park and Kim (2006). The following table 2 shows the proposed KM tools classification and its description. In the design process of the KM System, this classification was used in proposing the KM system components.

Table 2 The proposed classification of KM Tools based on KMS Function

KM Function	Related KM Tools	Description
Document Management (Desta, Garfield, & Meshesha, 2014); (Chua, 2004)	Knowledge Content Database	- Stores large amount of data and information - Provides the index, the link, the map, the navigation, and the versioning functions.
	Expert Database	Stores expert "Yellow Pages" database
	Reference Database	Stores external knowledge source
	Ontology Database	Facilitates knowledge retrieval from different sources based on the definition, the concept, and the context mapping
Knowledge Portal (Schmaltz, Hagenhoff, & Kaspar, 2004)	Personalization Tools	- Contain user management application - Contain administration tools such as content analysis tools, user analysis, roles, and profile
	Knowledge Presentation Tools	- Contain visualization tools - Contain knowledge maps and links tools - Facilitate mining-based visualization
Communication and Collaboration (Chua, 2004)	Communication tools	Facilitate chatting, voice call, and mailing tools
	Collaboration tools	Facilitate synchronous meeting, i.e. video conference, and asynchronous forum discussion
Information Retrieval (Desta, Garfield, & Meshesha, 2014)	Knowledge Search Tools	- Facilitate pull-service function, e.g. by using search engines - Facilitate search filter tools and search navigation tools
	Publishing Tools	Facilitate push-service function
Workflow Mgt. system (Chua, 2004)	Workflow Management System	Facilitates synchronous knowledge transfer based on the business process identification and the task identification.
	Knowledge Transfer Tools	
Analysis (Park & Kim, 2006)	Data Mining Tools	Facilitate data and information extraction for various analysis, i.e. user system analysis, market analysis, and social network analysis
	Decision Support System	Supports decision-making process

2.3.3. Knowledge Management (KM) System Architecture

The KM system architecture plays a significant role in the KM system since it serves as the blueprint or the reference model for the implementation of the information system (Maier, 2007). Several KM system architecture models have been proposed in the literature. Based on Jennex (2008) meta-analysis study, several KM system classifications were identified. For example, Borghoff and Pareschi (1998) proposed the KM system with four components, namely repositories & libraries, knowledge-worker communities, knowledge mapping, and knowledge flows. Binney (2001) classified the KM system components based on the user's perspectives, such as transactional KM, analytical KM, asset management KM, process based KM, development KM, and innovation & creation KM. In addition to Jennex (2008) study, the KM system classification was found based on the function layer. As an example, Maier (2007) and Chua (2004) suggested the KM system that consists of three layers, namely, infrastructure service layer, knowledge service layer, and presentation layer. Meanwhile, Tiwana (2000) proposed the KM system that consists of seven layers, namely, repository layer, middleware & legacy integration layer, transport layer, application layer, collaborative filtering & intelligence layer, access & authentication layer, and interface layer.

2.4. System Integration of the KM System and the ERP System

By considering the nature of this master thesis project, it is implied that the proposed KM System will have a direct integration with the existing ERP system. Therefore, it is important to understand both systems similarities, differences, and interaction. In this section, the related concepts and models in defining both systems interaction and integration are presented.

2.4.1. The Interaction between the ERP System and the KM System

Similar to the KM System, the ERP system has been widely and rapidly implemented in the global business environment as an essential strategic IT tools to help the company to gain the competitive advantages (Xu, Wang, Luo, & Shi, 2006). In its implementation, the ERP system supports the integration between business

processes and organization resources (Zheng, Yen, & Tarn, 2000). Thus, the application of ERP system arguably can support and improve the decision process due to the improvement of the data processing, the enhancement of the decision reliability, and the ability to gain a real-time data (Holsapple & Sena, 2001). Both KM and ERP system arguably have a similar goal which is to improve organization's competitive advantage by managing the company's assets (Xu, Wang, Luo, & Shi, 2006). Nevertheless, several key differences between the two systems are found in the system's focus, the system's processes and the system's goal as follows: 1) The ERP system focuses on managing the physical assets, while the KM system focuses on managing the intellectual capital assets, 2) The ERP system manages the company's business processes, while the KM system manages the KM processes, 3) The ERP system improves the company's efficiency through the cost reduction, the decision quality enhancement, and the productivity improvement, while the KM system improves the competitiveness through capturing, transferring, and storing knowledge.

The dynamic interaction between the ERP system and the KM system had been identified in the past studies. Xu et al. (2006) analyze the interaction of two systems based on two perspectives: the effects of ERP on KM and the effect of KM on ERP. Based on the effects of ERP on KM, it is argued that the ERP system consists of the key modules for capturing, exploring, and sharing knowledge within the organization's processes (Xu, Wang, Luo, & Shi, 2006). From the perspective effects of KM on ERP, it is argued that KM acts as one of critical success factors for the ERP implementation, by which different types of knowledge is needed to be utilized over different phases of the ERP implementation (Newell, Huang, Galliers, & Pan, 2003). Therefore, it can be said that the ERP system and the KM system have a complementary nature to each other, especially by considering their unique characteristics and goals (Xu & Li, 1989).

2.4.2. The Integration of the KM System and the ERP System

Several previous studies claim the possibility to implement ERP system and KM system concurrently (O'Reilly & Tushman, 1997); (Newell, Huang, Galliers, & Pan, 2003). Aligned with the claim, Xu et al. (2006) propose that parallel implementation of the ERP system and the KM system is logic from both practical and system point of views. From a practical point of view, the KM system is rarely implemented secluded from another enterprise system, while from a system point of view, it is widely believed that the KM implementation is critical to be applied throughout the ERP life cycle (O'Leary, 2002). Further, Xu et al. (2006) also propose two different approaches to integrating the ERP system and KM system: 1) the integration based on the system corporation by which two separate systems exist, 2) the integration based on an entirely new developed system, by which the KM system is integrated as a module in the ERP system. Based on the nature of this project, the first approach was utilized in designing the integration of the KM system and the ERP system.

Xu et al. (2016) propose the existence of the knowledge interfaces between the ERP system and the KM system to realize the cooperation modules. The proposed knowledge interfaces act as the application broker that facilitate the knowledge flow both from the ERP system to the KM system and from the KM system to the ERP system. By applying the knowledge interfaces, the ERP system is able to request the knowledge to perform the business process activities from the KM database, while the KM system is able to gain a real-time and a daily basis data/information from the ERP database (Xu, Wang, Luo, & Shi, 2006). Based on the knowledge flow's direction, two types of KM interfaces are identified, namely, the ERP to KM interfaces and the KM to ERP interfaces (Xu, Wang, Luo, & Shi, 2006).

- The interfaces from ERP system to KM system ensure that the ERP system gains the required data, information, and knowledge for implementing the company's business processes. According to its function, the interfaces from ERP to KM consist of K-Discovery (methods to access the data from the ERP system as a central database), K-Classifying (methods for categorizing the knowledge based on its type and its domain context), K-Storage (methods to save the knowledge in the knowledge base).
- The interfaces from KM systems to ERP system assure that the KM system has a proper channel to interact and to process data and information in the ERP database. The interfaces from KM to ERP system consist of K-Identifying (methods to send the knowledge request and to transfer the request with the context into the query on the knowledge base) and K-Indexing (methods to interact with a knowledge repository based on the query commands given).

2.5. Knowledge Management System Success Factors

Several past studies have been conducted to identify the success dimensions of an information system, specifically for the KM system (Sedera & Gable, 2004); (Wang & Wang, 2009). Regardless the existing KM system success model, the limited model exists to measure the success of the KM system architecture, by which not all dimensions are applicable to the system architecture. Therefore, the adjustment of the KM system success model was performed to design the validation method of the KM system architecture model.

The architecture system level validation intends to ensure the fulfillment of the required and the expected functions in the proposed system (Barbacci, Clements, Lattanze, & Northrop, 2003). One validation method of the KM system was introduced by Desta, Garfield, and Meshesha (2014) by measuring the user acceptance and the organizational capability. The user acceptance intends to measure the user acceptance of the KM system architecture based on its function fulfillment, while the organizational capacity aims to measure the organizational readiness to implement the proposed design (Desta, Garfield, & Meshesha, 2014). With regards to the user acceptance, the KM system adoption model proposed by Kuo and Lee (2009) was used as the basis of questions. The KM system adoption model itself consists of several constructs namely perceived usefulness, perceived ease of use, and information quality (Kuo & Lee, 2009).

- Perceived usefulness assesses the extent the users believe that the KM system enhances his/her job performance.
- Perceived ease of use evaluates the easiness of using the information technology
- Information quality measures the capability of the system. In the context of the KM System, as proposed by Wu and Wang (2006), the KM system quality consist of content, context, and linkage qualities.

On the other hand, the organizational readiness is performed by evaluating the organization's ability to actualize the KM system architecture design to implemented the KM system (Desta, Garfield, & Meshesha, 2014). In this master thesis, this dimension was performed by evaluating the feasibility to implemented each proposed KM system components.

2.6. Conclusion of the Literature Study

The extensive literature study was performed to gain thorough understandings regarding the previous studies in the KM area that act as the prerequisite to answering the research questions.

- For the first research question, the literature study was used to design the research instruments for diagnosing the current KM problems as follow:1) The KM capability framework as proposed by Gold and Malhotra (2001) was used to understand the organization's background information for the KM implementation, 2) The classification of KM processes was used to design the research instruments, in this case, the proposed classification from Supyuenyong and Islam (2006) was used, 3) The KM system functions were used in defining the research instruments to understand the need and the current fulfillment of organization's KM function.
- For the second and the third research questions, the literature study was performed to gain an input in designing a KM system architecture for Abyor. By considering the argument that the KM system components are readily available thus need to be configured, the understandings of several issues as proposed by Ma and Hemmje (2002) are required as follows: 1)The comprehension of various KM system functions and KM system tools that exist in the literature review was necessary to build an insight on proposing the KM system components based on the KM system's requirements, 2)The comprehension of existing KM system architecture model was required to gain an insight on designing the KM system.
- For the fourth research questions, the literature study was performed to develop the validity instruments to assess the validity of the proposed KM system. Despite several KM success models found in the literature, no explicit validation framework was found to evaluate the validity of a KM system architecture. Therefore, an adapted KM validation framework was developed based on Desta et al. (2014).

Several theoretical contributions were presented in this literature study. Firstly, this literature study proposed a mapping of the various KM tools exist in the literature into a particular KM function as proposed by Park and Kim (2006) that has not yet developed in the literature study. Secondly, the literature study proposed a validation framework for a KM system architecture that has not yet exist in the previous study.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter describes the methodologies and the steps performed in this master thesis project to answer the research questions. This chapter is divided into several sections as follows. The first section defines the general approach of the research design and its relation to the research questions. The second section describes the detail research methods for each design approach's stage. The third section presents the data collection methods that are used and its results. Last, the fourth section defines the research's validity and reliability issues.

3.1. General Research Design

This master thesis project was structured based on the regulative cycle proposed by van Strien (1986). This cycle was chosen due to the compatibility between the objective of the project and the focus of the regulative cycle. The van Strien cycle intends to solve the business problems based on the design rules and the knowledge bases that relevant to the company's environments and the company's situations (Simon, 1969). The following Figure 5 depicts the regulative cycle proposed by van Strien (1986) that consist of problem identification, problem selection, diagnosis and analysis, design, and validation.

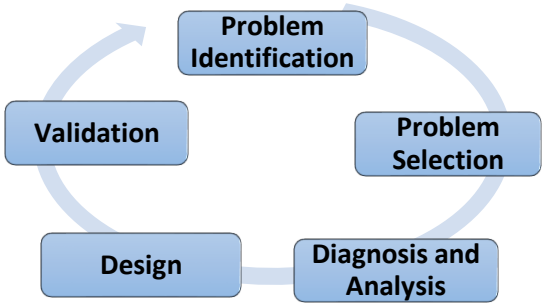


Figure 5 The Regulative Cycle (Van Strien, 1986)

The problem identification and problem selection had finished by the time the project was started. The remaining phases of the van Strien cycle were performed to answer the research questions. Figure 6 below illustrates how each phase of the van Strien cycle relates to the research questions.

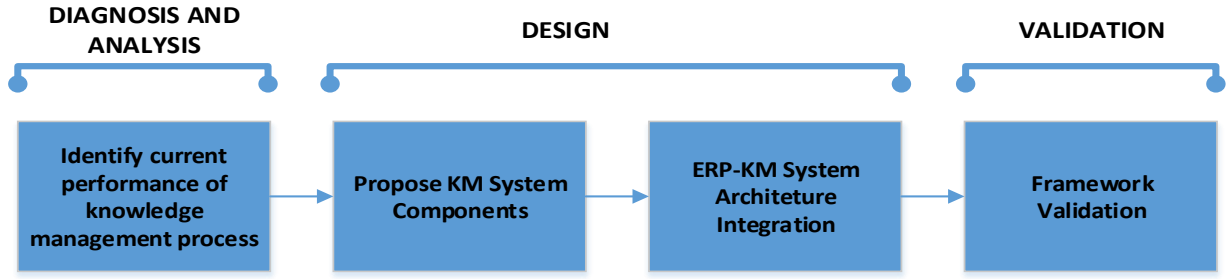


Figure 6 Relation between the Van Strien cycle with the research questions

Aligned with the Van Strien cycle, a combination of the mixed research method and the qualitative research method were used during the completion of each stage. For diagnosis and analysis stage, the mixed research method was used to gain a complete understanding of the research problems under the assumption that both qualitative research and quantitative research provide different types of information and data. While in the validation stage, only qualitative research was performed to gain a thorough understanding regarding the stakeholders' views on the proposed design.

3.2. Research Method

In this section, the detail methods and approaches in performing the remaining phases are defined.

3.2.1. Diagnosis and Analysis Stage

The diagnosis and analysis stage was conducted to gain a thorough understanding regarding the current performance of KM within Abyor as questioned in the first research question. The diagnosis and analysis results further were analyzed and translated into the business model and the requirements model for designing the KM system architecture. In this stage, the convergent parallel mixed method was used as the basis of the research method, while the KM scan was conducted as the basis of the research instrument.

The KM scan as proposed by Weggeman (1997) and Hoff, Vijfers, and Ridder (2003) was functioned as the instrument to evaluate the current performance of the KM processes within Abyor. This scan was performed since it is arguably common to be used to provide the insights to the company's existing KM performance and to generate appropriate strategies and tactics to enhance the KM implementation within the organization (Hooff , Vijvers, & De Ridder, 2003). Further, this research follows the Hoff, Vijfers, and Ridders (2003) study by using the convergent parallel mixed methods that consist of interviews and surveys. The results of the methods were used to gain a complete picture of Abyor's current performance by comparing and summarizing both qualitative and quantitative data (Creswell, 2013).

As a prerequisite to conducting the diagnosis and analysis stage, a prior literature study was performed as shown in Chapter 2 to build an understanding regarding the previous KM research and to design research instruments. Similarly, Abyor's internal documents, such as company vision, mission, values, structure organization, and standard operational procedures (SOP), were analyzed to gain a general understanding regarding Abyor's condition. Next, both qualitative and quantitative methods were performed in parallel.

The qualitative method was conducted in the two series of semi-structure interviews with the stakeholders. The semi-structured interview was chosen since it is considered suitable for the exploration of respondent's perception and opinion, enable the extensive information gathering, and enable the direct clarification of the answer (Creswell, 2013).

- The first interview was conducted to gain the general insights on the stakeholder's view on the KM, the company's knowledge infrastructure capabilities, and each division's business processes and each division's expectations on the KM system. The list of questions was prepared based on the KM scan guideline by Hooff, Vijvers, and Ridder (2013) as an interview protocol (see Appendix 1). The respondents of the first interview were chosen based on the representation and the availability of each Abyor's divisions. As a result, the first interview was conducted with five respondents: human resource manager, project control manager, finance manager, solution architect manager, and delivery service manager.
- The second interview was performed to identify the stakeholders of the KM system, the goal of the KM system, the requirements of the KM system, and the possible system integration with the current ERP system to be used as a basis for designing the KM system. This interview was conducted with the KM system developer and the KM system architect, namely human resource manager and solution architect manager. The questions in the interview protocol were developed based on the needs in the design process of the KM system architecture and based the proposed KM function based on Park and Kim (2006). The list of questions for both human resource and solution architect divisions are shown in Appendix 2.

For each interview, the following procedures were performed as follows. Firstly, the interviews were recorded based on each respondent's permission. Next, the interviews were transcribed to be reviewed by the respondent to ensure its validity. Further, the respondent's comments were proceeded to provide the final interview's result.

Furthermore, the observation was also performed to strengthen the analysis of the qualitative method's result. The observation was conducted throughout the three-week on-site project to the division of corporate service

and the division of business improvement & control as the most settled division in Abyor. The observation was conducted by observing Abyor employee's work culture and activities related to the KM processes.

As proposed by Hoff, Vijfers, and Ridders (2003), the quantitative method was conducted in the KM scan to gain a quantitative understanding regarding the real KM processes that has been perceived by all employees. This quantitative method was performed in the form of a survey with all Abyor's employees that have been recruited for more than six months based on the restriction from Weggeman (1997). The questionnaire for the research was designed based on the existing KM scan by Weggeman (1997), Hooff, Vijvers, and Ridder (2003), Co-Capacity (2012), and Geleyns (2014) that have been adapted to the Abyor's condition based on the preliminary interviews and the KM processes proposed by Supyuenyong and Islam (2006). The questionnaire consists of three parts, namely the individual characteristic part, the KM processes part, and the KM instruments part (see Appendix 3).

- The first part of the questionnaire identifies the respondent's job duration, division, and position. This data was used further to performed a group difference analysis in the KM processes.
- The second part of the questionnaire assesses the current performance of the KM processes based on 1 to 5 scale, by which scale 1 means negative result, scale 3 implies neutral, and scale 5 suggests positive result on the implementation of the specific KM processes within Abyor. Based on the mean values of the scales, the judgment whether Abyor is sufficient or insufficient in implementing the KM processes was made (Chen & Chen, 2006)
- The third part of the questionnaires aims to identify the current and the expectation fulfillment of the specific KM functions by using 1 to 8 scale, ranging from 'never' to 'always' (Hooff , Vijvers, & De Ridder, 2003). The result of this part was used further to gain the insights on designing the KM system components.

The following Figure 7 represents the research approach on the diagnosis and analysis stage.

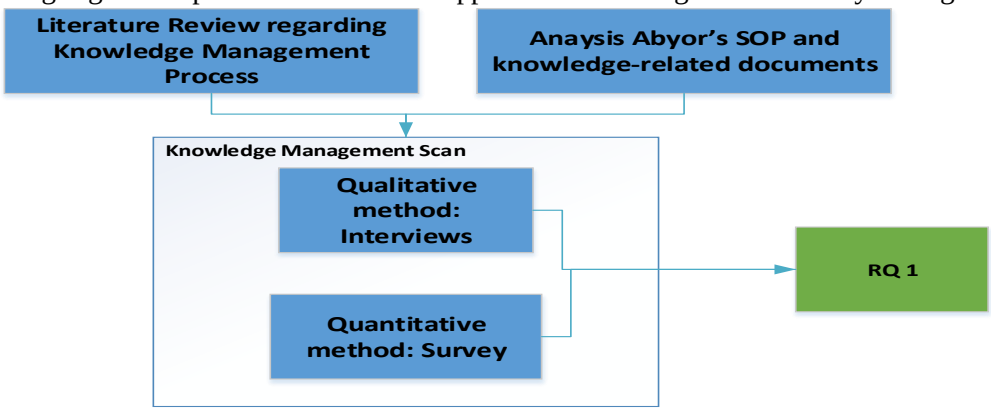


Figure 7 Research Approach for Diagnosis and Analysis Phase

This stage generated the analysis of Abyor's current performance on KM processes and the identification of Abyor's problems related to KM processes. Further, the KM problems found are classified based on KM infrastructure capability. The KM problems related to technology become the focused to be solved by implementing the proposed KM system.

3.2.2. Design Stage

The design stage was conducted to answer the second and the third research questions, which is to propose KM system components and KM system architecture, especially by considering its relation to the existing ERP system. As stated in Chapter 2, no best practice nor explicit procedure in designing the KM system exists (Desta, Garfield, & Meshesha, 2014). In this study, the adapted Component and Model-Based Development methodology (COMET methodology) were conducted based on the guide from Desta et al. (2014) study and based on the master thesis project's needs.

Several reasons motivate the used of this methodology approach as follows. Firstly, it is determined that the COMET methodology is fit to be the basic methodology approach. The COMET methodology is commonly used to bridge business problems and information technology requirements, by which the business context is viewed and modeled as an object. Secondly, the COMET methodology has the similar value with the KM System, by which beliefs that an information system is assembled from different components. Thirdly, in their study, Desta et al. (2014) performed a methodology approach similar to the COMET methodology but has been adapted to a specific goal which is to develop a KM System Architecture. Therefore, the methodology approach from Desta et al. (2014) was used to guide the choice of the necessary step to be performed in this master thesis project. The methodology approach is described in detail as follows.

The first modeling step was performed to understand the organizational context where the proposed KM system will be applied. Firstly, Abyor's stakeholders and Abyor's business processes were identified to gain a complete picture of the KM system implementation. Next, the goal model was defined based on each stakeholder's point of view and each stakeholder's business processes to be crafted further into the requirements modeling. Last, the model of the KM process and the business resources related to KM were made to identify the underlying KM processes within Abyor's business processes and its related knowledge resources. This model was used further to define the functional requirements of the proposed KM system.

The second modeling step was conducted to identify the requirements of the proposed KM system that consist of functional requirements and non-functional requirements. The functional requirements define the basic function that should be fulfilled by the KM system based on goal modeling, process modeling, and resource modeling. Based on COMET methodology, the functional requirements were presented in the form of use case model that are mapped further into the reference structure analysis (Berre, Elvesæter, Aagedal, & Ø, 2006). Meanwhile, the non-functional requirements describe the expected properties of the KM system.

In the last step, the architecture model was modeled in the form of KM system components and KM system architecture. The KM system components were suggested to answer the second research question, while the KM system architecture was developed to answer the third research question. The KM system components were suggested by mapping the expected KM system functions to the KM system tools/applications that are found in the literature, while the KM system architecture was proposed by aligning the KM components with the existing ERP system based on the literature.

Figure 8 below represents the design approach of the KM system by combining the Component and Model-Based Development methodology (COMET methodology) with the method used by Desta et al. (2014).

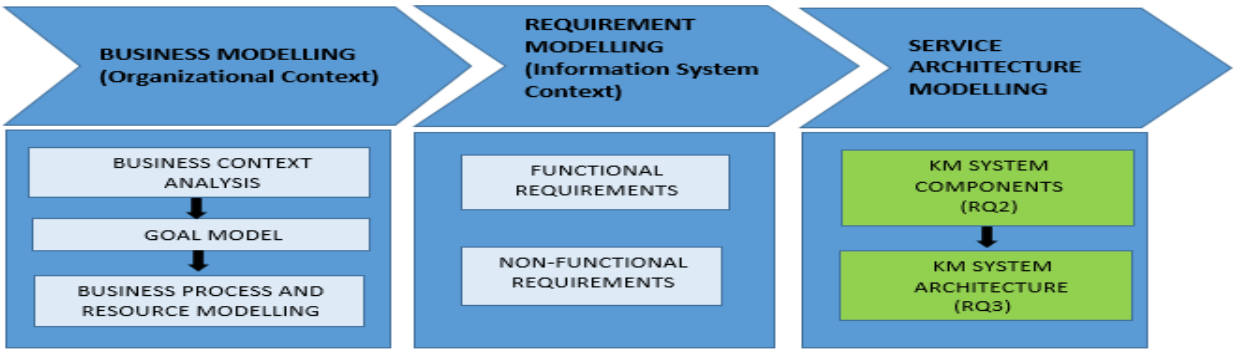


Figure 8 The Approached Used in Designing the KM System

As can be seen, this stage produced the business context analysis and the requirements model, leading to the answers for both the second and the third research questions

3.2.3. Validation Stage

This stage was performed to answer the fourth research question which intends to test the internal validity of the proposed KM system components and KM system architecture based on the in-depth interviews with the manager of human resource and the manager of solution architect. The validation stage was performed based on the descriptive evaluation method as proposed by Desta et al. (2014) by which intends to evaluate the user acceptance and the organizational capacity. The list of questions was derived based on the four dimensions of user acceptance proposed by Kuo and Lee (2009) and the feasibility analysis for each proposed KM system components (see Appendix 4). Further, this validation stage was conducted via Skype due to the geographical restriction faced in this study. Beforehand, the summary of the proposed KM system components and architecture was presented to both respondents to be discussed during the interviews.

3.3. Data Collection Methods

Based on the research method explained, the summary of the data collection methods and its results are presented in Table 3.

Table 3 The Summary of Data Collection and Analysis Methods

Data Generation	Activities	Result
Documentation	Document analysis was performed to the various documents, such as: 1. Abyor vision, mission, values, and organizational structure 2. Abyor's turnover rate 3. Abyor Standard Operational Procedure (SOP) 4. ERP system user's manual	- The identification of Abyor's goal, culture, and current situation of the turnover rate - The identification of Abyor's business processes - The identification of current ERP system
Observation	The observation was performed within the three-week on-site study in Jakarta, Indonesia to Abyor's corporate service and business improvement & control division. The observation used unstructured observation approach by spontaneously observing Abyor employee's work culture and activities related to the KM processes.	- The understanding of Abyor's culture and KM processes
Interviews	The first series of the interview was conducted by using the semi-structured interview to each Abyor's division managers namely HR manager, finance manager, delivery service manager, business improvement & control division, and solution architect division.	- The result of the KM scan as follows. 1. General opinion on KM 2. Organizational culture 3. Organization's degree of attention 4. Current KM implementation in Abyor's business processes
	The second series interview was performed by using the semi-structured interview to the KM system developer and architect, namely HR division manager and solution architect manager. The list of questions for interviews was derived based on COMET methodology developed by Berre et al. (2004) and based on the proposed KM system function based on Park and Kim (2006).	- The information needed that act as the basis to design the proposed KM system such as: 1. Current ERP system, modules, and system architecture 2. KM system stakeholder 3. KM system's goal and objectives 4. Expected KM system's functional and non-functional requirements
	Interviews for the validation was conducted to human resource and solution architect manager via Skype. The list of interview questions for validation was derived from the KMS adoption model (Kuo & Lee, 2009) and the feasibility assessment of KM System components.	- The validation result of user acceptance and feasibility assessment for the proposed KM System based the perspective of KM system's architect and developer

Survey	The survey was conducted with all Abyor employees that have been with the organization for more than six months. The survey's questionnaire was based on the KM scan proposed by Weggeman (1997), Hooff, Vijvers, and Ridder (2003), Co-Capacity (2012), and Geleyns (2014) that have been adapted. The questionnaire consists of three parts, namely identification of respondent, evaluation of KM processes assessment, and assessment of KM function.	- The first and the second part of questionnaire generate the quantitative result on the KM scan both for Abyor in general and for each division to be analyzed further in the group difference analysis. - The third part of the questionnaire was used to gain the insights on designing the KM system components.

To be noted, the detailed analysis of data adequacy is presented in Appendix 5. To summarize the analysis, the data is considered to be sufficient for both quantitative and qualitative research. The result of the survey, specifically, was considered to be adequate to perform the difference group analysis as presented in Chapter 4.2.2.

3.4. Validity and Reliability

To assure the quality of the research, the validity and reliability that might arise in this master thesis project are discussed. In this master thesis project, the case study tactics proposed by Yin (2009) were used to overcome the possible validity and reliability issues in the qualitative research, while the validity and reliability tests were performed in the quantitative research. According to Yin (2009), three tests of validity have been commonly used to established the quality of the study, namely construct validity, internal validity, and external validity as described follows.

- The construct validity is concerned with the degree to which a test measure is correct to measure the concepts that are being studied (Yin, 2009) To ensure the construct validity, multiple sources of evidence were used (i.e. documents, observation interviews, and surveys) thus a chain of evidence was established. Further, the respondents were always asked to crosscheck the transcript of the survey result to avoid misinterpretation. In the survey, construct validity was addressed by performing the correlation analysis for each construct.
- The internal validity is concerned with the appropriateness of the causal inferences (Yin, 2009). To minimize the internal validity issues, an explanation was building to identify the "why" and the "how" of the proposed concepts. As an example, the qualitative result was used to build a reason for the quantitative result in the KM Scan.
- The external validity is concerned with the generalizability of the study beyond the present domain of the case being studied (Yin, 2009). Based on the research's result, the analysis of generalizability was performed to identify specific criteria that determine whether the generalization of the research is feasible.

Another important quality criterion that should be addressed is reliability. Reliability is concerned with the question whether the research is replicable to generate the same result (Yin, 2009). The structured way of research (e.g. follow interview protocol) and the documentation of the evidence, thus, were performed in the interview's process to assure the reliability. Further, a reliability test was conducted to the survey's result by checking the Cronbach Alpha for each construct.

To summarize, this master thesis project was structured along the regulative cycle proposed by van Strien (1989). The KM Scan was used as the research instruments, while the convergent parallel mixed method was used as the basis of research methods in the diagnosis & analysis stage. Next, the design stage was performed by following the adapted COMET methodology based on the guide from Desta et al. (2014) study and the project's need. Last, the validation stage was conducted by using a descriptive evaluation method. Therefore, the multiple data collection methods were performed, namely documentations, observation, interviews, and surveys.

CHAPTER 4
KNOWLEDGE MANAGEMENT SCAN

This section reports the result of KM scan performed as the diagnosis and the analysis steps of Abyor's current KM processes. In this part, the result of qualitative and quantitative research is analyzed, leading to the comprehensive results that complement each other.

4.1. Qualitative Research

In this section, the result of the qualitative research is presented as the first stage of KM scan based on the documentation, interviews, and observation. This section covers the analysis of managerial opinions on KM, the diagnosis of organization's infrastructure capability, and each division's business processes. Next, the evidence base along with its source are presented clearly after each statement or assumption to ensure the validity of the result.

4.1.1. General Opinion on Knowledge Management

In general, Abyor's employees have a positive attitude towards KM. During the interviews, the respondents were asked regarding the degree of importance of the KM implementation by using a scale ranges from extremely important to extremely not important. As a result, all respondents from different divisions agreed KM has a significant importance level to be implemented in Abyor. They believe that KM will generate a positive impact on Abyor's work effectivity and efficiency. The following quotes show respondents' opinion and expectation on KM.

"KM is very important to be implemented in Abyor. It can faster employee's learning process inside and outside the project. In my division, for example, KM can reduce the time to make new administration documents for tender." (Solution Architect Manager)

"KM is expected reduce useless work activities by informing the employees beforehand what to do. By using the KM, employees are also expected be more productive by not reproducing the existing work" (Human Resource Manager)

From the interviews came forth that KM is expected to have negative relations with employees working time, specifically by reducing employee's duration time in facing the projects. In consulting industry, work duration has become critical parameters that determine project's success. Thus, the smaller amount of the proposed duration time is needed to finish a project; the higher opportunity Abyor can win the tender.

4.1.2. Abyor's Current Degree of Attention to the Knowledge Management

Abyor has a high level of attention to KM area. This attention is proven by the existence of KM roadmap plan in Abyor initiated by Abyor's board of directors that has not yet formalized. Nevertheless, this plan is always communicated at a monthly meeting with directors and manager divisions thus noted in the monthly meeting report. Abyor's directors have also pushed the development of KM within Abyor both formally and informally. The development of KM system which acts as the basis for this research is one concrete example of a formal attention, while, informally, the board of director encourages other managers to implement KM. The following quotes show Abyor's degree of attention to KM.

"Since I enter Abyor in 2010, KM is one aspect that is asked to be developed each year by board of director." (Delivery Service Manager)

"There exists KM roadmap in Abyor although still undocumented that communicated during monthly meeting. Currently, KM implementation is still manual, for example by using limited document library and applying internal module database (Solution Architect Manager)

"Based on board of director, KM has become an important issue to be paid attention of, thus the development of KM system was pushed to our division." (Human Resource Manager)

4.1.3. Abyor's KM Infrastructure Capability

In the following section, the current Abyor's KM infrastructure capability that fosters the implementation of KM processes is described as follows.

1. Abyor's KM Cultural Infrastructure

Abyor has an open culture to the new knowledge both formally and informally. Formally, Abyor is eager to send their best employees to take courses, seminars, and certifications of newly developed knowledge. While informally, employees are always expected to keep up with the new knowledge within their area of expertise.

> "Abyor is open to the new knowledge. The employees even are required to improve their knowledge, especially within their area of expertise. This issue is always stressed by manager in monthly meeting. Abyor as a consultant company has to keep up with the new developed technology in order to be survive in the competition." (Business Improvement & Control Manager)
>
> "Abyor is very open to the new knowledge, especially in board of director level. Every time a new technology from SAP is released, Abyor's consultants are encouraged to explore and to master it." (Human Resource Manager)

Abyor's employees are also considered open in sharing their knowledge with their colleagues. It is argued that Abyor's knowledge transfer is encouraged through division's SOP and best practices. Further, the implementation of knowledge transfer is motivated through the employee's benefits policy. The following quotes show the evidence.

> "In a project, new employees will be paired by one senior consultant so that the knowledge transfer process can be applied in a real life project. By using this scenario, new employee's skill is trained based on experiences." (Solution Architect Manager)
>
> "Knowledge transfer becomes one of criteria in determining employee's benefit. The more information that being shared, the more financials benefit one will get." (Human Resource Manager)
>
> "Abyor's consultant team is divided based on its modules. If the module's leader is proactive, sharing session will be arranged to improve team's capability and knowledge. On the other hand, if the leader is rather busy or less responsible, knowledge team will not be developed. "(Business Improvement & Control Manager)

2. Abyor's KM Structural Infrastructure

Despite the fact that Abyor has a high-level attention to KM, Abyor still has a low implementation of KM. Based on the interviews, it is found that there is no specific KM regulation and implementation in Abyor. Further, KM infrastructure has not developed well in Abyor. However, it seems that several KM initiatives regulate by Abyor's business processes and Abyor's division policies. Table 4 below presents KM-related activities that performed in each division based on the interviews and Abyor's business process documents.

Table 4 KM-Related Procedures within Division's Business Processes

Division	General activity in Division	KM Related Procedures within Division's Business Process
Solution Architecture Division	Solution architecture division responsible to approach the prospective clients and to offer solution to the clients using technical proposal	- Determine Abyor's capabilities and resources in developing a discovery proposal and technical proposal through a consultation wth HR division and delivery service division. - Retrieve Abyor's pre-qualification documents from Abyor's website - Document the technical proposal - Document the tender result

Delivery Service Division	Delivery service Division works as a consultant that develop project's deliverable to the client. Delivery service division consists of several SAP modules specialization, such as financial module, logistics module, HCM module, support module, BASIS model, sales distribution &CRM, and project management & OCM module	- Document the project's result such as blueprint, master data, authorization & UID - Fill the work order and daily time sheet - Pairing system between senior and junior consultant in the project
Marketing & Sales Division	Marketing & Sales division consists of two main tasks, which is to discover the prospective client and to promote and introduce Abyor	- Follow internal procedures, such as advertising procedure and hosting exhibition procedure. - Document the client - Document the discovery proposal and the commercial proposal - Use of man-days template to develop commercial proposal
Business Improvement & Control Division	This division has two main functions, namely, control the on-going project and improve company's business process. Both results are presented to the directors through managerial review documents	- Summarize the project report through the managerial review documents
Corporate Service Division consists of human resource division, finance & GA Division, and legal division	Human Resource Division consist of three main tasks, namely recruitment and assignment, benefits management, resource administration Finance & GA Division manage all related finance activity and develop all general affairs procedures Legal Division manage all related legal activities, for example, developing contract	- HR Division arrange special training program as requested - HR Division assesses employee's knowledge and capabilities through consultation with the respective manager. - Finance & GA division develop and follow financial templates and GA templates - Legal Division develop legal templates

3. Abyor's KM Technological Capability

Currently, Abyor does not have a specific technology enabler for the implementation of KM. However, several technology practices have enhanced the KM implementation within Abyor's divisions as follows.

1. The use of WhatsApp group that acts as a communication channel for both internal division and across the division.
2. The existence of internal division's database in several divisions. As an example, each SAP module specialization has a particular FTP database that contains necessary module documents.
3. The existence of ERP system that supports project control functions for Business Improvement & Control Division

Further, based on the interview with Abyor's Human Resource Division, it is also found that Abyor has implemented significant technology improvement in KM area. In early 2016, for instance, Abyor has initiated the implementation of the central database through a web page that has not yet finished. The project to develop the KM system as performed through this master thesis project also reflects in Abyor's efforts to improve their KM processes.

4.1.4. Knowledge Management Processes

In this section, the analysis of KM processes that was gained from qualitative research will be presented. The result is shown in each process as follows.

1. Knowledge Creation and Acquisition

Abyor has a clear procedure on training new employees. Every new employee will get three weeks training in which consists of the first week of company's introduction and SAP basic knowledge introduction, and the rest of the weeks for advance SAP modules. After the training, they will develop further throughout the

real-life problem in the project. Moreover, in the project, Abyor's new employee will be paired with the senior employee to ensure knowledge acquisition.

On the other hand, Abyor still lacks procedure on identifying needed knowledge to face client's needs. No procedure nor business processes exist to define how solution architect and delivery service consultants determine knowledge needed while working on the project. To determine required knowledge, Abyor depends on the manager's judgment and experience. In facing the project, for example, the consultants have a high degree dependency on defining project's strategy.

Abyor's manager division has the biggest role on available knowledge identification stage. Each division manager has a responsibility to identify their subordinate's knowledge and capability thus if needed he/she can give a referral to a particular subordinate. In initiating the project, for example, the manager of solution architect division incorporation with the manager of HR division and delivery service division will determine what type of knowledge and which employees are needed to perform specific project based on the project's qualification.

Most knowledge gaps in Abyor are identified throughout the project and real-life problems. Occasionally, Abyor faced a project that obliged them to develop new knowledge. This situation will be overcome by using three options of knowledge development depending on the situation faced by Abyor, such as hire new people to work on the project, hire an expert to train Abyor's employees, or autodidact learn the new knowledge by themselves. If needed, Abyor is willing to remedy the knowledge gap through high-cost training or internal development program.

"Most of the times employee's knowledge deficiencies are found in the project by the project manager. If that case happens project manager will inform division manager so that further action can be taken." (Delivery Service Manager)

"Every time needed, respective division manager along with me will held meeting with directors to decide what kind of action should be taken to fulfill employee's knowledge deficiency." (Human Resource Manager)

However, currently, no formal and well-documented procedures exist to guide Abyor's decision on knowledge development. The decision of knowledge development is not based on a grounded rationality but rather based on the manager knowledge, judgment, and experience. Further, Abyor's knowledge creation is still based on project problems. Thus, no long-term planning regarding knowledge creation exist.

2. Knowledge Organization and Retention

Currently, Abyor does not have a central database nor an expert database that can be accessed and used by all Abyor's employees. Despite the fact, Abyor's divisions have alternative practices such as have an internal database that can be used internally, have the practice to consult with human resource division to assign employees to the project, and have the practice to understand each employee's competence within one division. Therefore, knowledge is considered not available nor accessible to all employees. To overcome this problem, currently, Abyor is still developing a central database via a web. Further, this central database is planned to be integrated into the proposed KM system.

3. **Knowledge Dissemination**

Knowledge transfer in Abyor is supported through its open and supportive culture to share knowledge among employees. Abyor's employees do not consider sharing knowledge as a threat to their work, even willingly share knowledge both formally or informally. Based on Abyor's business process, it is also found that transfer documents between divisions are regulated and needed in the business process. Solution architect division, for example, has to send an approved technical proposal to marketing & sales division, thus the later division can develop a commercial proposal for the next stage.

"Abyor's employees is encouraged to share their knowledge to their colleagues. No employees should reluctant to share the information. This even become one of our criteria to assess employee's performance." (Human Resource Manager)

Knowledge communication within Abyor is also facilitated both formally and informally. The formal communication practices are presented through people development program, formal meeting, formal documentation, and project's pairing system. On the other hand, the informal communications are encouraged through Abyor's supportive culture on knowledge sharing between employees.

4. Knowledge Utilization

Abyor's employees are claimed to be open for new knowledge, procedure, or system as long it is beneficial for Abyor and not harmful to employee's financial benefit. Usually, the new knowledge, procedure, or system are gradually implemented starting from the high-level managerial and followed by its subordinate.

"In 2015, Abyor made a big change in organization system by which employees were obliged to fill daily activity time sheet. The employees tended to follow the instructions. Hereafter, time sheet was considered not enough thus work order sheet in project execution was introduced. The employees still followed the instruction. It took around 6 months to fully implement the new procedure" (Human Resource Manager)

Abyor's manager has a significant role in knowledge evaluation process, by which he/she is responsible for identifying and evaluating each subordinate's knowledge and capability. If it seems that one employee experiences lack of knowledge and skill compared to his/her colleagues, the respective manager has a duty to inform, encourage, and help their subordinate individual improvement. Additional knowledge development program such as training and certification will be held if it needed.

Based on the result of interviews, current Abyor's KM processes are summarized as shown in Figure 9.

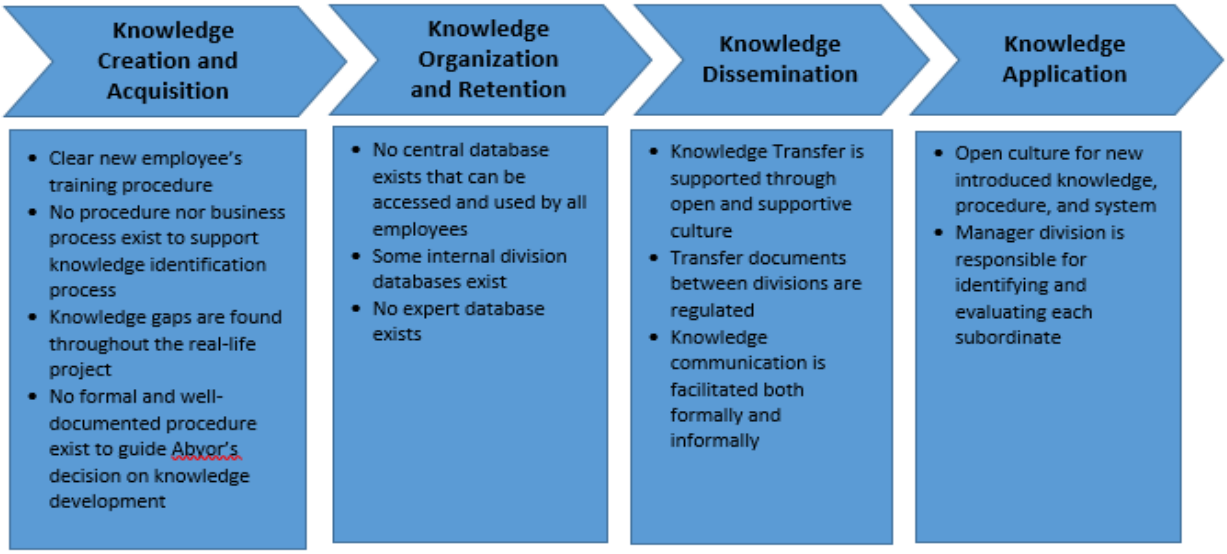


Figure 9 The Summary of KM Process Implementation

4.2. Quantitative Research

The quantitative research was conducted to gain an understanding regarding KM processes within Abyor that performed, felt, and impacted by all employees in Abyor. Further, by using the survey, the level of each current KM process can be found and judged quantitatively. The study also enables the analysis of group differences both from job durations, divisions, or positions.

The survey was conducted online for two and half week. Before spreading throughout the company, the list of question has to gain approval from the board of directors. Next, the HR manager helped to notify the employees via email and direct contact. The survey resulted in 78 responses from 198 employees that have been working for more than six months in Abyor. This result means that the survey got 40% response rate which is considered quite good by considering the nature of Abyor by which most of them worked on a client site and had a time limitation.

Several data preparation stages were performed to the resulted data from 78 respondents using SPSS. Firstly, each data variable was labeled and named according to SPSS rule. Next, data cleaning stage was performed to detect the incomplete and incorrect data. No missing data was found since it has been set that incomplete answer could not be submitted. Therefore, data cleaning was only performed by transforming the variables that have the backward scale to make them comparable and can be combined with other items in one KM process group.

Reliability analysis was performed for the group of variables that belongs to the same KM process group. Each group is considered valid if the Cronbach Alpha is more than 0.7. Low Cronbach Alpha was found both in knowledge evaluation dimension level and knowledge application constructs level with the value of Cronbach Alpha less than 0.5 in the first reliability test. To overcome the problem, a reliability test was conducted between one of two variables in the knowledge transfer process to find which variables gave higher Cronbach Alpha. As a result, only the second indicator of knowledge evaluation that was used further. Table 5 below presents the Cronbach alpha result as follows.

Table 5 The Reliability Test for the KM Process

Knowledge management process		**Number of variables within group**	**Cronbach's Alpha**	
Knowledge Creation and Development	Determine needed knowledge	3	α=0.908	α=0.91
	Determine available knowledge	3	α=0.864	
	Knowledge gap identification	1	-	
	Develop a new knowledge	6	α=0.853	
Knowledge organization and Retention	Knowledge Storing	1	-	α=0.78
	Knowledge Retrieval	2	α=0.937	
Knowledge Dissemination	Knowledge Transfer	6	α=0.711	α=0.902
	Knowledge Communication	8	α=0.905	
Knowledge Application	Knowledge Utilization	5	α=0.702	α=0.693 ~ 0.7
	Knowledge Evaluation	2 (before deletion) 1 (after deletion)	-	

4.2.1. Analysis of the Knowledge Management Process Scan

General KM processes scan in Abyor is presented through the mean variables of each process. The scale used is from the range 1 to 5, with scale 1 represents disagreement regarding the statement and scale 5 represents agreement regarding the statement. The following Table 6 shows the mean values and its standard deviation for knowledge management process implementation within Abyor. The mean value result was used further to judge the degree of knowledge management implementation within Abyor. The Appendix 7 presents the detail mean value results of the survey.

Table 6 The Mean Value Result of the KM Processes

Knowledge Management Process		Mean	Standard deviation
Knowledge creation and development	Determine needed knowledge	2.71	1.09
	Determine available knowledge	3.73	0.89
	Knowledge gap identification	3.82	1.20
	Develop a new knowledge	2.96	1.11
Knowledge organization and retention	Knowledge storing	2.92	1.52
	Knowledge retrieval	2.88	1.07
Knowledge Dissemination	Knowledge Transfer	3.47	1.09
	Knowledge Communication	3.03	1.11
Knowledge Application	Knowledge Utilization	3.55	1.06
	Knowledge Evaluation	3.12	1.08

As can be seen from Table 6, the mean values gained from the survey was revolved around the neutral point thus was analyzed further in the literature review. It was found that, by considering the nature of the respondents who are Indonesians, the respondents tended to avoid extreme answer both for positive and negative answers (Grandy, 1996). To judge the degree implementation of KM processes, the cut-off point was calculated based on the method proposed by Barua (2013) thus results in 0.519 as the cut-off point values. Next, to reduce the effect of respondent's biased due to the cultural problem, it is decided to reduce the cut–off point values by half as suggested by Grandy (1996). Therefore, it is suggested that the mean values lower than 2.74 are low-level implementation, while the mean values higher than 3.25 are high-level implementation. The detail calculation of the cut-off point is presented in Appendix 6.

As can be seen, Abyor has a low score in the needed knowledge identification process. On the other hand, Abyor has a more positive score of the available knowledge identification, the knowledge gap identification, the knowledge transfer, and the knowledge utilization processes.

4.2.2. Analysis difference between group

Separation analysis between the group was performed to check the different responses between the various group of respondents based on employee's job duration, division, and position. Previously, the respondent's adequacy analysis was performed to ensure the feasibility to performed group difference analysis (see Appendix 5). The decision regarding the type of test was based on the number of groups, the number of respondent within each group and the normality of the data. If the number of respondent for different groups (N) $\geq$ 20 and the data has a normal distribution, independent T-test will be used. On the other hand, if N < 20 or the data is not normally distributed, the non-parametric test will be utilized (Field, 2009). The non-parametric test consists of two options, which is the Mann-Whitney U test for two groups analysis and Kruskal-Wallis H test for more than two groups analysis.

The first group analysis was performed based on the employee's job duration. Since the data results from four different groups for job durations and not all groups have N> 20, Kruskal-Wallis test was used. Based on the test, it was found that some knowledge management processes experienced mean group differences in knowledge creation & development process, knowledge organization & retention process, and knowledge dissemination process. Next, a similar analysis was performed to the employee's division and employee's position based on the number of groups and number of respondents within the group. Both analyses resulted in similar mean group difference analysis in knowledge creation & development process and knowledge dissemination process. Appendix 7 presents the result of Kruskal-Wallis Test to determine group difference analysis. In the next step, based on the group difference found by using Kruskal-Wallis test, a group difference test was performed to specific KM process using descriptive statistic cross tabulation and ANOVA. The following Table 7 presents the summary of interesting results that were gained based on group difference analysis.

Table 7 The Summary Result of Group Difference Analysis

KM Process	Job Duration	Division	Position
Knowledge Creation and Development	- The employees who have shorter work duration have more positive attitude toward needed knowledge identification process. They agree that Abyor has a clear and explicit strategy, especially regarding needed knowledge identification - The employees who have shorter work duration more agree that Abyor has formal procedure to develop or buy a new knowledge	- Corporate service division and solution architect division have more positive attitude towards needed knowledge identification. Both divisions agree that Abyor's strategy acts as guideline to knowledge identification activity - Corporate service division and business improvement & control support division have more positive attitude toward Abyor's make or buy decision in developing a new knowledge	- Consultants give the lowest attitude toward needed knowledge identification process. They seem to disagree that strategy in Abyor has already clear, thus cannot help them much in identifying which knowledge needed to finish their work. - Consultants have the lowest attitude toward Abyor's decision to make or buy develop knowledge. They tend to disagree that the decision is based on logic and grounded decision
Knowledge organization and Retention	- The newer employees have more positive attitude toward knowledge retrieval. They agree that knowledge in Abyor is relatively accessible and available when needed.	-	-
Knowledge Dissemination	- The employees who work below three years in Abyor has more positive attitude toward Abyor's mechanism of transfer of knowledge - The employees with shorter job duration vote more positively toward on-the-job training mechanism	- Delivery service division has the lowest attitude toward knowledge communication through report, manual, instruction sheet	- Managers give more positive attitude toward sharing knowledge through discussion and meeting, while staffs give more positive result toward sharing knowledge through report, manual, and instruction sheet
Knowledge Application	-	-	-

4.3. Combining the Result

In this section, both qualitative and quantitative analysis of KM processes are combined to give a complete result of the KM scan. This scan was further used as a basis to develop Abyor's KM system. Table 8 below summarizes the result of KM scan both from qualitative and quantitative research.

Table 8 The Summarized Result of the KM Scan Performance

Knowledge Management Process	**Qualitative Result (Interviews)**	**Quantitative Result (Surveys)**
Needed Knowledge Identification	- No procedure nor business process exists to determine knowledge needed - High-level dependency on manager's judgment and experience to define the needed knowledge	- The process has the lowest level of implementation process with a mean value of 2.71.
Available knowledge identification	- No central database nor expert database that can be accessed by all employees BUT - Abyor has an open culture through formal and informal communication	- The process has a high level of implementation process with a mean value of 3.73
Knowledge Gap Identification	- Each manager division are responsible for identifying each subordinate specialization and deficiency - Knowledge gaps in Abyor are identified throughout the project and real-life problem	- The process has the highest level of implementation process with a mean value of 3.82
Knowledge development	- No formal and well-documented procedure to develop a new knowledge - High-level dependency on manager's knowledge, judgment, and experience to determine knowledge development BUT - Willing to remedy the knowledge gap through high-cost training or internal development program	- The process has a moderate level of implementation process with a mean value of 2.96
Knowledge Storing	- No central database exists BUT - Some division initiates internal database	- The process has a neutral level of implementation process with a mean value of 2.92
Knowledge Retrieval	- Limited access to the knowledge due to the internalization of databases	- The process has a moderate level of implementation process with a mean value of 2.88
Knowledge Transfer	- Has open and supportive culture to share knowledge - Knowledge sharing becomes one of the employee's assessments parameter - Has formal procedure to transfer documents	- The process has a high level of implementation process with a mean value of 3.47
Knowledge Communication	- The existence of some communication channel - Abyor facilitates knowledge communication both formal and informally.	- The process has a moderate level of knowledge communication with a mean value of 3.03 - Based on group difference analysis, difference preference on communication channel of each group was found

Knowledge Utilization	- Has a positive attitude towards new knowledge utilization, in which new knowledge will be widely accepted and implemented in the organization as long it is contributed to work's effectivity and efficiency.	- The process has a high level of implementation process with a mean value of 3.55 - Several employees still have a high attachment on their work habits, thus considers new knowledge is addressed to new employees only
Knowledge Evaluation	- Employees with discrepancy of knowledge will directly be proposed to have training	- The process has a moderate level of knowledge communication with a mean value of 3.12 - Low-reliability level

Based on Table 8, it can be seen that most of the qualitative and the quantitative results support each other. In some processes, the qualitative result gives the explanation why a particular process gains a high score. In available knowledge identification, for example, the supportive culture to share knowledge both formally and informally helps to reduce the impact of the central database inexistent. Another example is that knowledge retrieval gains low score due to employee's limited access to internal division database.

In one case, the qualitative result contradicts the quantitative result. The discrepancy between survey and interviews is found in knowledge identification process. In the interviews, it is said that employees with knowledge deficiencies will directly be proposed to have training, but the survey generated neutral mean values. Two possibilities caused are identified, especially by considering its low of reliability level. Firstly, the qualitative result can be valid in some divisions thus not all employees have experienced the treatment. Secondly, the quantitative result might be not valid due to its low-reliability level.

Another important thing can be gained from difference group analysis. It is found that Abyor has successfully improved their explicit strategy, document, and mechanism for transfer knowledge within the last one year. This success is reflected in new employee's positive attitude toward Abyor's policy and mechanism that can be seen in group difference analysis. It can be concluded that newer employees tend to experience the explicit documentation's benefit.

It is also found that delivery service division experience lacks score in knowledge identification, knowledge development, and knowledge communication. This condition seems to contrast with the expectation level, by which delivery service division or consultant is considered as the central brain of the organization. Therefore, it is expected that the proposed KM system can improve delivery service division's score on KM processes.

4.4. Knowledge Management Problems

Based on the KM scan, several KM problems were identified in Abyor's current business process. The following Table 9 summarizes Abyor's KM problems. Next, the problems were grouped into KM infrastructure capability framework's type based on Chan and Chao (2008).

Table 9 The Summary of Abyor's KM Problems

No.	Problem	Description	Source of information	Type of KM problem
1	The inexistence of long-term needed knowledge identification process and procedure	Currently, needed knowledge is always identified through project realization phase, thus creates poor vision on knowledge development within Abyor	- Low score in needed knowledge development process - Interview with delivery service division and clarification with human resource division	Structure problem

2	Lack of Abyor's formal and well-documented procedure in knowledge development process	Currently, the decision of knowledge development, especially in determining the make or buy decision, is based on higher manager's judgment and not based on formally grounded procedure.	- Low score in needed knowledge development process - Interview with human resource division	Structure and culture problem
3	The limitation of formal communication facility to support knowledge communication within Abyor	There exists difference preference of communication channel between divisions.	- Qualitative analysis of difference between groups	Technology problem
4	The inexistence of central knowledge repository to support knowledge storing and knowledge retrieval	Abyor does not have a single and central database, but several divisions have already had internal databases. These conditions create low chance of knowledge application and re-application	- Low score in knowledge organization & retention process - Interview with each manager division's representative	Technology problem
5	The limitation of the transfer knowledge formal procedure.	Abyor does not have a formal procedure for knowledge transfer, though several divisions have an implicit agreement to oblige project's documentation and storing process.	- Low score in needed knowledge development process - Interview with each manager division representative	Structure problem
6	The inadequate access to find the knowledgeable and available expert	Employees database are not explicitly available. If needed, one should contact HRD manager or respective division manager to find experts. This process is considered not effective, especially by considering a large number of projects that faced by Abyor at the same time.	- Interview with manager of the human resource, the delivery service, and the solution architect divisions	Technology problem

Based on problem's classification, several KM problems related to technology were found. In this master thesis project, the technology problems become the main topics to be solved by using the proposed KM system.

CHAPTER 5
DESIGNING KNOWLEDGE MANAGEMENT SYSTEM ARCHITECTURE

This chapter presents the design part of a knowledge management (KM) system architecture for Abyor. The KM system architecture was designed based on the KM system's business model and requirements model. Next, the design of KM system architecture is presented by proposing the KM system components and KM system architecture model to answer the second and the third research questions. Lastly, the validation analysis of the proposed KM system architecture is presented.

5.1. KM System Business Modeling

In this section, the business model is defined based on the previous KM scan, Abyor's documents, and the observations in Abyor. In the first part, Abyor's business context analysis is shown through a stakeholder analysis, a business process analysis and a current implemented system analysis. In the second part, the KM system goal model is defined through the goal hierarchy and the user's goal. Last, the KM system processes and knowledge resources are modeled to defined the behavioral model of the KM system process.

5.1.1. KM System Business Context Analysis

The proposed KM system is a new system that intends to be used by all employees and divisions in Abyor. The KM system will impact and relate to both Abyor's processes and Abyor's current implemented system thus the proposed KM system is expected to cope with all relevant contexts. Figure 10 below represents a graphical overview of the relevant stakeholders and systems to the proposed KM system. The detail explanations of each KM system context's component are presented in the next subsection.

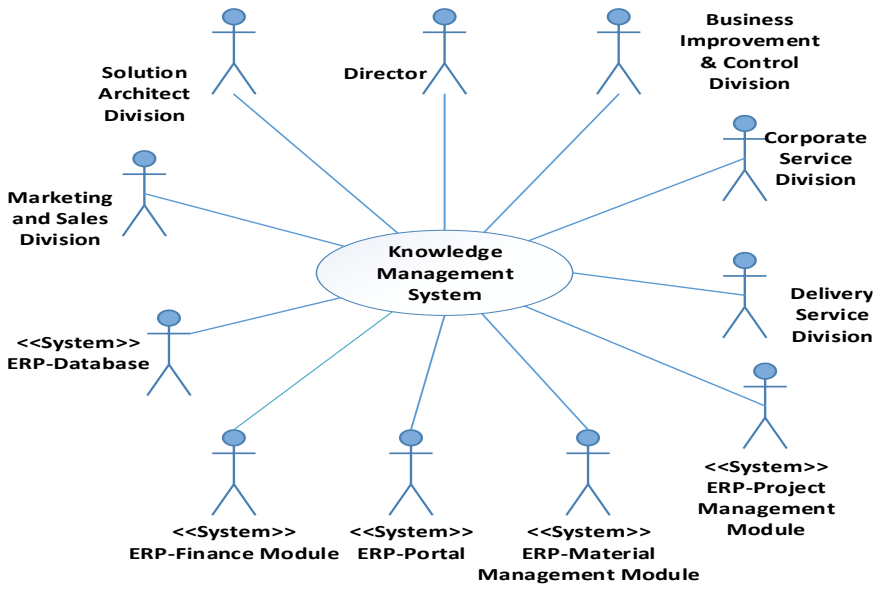


Figure 10 The KM System Context Statement

Several important issues related to the current KM processes performance were found based on the KM scan in Abyor. Firstly, not all divisions in Abyor should be prioritized to be taken account of in designing the KM system. As stated in the literature review, the KM system should be used to manage the organization's core competencies to achieve the organization's goal, thus divisions that have a direct relation with organization's core business processes are prioritized. Furthermore, it is found from the KM Scan that only several divisions in Abyor experienced a lack score of KM processes. Therefore, several divisions are prioritized if a contradiction in goals occurs. To be exact, the delivery service division should be prioritized since they act as organization's main asset, while also experience a lack implementation score in the KM processes.

Secondly, not all KM processes should be improved by using the KM system. It is found that Abyor experiences lack scores in several KM processes, such as needed knowledge identification, new knowledge development, knowledge storing & retrieval, and knowledge communication & transfer. Therefore, the implementation of a KM system is expected to increase the score of specific KM processes.

Thirdly, the proposed KM system should be aligned with the existing ERP system. Currently, Abyor has implemented several modules of ERP system, namely the finance module, the project management module, and the material management module. Therefore, it is expected that a particular interface exists to bridge the implementation of KM system and ERP system.

In detail, the KM system's business context is identified based on the analyses of the KM system's stakeholders, Abyor's business processes, and Abyor's current implemented the system as follows.

KM System Stakeholder

Based on the interviews and Abyor's SOP documents, the KM system's stakeholders along with its KM activities and its role in the KM system are identified in the following Table 10.

Table 10 The Description of KM System's Stakeholder

Stakeholder	Description Related to the KM System	Role in KM System
Director consists of BOD, president director, and divisions director	The directors decide the vision, mission, and strategies both for long and short terms. The directors drive the implementation of KM. Further, the directors are the one who appointed particular divisions to initiate the development of KM system. Next, the directors are also responsible for giving approval for each KM implementation or system development.	Initiator, Reviewer, and Approver
Delivery Service Division (Consultant)	The consultant is responsible for delivering Abyor's products based on client's needs. The consultant is responsible for identifying customer needs, configuring the system, developing SAP program based on each modules expertise, developing master data & blueprint, developing role authorization & UID, developing support's procedure & mechanism, and receiving an incident report.	Users
Solution Architect Division	This division is responsible for initiating the project based on three main stages, namely discovery stage, proposal stage, and presentation stage. In the discovery stage, solution architect division is responsible for finding the prospective client and doing an initial assessment to the potential client's needs and conditions. In the proposal stage, solution architect together with marketing & sales division develops a technical proposal. In the presentation stage, solution architect division collaborates with sales division presents a proposed product to the prospective clients.	Developer, Users, and Maintainers
Marketing and Sales Division	This division has two functions, namely marketing function and sales function. The sales function is responsible for finding and receiving information of prospective clients, doing initial contact with prospective clients using a discovery proposal, developing a commercial proposal for tender. The marketing function is responsible for hosting and organizing a seminar	Users
Business Improvement and Control Division	This division has two main functions, namely, control the on-going project and improve the company's business process. The control function is performed by comparing its plan cost and its actual cost, thus early prevention and correction actions can be taken. The improvement function is responsible for auditing the product's quality and managing the document to be reviewed by the managers.	Users
Corporate Service Divisions consists of finance & GA, HR, and legal divisions	The finance & GA division manages all related finance activities, such as cash flow analysis, payroll, financial data backup, and all related general affairs activities, such as asset management and project data backup. The human resource Division has three main functions namely resource administration, personnel administration & benefits management, and recruitment & assignment. The legal division manages the contracts and the legal affairs.	- All divisions act as users - HR division serves as system architects

Next, each stakeholder's expectations on the KM system are identified based on the interviews and Abyor's SOP documents as presented in Table 11.

Table 11 KM System's Stakeholder Expectation

Stakeholders	Expected KM System Benefits
Directors	- Increase profit gradually after the implementation of KM - Increase employee's productivity by reducing project's time duration - Increase product's performance by fostering decision-making process - Reduce knowledge loss through a high turn-over rate by the existence of knowledge storing process
Delivery Service Division (Consultant)	- Facilitates document management within internal division, e.g. managing the document based on modules, previous case, or previous problems - Accelerates communication with the clients to support the project realization phase - Reduces time in developing software by facilitating template storing process - Accelerates document sharing and document transfer to support the project realization by facilitating an automatic knowledge transfer process, especially from/to solution architect
Marketing and Sales Division	- Reduces time in finding prospective clients and initiating a contact with customers by integrating previous client cases - Accelerates communication with the solution architect to support the discovery process
Business Improvement and Control Division	- Facilitates document storing and sharing especially across divisions to support a business control process - Accelerates communication with the delivery service division, especially in the proposal development process - Facilitates a managerial review process by accelerating document transfer to the directors
Solution Architect Division	- Reduces repeating works by facilitating a document storing process of the previous cases - Reduces time in finding a related data or a similar case, e.g. finding required documents for tender by facilitating a document management process - Accelerates communication with the marketing & sales division, especially for project discovery stage
Corporate Service Divisions	- Accelerates employee's learning process by facilitating the knowledge storing and sharing within Abyor

As can be seen from Table 11, the stakeholder's expectations on the KM system are in line with each other. For example, the KM system is expected to facilitate the document storing and sharing within the division and across divisions, the communication for both internal Abyor and external parties, and the document management within Abyor. By considering the results, all stakeholders' expectations are taken into account in designing the KM system architecture.

Abyor's Business Processes

The proposed KM system will have a direct impact on Abyor's business processes, thus it is important to include Abyor's business processes into the KM system's context. In general, Abyor's business processes consist of three core processes and three support processes. The core processes consist of order & contract process, project implementation process, and project closing process. Meanwhile, the support processes consist of people development process, maintenance & improvement process, and support process. In detail, Abyor's general business processes and division's business processes were presented in Appendix 8.

Current Implemented System

Based on the interviews with the manager of the human resource and the solution architect, it is found that Abyor has already implemented an ERP system that consists of the finance module, the project management module, and the material management module. The following Table 12 describes each ERP system components.

Table 12 The ERP System Components

ERP System Components	Function	Related Abyor's Business Processes	Remark
ERP Database	Stores the data from the ERP modules	All Abyor's business processes	Only directors and managers have authority to access the database
ERP Portal	Serves as the system dashboard	All Abyor's business processes	Each employee has personalized access to the ERP portal
ERP Finance Module	Manages a real-time financial transaction in Abyor. The module helps in developing an income statement, a balance sheet, and an asset statement	All Abyor's business process	The master financial data can be inputted by the finance division after the verification process. The master financial data can also be accessed by the director, the finance division, the business improvement & control division, and each project managers.
ERP Material Management Module	Supports the procurement and the inventory functions. By using this module, the available resources will be matched with the work order request and the lack resource will be notified to the respective divisions.	Project implementation process	This module is accessible for every employee, by which employee can input a work order in the system. The module analysis, further, can be accessed by the director, the manager divisions, and the corporate service division.
ERP Project Management Module	Manages a real-time project management for project's planning, scheduling, and controlling. The outputs of the module consist of actual project cost, milestone report, project issue, and change management report.	Order & contract process, project Implementation process, project closing process, and maintenance & improvement process	The project management data can be inputted by each project manager. Further, the module can be accessed by directors, related delivery service division, business improvement & control division, finance division, human resource division, and solution architect division.

Each employee has a personal dashboard where he/she can access a particular data based on his/her user ID. Further, every employee is authorized to input their profile, create a work order for employees, equipment, and material resources, input daily time sheet, and input claim expenses for trip or remuneration. The implementation of ERP system has already provided a platform for capturing, storing, and sharing daily-based data and information based on the modules. Therefore, the proposed KM system is expected to facilitate the integration mechanism with the current ERP system.

KM System Vision Statement

Based on the KM problems (see chapter 4.4.) and the KM system business context, the target outcomes of the proposed KM system are summarized in the following vision to change.

The KM system is an information system that facilitates the KM processes by supporting:

- A knowledge and expert repository to facilitate the knowledge identification process
- An automatic document management to foster the knowledge storing & retrieval processes
- An integrated communication and collaboration with internal Abyor and/or external parties to foster the knowledge communication process and the knowledge transfer process

to be used by all internal stakeholders within Abyor, namely directors, delivery service division, marketing & sales division, business improvement & control division, solution architect division, corporate service division. Further, the system should be aligned and integrated with the existing ERP system.

5.1.2. KM System Goal Modelling

The proposed KM system is expected to be used by all employees in the Abyor, thus it is important to model the relationships and the hierarchies between each expected goals. Based on the KM system stakeholder's expectations (see Table 11), Abyor's general goals and internal division's goals were identified. The goals, further, were mapped based on the four dimensions of company success based on the balanced scorecard by Kaplan & Norton (1996). The balanced scorecard was used to map the goals since it is common to be used in Abyor to define their strategic level goals. Table 13 lists the goals based on the balanced scorecard categorization by using following abbreviation: I= Internal Business Process; F= Financial; L=Learning & Growth; C=Customer. Further, the goal's measurements were identified based on the interviews with the stakeholders.

Table 13 The KM System Goal Map based on the Balanced Scorecard

Perspectives	Obj.	Name	Description	Measure
Internal Business Process	I1	Productivity	By increasing efficiency, increasing number of clients, and increasing performance	Ratio number of projects faced per number of man-days
	I2	Efficiency	By reducing activity time	Number of man-days
	I3	Reducing work activity time	By reducing repeatable work and increasing communication	Number of man-days
	I4	Reducing repeatable work	Can be achieved by facilitating storing process	Number of repeatable works
	I5	Enhancing innovation	By increasing performance and reducing knowledge loss	Number of innovation products/ processes per year
	I6	Increase performance	Can be achieved by increasing communication process and facilitating storing process	Number of project charter's parameters meet
	I7	Reduce knowledge loss	By facilitating storing process	Number of documents stored and its version
Financial	F1	Increase Profit	By lowering costs and increasing productivity	Quarterly Cashflow
	F2	Reduce Cost	By increasing efficiency	Quarterly Cashflow
Learning & Growth	L1	Reducing Employee's time to learn	Can be achieved by facilitating storing process and facilitating communication/sharing process	Employee's training time until claimed as a senior consultant
Client	C1	Increase the number of clients	Reducing work duration time thus can increase the chance to work on another client's project	Number of projects faced per year

KM System Goal Hierarchies

Based on the previous goal model, the relation between goals is presented in the goal hierarchy as depicts in Figure 11. The positive sign represents a positive correlation between the goals, while negative sign represents a negative correlation between the goals. For the positive correlation, for example, reducing the number of repeatable work leads to decreasing the number of activity time. While for the negative correlation, for instance, reducing the number of activity time leads to increasing the work's efficiency. Based on the relation between variables, the optimum condition within the KM system's context can be achieved by the existence of specific conditions as follows: reducing the number of repeatable works, reducing the activity time, reducing the employee's learning time, increasing the work's efficiency, increasing the number of clients, reducing the knowledge loss, increasing the number of innovations, increasing the employee's performance, increasing the employee's productivity, reducing the company's cost, and increasing the company's profit.

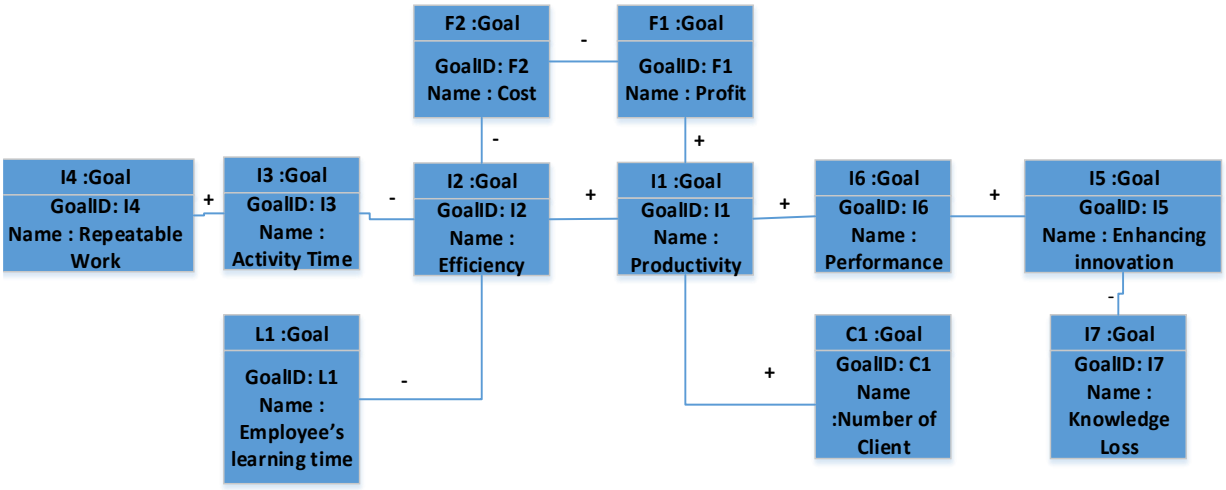


Figure 11 The Goal Hierarchy Model for the KM System

KM System User Goals

The next step is defining the individual stakeholder's goals to ensure the goals are aligned with each other. The user's goal can be found in Table 14.

Table 14 The User Goal for the KM System

Stakeholders	Goal ID	Goal	Supporting Business Process	KM System Goal
Director	Di1	Increase profit, reduce cost	Support Process	F1, F2, I2
	Di2	Increase product's quality and performance, foster innovation, reduce knowledge loss	Maintenance & Improvement Business process	I5, I6, I7
Delivery Service Division (Consultant)	Ds1	Deliver the product to client on quality, time, and cost demand	Project Implementation	I1, I2, I3, I4, I5, I6
	Ds2	Develop support mechanism that meets customer needs	Project Closing	I1, I2, I3, I4, I5, I6
Marketing & Sales Division	Ms1	Increase number of order, increase profit	Order and Contract	C1, F1
Solution Architect Division	Sa1	Develop technical proposal that satisfies prospective clients	Order and Contract	C1, I5, I6
Business Improvement & Control Division	Bi1	Maintain project deliverable's quality, project's duration, and project's cost	Maintenance & Improvement Business process	I2, I6
Corporate Service Division	Cs1	Human Resource division develop people development program	People Development Process	L1
	Cs2	Support Abyor's business process: finance, legal, human resource, and general affairs	Support Process	I1, I2

Both goal model and user model will serve as the KM system's references to assess the KM system throughout the development process and the system's life ((Berre, Elvesæter, Aagedal, & Ø, 2006).

5.1.3. KM Processes and Business Resource Modelling

In this section, the KM-related processes and the business resources related to KM in Abyor were mapped based on Abyor's business processes and KM system stakeholder's perspectives as follows.

Mapping Business Process into KM Process

Based on Abyor's Standard Operational Procedure (SOP) for each division, related KM activities and KM resources were identified. Due to a large number of activities and the complex stakeholder's relationship, not all mapping processes are shown in the report. As an example, the following Figure 12 presents the mapping process from Abyor's business processes into KM processes for Delivery Service Division in the project preparation stage and the project realization stage. The comprehensive mapping results from all business processes and stakeholders are depicted in Table 15.

Figure 12 Example of KM Process Mapping

Business Resource Model Related to KM System

The business resources related to the KM system were identified and modeled based on each Abyor's business process and each KM related activities (see Table 15). In the KM system, knowledge is considered as the main resource's assets thus their interaction and flow are considered important to be modeled. Appendix 9 identifies all knowledge resources related to the KM system based on its utilization and its type. To be noted, in the KM system, all stakeholders are also considered as one of knowledge resources by possessing tacit knowledge. Next, Figure 13 depicts the relationship between each knowledge resource both for tacit knowledge and explicit knowledge.

Table 15 Mapping KM Processes from Abyor's Business Processes

Abyor's Business Processes	Stakeholder's Perspective	Sub-Processes	Related KM Activities	Related KM Processes	Related Knowledge Resources
Order and Contract Process	Solution Architect Division	Discovery Stage- Approaching prospective clients	• Find and use the information of clients • Find and use the previous discovery proposals	Knowledge retrieval	List of clients, marketing & sales person, and discovery proposal
		Proposal Stage- Developing technical proposal	• Find and use the previous technical proposal • Develop a new technical proposal • Document the technical proposal • Document the clients • Communicate a technical proposal both with client and solution architecture division	Knowledge retrieval, knowledge utilization, knowledge storing, and knowledge communication	List of clients, technical proposal, marketing & sales person, and consultants
	Marketing and Sales division	Discovery Stage- Finding prospective clients	• Find and use the information of clients • Find and use the previous discovery proposal	Knowledge retrieval	List of client, marketing & sales person, and discovery proposal
		Document administration preparation	• Prepare the pre-qualification documents	Knowledge retrieval	Pre-qualification document
		Proposal Stage- developing commercial proposal	• Find and use the template of man-days data • Find and use the previous commercial proposal • Develop a new commercial proposal • Communicate the commercial proposal to the prospective clients • Document the commercial proposal	Knowledge retrieval, knowledge utilization, knowledge storing, and knowledge communication	Solution architect, consultants, man-days data and template, and commercial proposal
		Final Proposal- order license document	• Release the order license proposal	Knowledge transfer	Order license proposal
Project implementation process	Delivery Service Division (Consultant)	Project Preparation	• Determine a needed knowledge and an available knowledge for developing the project charter • Develop and communicate the project charter with the project's stakeholder (both internal Abyor and client) • Find and use technical proposal, commercial proposal, and contract	Determine needed knowledge, determine available knowledge, knowledge gap identification, knowledge retrieval, and knowledge utilization	Technical proposal, commercial proposal, blueprint, contract, project charter, and solution architect
		Blueprint development	• Develop the blueprint • Document and communicate the blueprint to the project's stakeholder	Knowledge communication, knowledge transfer, and knowledge storing	Blueprint
		Realization- - system configuration, functional specification development	• Find and use the blueprint • Find and use the SAP modules knowledge • Input the real-time data regarding project implementation	Knowledge retrieval and knowledge storing	Blueprint, on-going project report, and SAP modules

		Final Preparation- master data development, authority, and UID Development	• Develop and communicate the master data with the client • Develop and communicate the matrix authorization and UID with the client	Knowledge utilization and knowledge communication	Master data, matrix authorization, and UID
		Go-Live- training manual development, support manual development	• Develop the support manual • Develop and communicate the training manual with the client	Knowledge utilization, knowledge communication, and knowledge storing	Training manual and support manual
Project Closing Process	Delivery Service Division (Consultant)	Support manual agreement and incident report mechanism	• Communicate the support manual with the client • Develop and communicate the incident report manual with the client	Knowledge utilization, knowledge communication, knowledge storing	Support manual and incident report manual
People Development Process	Human Resource Division	Employee's recruitment	• Use the procedure of employee's recruitment	Knowledge utilization	Recruitment procedure
		Employee's training	• Use the training document • Use the internal expert or/and external expert • Training execution	Knowledge retrieval,	Internal expert, external expert, and training document
		Employee's assessment	• Develop an employee's assessment report	Knowledge evaluation	Employee's assessment report
Maintenance and Improvement Process	Directors	Managerial review	• Access and assess the managerial review document and the finance document	Knowledge retrieval, knowledge communication, and knowledge utilization	Managerial review document and finance document
	Business Improvement and Control	Project Control	• Assess the finance document and the on-going project	Knowledge retrieval, knowledge communication, and knowledge utilization	Finance document and on-going project report
		Audit internal	• Develop the managerial review document • Document and communicate the managerial review documents with directors	Knowledge utilization, knowledge storing, and knowledge communication	Managerial review document and directors
Support Process	Finance & GA Division	General finance activities	• Find, use, and develop the finance documents	Knowledge retrieval, knowledge communication, knowledge utilization, and knowledge storing	Finance document
		General affairs activities	• Find, use, and develop the general affairs documents	Knowledge retrieval, knowledge communication, knowledge utilization, and knowledge storing	General affairs document
	Legal Division	Develop contract	• Find and use the template of contract • Develop the contract based on project	Knowledge retrieval and knowledge utilization	Contract
		General legal activities	• Find, use, and develop the legal documents	Knowledge retrieval, knowledge communication, knowledge utilization, and knowledge storing	Legal activities document

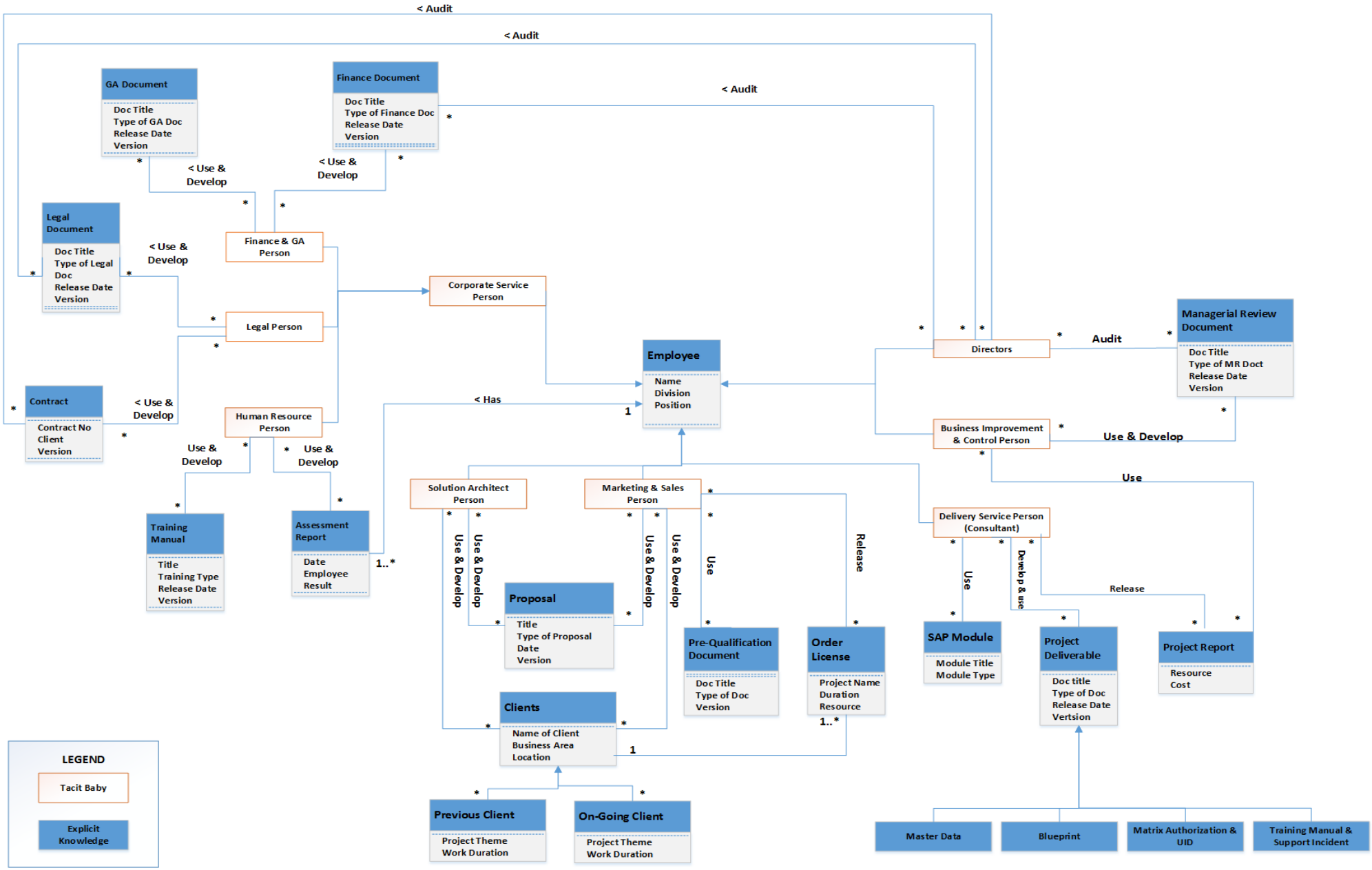


Figure 13 Abyor's Business Resource Model Related to the KM System

5.2. Requirements Modelling

In this section, the KM system requirements are presented based on the functional requirement and the non-functional requirement. The functional requirements define the basic functions that are expected to be fulfilled by KM system. Meanwhile, the non-functional requirements define the criteria that judge the operation and the performance of the proposed KM system.

5.2.1. KM System's Functional Requirements

The KM system functional requirements were defined based on the KM system's goals (see Table 13) and the KM activities derived from the mapping of KM process (see Table 15). Further, as stated earlier, several KM processes are expected to increase by the implementation of KM System, namely knowledge identification, knowledge transfer & communication, and knowledge storing & retrieval (see Chapter 5.1.1.). Therefore, these KM processes were taken into consideration in defining the KM system's functional requirements.

The KM system's functional requirements were identified through a use case model. The use case model defines the KM system in terms of services, actors, and scenario descriptions. The list of use cases identifies the main services offered by the product, while the use case scenario model depicts the relationship between services and actors (Berre, Elvesæter, Aagedal, & Ø, 2006). The following Table 16 presents the KM system's use cases, while Table 17 defines the relationship between the current ERP system and the KM system's use cases.

Table 16 The KM System's Use Case

KM System Use Case	Description	KM Process	Actors
1. Searching Information	Finding information of the prospective clients	Knowledge retrieval	Solution architecture division and marketing & sales division
2. Searching template	Finding the man-days template and the contract template	Knowledge retrieval	Marketing & sales division and legal division
3. Searching document	Finding the previous discovery proposal, the previous technical proposal, and the previous commercial proposal	Knowledge retrieval	Delivery service division, solution architecture division, marketing & sales division, director, business improvement & control division, finance & GA division, HR division, and legal division
4. Searching expert	Finding the availability of employees' capability and knowledge	Knowledge identification	HR division, solution architecture division, and delivery service division
5. Retrieve Document	Use the related documents, i.e. pre-qualification documents, proposals, finance documents, etc.	Knowledge retrieval	Delivery service division, solution architecture division, marketing & sales division, directors, business improvement & control division, finance & GA division, HR division, and legal division
6. Real time update knowledge retrieval	Automatically update the information that is shown in the personal dashboard	Knowledge retrieval	Business improvement & control division, finance & GA division, and directors
7. Communicating internally	Use the communication tools to correspondence with the colleagues	Knowledge communication	Delivery service division, solution architecture division, marketing & sales division, directors, business improvement & control division Finance & GA division, HR division and Legal division

8. Communicating externally	Use the communication tools to correspondence with the clients	Knowledge communication	Solution architecture division, delivery service division, and marketing & sales division
9. Input real-time data	Real-time data input regarding project's information	Knowledge storing	Delivery service division and Finance & GA division
0. Input document	Input the project-related documents (blueprint, project charter, master data, etc.), finance document, legal document, training document, and managerial review document	Knowledge storing	Delivery service division, solution architecture division, marketing & sales division, directors, business improvement & control division finance & GA division, HR division, and legal division
1. Input new version document	Input a new version of finance document, general affairs document, managerial review document, legal document, and proposals	Knowledge storing	Delivery service division, solution architecture division, marketing & sales division, directors, business improvement & control division finance & GA division, HR division, and legal division
2. Internal knowledge transfer	Send the documents within the internal division, i.e. project charter and order license	Knowledge transfer	Solution architecture division and marketing & sales division
3. External knowledge transfer	Send the documents to the client, i.e. project charter, blueprint, master data	Knowledge transfer	Solution architecture division, delivery service division, and marketing & sales division
4. Evaluate Knowledge	Analysis the finance document and the managerial review document	Knowledge evaluation	Directors, business improvement & control division, and HR division

Table 17 The Relation of the ERP System to the Use Case

System Actors	Relation to the Use Case
ERP- Database	Input real-time data, input document, search document, search template
ERP-Portal	-
ERP- Project Management	Internal knowledge transfer, external knowledge transfer, real-time update retrieval
ERP-Finance	Real-time update retrieval, evaluate knowledge
ERP- Material Management	Internal knowledge transfer, real-time update retrieval

The following Figure 14 depicts the use case scenario model for the proposed KM System with its stakeholders and its related systems.

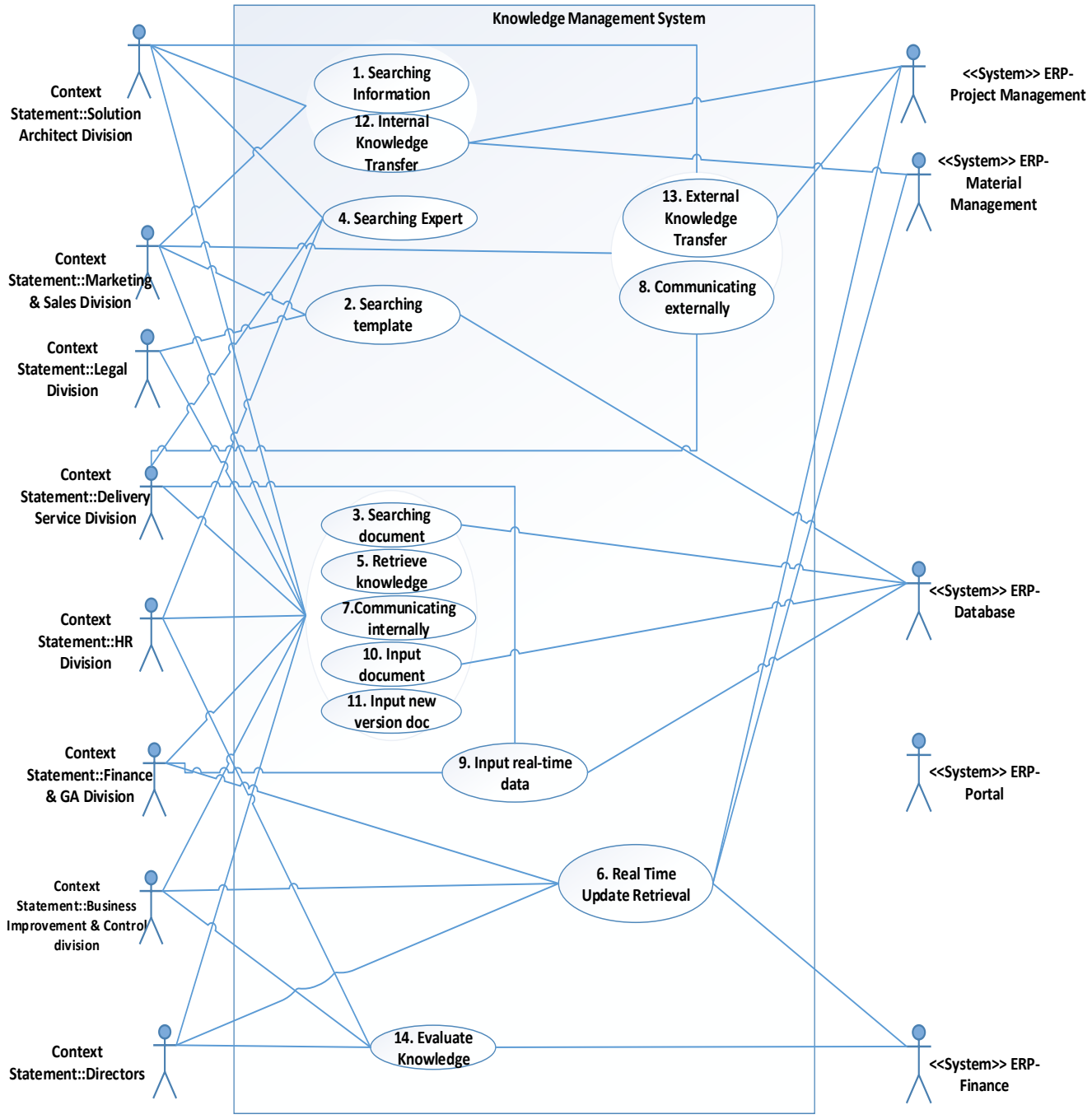


Figure 14 The KM System Use Case Scenario Model

5.2.2. KM System's Non-Functional Requirements

The KM System non-functional requirements are the characteristics that are expected and needed to operate the KM system. The non-functional requirements give an indirect effect to the system's user thus were derived from the goal model. Table 18 below presents the KM system's non-functional requirements.

Table 18 The KM System's Non-Functional Requirements

Category	Non-Functional Requirements	Description	Related Goals
Usability	Used by all employees	The KM system is intended to be used by all employees across divisions in Abyor. Currently, Abyor has 256 employees that work both on-site and off-site.	I1, I2, I3, I4, I5, I6, I7, L1
	Easy to use	The system should have a clear interface and a user manual, especially by considering that not all employees have a background and knowledge in the information system area.	
	Easy access to different devices	Abyor's employees have a high mobility thus the KM system should be easily accessed via mobile devices.	
Scalable	Support a large number of users	The KM system should support a large number of employees by considering its current employees.	
Security	Secure access permission	The KM system contains all important data, information, and knowledge that are vital to the company. It is important to ensure the authorized access both for the system and data. Therefore, the access permission for the KM system should only be changed by the KM system's data administrator.	
Extensible	Capable of being extended	Abyor is an expanding company, thus the system should enable the modules extension and the user's capacity enlargement.	
Flexible	Be able to handle a different kind of knowledge	The related data, information, and knowledge have different formats, such as document form, visual form, and audio form. The system should enable the storage and the transfer processes of those different forms of knowledge	I7
Maintainability	Cost to repair	The system should be easy to repair without great expenses	F2

5.3. KM System Architecture

In this section, the proposed KM system architecture is presented based on the business model and the requirements model. Further, this section intends to answer both the second and the third research questions.

5.3.1. KM System Components

In defining the KM system components, Abyor's KM reference architecture analysis was performed to bridge the requirements model and the KM system architecture model as suggested in COMET methodology (Berre, Elvesæter, Aagedal, & Ø, 2006). Based on the COMET methodology, the use cases of the system were clustered into specific sub-systems based on the shared functionality. As a result, a component can be proposed based on each component's end user functionality.

Several important things were taken into considerations to defined the proposed KM system components as follows.

- Most of the KM system components to support the distinctive KM system functions are readily available on the shelf (Desta, Garfield, & Meshesha, 2014). The decision whether specific KM tools/modules are proposed should be supported based on Abyor's requirements.
- Several KM system's use cases in Abyor are already covered by the implementation of an ERP system, for example storing and transfer functions have already applied in the ERP database, the ERP project management module, ERP finance module, and ERP material management module. Thus, the mechanism of data integration for both ERP and KM system should exist in the proposed KM system architecture.

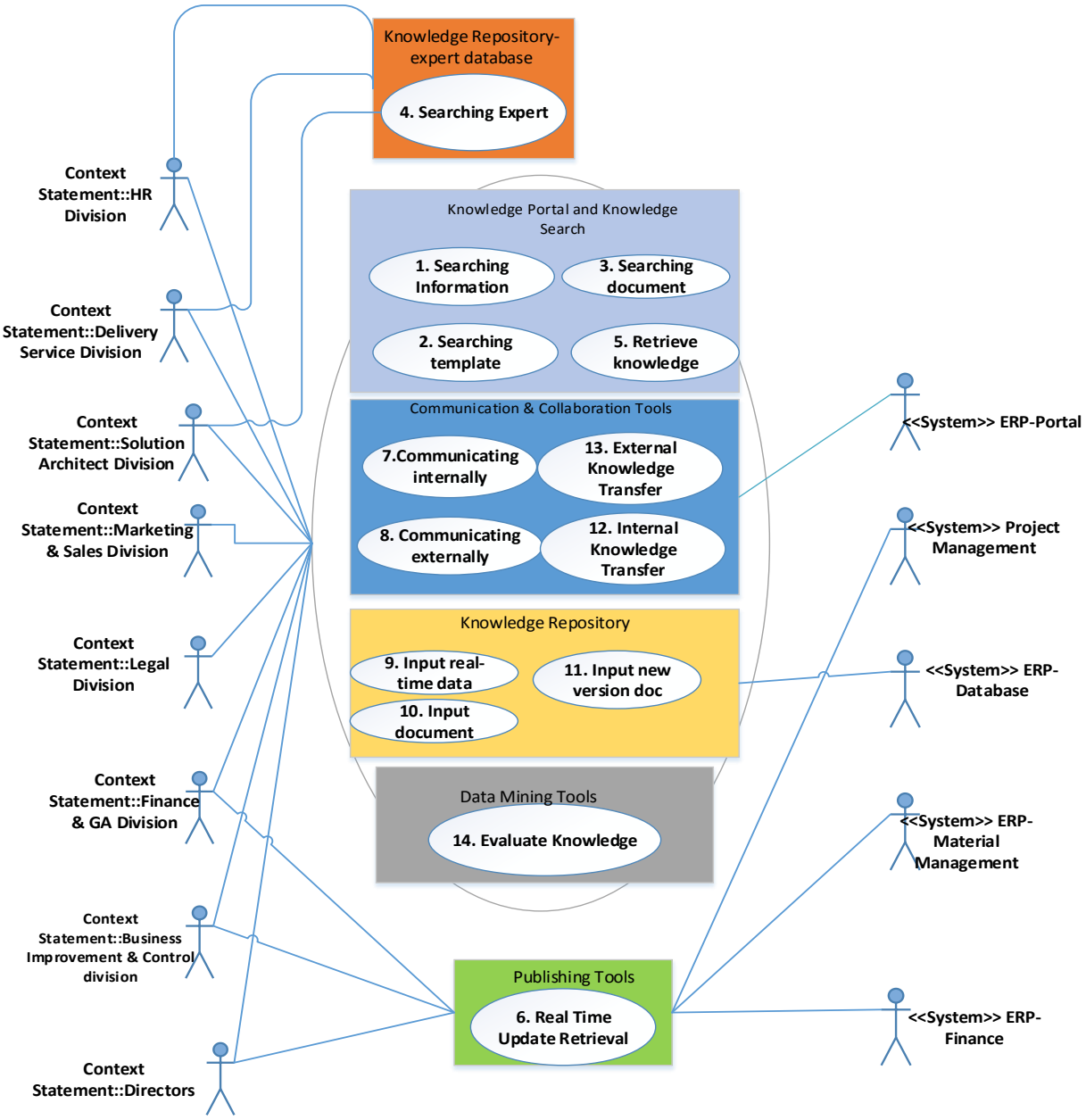
In defining the KM system components, the KM system use cases were grouped based on the similarity of KM system functions as proposed by Park and Kim (2006). Next, the KM system components were proposed based on the group of KM system use case. To be noted, in defining the KM system components, the proposed classification of KM tools as shown in Chapter 2.3.2. was used. Table 19 below presents the mapping process of the KM system's use cases to the KM system components.

Table 19 The Use Case Mapping to the KM System Components

KM Function (Park & Kim, 2006)	**KM System Use Cases**	**Related KM System Components**	**Related ERP system**	**Remark**
Knowledge Portal	1. Searching information	- Knowledge search tools Knowledge portal	-	The system enables general searching process to the internal and external data for both content and expert information
	2. Searching template			
	3. Searching document			
	4. Searching expert		-	
Document Management	9. Input real-time data	- Knowledge repository	ERP-database	The system enables storing process and versioning document process
	10. Input document			
	11. Input new version document			
Information Retrieval	5. Retrieve document	- Knowledge search tools - Knowledge portal	ERP- Project management module, ERP-Finance module, and ERP- Material Management module	The system enables recalling data, information, and knowledge process
	6. Real-time update knowledge retrieval	- Publishing tools		
Analysis	14. Evaluate knowledge	- Data mining tools	-	The system enables knowledge evaluation analysis
Communication	7. Communicating internally	- Communication and collaboration tools	ERP-Project management module, ERP-material management module, and ERP-finance module	The system enables communication between and beyond stakeholders
	8. Communicating externally			
Workflow management	12. Internal knowledge transfer			The system enable work item delivery to the appropriate users
	13. External knowledge transfer			

The following Figure 15 presents the KM system reference structure architecture analysis by performing the use case mapping. The relations between the KM system components and the actors/ related systems that are depicted in the following reference structure analysis are based on the KM system use case model. To be noted, the communication & collaboration tools are suggested to have a direct relation with the ERP portal thus can be accessed via the ERP portal.

Figure 15 The Reference Structure Analysis for the KM System Architecture



Based on the reference structure architecture analysis, several KM tools/modules are suggested to facilitate the KM activities within Abyor. In the following section, the proposed KM components' requirements, especially with regards to the KM activities within Abyor, are described further.

1. The Knowledge Repository

In the proposed KM system architecture, a knowledge database that separates from an ERP database is suggested to exist due to different databases' functions. The ERP database intends to store the daily data and the information relates to the project management, finance, and material management modules, while the knowledge database stores the processed data and information within the specific context folders. This separation is also suggested in the best practice to foster the security, the load balance, and the capacity for

each system (Li, Chaudhry, & Zhao, 2006). The proposed knowledge repository acts as the main data, information, and knowledge source for the KM system by which covers three main elements of databases, namely content database, reference database, and expert database.

a. **Knowledge content database** serves as a knowledge warehouse that populated with the processed information and documents. This KM component is required to facilitate all storing processes in Abyor's business processes, such as document the proposals, document the project's deliverables, and document the managerial reviews. Currently, only several storing processes cover by ERP system, namely, input the real-time finance data and input the real-time project information. Meanwhile, the rest of storing process are facilitated via separate internal division databases, such as FTP folders and Dropbox. Therefore, a central knowledge content database is suggested by considering a large amount of knowledge that will be stored and a large number of users.

   The knowledge content database is proposed to have the basic repository functions such as indexing function, mapping function, building link function, and navigation function which facilitates the management of stored knowledge. Furthermore, the knowledge content database is expected to support the case base repository and the problem base repository. The case base repository stores the previous cases faced by Abyor, i.e. case in designing and implementing the system in client's project, thus if needed the users can easily retrieve the information regarding the previous cases. Meanwhile, the problem base repository stores the previous problems faced by Abyor, especially that are faced by delivery service division in developing the client's deliverables.

   The knowledge database is suggested to have a direct interface with the existing ERP database since the daily basis information regarding financial, material, and project information is stored in the ERP database.

b. Reference Database stores the information regarding the location of relevant knowledge, especially for the external knowledge resources. The reference database consists of the website URL database, the documents' title, and the source of knowledge (Garfield, 2014). By using this reference database, the searching activity time of external information, such as finding the clients and finding the undeveloped knowledge, can be reduced.

c. Expert Database acts as the employee's yellow page that gives information regarding each employee's specialization and project experiences. By using this reference database, the solution architect, and the human resource divisions can easily find the consultants that fit with the project's requirements.

2. The KM-ERP Interfaces

Based on Xu et al. (2006), the parallel implementation of the ERP system and the KM system is enabled by the existence of knowledge interfaces that act as a software broker. These interfaces facilitate knowledge flows from both ERP to KM and KM to ERP. Based on the direction of knowledge flow, Xue at al. (2006) identifies two types of ERP-KM interfaces, namely, ERP to KM interface and KM to ERP interface. Both types of interfaces are proposed to exist in Abyor's KM System to facilitate the system integration with the current ERP system in the form of a system application. In detail, the proposed KM system in Abyor should consist of the following type of KM-ERP interfaces as proposed by Xu et al. (2006).

- **The Interface from ERP to KM** enables knowledge mining from the ERP system to be discovered, classified, and stored in the KM system. The interface consists of the three knowledge interfaces:
  - **a. K-Discovery** enables knowledge access and knowledge discovery of data and information within the ERP system that have an information context.
  - **b. K-Classifying** allows knowledge categorization based on the type of knowledge and the domain context.
  - **c. K-Storage** enables knowledge storing based on the specific context from the ERP system. The interface allows replication of meaningful data and information from the ERP system to be stored based on K-Discovery and K-Classifying functions.
- **The Interface from KM to ERP** enables knowledge mining from the KM system as requested by the ERP system to be used in Abyor's business process. The interface consists of two knowledge interfaces:

a. **K-Identifying** enables knowledge identification process in the KM process as requested by the ERP system based on the query command.

b. **K-Indexing** allows the interaction from the KM system to the ERP system based on the query command

3. The Knowledge Search Tools (Search Engines)

The knowledge search tools are proposed to exist in Abyor's KM system to facilitate the search and retrieval processes of knowledge both from the knowledge repository and the external knowledge source. The knowledge search tools are suggested to have two basic functions, namely, search filters and navigation. These functions are expected to improve the search and retrieval result by facilitating the search restriction and the search categorization.

4. The Data Mining Tools

The data mining tools enable the extraction of knowledge from hidden data and information in the database. Currently, the data mining tools have already implemented in Abyor within the ERP modules. The data mining tools are suggested to exist in Abyor's KM system to enhance the knowledge search process and the knowledge evaluation process. In the knowledge search process, the data mining tools are expected to suggest the most relevant knowledge for each user based on the most search keywords or folders and to analyze the document versioning process. In the knowledge evaluation process, the data mining tools are expected to support the audit process of Abyor's KM system usability.

5. The Knowledge Portal

The knowledge portal serves as the main knowledge presentation tool that supports the personalization of storing and retrieving process in Abyor's KM system. As the main KM system's dashboard, the knowledge portal is proposed to provide a direct link to the knowledge search tools, the publishing tools, and the communication & collaboration tools. The knowledge portal is expected to cover two main features namely personalization function and visualization function

a. **Personalization** enables Abyor's employees to input their data and information both regarding the profile and the work activities. Next, this feature also enables Abyor's employee to retrieve the appropriate data and information that meet with each employee' s work activities and searching habit. This personalized retrieval process is enabled by aligning user's profile, user's content, and user's business process (Instone, 2000). Further, personalization is enabled by using a security access to the KM system, by which restricts the employees to access the specific knowledge content.

b. **Visualization** enables the presentation of knowledge based on the knowledge search tools and the data mining tools.

6. The Communication and Collaboration Tools

The communication and collaboration tools are proposed to exist in Abyor's KM system to facilitate both internal and external knowledge communication & transfer processes. Further, it is suggested that the communication and collaboration tools can be accessed via the knowledge portal to ease KM system used. The tools are expected to have two main services as follows (Garfield, 2014).

a. **Communication services,** intend to facilitate the internal/external knowledge communication process and the knowledge transfer process within Abyor's business processes. Several communication tools are readily available, thus need to be integrated into one communication and collaboration system, namely mailing (e-mail), voice calls (telephone), and video calls. It is also important that the communication tools should be able to facilitate multimedia contents, such as images and videos.

b. **Collaboration services,** enable the online discussion through both synchronous meetings and asynchronous forums. Various forms of collaboration tools have already existed, such as video conference tools and shared screen tools, thus need to be integrated into the communication and collaboration tools.

7. The Publishing Tools

The publishing tools act as the push-search services by which enable a real-time automatic knowledge transfer to the respective parties, usually via emails or personalized knowledge portal. Currently, these services have been performed through the ERP system modules. The same mechanism thus is proposed to exist in Abyor's KM system to enhance the knowledge transfer process within Abyor.

5.3.2. KM System Architecture Model

The KM system architecture provides a high-level conceptual model of the proposed KM system that defines the system structures. In the following section, the KM system architecture is presented in the form of KM system conceptual-level architecture and several KM use case scenarios to define the KM system components' interdependencies, interactions, and interfaces as guided by COMET methodology (Berre, Elvesæter, Aagedal, & Ø, 2006).

KM System Conceptual-Level Architecture

The following Figure 16 shows the conceptual-level architecture for the proposed KM system architecture. The KM system components are derived from the reference structure analysis and the existing ERP system components (in blue). The components are connected by using four different interaction patterns, namely direct invocation (call), file transfer, shared databases, and bus pattern.

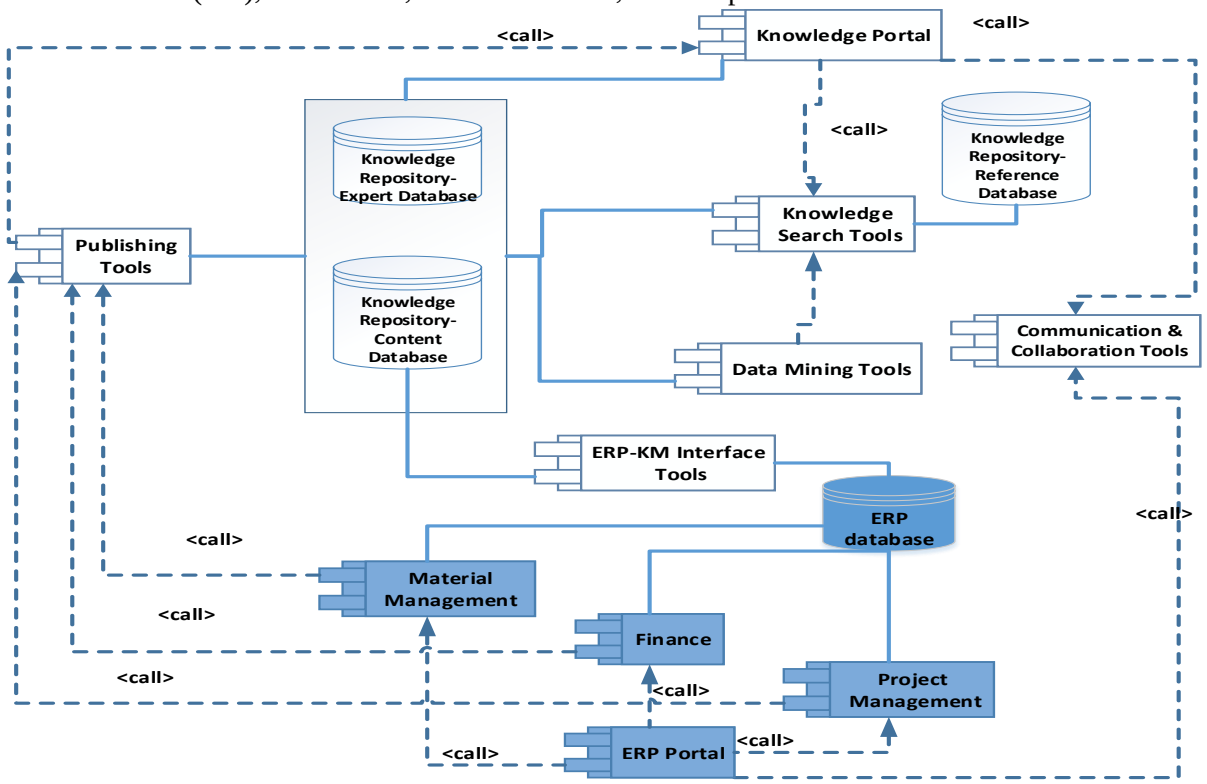


Figure 16 The Conceptual-Level Architecture for the KM System

As can be seen from Figure 16, the knowledge portal acts as the main presentation tool that enables the user to input information and knowledge to the knowledge repositories, connect with knowledge search tools, and connect with the communication & collaboration tools. The knowledge portal is proposed to have a pull service to call the knowledge search tools and the communication & collaboration tools based on the user's request. Further, it is proposed that the knowledge portal should enable the personalized storing for both knowledge and expert's information. Therefore, a direct link from the knowledge portal to the knowledge content database and the knowledge expert database is suggested as depicted in Figure 16. The knowledge portal is supported by the personalization function to ensure the system's access and the visualization function to present the results of query command. To be noted, each KM system's user is proposed to have special access to the knowledge portal that is limited based on the user's business processes and position within Abyor. This personalized access will determine the accessibility of each KM system's components.

Next, the publishing tools have a push service to call the knowledge portal if a relevant content is required to be automatically processed and distributed. Further, as depicted in Figure 16, the publishing tools act as a broker to facilitate the automatic knowledge retrieval process from the ERP system modules to the KM system portal. The similar call mechanism is proposed to be applied in the ERP portal to the communication & collaboration tools. By using this mechanism, the ERP system's users can also access the KM system's communication & collaboration tools. Meanwhile, the knowledge search tools are proposed to have the interactions with the knowledge repositories and the data mining tools based on the query command inputted in the KM portal.

The knowledge repositories, i.e. knowledge content database, knowledge expert database, and knowledge reference database, serve as the foundation of the KM system that provides the KM resources. Further, the integration between KM system and ERP system is proposed to exist in this repository functions. Therefore, the existence of ERP-KM interfaces is proposed to facilitate the transfer process of data, information, and knowledge both from KM system to ERP system and from ERP system to KM system.

KM System Use Case Scenarios

In this subsection, several Abyor's KM System use case scenarios are introduced to understand the relationship between the KM system components and the actors. Each scenario was triggered by an event from a user of the KM System. The use case scenario, thus, presents the response of the KM system to the trigger event in the form of path to each KM system components. Due to the system's complexity and actors, the description of all use case scenario is not possible to be reported. Therefore, several representative scenarios are introduced to give the insights. To be noted, the business resource model (see Chapter 5.1.3.) was used to identify the related elements for each scenario.

1. Find the previous proposals

Table 20 Search and Retrieve Scenario

Name: Marketing & Sales division searches previous proposals to be used in the similar project			
Contribution to Goals: I4 (Repeatable work), I3 (Activity time), I 2 (Efficiency), F2 (Reduce cost)			
#	**Message**	**Information elements**	**Related KM Tools**
1	StartSearch	Keywords	Knowledge Portal
2	KnowledgeSearch	Keywords	Knowledge search tools
3	KnowledgeRetrieval	Technical, discovery, commercial proposal	Knowledge content database
4	KnowledgeVisualization	Technical, discovery, commercial proposal	Knowledge portal-visualization

2. Store new version document

Table 21 Store Data, Information, and Knowledge Scenario

Name: Business & Improvement Control division inputs new version of managerial review document			
Contribution to Goals: I7 (Reduce knowledge loss), I5 (enhancing innovation)			
#	**Message**	**Information elements**	**Target**
1	StartStore	Managerial Review document	Knowledge Portal
2	VersioningProcess	Managerial Review document	Knowledge Expert Database
3	NavigationProcess	Managerial Review document	Data Mining Tools

3. Finding Knowledge transfer via ERP

Table 22 Knowledge Transfer Scenario

Name: Finance division got an automatic publish document based on on-going project report via ERP system			
Contribution to Goals: I1 (Productivity), I2 (Efficiency), I5 (Enhancing innovation)			
#	**Message**	**Information elements**	**Target**
1	StartInput	Finance data	ERP Portal
2	DataProcess	Finance data	ERP Project Management, ERP Finance, ERP Database
3	PublishingProcess	Finance data	Publishing Tools
4.	Publish	Finance data	Knowledge Portal

4. **Finding expert availability**

Table 23 Search Expert Scenario

Name: Solution architect division searches the availability of the expert to develop technical proposal			
Contribution to Goals: I4 (Repeatable work), I3 (Activity time), I 2 (Efficiency), F2 (Reduce cost)			
#	**Message**	**Information elements**	**Target**
1	StartSearch	Keywords	Knowledge Portal
2	ExpertSearch	Keywords, Expert Profile	Knowledge search tools
3	SearchProcess	Expert Profile	Data Mining Tools
3	ExpertRetrieval	Expert Profile	Expert Database
4	KnowledgeVisualization	Expert Profile	Knowledge portal-visualization

5.4. The Validation of Knowledge Management System Architecture

As discussed in Chapter 2 and Chapter 3, the validation of the proposed KM System architecture was based on the descriptive evaluation methods proposed by Desta et al. (2014) to assess the KM system architecture on two dimensions, namely, the user acceptance and the organizational capacity. In defining the user acceptance, the KM System acceptance model was used by assessing the perceived usefulness, the perceived ease of use, and the information quality. The information quality, especially, was assessed to ensure whether the proposed KM system can solve the KM problems related to technology that was found earlier (see Chapter 4.4.). Next, in defining the organizational capacity, the feasibility analysis of each proposed KM tool was performed. The validation process was performed to the solution architecture division and the human resource division as the KM system's architect and developer. The validation results are presented as follows.

The User Acceptance

For the perceived usefulness, both divisions agreed that the proposed KM system could be used to increase the employee's productivity by enhancing the utilization of knowledge resources in the organization. The human resource respondent also pointed out the usefulness of the knowledge portal to easily update the employee's information, thus can facilitate HR's assignment task. Further, the solution architect respondent agreed on the existence of knowledge database that separates from the ERP database. It is believed that the existence of separate databases can increase the security and the load balance for both systems.

For the perceived ease of use, both respondents confirmed that the proposed KM system architecture was clear and understandable to be developed in the further stage. The human resource respondent confirmed that Abyor's employees have a high acceptance of new technology. Moreover, by considering the fact that the proposed KM system composed of the common and widely used components, it is believed that the employees will feel ease on using the proposed KM systems in the future.

The information quality was assessed by considering the KM problems found in the KM Scan and the KM system functions. As a result, both respondents affirmed that all KM system functions had been fulfilled in the proposed KM system thus should be able to solve the KM problems related to technology. Firstly, related to the limitation of a formal communication facility in Abyor, both divisions confirmed that the existence of both the communication & collaboration tools and the publishing tools serves as the main communication channel to foster knowledge sharing within Abyor, especially by considering Abyor's high mobility as a consultant company. Secondly, related to the inexistence of a central knowledge repository, both respondents agreed on the existence of a central knowledge database, specifically for content database and reference database. Further, both respondents affirmed that the existence of knowledge portal and knowledge search tools could enhance the search and retrieval process within Abyor, specifically to retrieve internal data, information, and knowledge. Thirdly, related to the inadequate access for knowledge source identification, partial agreements were found during the validation process by which the human resource respondent showed an objection on the idea that everyone should be able to access the expert database. Alternatively, human resource respondent suggested adding security tools to control the user's access to several KM system components.

The Organizational Capacity

Based on the interviews, it was found that technically Abyor is able to develop the proposed KM system as designed at the system architecture level. Both respondents believed on Abyor's capability as an IT consultant to embody the proposed KM system. The result of the validation process for each KM system components is presented as follows.

The knowledge portal and the publishing tools are considered feasible to be implemented in Abyor, especially by considering the existence of current ERP portal. Furthermore, there is a discussion regarding the possible integration between the two system's portals in actualizing the proposed KM system. It is also suggested that the KM portal should be able to be used in the mobile format via internet access.

Relates to the communication & collaboration tools and the knowledge search tools, both respondents affirmed the possible integration of those components within one system. Currently, every Abyor's employee has an official email, thus it is possible to add an email feature in the KM system. Regarding the conference tools, Abyor has bought a video conference tool named GTM (Go to Meeting). Thus it is also possible to integrate the current video conference tool into a single system. Regarding the knowledge search tools, it is argued that the search tools are able to be integrated with the external search engines, i.e. google.

The knowledge repository was supported to exist by the solution architect respondent. It was argued that the knowledge content database is important to exist in separate with the existing ERP database to enhance system's security and system's load balance. Next, the knowledge reference database was proposed to be actualized by using the same technique as the bookmarking process. Regarding the knowledge expert database, human resource respondent argued that the most influential factors to ensure the tools' feasibility are the users. The users should be encouraged and pushed to use the profile system in the knowledge portal by which this information is stored in the knowledge expert database. Therefore, a clear procedure on the application of the KM system is necessary to exist that consists of the application benefit and the punishment mechanisms.

To summarize the validation result, it is found that the proposed KM system architecture gain a high level of acceptance from both respondents who act as the KM system's architect and developer. Both respondents validated the proposed KM system's usefulness and ease of use to be used by all Abyor's employees. Furthermore, related to the KM problems that are found, the proposed KM system has been validated to solve the KM problems, specifically related to the technology problems. Related with the organizational capacity, both respondents ensured Abyor's capability to embody the proposed KM system.

CHAPTER 6
SUMMARY AND DISCUSSION

This chapter provides the summary and the discussion of each research question's findings. Next, this chapter also presents the contributions of the study both practically and theoretically. Last, the limitations and the recommendations for further research are mentioned.

6.1. Summary and Discussion of Research Findings

This master thesis project aims to propose a KM system architecture model based on Abyor's current KM processes performance, Abyor's current KM problems related to technology, and Abyor's existing ERP system. The four research questions, further, were defined to answer the research goals.

The first research question aims to understand Abyor's current performance on the KM processes thus Abyor's KM problems can be identified. For this question, the KM scan was performed by conducting the convergent parallel mixed method of the qualitative and the quantitative research. As a result, several KM processes were found to experience the low degree of the implementation process, namely the needed knowledge identification process, the new knowledge development process, the knowledge storing & retrieval process, and the knowledge communication process. Next, Abyor's KM problems were identified and classified into the cultural-structural-technology problems as proposed by Chan and Chao (2008). The technology problems, further, were expected to be solved by using the proposed KM system. The identified KM problems related to technology consist of the inexistence of a central knowledge database, the inadequate access to find the knowledgeable experts, and the limitation of a formal communication facility.

The second research question is to propose the system components for Abyor's KM system. To do so, the business model and the requirements model were developed based on the KM scan and Abyor's documents. Based on the business model, it was found that the identified KM system's user goals were aligned with each other. Therefore, all stakeholder's goals were taken into consideration in developing the KM system architecture. The requirements model, specifically the functional requirements, was developed in the form of a use case model to identify the main services of the proposed KM system based on the identified KM system's goals and the identified KM activities. The use cases, further, were grouped based on the similarity of each KM system function thus were mapped into related KM tools. As a result, several KM system components were proposed namely the knowledge portal, the knowledge search tools, the communication & collaboration tools, the knowledge repositories, the publishing tools, and the data mining tools. Furthermore, to ensure the KM system integration with the existing ERP system as suggested in the KM system vision, the ERP-KM interfaces were proposed to exist to interact with the knowledge content repository that consists of the ERP to KM interface and the KM to ERP interface.

The third research question aims to propose the conceptual level of the KM system that defines the system's components, interaction, and interfaces. The third research question, further, was used to ensure the integration between the proposed KM system and the existing ERP system. As a result, the integration was proposed to exist in the ERP modules, ERP database, and ERP portal. The ERP modules are proposed to have a direct invocation mechanism to the KM system's publishing tools, the ERP portal is proposed to have a link with the KM system's communication & collaboration tools, and the ERP database is proposed to have the connection with the KM system's repository by using the proposed ERP-KM interfaces tools.

The fourth research question intends to validate the proposed KM system architecture by performing the interviews with the KM system's architect and developer. As a result, it was confirmed that the proposed KM system has a high level of acceptance both from the usefulness and the ease of use. Moreover, both respondents validated the fulfillment of KM problems related to technology that was identified in the KM scan and the fulfillment of each required KM system function in Abyor. Last, both respondents also ensured Abyor's capability to embody the proposed KM system architecture.

To summarize, the proposed KM system components were confirmed to solve the KM problems related to technology and to fulfill the KM system vision statements by promoting the centralized knowledge and expert repositories, accommodating the automatic document management and facilitating the integrated communication and collaboration both for internally and externally. Furthermore, by considering the lack of score in implementing several KM processes, the implementation of the proposed KM system was expected to enhance the implementation of specific KM processes within Abyor's business processes. As an example, the centralized knowledge database can facilitate the knowledge storing & retrieval process, the communication & collaboration tools and the publishing tools can enhance the knowledge transfer & communication process, and the expert repository can promote the knowledge identification process.

To compare the proposed KM system with the existing KM system architecture model (see Chapter 2.3.3.), Abyor's KM system architecture consists of three main functions as proposed by Maier (2007) and Chua (2004). The repository layer is embodied in the knowledge content repositories, the knowledge expert repositories, and the knowledge reference repository. Next, the service layer is served by the communication & collaboration tools, the data mining tools, the publishing tools, and the knowledge search tools. Meanwhile, the presentation layer is embodied by the knowledge portal. Abyor's KM system also consists of most KM system components that have been introduced in the literature (see Chapter 2.3.2). However, the existence of each KM system component was motivated based on the use case model and the reference structure analysis that were performed for Abyor's case. This process was aligned with the proposal from McDermott and O'Dell (2001) by which argued that no best solution adapted to every organization thus each system should be personalized based on individual organization's needs.

The main difference that exists between the proposed and the existing KM system architecture model resides on the existence of the ERP system that has to be aligned with the proposed KM system. To bridge the systems, the KM-ERP interfaces tools, as proposed by Xu et al. (2006), was suggested to exist at the repository level. In addition to the previous study, the interaction of the KM system and the ERP system was also suggested to exist in the ERP modules level and the ERP portal level. Furthermore, the proposed KM system architecture was also validated by the experts, in this case by internal KM system architect and developer, which has not yet performed in the previous KM-ERP integration model.

Related to the validation issue, the multiple source research method of this master thesis project contributes to the strong construct validity thus making it possible to establish a chain of evidence. The crosscheck of interview's transcripts was also performed to validate the interview's result. Related to the external validity, the generalizability of research's result is low due to the context-specific research by which the KM system components and architecture model were designed based on the personalized Abyor's use case model and reference structure model. The reliability of the research is good since the determined procedure was followed. However, the replication of research in the future most likely will lead to different result due to the change of organization and process.

6.2. Contribution

The contributions of this research for the organization are the assessment of the current KM processes performance, the proposal of KM system components, and the design of KM system architecture model. The assessment result of Abyor's KM processes performance will be used by Abyor's managers to determine the strategic level decisions to improve the KM processes implementation. Next, the design of KM system architecture will be used by Abyor's solution architect division as the basic reference model to develop the KM system. Furthermore, the current result of KM scan can be utilized as the comparison to assess whether the KM system implementation improves the KM processes performance in the future.

This master thesis project contributes to the existing literature in three ways, namely related to the theoretical, related to the methodology, and related to the result. Related to the theoretical issues, this master thesis project proposes a mapping of the various KM tools that exist in the literature into a particular KM

system function and a validation framework for a KM system architecture that has not yet exist in the previous study. Related to the methodology issue, this master thesis project contributes the procedures that could be followed by other research by integrating both quantitative and qualitative research that still rarely performed in the previous study (Deve & Hapanyengwi, 2014). Related to the result, this master thesis project adds the case study analysis on designing the KM system architecture to the consultant company, since no previous study found has performed this study. The proposed KM system architecture also contributes in adding the validated KM system architecture model that was integrated with the ERP system, specifically by considering the limited existence of an empirical system integration framework in the literature (Xu, Wang, Luo, & Shi, 2006).

Despite the research result's low generalizability, the proposed KM system architecture can give an insight on designing the KM system architecture, especially in the IT consultant company. Furthermore, the theoretical and methodological contributions could be used in designing the KM system architecture in the general case.

6.3. Limitation

This master thesis project is subject to several limitations. This section describes the most important limitations of this project:

1. Due to the geographical barriers, the onsite project to perform the KM scan was only conducted for the diagnosis & analysis stage, while the design stage and the validation stage were performed remotely. Although the limitation might influence the validity result of the research, several prevention efforts were conducted to minimize the geographical barriers limitations. As an example, the regular call and the incidental call were conducted to ensure the design process. Next, the presentation of the proposed KM system architecture was conducted before the validation interviews to ensure the respondents' understanding of the proposed KM system.
2. Due to the employee's high mobility and the limited resources, it is not possible to perform the interviews with all Abyor's division managers. The representative, thus, was chosen from each division. Within the diagnosis and analysis phase, it was not possible to conduct an interview with any representative of marketing & sales division. Therefore, the Standard Operational Procedure (SOP) documents were used to identify marketing & sales division's activities and goals.
3. To judge the implementation level of each KM process, especially in the quantitative research, a comparison study is preferably performed with the previous Abyor's condition or to the similar industry. However, no data was found to compare the quantitative result, thus the judgment was based on the cut-off point analysis. In the future, the similar longitudinal study was suggested to be performed, especially by considering the implementation of the proposed KM system in Abyor.
4. This master thesis project focuses on the system architecture level development. The technical problems on the embodiment of the system are being left to the solution architect division as the system developer.

6.4. Recommendation for Possible Further Research

This master thesis project's limitations and results lead to several further studies. This section describes the possible further research as follows.

1. Due to the limitation of the thesis, the further study for the embodiment of the proposed KM system should be performed. The further studies of the KM system development consist of the pilot project study, the KM system validation study, and the KM system implementation study.
2. Based on the KM scan, it was found that Abyor experienced several KM structure and KM culture problems that are not solved by using the proposed KM System. The strategic level study should be performed to provide insight to Abyor regarding the best strategic decision to address these problems.
3. To assess the implementation effect of the KM system, it was suggested that the longitudinal KM scan is performed in the future. Further, the current result of the KM scan could be used as the basis for conducting a comparison analysis to assess the implementation effect.

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APPENDIX 1
INTERVIEW GUIDELINES FOR DIAGNOSIS & ANALYSIS PART 1

Respondent: Abyor's division managers

1. **Opinion on knowledge management**
   - Are you familiar with the knowledge management terminology?
   - How important is knowledge of the organization in your opinion?
   - Do you believe that managing knowledge is important for an organization?
     (Please give rates from extremely not important, not important, neutral, important, extremely important)
2. **The degree of organizational attention of knowledge management**
   - Do you feel that Abyor has put enough emphasis on knowledge management?
   - If so, in what forms exist?
3. **Organization's culture**
   - Is the organization culture open to the new knowledge?
     Is the organization culture open to the knowledge sharing?
4. **Existing organization's knowledge management policy, knowledge instruments and knowledge infrastructure that implemented in specific division**
   - Are there any current knowledge management policy exist? If so, what it is?
   - Are there any current knowledge management instruments used? If so, what it is?
   - Are there any current knowledge management infrastructures used? If so, what it is?
5. **The activity and objective within the division, especially in relation to knowledge management activities?**
   - What are the main objectives in your division?
   - What are the tasks in your division?
   - What is the related- knowledge management activities within your tasks?
   - Could you give a rating to the previous mention tasks based on the degree of knowledge importance?
6. **Knowledge management expectancy**
   - Which components of knowledge management that should be improved in Abyor, in terms of knowledge management activity, policy, instrument, and infrastructure?
7. **Knowledge management system development**
   - Have you familiar with Abyor's plan to develop knowledge management system? What do you think?
   - What is your main expectancy for the proposed knowledge management system both for Abyor's interest and specific division's interest?
   - If the system has already implemented, what is your desired situation happened in Abyor in general and in your specific division?

APPENDIX 2
INTERVIEW GUIDELINES FOR DIAGNOSIS & ANALYSIS PART 2

Respondent: Abyor's Human Resource Division

A. Knowledge Management System

1. Who are the stakeholders for the proposed knowledge management system in Abyor? What are his/her roles?
2. What is the main objective of the proposed knowledge management system for both Abyor in general and for each specific division? What are the parameters for each goal?
3. What is the desired state of affairs that you wish to bring as a result of knowledge management system implementation?
4. What kind of functions are expected from knowledge management system?
5. What kind of non-functional requirement, i.e. performance, availability, security, reliability, and so forth, are expected from the proposed knowledge management system?

B. Opinion on current application of specific knowledge management function

Knowledge Management Function	Question for each KM IT enabler
1. Communication and Collaboration Tools	- Do you think this specific knowledge management function is important to exist within Abyor? Why so and why not? - What are the current tools that implemented to facilitate the specific knowledge management function within Abyor? - Is there any problem occurred for this specific functions? - How to solve this problem?
2. Information Retrieval	
3. Knowledge Portal	
4. Document Management System	
5. Workflow Management System	
6. Analysis	

Respondent: Abyor's Solution Architect Division

A. Current ERP System Architect Structure

1. What are ERP modules that currently being used in Abyor?
2. What are business processes that currently supported by specific ERP modules?
3. What is the structure of ERP system architecture in which implemented in Abyor?
4. Is there any problem occurred in the ERP system? If so, how to solve it?

B. Designing Knowledge Management System

1. What kind of functions are expected from knowledge management system?
2. What kind of non-functional requirement, i.e. performance, availability, security, reliability, and so forth, are expected from knowledge management system
3. Relates with the existing of ERP system, what are your views on integrating both systems?
4. In your point of view, is it technically possible to integrate both systems?

APPENDIX 3
QUESTIONNAIRE FOR DIAGNOSIS AND ANALYSIS

This survey is part of an investigation into the knowledge management within Abyor. I would like to ask you to complete the survey as complete as possible. This questionnaire will take 15 minutes or so. Further, your answer will remain anonymous.

Part 1

1. How long have you been employed by Abyor?
   - < 1 year
   - 1-3 year
   - 3-5 year
   - > 5 year
2. In which division do you work within Abyor?
   - Solution Architect division
   - Delivery Service division
   - Business Improvement and Control division
   - Corporate Service division
   - Marketing and Sales Division
   - Other: …
3. What is your position within Abyor?
   - Director
   - Manager
   - Consultant
   - Staff
   - Other: ...

Part 2

Note: 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree

Knowledge Creation and Acquisition					
4. Determine needed knowledge					
a. The strategy of our organization is clear that each individual can deduce what knowledge is needed to realize this strategy	1	2	3	4	5
b. The explicit deduction of knowledge needed has been part of our systemized routine process	1	2	3	4	5
c. The strategy of our organization is clear that each individual can deduce what knowledge is needed from other colleagues to realize this strategy	1	2	3	4	5
5. Determine available knowledge					
a. We know in which area we have more knowledge in-house than our competitors.	1	2	3	4	5
b. I am aware which knowledge workers in my work environment possess knowledge that is valuable to the specific work	1	2	3	4	5

c. If I get certain question from a client, I am able to say which person in my work environment that is the most knowledgeable to answer that question	1	2	3	4	5
6. Knowledge gap identification					
We are aware of the knowledge gaps within the organizations	1	2	3	4	5
7. Develop a new knowledge					
a. We have formal knowledge development procedures like pilots, studies, etc.	1	2	3	4	5
b. Decision about make or buy of new required knowledge are made on rational grounds, such as standard operational procedures (SOP)	1	2	3	4	5
c. We have good contacts with the research institutes that have a reputation in the area of expertise that is related to us	1	2	3	4	5
d. We have regular structural think about the questions of what knowledge the organization will need in the long term	1	2	3	4	5
e. In general, people here are positive towards renewing products or services	1	2	3	4	5
f. It sometimes happens that knowledge gaps between divisions exist, thus need to be remedied by relatively high cost	1	2	3	4	5
Knowledge Organization and retention					
8. Knowledge Storing					
We have a formal index/database (automated or otherwise)- where we can find which knowledge is needed	1	2	3	4	5
9. Knowledge Retrieval					
a. Knowledge is relatively available when needed	1	2	3	4	5
b. Knowledge is relatively accessible when needed	1	2	3	4	5
Knowledge Dissemination					
10. Knowledge Transfer					
a. Explicit and formal attention to knowledge dissemination has become our main strategy in our organization	1	2	3	4	5
b. The culture, the atmosphere and the climate of cooperation within our organization support transfer knowledge spontaneously and informally with others	1	2	3	4	5
c. Sharing knowledge with others can weaken the position of the relevant knowledge worker in the organization	1	2	3	4	5
d. In the case of looking help for work to a certain knowledge, individual in most cases will turn to ask the expert within the organization	1	2	3	4	5

e. Every knowledge worker performed transfer knowledge duty	1	2	3	4	5
f. Other's mistakes are used as lesson learned	1	2	3	4	5
11. Knowledge Communication					
a. Knowledge sharing is facilitated in our organization through internal lectures, seminars, discussion meeting, and the like.	1	2	3	4	5
b. Knowledge sharing is facilitated in our organization through training and courses.	1	2	3	4	5
c. Knowledge sharing is facilitated in our organization via reports, manuals, instruction sheets and other documents.	1	2	3	4	5
d. Knowledge sharing is facilitated in our organization through case-assessments completed (successful or unsuccessful) projects.	1	2	3	4	5
e. Knowledge sharing is facilitated in our organization through training-on-the-job apprentice in master-apprentice relation	1	2	3	4	5
f. Knowledge sharing is facilitated in our organization through rotation of valuable scarce knowledge providers across various divisions.	1	2	3	4	5
g. Knowledge sharing is facilitated in our organization through information technology (databases, intranet, groupware)	1	2	3	4	5
h. Knowledge sharing is facilitated in our organization through informal face-to-face contacts.	1	2	3	4	5
Knowledge Utilization					
12. Knowledge Application					
a. Newly developed or acquired knowledge usually be quickly and spontaneously implemented when needed	1	2	3	4	5
b. Insufficient individual involvement in the development of new knowledge causes the resistance to applying new knowledge	1	2	3	4	5
c. Limited contribution of new knowledge to the task effectivity and efficiency causes the resistance to applying new knowledge	1	2	3	4	5
d. Tight attachment with previous routines and habits causes the resistance to applying new knowledge	1	2	3	4	5
e. The thought that new knowledge only intended to young people and new employees causes the resistance to applying new knowledge	1	2	3	4	5
13. Knowledge evaluation					
a. We are able to identify which knowledge that is no longer relevant to implement organization's strategy by identifying our current strategy and available knowledge (deleted due to low-reliability result)	1	2	3	4	5

b.	Knowledge workers who possess less knowledge than on its standard will be the subject of coaching, training, (re) training, or another learning program to yield acceptable level of knowledge possession	1	2	3	4	5

Part 3 Knowledge Management System Function

How much is the degree of current fulfillment for each knowledge management function?

		Never		**Sometimes**		**Often**		**Always**	
1.	**Communication and Collaboration**								
	a. Chatting	1	2	3	4	5	6	7	8
	b. Mailing	1	2	3	4	5	6	7	8
	c. Conferencing	1	2	3	4	5	6	7	8
2.	**Information retrieval**								
	a. Search agents	1	2	3	4	5	6	7	8
	b. Visualization	1	2	3	4	5	6	7	8
	c. Finding expert	1	2	3	4	5	6	7	8
3.	**Knowledge portal**	1	2	3	4	5	6	7	8
4.	**Document management system**	1	2	3	4	5	6	7	8
5.	**Workflow management system**	1	2	3	4	5	6	7	8
6.	**Analysis**								
	a. User analysis	1	2	3	4	5	6	7	8
	b. Market analysis	1	2	3	4	5	6	7	8
	c. Decision support	1	2	3	4	5	6	7	8

How much do you think this specific knowledge management function should be fulfilled in the Abyor?

		Never		**Sometimes**		**Often**		**Always**	
1.	**Communication and Collaboration**								
	d. Chatting	1	2	3	4	5	6	7	8
	e. Mailing	1	2	3	4	5	6	7	8
	f. Conferencing	1	2	3	4	5	6	7	8
2.	**Information retrieval**								
	d. Search agents	1	2	3	4	5	6	7	8
	e. Visualization	1	2	3	4	5	6	7	8
	f. Finding expert	1	2	3	4	5	6	7	8
3.	**Knowledge portal**	1	2	3	4	5	6	7	8
4.	**Document management system**	1	2	3	4	5	6	7	8
5.	**Workflow management system**	1	2	3	4	5	6	7	8
6.	**Analysis**								
	d. User analysis	1	2	3	4	5	6	7	8
	e. Market analysis	1	2	3	4	5	6	7	8
	a. Decision support	1	2	3	4	5	6	7	8

APPENDIX 4
INTERVIEW GUIDELINES FOR VALIDATION

Respondents: Manager of Human Resource and Solution Architect

A. User Acceptance based on KM System adoption model (Kuo & Lee, 2009)

1. Perceived usefulness

- Do you believe that the proposed KM system can improve employees working performance?
- Do you think that the proposed KM system can improve employee's job productivity?
- Do you think that the KM system will be useful in employee's job?

2. Perceived ease of use

- Do you think the proposed KM system architecture is clear and understandable?
- Do you think the proposed KM system will be easy to use?
- Do you think the proposed KM system will be flexible scalable?

3. Information Quality

- Do you think the proposed KM system components can provide the function that needed in the organization relates to knowledge content, context, and linkage?

B. Feasibility for each knowledge management IT enabler

KM Proposed Tools	**Question for each KM IT enabler**
1. Knowledge Repository - Knowledge content database - Reference Database - Expert database	1. Do you think this specific tools proposed can be implemented in Abyor? 2. Do you have in your mind the similar tools that can replace/support this specific KM tools? 3. Are there any KM tools problems ever occurred in the implementation of the current tools? 4. If so, how to solve it? 5. In general, do you have any suggestions to improve KMS architecture design?
6. KM-ERP interface - Interface from ERP to KM - Interface from KM to ERP	
3. Knowledge search tools	
4. Knowledge Portal	
5.Communication and Collaboration Tools	
6. Publishing Tools	

APPENDIX 5
THE DETAIL ANALYSIS OF DATA ADEQUACY

1. Interview

In this master thesis project, the three interviews performed become the primary method of gaining qualitative data. The respondent information for each interview type is presented as follows.

a. The first series of knowledge management scan interview

In this series, the respondents were chosen based on the representativeness and the availability of each manager divisions, especially by considering the high mobility of Abyor's employee. The list of respondents is presented as follows.

1. Human Resource Manager
2. Delivery Service Manager
3. Business Improvement and Control Manager
4. Solution Architect Manager
5. Finance Manager

b. The second series of knowledge management scan interview and the validation interviews

The second interviews of Knowledge Management Scan and the validation stage interviews were conducted to the same respondent but with different purposes. While the second interview for KMS aims to gain the system requirements regarding designing a KMS, the validation interview intends to ensure that the requirements were fulfilled in the proposed system. For both interviews, the respondents were chosen based on its role in the KM System development process as shown below.

No.	Respondent's Role	Remark
1.	Human Resource Manager	The HR division acts as KM system architect that is responsible for defining the KM system requirement
2.	Solution Architect Manager, specifically in BASIS module	The solution architect division acts as KM system developer that is in charge of developing the embodiment of the KM system

2. Survey

The survey that was conducted online for two and half week resulted in 78 responses from 198 employees that have been work for more than six months in Abyor. The following section presents the respondent's demographic information to be used to analyze the respondent adequacy for the KM scan.

- **Respondent's job duration distribution**

The survey resulted in 19% respondents who have worked for less than one year, 42% respondents who have worked between one and three years, 25% respondents who have job duration between three and five years, and 14% respondents who have worked more than five years. This situation represents the real condition in Abyor by which dominated by employees who started their work in 2012.

- **Respondent's Division distribution**

The following table represents the adequacy respondent based on division by comparing the respondent with total employees for each division.

ivision	Respondents	Total employees	Respondent's percentage
Business Improvement & Control	5	7	71.4%
Corporate Service	8	20	40%
Marketing and Sales	6	21	28.6%
Professional Delivery services	50	130	38.5%
Solution architect	9	20	45%
Total	78	198	

As can be seen, apart from business improvement and control division who have high response rate, other divisions have a relatively comparable percentage which ranges between 28% to 45%.

- **Respondent's position distribution**

  The adequacy respondent based on employee's position by comparing the respondent by total employees for each position is presented as follows.

Position	Respondent	Total Employees	Respondent's percentage
Directors	0	6	0
Manager	6	21	28.6%
Consultant	59	150	39.3%
Staff	19	48	39.6%
Total	78	198	

Based on the result, it can be seen that Abyor's directors did not fill out the questionnaire thus was not involved in group difference analysis. On the other hand, other positions percentage was comparable with each other thus was used in group difference analysis.

APPENDIX 6
CUT-OFF POINT CALCULATION

The calculation of Likert's cut-off point was based on the method proposed by Barua (2013). The calculation steps are presented as follows.

1. The calculation of equal weight to each process. There are ten KM processes thus each process has weight of 0.1
2. The calculation of Discrimination Index (DI) for each process based on Spearman's Correlation Coefficient calculated in SPSS.
3. Weightage of each process by using following equation
   =(Observed Process Score) X (Equal Weightage) X (Discrimination Index) X (Cronbach Alpha)
4. The calculation of correction factor as follows.
   =(Total Weighted Score)/(Total Raw Score)
   =(30.702)/2.069 = 0.067

Knowledge Management Process		**DI**	**Weightage**	**Percentile**
Knowledge creation and development	Determine needed knowledge	0.831	0.204	2
	Determine available knowledge	0.721	0.232	3.667
	Knowledge gap identification	1	0.374	2
	Develop a new knowledge	0.552	0.139	2.33
Knowledge organization and retention	Knowledge storing	1	0.280	2
	Knowledge retrieval	0.58	0.165	2
Knowledge Dissemination	Knowledge Transfer	0.439	0.0975	2.5
	Knowledge Communication	0.526	0.144	2
Knowledge Application	Knowledge Utilization	0.718	0.1304	2
	Knowledge Evaluation	1	0.3	2

5. The calculation of cut-off point
   = Sum [(Median of Individual Process Score – 25th Percentile) X (Correction Factor)]
   = 0.519

APPENDIX 7
THE RESULT OF QUANTITATIVE RESEARCH

1. Means of The Process Variable

Statistic

		Determine Needed Knowledge 1	Determine Needed Knowledge 2	Determine Needed Knowledge 3
N	Valid	78	78	78
	Missing	0	0	0
Mean		2.769	2.667	2.705
Std. Deviation		1.103	1.124	1.04

Statistic

		Determine Available Knowledge 1	Determine Available Knowledge 2	Determine Available Knowledge 3
N	Valid	78	78	78
	Missing	0	0	0
Mean		3.487	3.897	3.794
Std. Deviation		0.949	0.846	0.811

Statistic

	Develop a new knowledge 1	Develop a new knowledge 2	Develop a new knowledge 3	Develop a new knowledge 4	Develop a new knowledge 5	Develop a new knowledge 6
N	78	78	78	78	78	78
Valid	0	0	0	0	0	0
Missing	2.448	2.705	2.859	2.987	3.423	3.359
Mean	1.064	1.082	1.065	1.087	1.013	1.08
Std.Deviation						

Statistic

		Knowledge Retrieval 1	Knowledge Retrieval 2
N	Valid	78	78
	Missing	0	0
Mean		2.884	2.872
Std. Deviation		1.068	1.073

Statistic

	Knowledge Transfer 1	Knowledge Transfer 2	Knowledge Transfer 3	Knowledge Transfer 4	Knowledge Transfer 5	Knowledge Transfer 6
N	78	78	78	78	78	78
Valid	0	0	0	0	0	0
Missing	2.769	3.615	1.961	3.333	3.435	3.628
Mean	1.08	1.13	0.973	0.963	1.014	0.968
Std.Deviation						

Statistic

	Knowledge Sharing 1	Knowledge Sharing 2	Knowledge Sharing 3	Knowledge Sharing 4
N Valid	78	78	78	78
Missing	0	0	0	0
Mean	2.859	2.833	2.833	3.23
Std.Deviation	1.101	1.242	1.074	1.043

Knowledge Sharing 5	Knowledge Sharing 6	Knowledge Sharing 7	Knowledge Sharing 8
78	78	78	78
0	0	0	0
3.346	2.667	2.962	3.487
1.103	0.949	1.133	0.976

Statistic

	Knowledge Application 1	Knowledge Application 2	Knowledge Application 3	Knowledge Application 4	Knowledge Application 5
N Valid	78	78	78	78	78
Missing	0	0	0	0	0
Mean	3.333	2.551	2.589	2.333	2.115
Std.Deviation	1.002	1.124	1.098	1.002	0.98

Statistic

	Knowledge Evaluation 1	Knowledge Evaluation 2
N Valid	78	78
Missing	0	0
Mean	3.23	3.00
Std.Deviation	0.924	1.217

2. Kruskall Wallis Test

Job duration group differences

Significance level: 005

Null Hypothesis	**Significance Level**	**Decision**
The distribution of Determine Needed Knowledge 1 is the same across job duration	0.27*	Reject the Null hypothesis
The distribution of Determine Needed Knowledge 2 is the same across job duration	0.006*	Reject the Null hypothesis
The distribution of Determine Needed Knowledge 3 is the same across job duration	0.009*	Reject the Null hypothesis

The distribution of Determine Available Knowledge 1 is the same across job duration	0.786	Retain the null hypothesis
The distribution of Determine Available Knowledge 2 is the same across job duration	0.452	Retain the null hypothesis
The distribution of Determine Available Knowledge 3 is the same across job duration	0.297	Retain the null hypothesis
The distribution of Knowledge Gap Identification is the same across job duration	0.197	Retain the null hypothesis
The distribution of Develop a new knowledge 1 is the same across job duration	0.08*	Reject the null hypothesis
The distribution of Develop a new knowledge 2 is the same across job duration	0.011*	Reject the null hypothesis
The distribution of Develop a new knowledge 3 is the same across job duration	0.011*	Reject the null hypothesis
The distribution of Develop a new knowledge 4 is the same across job duration	0.34*	Reject the null hypothesis
The distribution of Develop a new knowledge 5 is the same across job duration	0.283	Retain the null hypothesis
The distribution of Develop a new knowledge 6 is the same across job duration	0.570	Retain the null hypothesis
The distribution of Knowledge Storing is the same across job duration	0.154	Retain the null hypothesis
The distribution of Knowledge Retrieval 1 is the same across job duration	0.027*	Reject the null hypothesis
The distribution of Knowledge Retrieval 2 is the same across job duration	0.034*	Reject the null hypothesis
The distribution of Knowledge Transfer 1 is the same across job duration	0.017*	Reject the null hypothesis
The distribution of Knowledge Transfer 2 is the same across job duration	0.645	Retain the null hypothesis
The distribution of Knowledge Transfer 3 is the same across job duration	0.695	Retain the null hypothesis
The distribution of Knowledge Transfer 4 is the same across job duration	0.394	Retain the null hypothesis
The distribution of Knowledge Transfer 5 is the same across job duration	0.018*	Reject the null hypothesis
The distribution of Knowledge Transfer 6 is the same across job duration	0.650	Retain the null hypothesis
The distribution of Knowledge Communication 1 is the same across job duration	0.548	Retain the null hypothesis
The distribution of Knowledge Communication 2 is the same across job duration	0.742	Retain the null hypothesis
The distribution of Knowledge Communication 3 is the same across job duration	0.352	Retain the null hypothesis
The distribution of Knowledge Communication 4 is the same across job duration	0.106	Retain the null hypothesis
The distribution of Knowledge Communication 5 is the same across job duration	0.839	Retain the null hypothesis
The distribution of Knowledge Communication 6 is the same across job duration	0.024*	Reject the null hypothesis

The distribution of Knowledge Communication 7 is the same across job duration	0.248	Retain the null hypothesis
The distribution of Knowledge Communication 8 is the same across job duration	0.886	Retain the null hypothesis
The distribution of Knowledge Application 1 is the same across job duration	0.989	Retain the null hypothesis
The distribution of Knowledge Application 2 is the same across job duration	0.485	Retain the null hypothesis
The distribution of Knowledge Application 3 is the same across job duration	0.505	Retain the null hypothesis
The distribution of Knowledge Application 4 is the same across job duration	0.411	Retain the null hypothesis
The distribution of Knowledge Application 5 is the same across job duration	0.919	Retain the null hypothesis
The distribution of Knowledge Evaluation 1 is the same across job duration	0.498	Retain the null hypothesis
The distribution of Knowledge Evaluation 2 is the same across job duration	0.548	Retain the null hypothesis

Division group differences

Significance level: 005

Null Hypothesis	**Significance Level**	**Decision**
The distribution of Determine Needed Knowledge 1 is the same across division	0.08*	Reject the null hypothesis
The distribution of Determine Needed Knowledge 2 is the same across division	0.036*	Reject the null hypothesis
The distribution of Determine Needed Knowledge 3 is the same across division	0.025	Reject the null hypothesis
The distribution of Determine Available Knowledge 1 is the same across division	0.871	Retain the null hypothesis
The distribution of Determine Available Knowledge 2 is the same across division	0.582	Retain the null hypothesis
The distribution of Determine Available Knowledge 3 is the same across division	0.420	Retain the null hypothesis
The distribution of Knowledge Gap Identification is the same across division	0.751	Retain the null hypothesis
The distribution of Develop a new knowledge 1 is the same across division	0.413	Retain the null hypothesis
The distribution of Develop a new knowledge 2 is the same across division	0.037*	Reject the null hypothesis
The distribution of Develop a new knowledge 3 is the same across division	0.227	Retain the null hypothesis
The distribution of Develop a new knowledge 4 is the same across division	0.179	Retain the null hypothesis
The distribution of Develop a new knowledge 5 is the same across division	0.064	Retain the null hypothesis

The distribution of Develop a new knowledge 6 is the same across division	0.990	Retain the null hypothesis
The distribution of Knowledge Storing is the same across division	0.188	Retain the null hypothesis
The distribution of Knowledge Retrieval 1 is the same across division	0.178	Retain the null hypothesis
The distribution of Knowledge Retrieval 2 is the same across division	0.119	Retain the null hypothesis
The distribution of Knowledge Transfer 1 is the same across division	0.068	Retain the null hypothesis
The distribution of Knowledge Transfer 2 is the same across division	0.946	Retain the null hypothesis
The distribution of Knowledge Transfer 3 is the same across division	0.095	Retain the null hypothesis
The distribution of Knowledge Transfer 4 is the same across division	0.133	Retain the null hypothesis
The distribution of Knowledge Transfer 5 is the same across division	0.842	Retain the null hypothesis
The distribution of Knowledge Transfer 6 is the same across division	0.517	Retain the null hypothesis
The distribution of Knowledge Communication 1 is the same across division	0.059	Retain the null hypothesis
The distribution of Knowledge Communication 2 is the same across division	0.131	Retain the null hypothesis
The distribution of Knowledge Communication 3 is the same across division	0.044	Reject the null hypothesis
The distribution of Knowledge Communication 4 is the same across division	0.482	Retain the null hypothesis
The distribution of Knowledge Communication 5 is the same across division	0.685	Retain the null hypothesis
The distribution of Knowledge Communication 6 is the same across division	0.115	Retain the null hypothesis
The distribution of Knowledge Communication 7 is the same across division	0.163	Retain the null hypothesis
The distribution of Knowledge Communication 8 is the same across division	0.543	Retain the null hypothesis
The distribution of Knowledge Application 1 is the same across division	0.969	Retain the null hypothesis
The distribution of Knowledge Application 2 is the same across division	0.113	Retain the null hypothesis
The distribution of Knowledge Application 3 is the same across division	0.732	Retain the null hypothesis
The distribution of Knowledge Application 4 is the same across division	0.166	Retain the null hypothesis
The distribution of Knowledge Application 5 is the same across division	0.497	Retain the null hypothesis
The distribution of Knowledge Evaluation 1 is the same across division	0.532	Retain the null hypothesis
The distribution of Knowledge Evaluation 2 is the same across division	0.167	Retain the null hypothesis

Position group differences

Significance level: 005

Null Hypothesis	Significance Level	Decision
The distribution of Determine Needed Knowledge 1 is the same across position	0.015*	Reject the null hypothesis
The distribution of Determine Needed Knowledge 2 is the same across position	0.054	Retain the null hypothesis
The distribution of Determine Needed Knowledge 3 is the same across position	0.021*	Reject the null hypothesis
The distribution of Determine Available Knowledge 1 is the same across position	0.829	Retain the null hypothesis
The distribution of Determine Available Knowledge 2 is the same across position	0.625	Retain the null hypothesis
The distribution of Determine Available Knowledge 3 is the same across position	0.911	Retain the null hypothesis
The distribution of Knowledge Gap Identification is the same across position	0.573	Retain the null hypothesis
The distribution of Develop a new knowledge 1 is the same across position	0.152	Retain the null hypothesis
The distribution of Develop a new knowledge 2 is the same across position	0.013*	Reject the null hypothesis
The distribution of Develop a new knowledge 3 is the same across position	0.258	Retain the null hypothesis
The distribution of Develop a new knowledge 4 is the same across position	0.074	Retain the null hypothesis
The distribution of Develop a new knowledge 5 is the same across position	0.175	Retain the null hypothesis
The distribution of Develop a new knowledge 6 is the same across position	0.757	Retain the null hypothesis
The distribution of Knowledge Storing is the same across position	0.374	Retain the null hypothesis
The distribution of Knowledge Retrieval 1 is the same across position	0.404	Retain the null hypothesis
The distribution of Knowledge Retrieval 2 is the same across position	0.198	Retain the null hypothesis
The distribution of Knowledge Transfer 1 is the same across position	0.305	Retain the null hypothesis
The distribution of Knowledge Transfer 2 is the same across position	0.439	Retain the null hypothesis
The distribution of Knowledge Transfer 3 is the same across position	0.427	Retain the null hypothesis
The distribution of Knowledge Transfer 4 is the same across position	0.709	Retain the null hypothesis
The distribution of Knowledge Transfer 5 is the same across position	0951	Retain the null hypothesis
The distribution of Knowledge Transfer 6 is the same across position	0.984	Retain the null hypothesis

The distribution of Knowledge Communication 1 is the same across position	0.031*	Reject the null hypothesis
The distribution of Knowledge Communication 2 is the same across position	0.108	Retain the null hypothesis
The distribution of Knowledge Communication 3 is the same across position	0.010	Reject the null hypothesis
The distribution of Knowledge Communication 4 is the same across position	0.121	Retain the null hypothesis
The distribution of Knowledge Communication 5 is the same across position	0.174	Retain the null hypothesis
The distribution of Knowledge Communication 6 is the same across position	0.507	Retain the null hypothesis
The distribution of Knowledge Communication 7 is the same across position	0.494	Retain the null hypothesis
The distribution of Knowledge Communication 8 is the same across position	0.825	Retain the null hypothesis
The distribution of Knowledge Application 1 is the same across position	0354	Retain the null hypothesis
The distribution of Knowledge Application 2 is the same across position	0.853	Retain the null hypothesis
The distribution of Knowledge Application 3 is the same across position	0.491	Retain the null hypothesis
The distribution of Knowledge Application 4 is the same across position	0.996	Retain the null hypothesis
The distribution of Knowledge Application 5 is the same across position	0.839	Retain the null hypothesis
The distribution of Knowledge Evaluation 1 is the same across position	0.165	Retain the null hypothesis
The distribution of Knowledge Evaluation 2 is the same across position	0.207	Retain the null hypothesis

APPENDIX 8
ABYOR BUSINESS PROCESSES

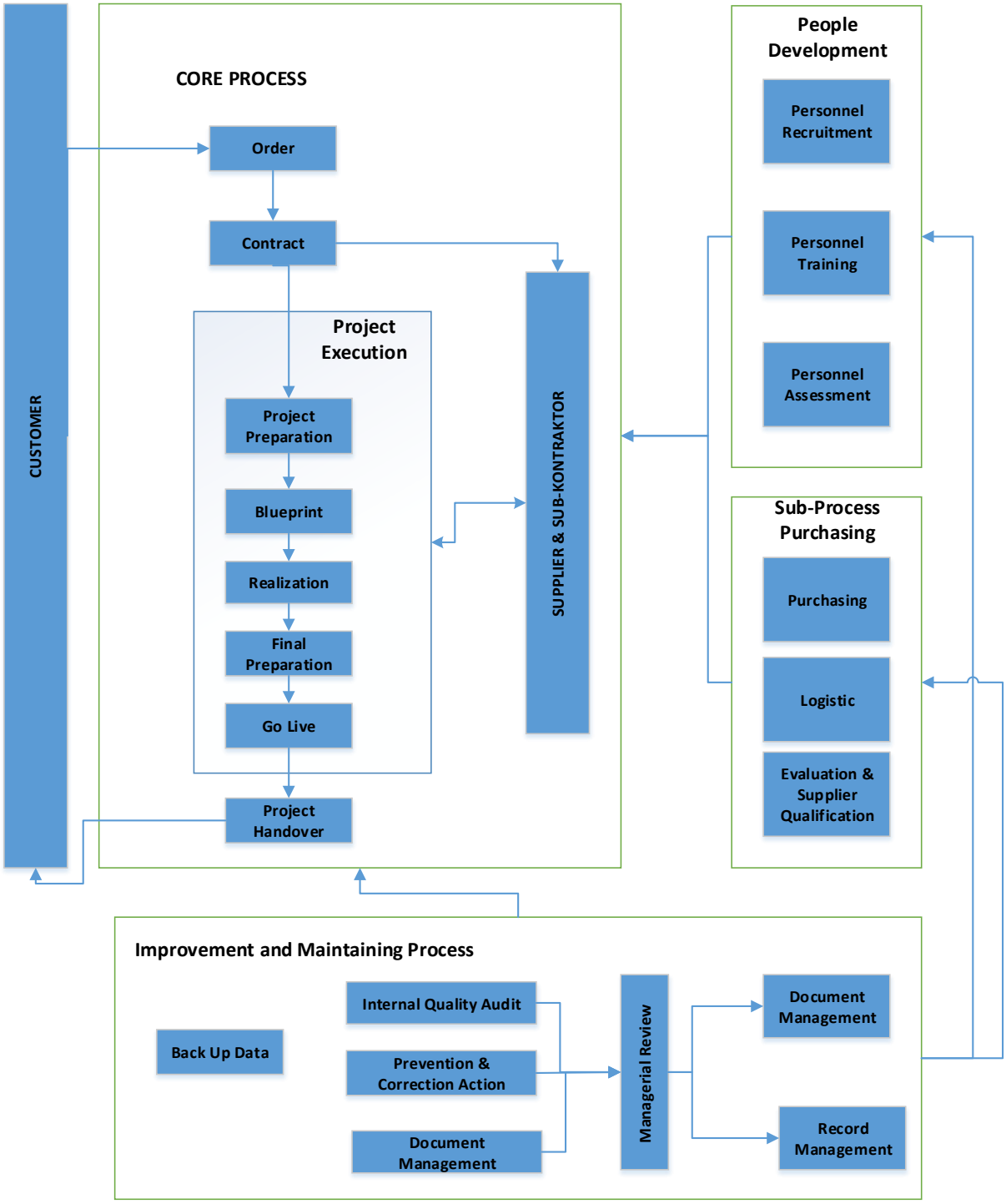
- **Description of each Abyor's Business Process**

Process	Description	Related Stakeholders	Current Related ERP system
Order and Contract Process	This process consists of three main sub-process namely discovery stage, proposal stage, and final proposal stage. Discover stage focuses on finding potential clients, initiate contacts, or arrange company's introduction in the industry's seminar; Proposal stage focuses on developing commercial and technical proposal; final proposal focuses on tendering process.	• Solution Architect Division • Marketing & Sales Division	• ERP Database • Project management module • Finance module
Project Implementation Process	This process consists of five sub-process, namely project preparation, blueprint, realization, final preparation, and go-live. Project preparation involves internal preparation and project charter development with clients; Blueprint process consists of all blueprint-related development process; Realization process consists of system configuration process, functional specification development, and SAP program development; Final preparation involves master data development and authorization configuration; Go-Live process focuses support development and discussion of Go/No-Go meeting.	• Delivery Service Division	• ERP database • Project management module • Finance module • Material management module
Project Closing Process	Project closing consists of the system's support agreement and incident report mechanism.	• Delivery Service Division	• ERP database • Project management module • Finance module
People Development Process	This process consists of three main sub-process, namely employees recruitment, training, and assessment.	• Human Resource Division	• ERP database • Project management module

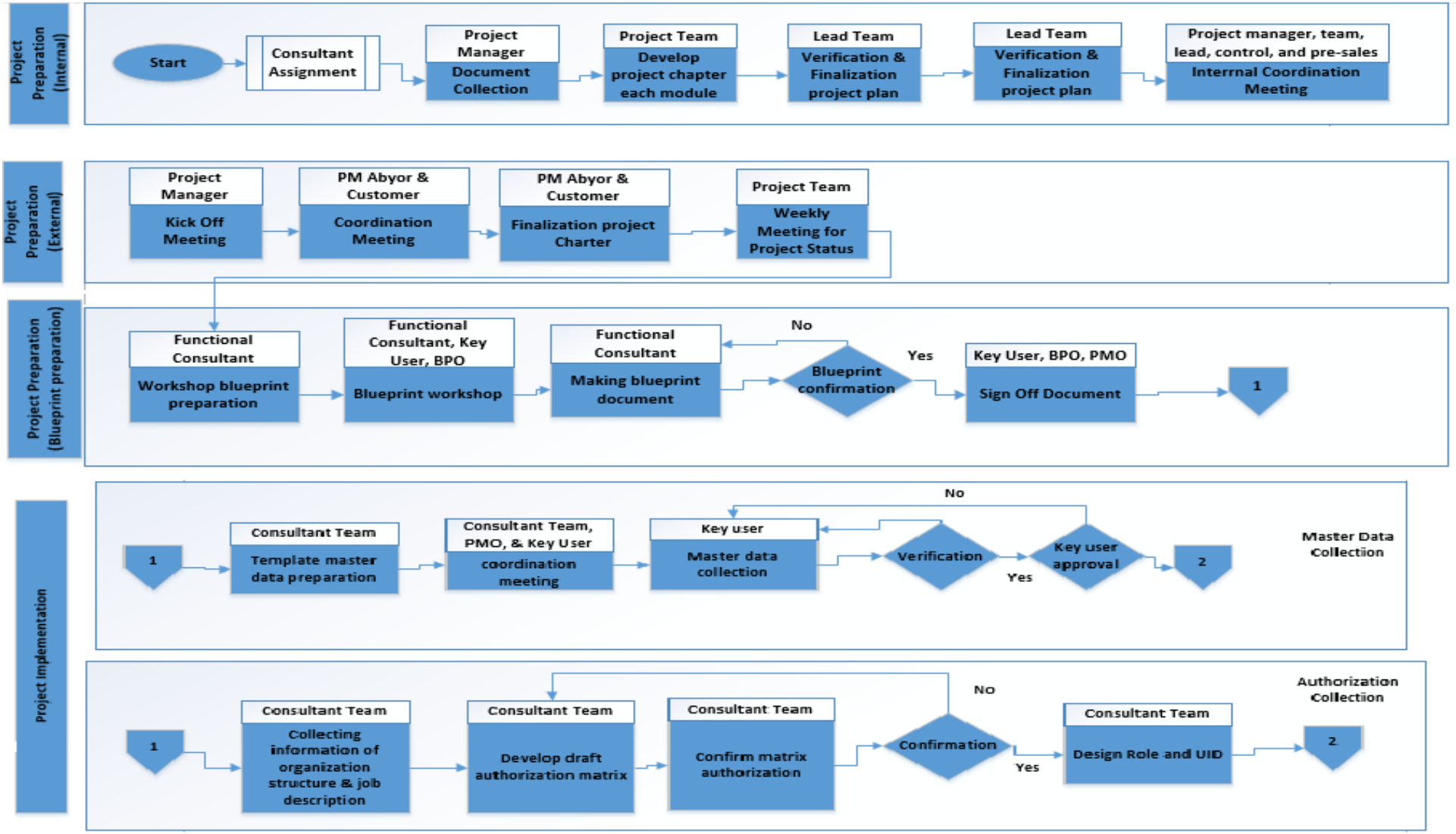
Support Process	Support process consists of all business supporting activities, such as financing, budgeting, general affairs activity, and law-related activity.	• Finance & GA division • Legal division	• ERP database • Finance Module
Maintenance & Improvement Process	Maintenance process focuses on backup and maintaining both on-going project's data and support's process data; Improvement process consists of several sub-process, namely document control, correction & prevention action, internal audit quality, and managerial review.	• Directors • Business Improvement & Control	• ERP database • Finance Module • Project Management Module

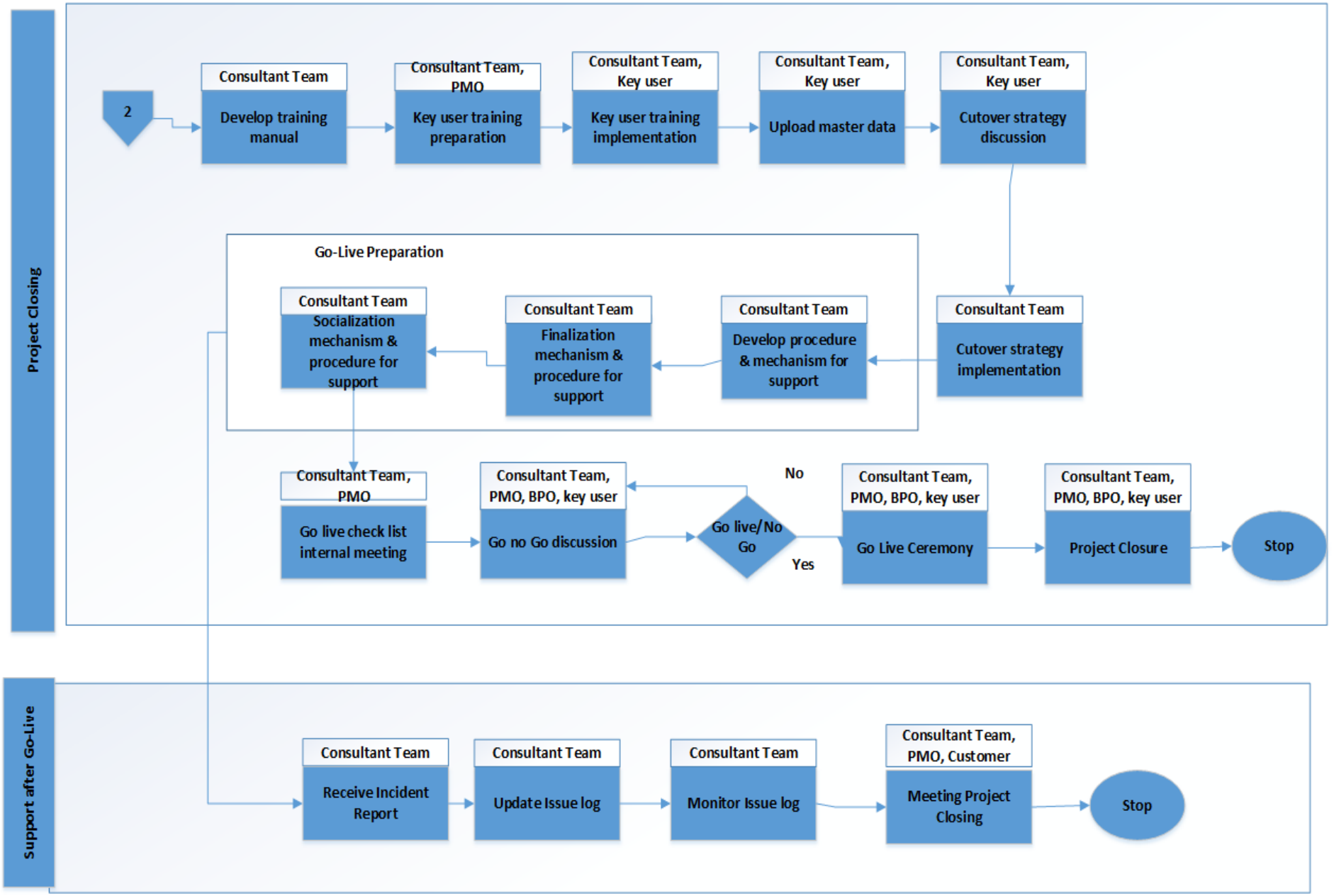
In the following section, the general business processes of Abyor are presented based on Abyor's documents. Further, several divisions' business processes are shown to present the example depiction of business process in Abyor's documents, namely, the delivery service division, the solution architect division, and the business & improvement control division.

- **The General Business Processes of Abyor**

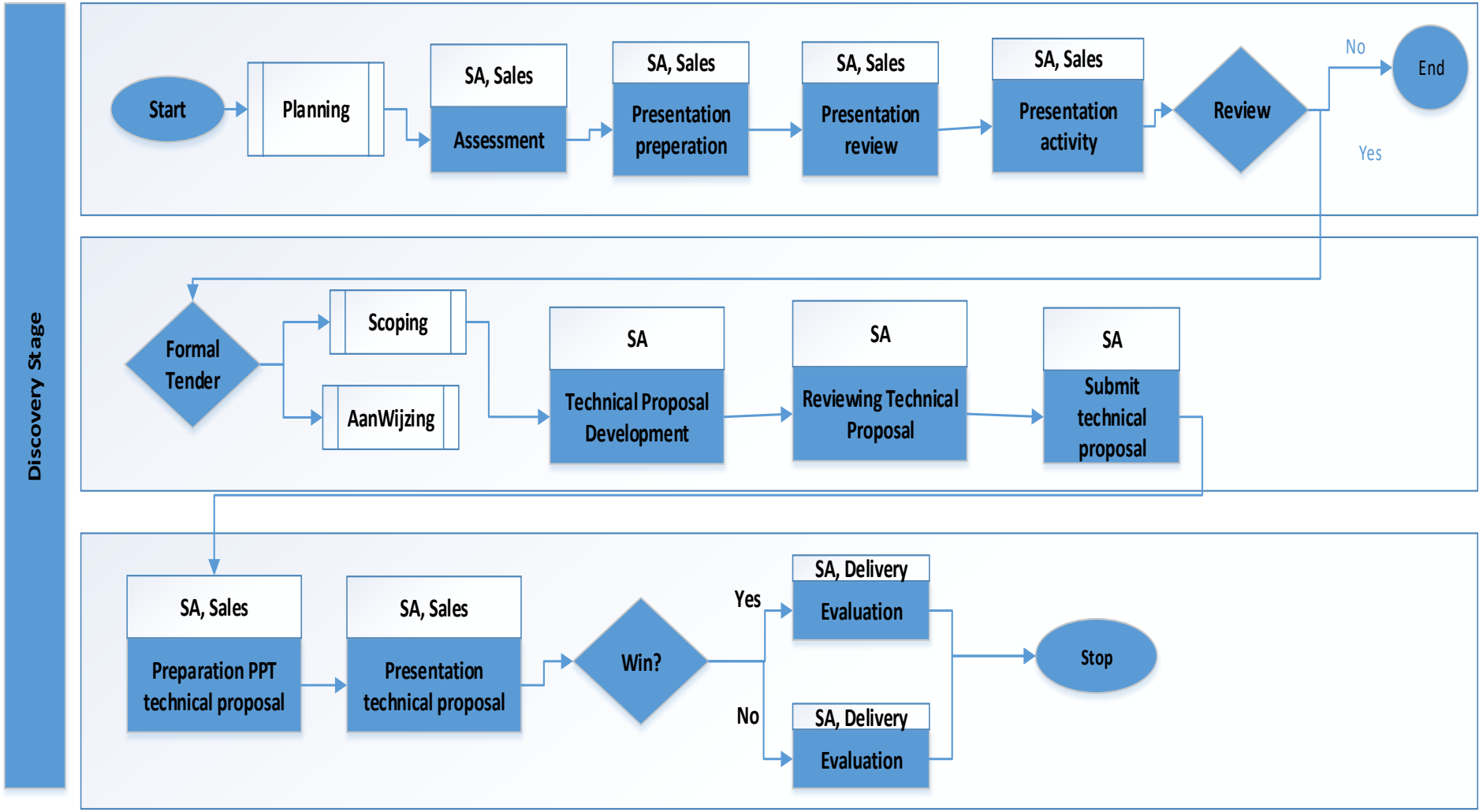


- **The Business Process of Delivery Service Division**

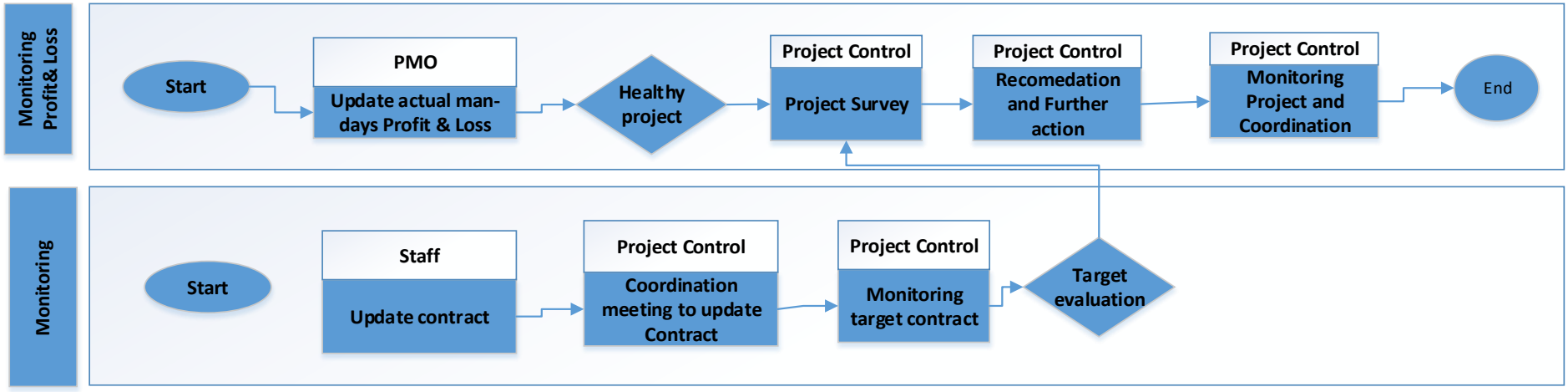



Project Closing
2
Consultant Team
Develop training manual
Consultant Team, PMO
Key user training preparation
Consultant Team, Key user
Key user training implementation
Consultant Team, Key user
Upload master data
Consultant Team, Key user
Cutover strategy discussion
Go-Live Preparation
Consultant Team
Socialization mechanism & procedure for support
Consultant Team
Finalization mechanism & procedure for support
Consultant Team
Develop procedure & mechanism for support
Consultant Team
Cutover strategy implementation
Consultant Team, PMO
Go live check list internal meeting
Consultant Team, PMO, BPO, key user
Go no Go discussion
Go live/No Go
No
Yes
Consultant Team, PMO, BPO, key user
Go Live Ceremony
Consultant Team, PMO, BPO, key user
Project Closure
Stop
Support after Go-Live
Consultant Team
Receive Incident Report
Consultant Team
Update Issue log
Consultant Team
Monitor Issue log
Consultant Team, PMO, Customer
Meeting Project Closing
Stop

- **The Business Process of Solution Architect Division**



- **The Business Process of Business Improvement & Control Division**



APPENDIX 9
ABYOR BUSINESS RESOURCES RELATED TO KM

Resource Class Model	Knowledge Resource	Description	Type of Knowledge
Employee	Directors	Directors audit managerial review documents, audit finance, and legal document, approve contract	Tacit knowledge
	Delivery Service Division (Consultant)	Consultants use SAP knowledge modules to develop project's deliverable such as master data, authorization matrix & UID and support manual & incident manual. Consultants also release project report on daily basis.	Tacit knowledge
	Solution architect person	Solution architect person uses the list of clients and discovery proposal in approaching prospective clients. Next, solution architect develops technical proposal with marketing & sales person	Tacit knowledge
	Marketing and Sales person	Marketing & sales person uses list of clients, develops commercial proposal, releases order license	Tacit knowledge
	Business & Improvement Control person	Business & improvement person controls the project based on project report and develop marketing review document	Tacit knowledge
	Human Resource person	Human resource person develops and uses recruitment procedures, develops training document with consultant, develops and uses employee's assessment report	Tacit knowledge
	Finance & GA person	Finance & GA person develops and uses finance documents and general affairs procedures	Tacit knowledge
	Legal person	Legal person develops a contract, develop and uses legal documents	Tacit knowledge
Clients	List of clients	The list gives the information and former clients and on-going clients	Explicit knowledge
Pre-qualification document	Pre-qualification document	The administrative documents are used for tendering process, consists of company's annual report and several statement letters, legal document, and finance document	Explicit knowledge
Proposal	Discovery proposal	The discovery proposal is used to approach the potential clients that consist of company's introduction and offering letter	Explicit knowledge
	Commercial proposal	The commercial proposal is developed based man-days template together with consultants. In developing commercial proposal, man-days template is used	Explicit knowledge
	Technical proposal	Technical proposal is developed based on client's need, Abyor's solutions, and consultant's capability	Explicit knowledge
Contract document	Contract	Contract is developed by legal division after winning the tender	Explicit knowledge

Order License & Project Charter	Order license document	Order license documents are released by sales consists of purchase order end user, end user license agreement, and annual maintenance info	Explicit knowledge
	Project charter	Project charter defines the scope statement, stakeholders, objective, milestone, durations, and budget	Explicit knowledge
Finance Document	Finance document	The documents consist of project budget, real-time cash flows, asset statement, and other financial statements	Explicit knowledge
GA document	General affairs (GA) document	The GA documents guide asset management, accommodation management, correspondence management, reception procedures, and project backup data procedure	Explicit knowledge
SAP Modules	SAP modules knowledge	SAP modules act as the main knowledge resource for the consultants. SAP modules consist of 1) Project management & Order change management module, 2) Sales distribution and customer relation management module, 3) Financial module, 4) Human capital management module, 5) Logistics module, 6) Plant Maintenance/ Project System module,7) SAP technical solution (BASIS), 8) SAP support modules, 9) SAP Business Intelligence/ Business Information Warehouse module	Explicit knowledge
Project Deliverable	Blueprint	Blueprint represents functional specification, system configuration, and technical documentation. Blueprint is developed by consultants	Explicit knowledge
	Master data	Master data acts as the center SAP application as Abyor's deliverable. Master data is developed by consultants.	Explicit knowledge
	Authorization matrix and UID	Authorization matrix is the analysis's result of client's organizational structure, thus represent in UID.	Explicit knowledge
	Training Manual and Support Incident	Training manual provides system user's training detail explanation, while support incident presents the after client's agreement support	Explicit knowledge
Assessment Report	Employee's assessment report	The report presents the result of employee's assessment of personality, capability, and other assessment's criteria	Explicit knowledge
Training Manual	Training Manual	Training manual consists of internal training procedure and training material	
Managerial Review Document	Managerial review document	The documents consist of: 1. Internal audit document 2. Correction & prevention strategy 3. Document control procedure	Explicit knowledge
Legal Document	Legal document	The documents guides all related legal activities	Explicit knowledge