REQUIREMENT PRIORITIZATION FOR SOFTWARE RELEASE PLANNING BASED ON CUSTOMER VALUE WITH ANALYTIC HIERARCHY PROCESS

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ABSTRACT

The requirement prioritization process is a big challenge in a software company that develops software using the incremental model. Because of limitations in efforts and time, the proper requirements in proper time must be selected for implementation. A requirement prioritization framework with customer value base is introduced in this work. Four factors of customer value are extracted from the requirements, including business rules, revenue, process improvement, and technology. Analytic Hierarchy Process is applied for calculating's weighting factors of customer value. The number of requirements is reduced for minimizing the complexity of the proposed framework by using a filtration process. Key customer and requirement types are used as the controlled parameters in this process. The result of this study is a ranking list of requirements for a software release project. The list is ordered by the score manipulated with the weighting factors of the customer value. The highest score means the highest priority. Framework performance is evaluated by stakeholders of the software release project. The stakeholders agree and accept that the proposed framework could enhance the existing manual process and customer satisfaction.

KEY WORDS: REQUIREMENT PRIORITIZATION / CUSTOMER VALUE / ANALUSTIC HIERARCHY PROCESS

53 pages

การจัดความสำคัญของความต้องการสำหรับการวางแผนพัฒนาซอฟแวร์โดยการใช้คุณค่าต่อลูกค้าด้วยการวิเคราะห์เชิงลำดับชั้น

REQUIREMENT PRIORITIZATION FOR SOFTWARE RELEASE PLANNING BASED ON CUSTOMER VALUE WITH ANALYTIC HIERARCHY PROCESS

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บทคัดย่อ

กระบวนการจัดความสำคัญความต้องการของลูกค้าเป็นสิ่งท้าทายของบริษัทซอฟแวร์ที่พัฒนาซอฟแวร์โดยการแบ่งระบบงานออกเป็นระบบย่อยๆแบบก้าวหน้า เนื่องจากข้อจำกัดของเวลาและทรัพยากรทำให้ต้องเลือกความต้องการของลูกค้าที่เหมาะสมมาดำเนินการในเวลาที่เหมาะสมกัน งานวิจัยนี้ได้นำเสนอกรอบการทำงานในการเลือกความต้องการของลูกค้าโดยใช้คุณค่าต่อลูกค้า 4 คุณค่าเป็นเกณฑ์ ได้แก่ คุณค่าในด้านการตอบสนองต่อหลักเกณฑ์ในการทำธุรกิจ รายได้ การพัฒนากระบวนการทำงาน และเทคโนโลยี งานวิจัยใช้การวิเคราะห์เชิงลำดับชั้นในการหาน้ำหนักความสำคัญของแต่ละคุณค่า เนื่องจากปริมาณความต้องการมีมากมาย กระบวนการคัดกรองความต้องการได้ถูกนำมาใช้เพื่อลดปริมาณและซับซ้อนของกรอบการการทำงานลง ลูกค้าคนสำคัญและประเภทของความต้องการได้ถูกนำมาใช้เป็นตัวแปรเพื่อคัดกรองความต้องการของลูกค้า ผลของงานวิจัยนี้คือรายการความต้องการของลูกค้าเรียงตามลำดับความสำคัญสำหรับใช้ในการวางแผนพัฒนาซอฟแวร์ในส่วนย่อยถัดไป ลำดับความสำคัญนั้นหาได้จากคะแนนของความต้องการคูณด้วยน้ำหนักของคุณค่า ความต้องการที่ได้คะแนนมากที่สุด คือความต้องการที่มีลำดับความสำคัญสูงสุด ประสิทธิภาพของกรอบการทำงานนี้ถูกวัดจากผู้ที่รับผิดชอบในการเตรียมแผนพัฒนาซอฟแวร์ โดยผู้รับผิดชอบเห็นด้วยและยอมรับกรอบการทำงานนี้ว่าสามารถพัฒนากระบวนการที่มีอยู่เดิมและความพึงพอใจของลูกค้าได้

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CHAPTER I
INTRODUCTION

1.1 Background and Problem Statement

Delivering right software features is a key success of software development business. Providing software features that meet customer needs in the right time can improve customer satisfaction. The customer satisfaction is depended on price and benefits. To focus on benefit aspect, which is represented by “value” in this work, requirement engineering is very important for offering the right benefits to customer. On the other hand, to be on track of product roadmap, requirement engineer or product manager needs to identify what the customer needs.

Software production is driven by competition in global market. Many organizations utilize information technology (IT) system to be a solution for their business. However, the business behavior is very dynamic, i.e., the strategies always change for increasing their competitiveness. While business changes, a new requirement occurred. To respond to this event, the software requirement analysis needs to be performed.

Software requirement analysis or requirement engineering (RE) is a method for addressing customer’s needs on a new or modified project. There are five sup-processes of requirement engineering, given as:

1) Prioritize requirement,

2) Select requirement,

3) Define release requirement,

4) Validate release requirement,

5) Prepare for launch.

Sub-process 1-3 could be called “Requirement Decision Making Process.”

Requirement decision making process is a crucial to the success of software release project. It is an initiative process of production. Hence, this process is a very critical phase.

There are a lot factors involved in this process, such as complexity of requirement, available resource, timeframe, level of significant, technology, tools for development, and company policies.

Moreover, the requirement engineer or the product manager has to be careful in the requirement prioritization. Some part of software need to be implemented as fast as possible while some parts of software are just optional functions, which can be waited. Currently, many techniques have been applied in many software companies to resolve this problem, e.g., Cost-Value approach, Value Oriented Prioritization Method (VOP), and EVOLVE.

This work focuses on finding out the candidate requirements for the requirement decision making process by using the customer value, which can be extracted from the customer requirement. Customer value is become a decision making support in the requirement decision making process.

1.2 Objectives

• To develop a framework of requirements prioritization for software release planning by the customer value.

• To improve the customer satisfaction by developing the software release package that determine by customer value based.

1.3 Scope of Study

This study focuses on requirement prioritization process in software production project. The scope's details of work are as follows:

1. The software was developed in incremental model;
2. The prioritization process is used for release planning project;
3. Requirement data is acquired from Change Request (CR) in a Change Management System, where the CR type is "New feature".

1.4 Expected Result

1. A framework for prioritized requirement for release planning process.
2. The weight of software features according to the customer value.

1.5 Outline Summary

This thematic paper contains 5 chapters. Chapter 1 is the introduction of study as represented previously. Chapter 2 introduces to literature review to describe the related subjects and works of this study. Chapter 3 is the research methodology to demonstrate the developmrnt of software requirement prioritization conceptual framework. Chapter 4 provides the research results and analysis. Lastly, the conclusion and discussion are given in Chapter 5.

CHAPTER II
LITERATURE REVIEW

This chapter consists of reviews of related theories, and studies of software release planning, requirement prioritization management, and software requirement prioritization techniques. All literature reviews are provided as follows.

2.1 Customer Value

There are many definitions of “Value” or “Customer Value” in marketing theory. In this work, we refer to Zeithaml’s work [1] which is defined the customer value as ‘‘the customer’s overall assessment of the utility of a product based on perceptions of what is received and what is given.’’ From this definition, we could present the customer value by following equation:

$$\text{Customer Value} = \text{Benefit} - \text{Cost}. \tag{2.1}$$

From Eq. (2.1), we found that the customer value is the product benefits related to the cost or price for getting that product.

The customer value is a key attribute of customers’ purchase decision making. When the customer makes a decision to buy a product offered by several venders, he has to compare the customer value of those products and select the product which provides the highest customer value.

To make the customer perceived value of our product, there are 3 basic methods for delivering the customer value, as follows:

1) Providing the best price

Reasonable price is the key strategy of this method. Even though, the lower price makes an increase of the customer value, however some customer might think that it is a spending for a cheap product, which he might get the low quality

product. Thereby, the company should provide the reasonable price which relies on reliable product quality.

2) Delivering the best product

To increase the customer value, the vender should provide the high benefits on the product to customers. The provided benefit must meet the customer need in the right time. Hence, customer needs analysis is the key success of this method.

3) Providing the best service

Providing the high quality product and the reasonable price are the general methods of customer value improvement. The preference of product is an emotional factor of purchase decision making. Therefore, providing the high quality service is a key to improve the customer preference and to make higher value of our product than product's value of competitors.

2.2 Software Production Development

To develop the software, there are several types of software development life cycle models that can be applied. To have an effective requirement engineering process, it is necessary to understand the software production development model first. There are two important models that need to study, including waterfall and incremental models.

2.2.1 Waterfall Model

This model is the software production development implemented in sequential stage. Summerville [2] introduced five stages of software production development for waterfall model as shown in Figure 2.1. The first stage is requirement definition. This stage is gathering all user requirements and defining requirements for project implementation. The second stage is designing system for development. The third stage is time for implementation. Moreover, the unit test is involved in this stage. After implementation stage, all software parts are integrated to be one system. The system integration and system test are required in this stage. The last stage is delivering to customer and maintaining system.

The waterfall model is a traditional model. This model consumes a long time for software production development. The software is released to customer in the final stage. Therefore, the requirement definition stage is very important. If the selected requirement is not match with the customer need, it means that following stages might have some problem. However, production management of this model is simple because the direction of implementation is clear.

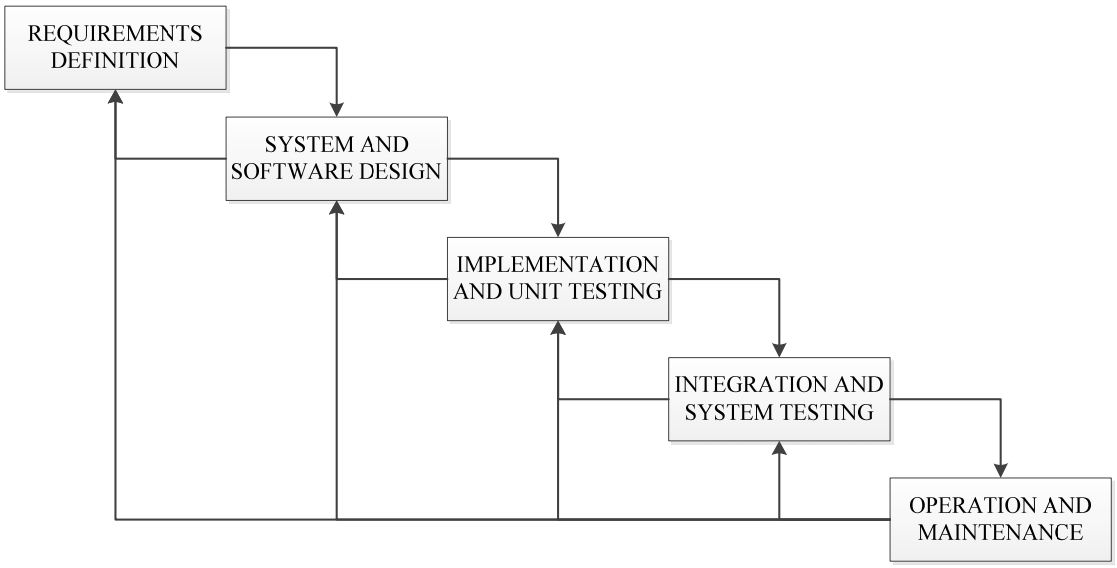

Figure 2.1 The waterfall software development model.

2.2.2 Incremental Model

Because of market-driven in the present, the software development needs to adjust the process of product delivery as fast as possible. A newer model is called incremental model. The model divides software development process into a short period called increment. Each increment contains system requirement engineering, system designing, coding, and testing. It is delivered to customer as a software package. This model does not need to complete the software development for customer in one increment, but the most critical functions for customers are firstly delivered. After that other incremental or release versions with lower priority are developed until obtains a full software version. The process of incremental model is shown in Figure 2.2.

Because of time limitation, the incremental model has to select a set of requirements that should be firstly implemented. Thus, the requirement prioritization is

very important for this model. Customers will satisfy the products when those costomers get the right values in the right times.

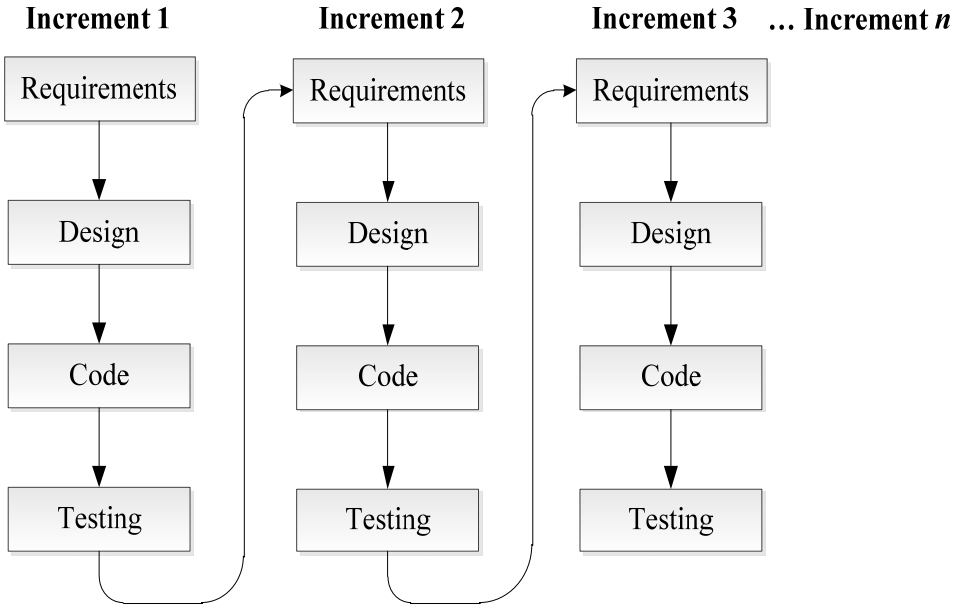

Figure 2.2 The incremental software development model.

2.3 Requirement Prioritization

Requirement prioritization is a part of software product management for identifying which requirements should be implemented in the next software release project. In a software release project, there are many constrains of implementation, such as time, resource, cost, and so on.

The requirement prioritization helps the project development team to understand which requirements are more important and more urgent. In addition, the requirement prioritization helps the project manager to know the scope of project development, and able to estimate time and resources for this project.

Many techniques are introduced to determine the priority requirement for each software release planning process. Some technique utilizes mathematical models as a tool to support their concept, whereas some technique is simply done by voting process among stakeholders. These techniques are used for convincing among the

stakeholders to clarify the essential requirements. There are several famous techniques of the software requirement prioritization, which are presented as follows.

1) Theory W

Theory W is also known as “Win-Win Model” [3]. Negotiation is the best way to solve different opinion among stakeholders. The success- critical stakeholder is identified, then ask them to rank the requirements carefully. After that the negotiation is performed to find the win-win situation packages of requirements. Finally, value-based controls and monitors for win-win equilibrium, until the implementation process is completed.

2) MoScow

MoScow technique is presented in [4]. This technique is included in software development methodology DSDM (Dynamic Systems Development Method) [5] to group all requirements into following priority groups, given as:

- MUST have - The top priority requirements in project could not be excluded from the project scope. If project could not deliver these requirements, it means that the project would be fail.
- SHOULD have - Project would be great, if it included this group of requirements.
- COULD have - The meaning like “SHOULD have”, but the level of significant is lower.
- WON’T have - Group of nice requirements, but it is optional. Thereby, there are not allocated in current release, and it could be candidate in next release.

3) Cost-Value Approach

Prioritizing requirement based on relationship of value to cost of implementation. This approach was created by Joachim Karlsson and Kevin Ryan [6]. The customer interests candidate requirements in view of benefit or value. The company view is the cost of implementation the candidate requirement. Analytic Hierarchy Process (AHP) is applied to calculate value-cost ratio. The result of this approach is represented in cost-value graph to be used in release decision.

To apply appropriated technique, there are many associated factors of software production environment, such as amount of requirement, and the formality of the requirements engineering process [7]. Aurum et al. [8] described the requirement

prioritization process, in essence, a complex communication and negotiation process involving many stakeholders. They argued that it includes a great deal of invisible decision-making [9].

Selecting candidate requirements for a release project is very complicated process, because each customer requirement has different level of urgent and important. To deliver a product that meets the customer's need is the highest priority of the software development, which is often determined by the ability to satisfy the needs of the customers and users [10].

When release managers or product managers have prioritized a list of candidate requirements for release planning project, they have to be careful about the factors that affect to project management, such as complexity of requirement, target users, risks, scope, software roadmap, and market-driven base on the situations. As a result of several factors related to decision making in each release project, Multi-Criteria Decision-Making (MCDM) techniques are utilized to support this decision process.

2.4 Multi-Criteria Decision-Making

Multi-Criteria Decision-Making (MCDM) is an approach developed for a complex problem. The MCDM is used for trading off something among multiple criteria. The approach is useful for supporting complex decision. The MCDA provides solutions for the problems, which involve and conflict with multiple objectives [11].

Practically, business problems have some common characteristics, namely:

- A large number of criteria,
- Conflict among the criteria,
- Incomparable units of measurement,
- Projection or selection [12].

Solutions for these problems are either projection of the best action (alternative) or a selection of the best action from a set of predefined finite action. There are three general processes of the MCDM approach, given as:

1) Dividing into multiple parts,

2) Analyzing each part,

3) Combining all parts to find the optimized solution.

First of all, to clarify the problem, the problem should be decomposed by some aspect. Second, we try to understand and find the solution for each part. Third, we determine the solution of problem which is compiling all analyzed parts and search the best solution of problem.

Nowadays, several MCDM techniques are used to solve the complex problem. Each technique has its own characteristic and method. For example, S.D. Pohekar and M. Ramachandran [11] described eight examples of MCDM techniques in their study as follows:

1) Weighted sum method (WSM),

2) Weighted product method (WPM),

3) Analytic hierarchy process (AHP),

4) Preference ranking organization method for enrichment evaluation (PROMETHEE),

5) The elimination and choice translating reality (ELECTRE),

6) The technique for order preference by similarity to ideal solutions (TOPSIS),

7) Compromise programming (CP),

8) Multi-attribute utility theory (MAUT).

According to those techniques, the results could be different even though those have tested on the same problem. Accuracy of the result depends on method, situation, view of problem, and background knowledge of user.

2.5 Multi-Criteria Decision-Making

This work studies about Analytic Hierarchy Process (AHP) for support decision-making process. The AHP was introduced by T. Saaty in 1970s [13]. The AHP is a well-known method of the MCDM to search the best solution for a decision. Decision situations to which the AHP applied include:

- Choice,
- Ranking,
- Prioritization,
- Resource Allocation,
- Benchmarking,
- Quality Management,
- Conflict resolution [14].

Input data of the approach could be qualitative or quantitative value, for example, height, size, color, customer satisfaction, and subjective opinion. The problem will be decomposed to a hierarchy. The hierarchy consists of 3 levels: top level – goal of decision-making, intermediate level- criterions and sub-criterion to determine, and low level- alternatives of decision. The example of hierarchy is shown in Figure 2.3.

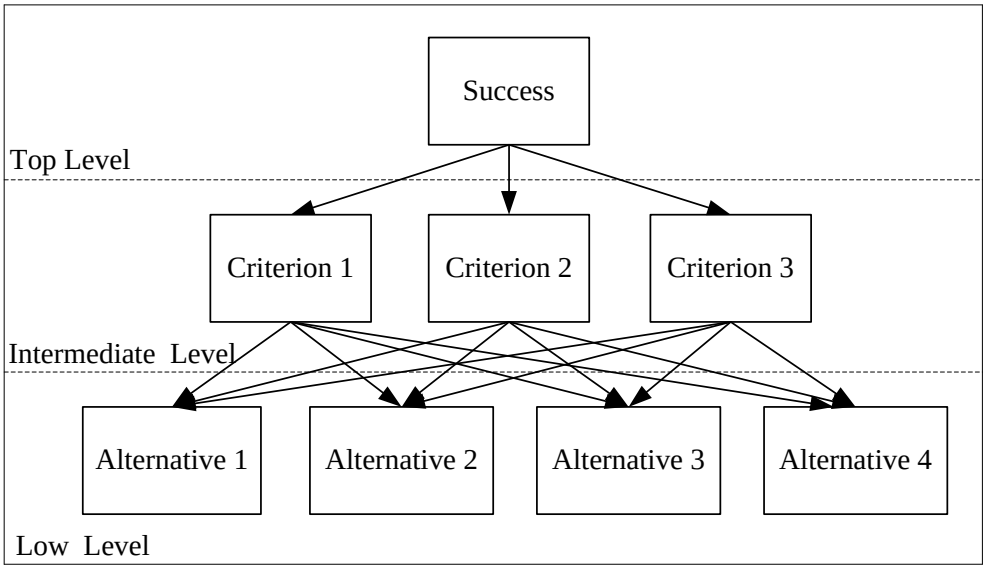

Figure 2.3 Simple block diagram of AHP hierarchy.

This method is based on comparison between one-by-one elements (criteria and alternative) until all alternatives are compared to the others. The comparison is determined by decision-maker preference relying on a set of criteria. This is called “pairwise comparison.”

The AHP uses pairwise comparison matrices to compare value of preference on one element with the other one element. The structure will be translated into a series of questions of the general form to ask the decision maker like “How important is criterion A relative to criterion B?” [15]. Responses are gathered in verbal form and subsequently codified on a nine-point intensity scale as shown in Table 2.1.

Table 2.1 AHP pairwise comparison values.

Important Level	**Definition**
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong or demonstrated importance
9	Extreme importance
2,4,6,8	Intermediate values

To compare the importance between criterion A and to criterion B, the paired comparison scale is as:

(Criterion A) **9** 8 **7** 6 **5** 4 **3** 2 **1** 2 **3** 4 **5** 6 **7** 8 **9** (criterion B)

The result of the comparison for each pair is described in integer. Important level 1 is when the criterion A and B are the same level of importance. Important level 9 in left side is criterion when the criterion A has extreme importance than criterion B and vice versa.

Next step is to determine priority and weight of each alternative by performing the comparison matrix. AHP applies eigenvector technique to get weight of each criteria and a ranking of priorities from pairwise matrix. The member of matrix is inserted by this formula;

$$a_{ji} = \frac{1}{a_{ij}}. \tag{2.2}$$

The result of the AHP is based on preference of decision-maker. Thus, the consistency of hierarchy needs to be checked. T. Saaty proposed the consistence by Consistency Index (CI) [16]; given as:

$$\text{CI} = \frac{\lambda_{\max} - n}{n-1}, \tag{2.3}$$

where $\lambda_{\max}$ is maximal eigenvalue, and n is size of pairwise matrix.

The Consistency Ratio (CR) being less than 0.1 is acceptable consistency matrix. The value of CR can be calculated by:

$$\text{CR} = \frac{\text{CI}}{\text{RI}}, \tag{2.4}$$

where RI, the random index, is the average CI of 500 randomly filled matrices. It is given in Table 2.2.

Table 2.2 The mean consistency index of randomly generated matrices

N	1	2	3	4	5	6	7
RI	0	0	0.52	0.89	1.12	1.26	1.36

2.6 Related Research

Lehtola L, Kauppinen M, and Kujala S (2004) [9] studied about the requirement prioritization process in two organizations and identified what challenges are in current state. They found that the process is informal and performing iteratively in many phase of software production. Moreover, the concept of prioritization is ambiguous. The practitioner needs a systematic prioritization process, but there are many factors that they need to determine. These factors have summarized into three points of view, i.e., business view, customer view, and implementation view. However, their work shown that the priority list is relied individual experience of practitioner.

Azar J, Smith RK, and Cordes D (2007) [17] believed that a valid Requirement Engineering process (RE) must produce a set of candidate requirements by balancing customer needs, business value, cost, and schedule. Therefore, they introduce a novel process called "Value-Orientated Prioritization (VOP)" to overcome the limitations of RE process. The VOP approach provides the fundamental needs (customer needs, business values and project risks) to prioritize and make decision. All stakeholders are involved in the VOP for discussion and argument over one by one requirement. The process helps stakeholder to visible the relation of requirement and their business values. The VOP approach contains two main steps, i.e. framework establishment and framework implementation, respectively. The first step, framework establishment, is to create the framework of an organization. The framework consists of the organization's core business values and weight. The second step, framework implementation, is to apply the established framework to prioritize the requirements. Here is a case study using VOP. Technology Builders Incorporated (TBI) applied VOP technique in their requirement prioritization process. TBI is a software company who develops and publishes a requirements management tool named CaliberRM^{TM}. The result is shown that TBI realized that the priority list of requirement is acceptable. The time consume of RE process is less than previous requirement review meeting. At the conclusion, the relative importance of requirement is addressed to the organization's core values. This framework increases productive of stakeholder discussion.

Greer D, and Ruhe G (2004) [18] presented that software production in incremental model is a fashion because this model helps software vender to be more understand the actual customer requirement. However, to adopt this model to the real situation, customer requirements have to be selected for each delivered release. Thus, the decision-making would be performed to determine which requirement will be included in which release. The researchers proposed a method to optimally allocate requirements to increments called “EVOLVE”. The method focuses on balancing between requirement and available effort. It uses genetic algorithm to conduct the requirements in each iteration and continual planning of incremental software development. The result of this approach is a set of promising candidate solutions for supporting the final release planning process.

CHAPTER III
RESEARCH METHODOLOGY

In this chapter, the methodology of developing requirement prioritization and proposed framework for software release planning project are described. Research design and data collection are planned in this chapter.

3.1 Introduction

From the related works of this study, we have found that the requirement prioritization is a key success of software release project. The success of a product depends on satisfaction of customer. Thereby, delivering product which meets their need is very critical. Many works introduced the technique to organize the priority of requirement to be implemented in each release. However, prioritizing requirement is very complicated and hard to be compared because the nature of customer need is inconsistence and rapidly changed. Our work focuses on analyzing customer values from the customer requirements in a change management system, using extracted values as the primary factors of requirement prioritization process, and applying AHP technique for weighting criteria.

3.2 Research Design

The hypothesis of this research is to prioritize the customer requirement by the customer value, which is the solution of organizing customer requirement in release project. This work collects data from a helpdesk support system. Customer requirement type must be requested for new feature, i.e., it is not correcting bug in previous release package. Each requirement has different value, but this research proposes four values for prioritization criteria, given as:

1) Business Rule,
2) Revenue,
3) Process improvement,
4) Technology.

After collecting data, and getting interested values to be focused, the work will design the study workflow for requirement prioritization process.

3.3 Proposed Framework

From the research design, we establish a proposed of framework for this study. The proposed of framework is shown in Figure 3.1. The figure shows data input, data output, processes, and stakeholders of our proposed framework.

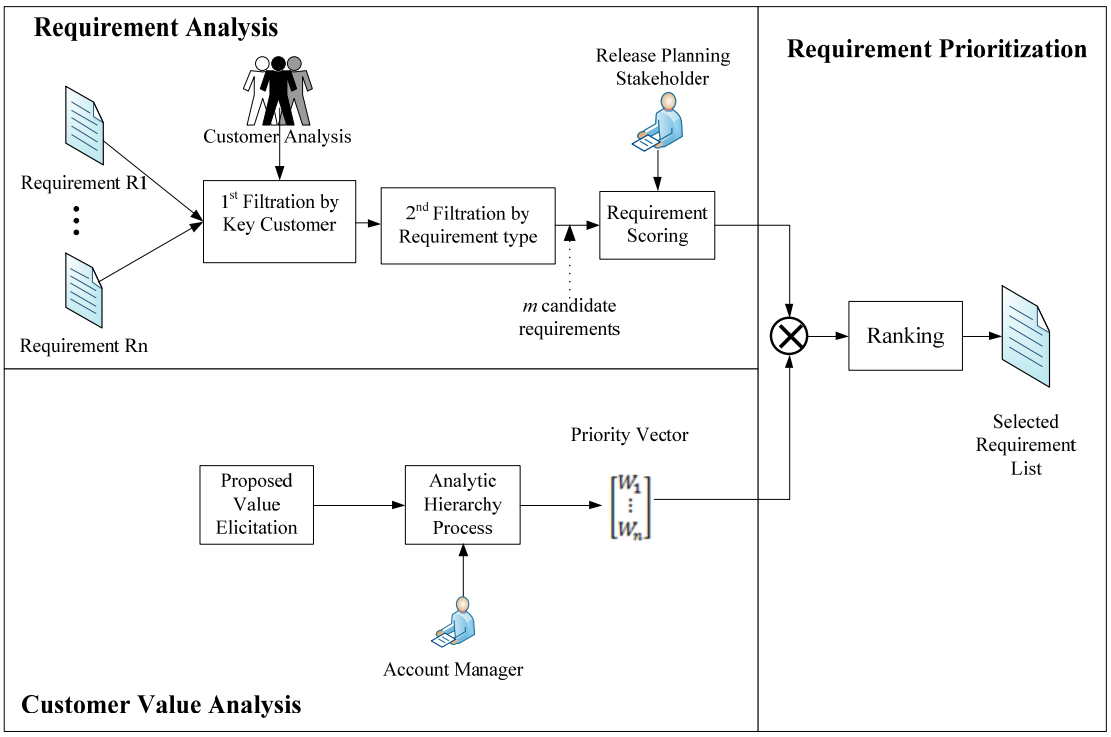

Figure 3.1 Proposed framework.

The proposed framework contains 3 main activities, requirement analysis, customer analysis, and prioritizing requirement.

1) Requirement Analysis

The objective of this activity is searching for the proper requirements for release project. It is done by passing the requirement data to filtration processes. The filtration process means the process that permits only the interesting information to be able pass. The requirement data are obtained from a change management system, which is a system for the users to submit all bugs and requests the reports back to the developer. In the requirement analysis process, there are two filtration processes. The first one considers the essential requirements by key customer. The second one considers the essential requirements by type of request. In addition, scoring requirement is done by release planning stakeholders.

2) Customer Value Analysis

Proposing customer values for offering to customer is analyzed in this activity. The proposed framework shows that customer value analysis is applied AHP to calculate the priority vector for requirement score calculation.

3) Requirement Prioritization

This activity combines 2 previous results together for prioritization and ranking it to get the final result of framework that is the candidate requirement list for release project

3.4 Methodology

3.4.1 Data Collection

To perform this work, data must be to collected. There are two types of following data are needed: customer data and change request data.

1. Customer Data

The customer data are collected from customer's portfolio. The using data are selling information, and volume of usage system.

2. Change Request Data

Data to be analyzed are customer's CR. The request's type must be new customization; request for new feature or new implement.

3.4.2 Requirement Selection

Key customer is a person who has high volume of system purchasing. This person is a target customer, which company needs to build long relationship. Hence, addressing key customer need is a very essential.

To get the critical requirement, requirement owner must be considered. This work determines that CR from key customer is higher priority than those of others. Hence, the proposed framework utilizes the customer data to identify who the key customers are. Then CR data of the key customers are picked up for prioritization process.

3.4.3 Customer Value Analysis

As proposed in Section 3.2, this work focuses on four customer values; business rules, revenue, process improvement, and technology. This step is to determine the weight of each criterion. From Chapter II, we present a technique which can be applied in the proposed framework called AHP. The AHP is MCDM, which can evaluate weight of each criteria, even if the criteria has different type of measure scale. To evaluate weighting factor of customer value for each customer, the contact person of key customer is assigned to give weighting factors of customer values by using AHP approach. Result of this step becomes the priority vector of proposed customer values.

3.4.4 Requirement Prioritization Matrix

When reached to this step, the work gains a set of requirement to be prioritized and the customer values with weighting factors. The requirement prioritization matrix is ready to be constructed. Once, the matrix is established, and then it is distributed to release planning stakeholders to score each requirement in each proposed value.

3.4.5 Scoring and Ranking

Experts will evaluate requirement by giving score to each determined value. The highest score is 10, which means the requirement can response 100% of customer need in determined value. The lowest score is 0, which means the

requirement cannot provide the value. When the scoring process is done, finding the final score is performed by multiplying score of each requirement by each element of priority vector obtained from step 3.4.3. The final score of requirement will be ranked from the highest to the lowest. The ranking result is the list of prioritized requirement which is ready for software release planning kick-off process.

3.5 Result Validation

This framework will be evaluated by interviewing the experts of system, who involve with product and customer. In this work, the prioritized requirement list is distributed to Account Manager (AM), Product Manager (PM), and Business Analyst (BA) for result evaluation. Nevertheless, the values of the system satisfaction are also evaluated. Questionnaire is created and distributed to all of the experts.

CHAPTER IV
DATA ANALYSIS AND IMPLEMENTATION RESULTS

This work consists of four main parts. The first part is requirement analysis. The software release project is scoped by extracting the key requirements from a lot of CR in change management system. The second part is customer value analysis. An aim of part is to elicit the core customer values that proposed for improving customer satisfaction. Moreover, priority vector of customer value is obtained by using analytic hierarchy process. The third part is requirement prioritization. To perform requirement prioritization, sample requirement lists are distributed to stakeholders of software release project for scoring, and then scores are calculated and requirements are prioritized in ranking manner. The last part is evaluation and discussion of implementation results. For evaluating the implementation results, stakeholders are interviewed about the requirement list generated from our proposed systems compared with the requirement list that is ranked manually.

4.1 Requirement Analysis

The requirement analysis is performed to extract the key requirements for software release project from abundant requirements in change management system. In this research, a set of sample data from a software company, who provides a system and service for supporting passenger service in airline business, is used.

For this study, we determine the key requirement by aspect of the key customer. Therefore, we have to analyze who the key customer is.

4.1.1 Customer Analysis

Customer payment data collected from customer payment report are shown in Table 4.1

Table 4.1 Customer payment data in first quarter of 2015 (USD).

Customer	January	February	March	Total
A	50,770	49,900	56,400	**157,070**
B	13,500	13,500	13,500	**40,500**
C	8,950	9,650	10,480	**29,080**
D	5,500	5,500	5,500	**16,500**
E	7,550	7,550	-	**15,100**
F	5,500	5,500	5,500	**16,500**
G	2,780	2,780	2,780	**8,340**
H	7,500	7,500	7,500	**22,500**
I	5,000	5,000	5,000	**15,000**
J	5,500	5,500	5,500	**16,500**
K	2,800	3,500	4,900	**11,200**
L	5,500	5,500	5,500	**16,500**
M	3,150	4,500	4,500	**12,150**
N	930	940	935	**2,805**
O	6,250	6,080	5,980	**18,309**
P	3,400	3,360	3,618	**10,378**
Q	5000	5000	6000	**16,000**
Total	**139,580**	**141,260**	**143,593**	**424,433**

According to Table 4.1, the company's revenue was got paid from 17 customers. The revenue came from number of transactions which customers used the system. Thus, total amount of revenue is implied of customer's usage volume of system.

To identify the key customer, we apply Pareto analysis to identify who the key customer is. The cumulative revenue is summarized as Table 4.2 ordering by total revenue. According to Table 4.2, the revenue cumulative data are utilized to create a Pareto chart for analyzing the key customer. The result is shown as Figure 4.1.

Table 4.2 Cumulative customer total payment summary.

Customer	Total payment	Cumulative payment	% Cumulative payment
A	157070	157,070	37.01%
B	40500	197,570	46.55%
C	29080	226,650	53.40%
H	22500	249,150	58.70%
O	18309	267,460	63.02%
D	16500	283,960	66.90%
F	16500	300,460	70.79%
J	16500	316,960	74.68%
L	16500	333,460	78.57%
Q	16000	349,460	82.34%
E	15100	364,560	85.89%
I	15000	379,560	89.43%
M	12150	391,710	92.29%
K	11200	402,910	94.93%
P	10378	413,288	97.37%
G	8340	421,628	99.34%
N	2805	424,433	100.00%

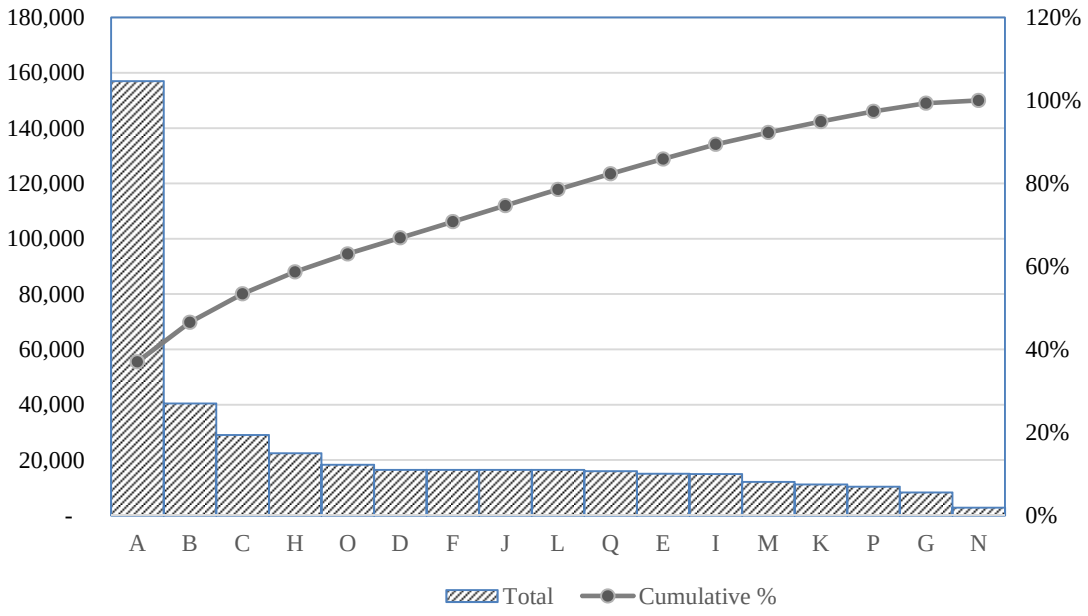

Figure 4.1 Pareto chart of customer total payment.

Table 4.3 Requirement filtration by customer A result.

Requester	Number of customer request
Customer A	214
The other customers	234
Total	**448**

Referring Pareto principal, i.e., “80:20 rule”, it states that approximately 80% of wealth is concentrated in about 20% of a population [13]. From Figure 4.1, we found that customer A is the most important customer because it purchased the highest amount of the service at 37.01% of cumulative of payment. This is harmonizes with Pareto principal. Hence, we can conclude that the customer A is the key customer of this company.

4.1.2 Requirement Filtration

In change management system, there are a lot of customer requests. The request was created by many reasons. The complete task is assigned status “Close” by customer or user. Otherwise, the task is “In Progress” or “On-Hold” in system. The example of customer is given in appendix A.

From this sample data, there are 448 requests which did not assign “Close” or “On-Hold” status by customer. We need to identify the related requests from unrelated requests.

1. Requirement Filtration by Key Customer

To penetrate the essential customer requirements, the first round of requirement filtration utilized result of Subsection 4.1.1 to be the criteria of selection. The result is show in Table 4.3.

As regards Table 4.3, we found that 214 requests are requested by customer A from total 448 requests. To reform number of customer request into percentage scale, the percentage of request from customer A is 47.77 while the percentage of requests from the other customers is 52.23. The result is illustrated in pie graph as shown Figure 4.2. According to this process, we can eliminate related data from 447 requests to 214 requests.

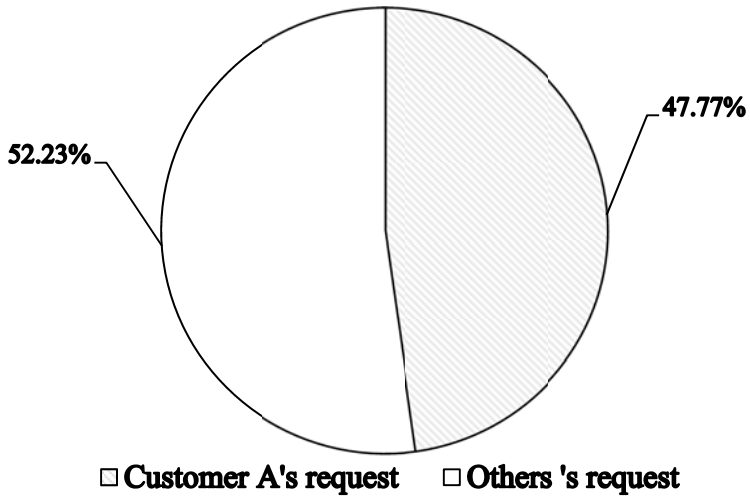

Figure 4.2 Request percentage comparison of the customer A and the other customers.

2. Requirement Filtration by Type of Request

As mentioned in previous, there are several reasons of customer creating a request. But from the software release project, we need only requests that create new features of the system. This type of request is called Change Request (CR).

The 214 requests of customer A is classified by type. The result is shown in Table 4.4. There are 6 types of customer request. The type of request description is given in appendix A

Change type has 49 requests, Error type has 105 requests, Help type has 23 requests, new type has 11 requests, Implement type has 3 requests, and Task type has 23 requests. Only Change, New, and Implement types can pass filtration process and send to next step. So, the result of this process is 63 requests.

Because of time limitation of this work, using all 63 requests could take long time for next process. Thus, we roughly prioritized and selected 18 requests that probably included in this release project. The list of selected request is shown in Table 4.5. To simplify the presentation, customer requirement is denoted by R1-R18. Remember that all of the filtered requirements must be used when the proposed framework is applied to the real application.

Table 4.4 Request types of customer A.

Request type	Number of request
Change	49
Error	105
Help	23
New	11
Implement	3
Task	23
Total	**214**

Table 4.5 List of selected CR.

No.	Requirements	Description
1	R1	Customer self-service : Auto ticket refund process
2	R2	Data Updater engine
3	R3	Reassign passenger API
4	R4	Messaging service to support Japanese airport policy
5	R5	Passenger check-in API
6	R6	Booking API - additional payment method
7	R7	Booking API – customer profile
8	R8	Reengineering of seat assignment function
9	R9	Authorization enhancement of customer self-service menu
10	R10	Modifying format of data for supporting a new law
11	R11	Customer self-service API
12	R12	Creating a new security to control accessing to system
13	R13	Process refund in multi-currency
14	R14	Load control function
15	R15	New credit card payment method
16	R16	Changing batch process to automatic
17	R17	Search Flight by time of booking
18	R18	Increase system capabilities for Promos period

4.2 Customer Value Analysis

According to literature review in Chapter II, the success of release project is considered by customer satisfaction. Customer value that will be distributed to customer is deal with customer satisfaction. Thus, this section describes the process of elicitation of proposed customer values and the process of AHP to determine the weight of each customer value.

4.2.1 Customer Value Elicitation

To elicit customer value, business characteristics of all customers have to be analyzed. The business characteristic could indicate classes of benefit that customers expect from the product, while the customers of this company are airlines. After studying the business characteristics of airline software industrial, we can extract the customer value into 4 dimensions as follows.

1. Business Rule

Customers' business characteristic is multi-country business. It means that many laws, rules, policies of multi-country must be followed. Moreover, the safety is very important for business. There are some specific rules that need to take action seriously. So, some of customer requirement is to customize the system for responding some business rules. To simplify the presentation, the customer value in dimension of business rule is denoted by CVB.

2. Revenue

Everybody does a business for revenue including airline. Many requirements were requested functions or features of software for increasing company's revenue. Hence, the release package software should provide this value to customer. To simplify the presentation, the customer value in dimension of revenue is denoted by CVR.

3. Process Improvement

Because of the complexity of business operation, the customers spend a lot effort to operate it. Nowadays, IT can support many process of business. It causes many requirements for improving their business process and reducing time for each task. To simplify the presentation, the customer value in dimension of process improvement is denoted by CVP.

4. Technology

In the present, e-commerce is the strategy of many companies. To be a market leader, they need to update their tools frequently for the latest technology for overtaking and taking the benefit of them to improve their business. Therefore, technology is an important factor which could improve customer satisfaction. To simplify the presentation, the customer value in dimension of technology is denoted by CVT.

4.2.2 Priority Vector of Customer Value

After obtaining a set of customer values, it needs to determine how each customer value influences to the others, which can be done by using the AHP. Priority vector or eigenvector is a result of the AHP. The outcome is depended on situations. The priority vector can apply as weight factor for each customer value dimension. Thus, the AHP is applied for calculating the weight of each customer value as follows.

1. Hierarchy Construction

The AHP hierarchy states the top level as objective. Our work states the problem as “the priority of customer values”. In intermediate level, we stated as customer values that are “Business rule”, “Revenue”, “Process improvement”, and “Technology”. Our hierarchy did not need the alternative level, because we just need to know the weight of each value. The hierarchy is shown in Figure 4.3.

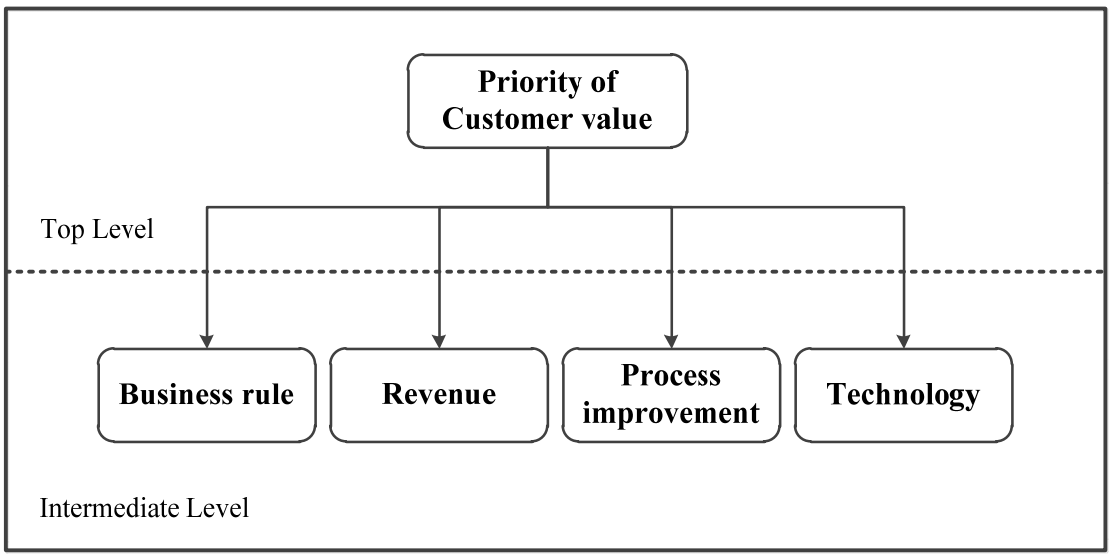

Figure 4.3 The AHP hierarchy for finding customer value’s priority.

2. Pairwise comparison evaluation

This process is creating a pairwise comparison form and distributing it to Account Manager (AM) for evaluate how important of each value is, in case of comparing one by one. The result is depicted in term pairwise matrix as shown in Table 4.6.

Table 4.6 Pairwise matrix of customer value.

Customer Value	**CVB**	**CVR**	**CVP**	**CVT**
CVB	**1**	7	7	8
CVR	1/7	**1**	7	7
CVP	1/7	1/7	**1**	3
CVT	1/8	1/7	1/3	**1**

According to Table 4.5, we use eigenvector technique to derive the weight matrix of customer value. $PV = [0.663, 0.231, 0.067, 0.038]^T$ is the priority vector result of business rule, revenue, process improvement, and technology, where $(.)^T$ is matrix transpose. Principal eigenvalue = 4.610 and CR = 22.3%. As proposed by Saaty, CR which is less than 10% is acceptable matrix. Thus, the balanced scale [19] is used to improve consistency.

The balanced scale is proposed by Pöyhönen et al. The balanced scale, Saaty's scale, and their matching with verbal judgments are given in Table 4.7.

Table 4.7 The association of Saaty's scale and Balanced scale with verbal judgments.

Verbal Description	Saatty's Scale	Balanced Scale
Equal importance	1	1
-	2	1.22
Moderate importance	3	1.50
-	4	1.86
Strong importance	5	2.33
-	6	3
Very strong or demonstrated importance	7	4
-	8	5.67
Extreme importance	9	9

The balanced scale is applied to improve consistency of matrix. Therefore, the new pairwise matrix from this modification is represented in Table 4.8.

Table 4.8 Pairwise matrix of customer value with balanced scale.

Customer Value	CVB	CVR	CVP	CVT
CVB	**1**	4	4	5.67
CVR	0.25	**1**	4	4
CVP	0.25	0.25	**1**	1.50
CVT	0.18	0.25	0.67	**1**

From table 4.8, the eigenvector technique derives eigenvalue = 4.212, CR = 7.5%, and $PV = [0.572, 0.258, 0.098, 0.072]^T$. Now, CR is less than 10% which is acceptable value. The weighting factor to be applied for this framework is shown in Table 4.9.

Table 4.9 Weighting factors of customer value.

CVB	CVR	CVP	CVT
0.572	0.258	0.098	0.072

4.3 Requirement Prioritization

At this point, all requirement parameters are archived, including candidate requirements, customer value, and priority vector for customer value. This state consists of scoring the candidate requirements, calculating score, and ranking requirements to derive the priorities of each requirement, respectively.

4.3.1 Stakeholder of Software Release Planning

For this study, we found that the stakeholders of software release project, who should score for candidate requirements, are 3 positions.

1. Account Manager

Account Manager (AM) is a contact person for the customers. AM will support customers for the issues which they found during release periods and will estimate feasibility for new requirement in business aspect. In software release planning process, AM is in role of the customer agent.

2. Product Manager

Product Manager (PM) is an expertise of product, he knows all the product specification, product constrains and customer requirements. PM knows what the product roadmap is, and can estimate the feasibility of new requirement for implementation.

3. Business Analyst

Business Analyst (BA) is an expertise for airline business, who cooperates with PM for analyzing customer requirements and designing the specification for PM, and develops team to implement.

These are 3 people, who need to score the candidate requirements on each dimension of customer value.

4.3.2 Scoring Requirement

The candidate requirement lists are distributed to all stakeholders (AM, PM, BA) for scoring each requirement referring to each customer value, where the minimum score, 0, means that requirement does not provide the benefit in this value aspect, and the maximum score, 5, means that the requirement absolutely provides the benefit in this value aspect. The scoring result is shown in Table 4.10.

Table 4.10 Requirement scoring results.

No.	Reqmt.	CVB			CVR			CVP			CVT		
		AM	PM	BA	AM	PM	BA	AM	PM	BA	AM	PM	BA
1	R1	5	2	4	2	3	3	5	5	5	2	3	1
2	R2	0	3	3	4	5	2	5	4	4	2	3	1
3	R3	0	3	3	0	2	2	4	3	4	3	3	1
4	R4	5	5	5	0	0	1	0	0	3	2	0	2
5	R5	0	4	4	5	0	1	5	3	4	4	3	1
6	R6	0	4	3	5	5	5	4	3	2	2	3	1
7	R7	0	4	3	0	2	4	4	2	1	4	3	1
8	R8	0	3	2	0	0	0	5	4	5	2	0	1
9	R9	0	3	0	0	0	0	2	3	3	0	1	3
10	R10	3	3	5	0	0	2	2	0	0	1	0	2
11	R11	0	4	5	5	4	5	5	3	5	4	3	3
12	R12	0	4	2	0	0	0	5	3	4	2	0	1
13	R13	4	3	3	0	3	3	4	3	3	3	0	5
14	R14	5	4	2	5	0	1	4	3	3	2	3	2
15	R15	0	4	2	4	5	3	2	2	2	4	4	5
16	R16	0	4	3	0	2	0	3	4	3	2	0	1
17	R17	0	3	2	0	0	2	3	3	4	2	0	4
18	R18	5	4	3	5	5	4	4	3	4	2	3	3

Remark: Reqmt**.** is abbreviation of requirement.

After receiving requirement scores from the stakeholders, the average score of each factor of each requirement is calculated. The result is in Table 4.11.

Table 4.11 Average score of each requirement.

No	Reqmt.	AVG. CVB	AVG. CVR	AVG. CVP	AVG. CVT
1	R1	3.67	2.67	5.00	2.00
2	R2	2.00	3.67	4.33	2.00
3	R3	2.00	1.33	3.67	2.33
4	R4	5.00	0.33	1.00	1.33
5	R5	2.67	2.00	4.00	2.67
6	R6	2.33	5.00	3.00	2.00
7	R7	2.33	2.00	2.33	2.67
8	R8	1.67	0.00	4.67	1.00
9	R9	1.00	0.00	2.67	1.33
10	R10	3.67	0.67	0.67	1.00
11	R11	3.00	4.67	4.33	3.33
12	R12	2.00	0.00	4.00	1.00
13	R13	3.33	2.00	3.33	2.67
14	R14	3.67	2.00	3.33	2.33
15	R15	2.00	4.00	2.00	4.33
16	R16	2.33	0.67	3.33	1.00
17	R17	1.67	0.67	3.33	2.00
18	R18	4.00	4.67	3.67	2.67

Remark: Reqmt**.** is abbreviation of requirement.

Next, we calculate the total score by multiplying average score of each factor which weighting factor obtaining from Subsection 4.2.2, i.e., PV = [0.572, 0.258, 0.098, 0.072]^T. The equation for calculating the total score is given in (4.1).

$$Z = \sum_{i=1}^{n}(V_i W_i), \tag{4.1}$$

where Z is total score of a requirement, n is number of customer values, V_i is average score of the i^{th} customer value, and W_i is weighting factor of the i^{th} customer value. The calculated result of this process is represented in Table 4.12.

Table 4.12 Requirement score with weighting factors.

No	Reqmt.	CVB *W*=0.572	CVR *W*=0.258	CVP *W*=0.572	CVT *W*=0.072	*Total Z*
1	R1	2.10	0.69	0.49	0.14	3.42
2	R2	1.14	0.95	0.42	0.14	2.66
3	R3	1.14	0.34	0.36	0.17	2.02
4	R4	2.86	0.09	0.10	0.10	3.14
5	R5	1.53	0.52	0.39	0.19	2.63
6	R6	1.33	1.29	0.29	0.14	3.06
7	R7	1.33	0.52	0.23	0.19	2.27
8	R8	0.95	0.00	0.46	0.07	1.48
9	R9	0.57	0.00	0.26	0.10	0.93
10	R10	2.10	0.17	0.07	0.07	2.41
11	R11	1.72	1.20	0.42	0.24	3.58
12	R12	1.14	0.00	0.39	0.07	1.61
13	R13	1.91	0.52	0.33	0.19	2.94
14	R14	2.10	0.52	0.33	0.17	3.11
15	R15	1.14	1.03	0.20	0.31	2.68
16	R16	1.33	0.17	0.33	0.07	1.91
17	R17	0.95	0.17	0.33	0.14	1.60
18	R18	2.29	1.20	0.36	0.19	4.04

From Table 4.12, we can see that the highest score is 4.04, R18, while the lowest score is 0.93, R9.

4.3.3 Ranking Requirement

From previous section, the scores of candidate requirements are determined. In this section, the candidate requirements are ordered according to the total score in Table 4.10. Ranking result is presented in Table 4.13, which is the outcome of this implementation.

This ranking list will be a decision support for the management team for selecting the requirements to be implemented in the next incremental software package. Because of resource limitation as described previously, only some requirements could be selected for the next incremental software package. For example, only the first 10 ranked requirements of all 18 requirements are selected for implementation. This set of requirement is called “selected requirement.” The left of

candidate requirements, which do not select for the upcoming software release, will be selected for the further software release sequentially.

Table 4.13 Ranking list of candidate requirement.

Rank	Reqmt.	Description	Score
1	R18	Increase system capabilities for Promos period	4.04
2	R11	Customer self-service API	3.58
3	R1	Customer self-service : Auto ticket refund process	3.42
4	R4	Messaging service to response Japanese airport policy	3.14
5	R14	Load control function	3.11
6	R6	Booking API - additional payment method	3.06
7	R13	Process refund in multi-currency	2.94
8	R15	New credit card payment method	2.68
9	R2	Data Updater engine	2.66
10	R5	Passenger check-in API	2.63
11	R10	Modifying format of data for supporting a new law	2.41
12	R7	Booking API – customer profile	2.27
13	R3	Reassign passenger API	2.02
14	R16	Changing batch process to automatic	1.91
15	R12	Creating a new security to control accessing to system	1.61
16	R17	Search Flight by time of booking	1.60
17	R8	Reengineering of seat assignment function	1.48
18	R9	Authorization enhancement of customer self-service menu	0.93

4.4 Result Evaluation and Discussion

To confirm the potential of the proposed framework, evaluation process is demonstrated in this section, which consists of three processes. The first process is to evaluate ranking consistency, the second process is to evaluate stakeholder satisfaction and the third process is to interview stakeholder about framework acceptation as discussion.

4.4.1 Ranking consistency evaluation

To create the benchmark of this study, after we got the candidate requirement, the AM is asked to rank the list manually. The list was ranked by the most customer preference. It is the existing method in this company. The result is shown in Table 4.14 ordered by the most preference to the lowest preference.

Table 4.14 The requirement prioritization by customer preference.

Rank	Reqmt.	Description
1	R4	Messaging service to response Japanese airport policy
2	R18	Increase system capabilities for Promos period
3	R13	Process refund in multi-currency
4	R14	Load control function
5	R5	Passenger check-in API
6	R6	Booking API - additional payment method
7	R7	Booking API – customer profile
8	R11	Customer self-service API
9	R8	Reengineering of seat assignment function
10	R15	New credit card payment method
11	R1	Customer self-service : Auto ticket refund process
12	R3	Reassign passenger API
13	R12	Creating a new security to control accessing to system
14	R2	Data Updater engine
15	R9	Authorization enhancement of customer self-service menu
16	R10	Modifying format of data for supporting a new law
17	R17	Search Flight by time of booking
18	R16	Changing batch process to automatic

To evaluate the ranking result, using the customer preference top 10 ranking result from Table 4.14 compared with the top 10 ranking result of framework from Table 4.13. We can obtain the result as given in Table 4.15.

Table 4.15 Top 10 ranking of the proposed framework and ranking of existing process.

Reqmt.	Description	Framework ranking	Manual ranking
R18	Increase system capabilities for Promos period	1	2
R11	Customer self-service API	2	8
R1	Customer self-service : Auto ticket refund process	3	11
R4	Messaging service to response Japanese airport policy	4	1
R14	Load control function	5	4
R6	Booking API - additional payment method	6	6
R13	Process refund in multi-currency	7	3
R15	New payment method of payment by credit card	8	10
R2	Data Updater engine	9	14
R5	Passenger check-in API	10	5

According to result in Table 4.15, from top 10 requirements, there are only 2 requirements R7 and R8 that are not in the top 10 ranking of proposed framework ranking. We can say that the difference between the result of the proposed framework and the result of the conventional process is 20%.

4.4.2 Stakeholder Satisfaction Evaluation

To evaluate stakeholder satisfaction of the proposed framework, we asked the experts to evaluate the framework in 4 dimensions. The dimension of evaluation contain, improving key customer satisfaction, ranking consistency, supporting release planning process, and applying feature for all customers. Score 5 is the maximum score which is represented as strongly agree and Score 1 is lowest score which is represent as strongly disagree. The result of stakeholder satisfaction is given in Table 4.16.

Table 4.16 Result of stakeholder satisfaction evaluation.

No.	Dimension of Evaluation	AM	PM	BA	AVG
1	Improve key customer satisfaction	3	4	4	3.67
2	Ranking consistency	4	3	2	3.00
3	Support release planning process	5	4	3	4.00
4	Apply feature for all customer	3	5	3	3.67

The satisfaction evaluation of proposed framework results in Table 4.15 show that the most satisfied dimension of stakeholder is supporting release planning process with average score = 4.00. Improving key customer satisfaction and applying feature for all customer gets equal score 3.67. The lowest score is 3.00, ranking consistency. The dimension association of evaluation result is shown in Figure 4.4.

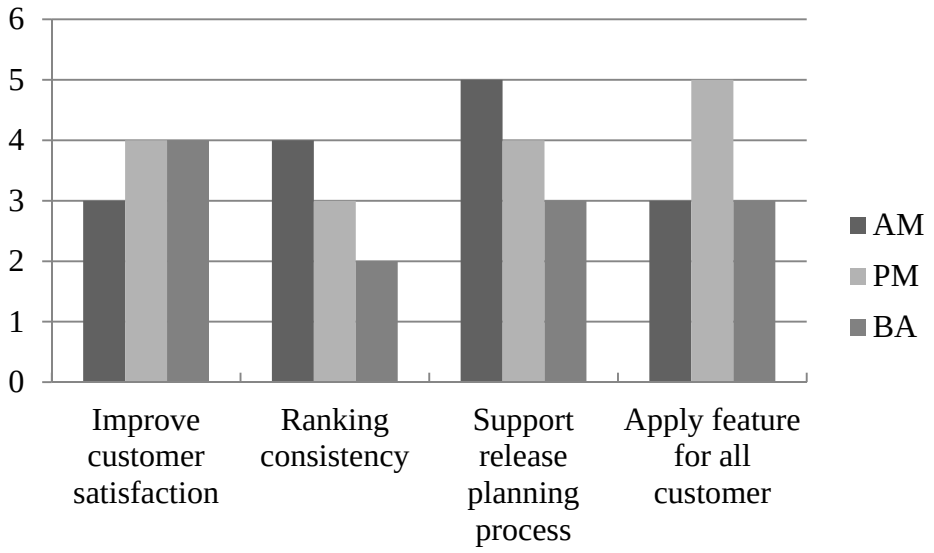

Figure 4.4 Result of stakeholder satisfaction in 4 dimensions.

4.4.3 Stakeholder Discussion

1. Discussion of Account Manager

After comparing ranking results and satisfaction evaluation, AM said that the result of the proposed framework is acceptable. It provides a clearer direction and more reasonable to implement than the manual ranking. He could use the list of requirements and its value for offering new product package to customer. However,

there are some conflict between framework result and the reality. For example, requirement R1, AM ranked for 11 while the proposed framework ranked for 3, which is a big difference. This is because the requirement was evaluated to have high score based on customer values. However, AM gave low score because customer needs other tasks to be done first.

2. Discussion of Product Manager

PM said that the framework could support the process of selecting requirements and managing it for software release planning process. It is easier for direct the theme of release software by weighing customer value with AHP. But it is quite a lot of calculation process. So, it should have a system to support the whole framework, and it should concern more about the project effort and internal value. However, the requirement list is reasonable enough to present it in the release preparation meeting.

3. Discussion of Business Analyst

BA said that the framework could support customer's business. It means that it could improve customer satisfaction. It is a value added release. The list of requirement is agreeable but it should be concerned about the technical and compatibility aspects of implementation.

To sum up of discussion with stakeholders, they accept the ranking result of framework. It makes the process of selecting requirement for software release planning process easier. It decreases the time of review requirements meeting, the release direction is clear to all stakeholders. However, there are some comment about the framework should be concerned with the internal organization factors, e.g. resource available, cost, version compatibility, and so on.

CHAPTER V
CONCLUSION

In this chapter, the implementation results of the requirement prioritization by the customer value based framework are summarized. Moreover, the suggestions for improvement of the future work are also provided.

5.1 Summary of Results

This research introduces a framework for an enhanced requirement prioritization process for the release planning project by customer value based. The proposed framework consists of 3 majors parts, including requirement analysis, customer value analysis, and prioritization process. The requirement analysis is a process for looking through the proper candidate requirements for the prioritization. Customer value analysis is to elicit the customer values to be factors for decision making in prioritization process. For last part, the prioritization process is to generate the prioritized requirements list for the software release planning process, which is the outcome of this study.

This study uses a sample data taken from the company that providing the passenger service system for airline industry. The result is evaluated by comparing the framework result with manual result. For additional support information, stakeholders of release planning process are interviewed about acceptation of the proposed framework.

From 448 customer requests in change management system, it is filtered by the requester who is the key customer of company, and filtered again by request type. These make it remained only 63 requests. From the 63 request, we manually selected 18 probable requests to simplify the work for stakeholders.

After analyzed business characteristics and categories of benefits expected from requirements, four customer values, including business rule, revenue, process improvement, and technology, are introduced. Weight factors for these customer values are determined by the AHP.

From the requirement prioritization process, the result shows that the highest priority is the requirement that contains several values in one requirement. As compared to the ranking from manual process, the average different ranking of a requirement is 3.56. However, as discussed with stakeholders, AM, PM and BA agreed and said that the result of the proposed framework is acceptable.

5.2 Suggestions

From the discussion with release planning stakeholders, there are some comments from them. They suggested it for improving process in the future work. It can be concluded as follows.

- The ranking list is the ideal product. So, it should concern other factors in the reality, for example, the urgency of task, technical, and the compatibility.
- The framework should consider about the project management factors, e.g., time period, available resource, and scope of release.
- Because of a lot of calculations and processes, so it should have a tool or system to support the framework.

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APPENDICES

APPENDIX A

CHANGE REQUEST DESCRIPTIONS

Table A.1 Sample Change Request Data.

CR. ID	Functional Area	Customer	Title	Status	Type	Priority	Release
1	Departure Control	C.1	New boarding pass design	CLOSED	New	High	AERO080501
2	Revenue Accounting	C.3	Currency rounding up	PROGRESS	Change	Medium	-
3	Schedules	C.8	Split flight schedule	CANCEL	New	High	-
4	Reporting	C.2	Cargo revenue report	ON HOLD	Change	Low	-
5	B2B	C1	Error spelling for B2B_SK template	CLOSED	ERROR	High	-
6	B2C	C.3	Delete errors e-mail account	CLOSED	Task	High	-
7	B2C	C.1	New Google Analytics Code	ACCEPT	Implement	Medium	-

Table A.2 Change Request Type.

Request type	Description
Change	Request for customization the existing feature of software.
Error	Request for fixing issues or bug.
Help	Request for support or asking about software functions.
New	Request for new features of software which never exist in current software.
Implement	Request for new engine.
Task	Request for one time support (case-by-case).

Table A.3 Change Request Status.

Request Status	Description
ACCEPT	To acknowledge customer that request is accepted by 1-tier support.
CANCEL	CR is accepted, but is cancelled by some reason e.g. cost, unrelated service.
REJECT	CR is not accepted. It is unrelated service.
ON HOLD	CR is accepted, but could not start to proceed.
PROGRESS	CR is accepted and in the process of development.
CLOSED	CR is delivered to customer.

APPENDIX B
SOURCE CODE OF PRIORITY VECTOR CALCULATION BY FREEMAT

```
% Eigenvalue and Eigenvector Calculation
% A is Matrix to determine the eigenvalue and eigenvector
% PrEigValue = Principal Eigenvalue
% PrEigVector = Eigenvector
% PV  = Priority Vector (Eigenvector in nomalized form)
A = [1 7 7 8; 1/7 1 7 7; 1/7 1/7 1 3; 1/8 1/7 1/3 1]
[V,D] = eig(A)
PrEigValue = real(D(1,1))
PrEigVector = real(V(:,1))
PV =  PrEigVector./sum(PrEigVector)
```

APPENDIX C
CUSTOMER VALUE ANALYSIS WITH PAIRWISE COMPARISON

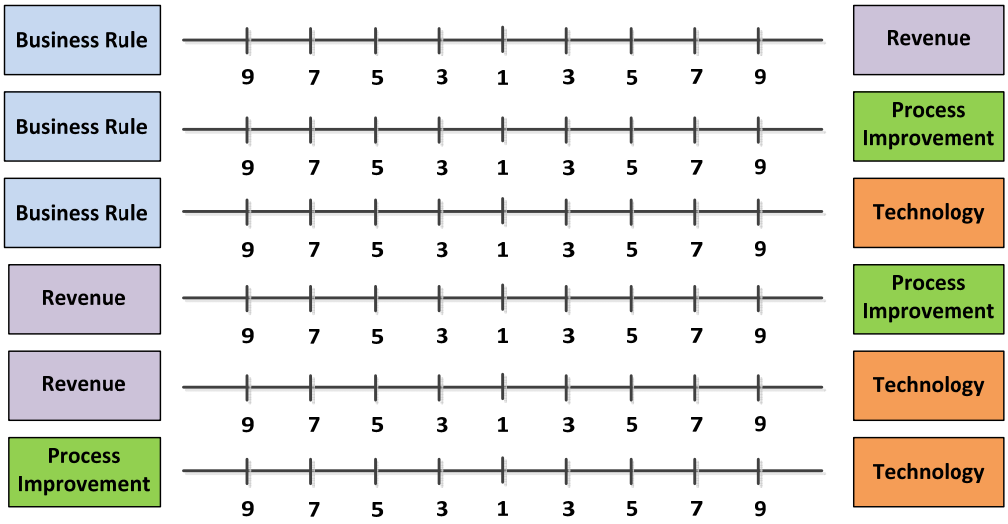
Customer Value factors Evaluation for Release Project Planning

To evaluate the weight of each customer value, the pairwise comparison technique is applied. There are four customer values are extracted as shown in the Table C.1. Please score each pairwise comparison of customer value by choosing the value on the score line.

Table C.1 Customer Value Descriptions.

Value	Description
Business Rule	Product must respond business rules (e.g. law, policies, agreements for business processes)
Revenue	Product support the solution for increasing customer's revenue
Process Improvement	Product help customer to improve productivity
Technology	Product deliver the solutions to customer with modern technology

How important were the following customer value in comparison when your customer expect in your new release software product?



1 : Equal,

3 : Moderately,

5 : Strongly More Important,

7 : Very Strongly More Important,

9 : Extremely More Important,

APPENDIX D

CANDIDATE REQUIREMENT SCORING FORM

This form is for giving the score of change request on each customer value. Please assess the change request shown in Table D.1, where the description of each customer value is shown in Table D.2

Table D.1 Customer Change Request Prioritization Matrix

No.	Description	CVB (0-5)	CVR (0-5)	CVP (0-5)	CVT (0-5)
1	Customer self-service : Auto ticket refund process				
2	Data Updater engine				
3	Reassign passenger API				
4	Messaging service to support Japanese airport policy				
5	Passenger check-in API				
6	Booking API - additional payment method				
7	Booking API – customer profile				
8	Reengineering of seat assignment function				
9	Authorization enhancement of customer self-service menu				
10	Modifying format of data for supporting a new law				
11	Customer self-service API				

No.	Description	CVB (0-5)	CVR (0-5)	CVP (0-5)	CVT (0-5)
12	Creating a new security to control accessing to system				
13	Process refund in multi-currency				
14	Load control function				
15	New credit card payment method				
16	Changing batch process to automatic				
17	Search Flight by time of booking				
18	Increase system capabilities for Promos period				

0 = The CR does not provides the benefit in this value aspect

5 = The CR absolutely provides the benefit in this value aspect

Table D.2 Customer Value Description.

Value	Description
Business Rule (CVB)	Product must respond business rules (e.g. law, policies, agreements for business processes)
Revenue (CVR)	Product supports the solution for increasing customer's revenue
Process Improvement (CVP)	Product help the customer to improve productivity and security
Technology (CVT)	Product delivers the solutions to customer with modern technology

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