

**RISK ASSESSMENT OF ENTERPRISE RESOURCES PLANNING
SYSTEM IMPLEMENTATION USING FUZZY ANALYTICAL
NETWORK PROCESS**

(Case study in DSP and DKA Universitas Islam Indonesia)

THESIS

Submitted to International Program Faculty of Industrial Technology
in Partial Fulfillment of the Requirements for the degree of Sarjana Teknik Industri



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For the sake of Allah, I confess this work is my own work except for the excerpts and the summaries that each of their sources has already been cited and mentioned. If in the future my confession is proved to be wrong and dishonest resulting the violence of the legal regulation of the papers and intellectual property rights, then I would have the will to return my degree to be drawn back to Universitas Islam Indonesia.

Yogyakarta, August 2017



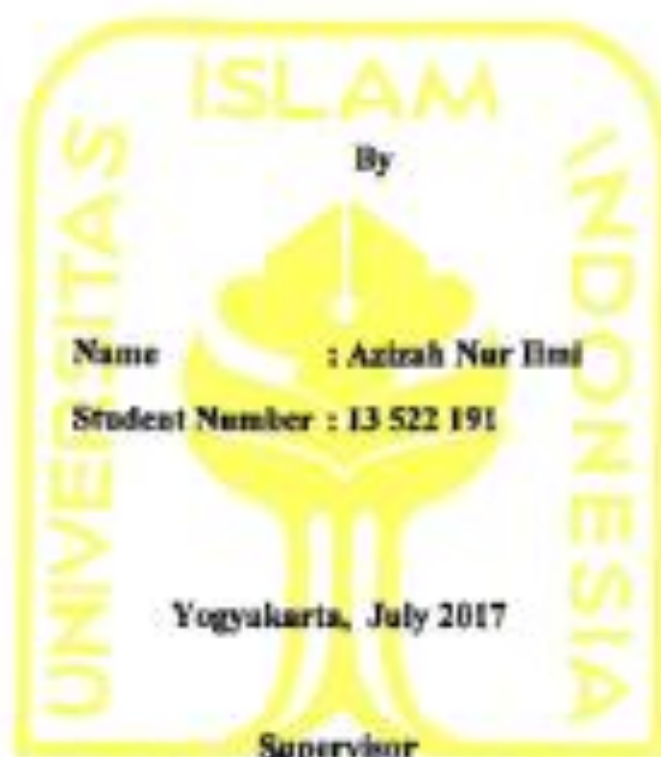
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(Muhammad Ridwan Andi Purnomo, ST., M.Sc., PhD.)

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DEDICATION

This thesis is dedicated for the one and only, my super mom, Suchruliyawati, SE., my super grandmother, Hj. Nafsiyah, my father, Drs. Gunadi Kasnowihardjo, M. Hum., all of my brothers and my sisters in law Bang Irul – Mba Anif, Bang Upik – Mba Yayah, Bang Aji – Mba Panji, and all of my nephews and nieces, Dani, Serena, Hilmy, Hafiz, Asyam and Hana, Teknik Industri Universitas Islam Indonesia, and all of my friends.

MOTTO

“So verily, with the hardship, there is relief. Verily, with the hardship, there is relief (i.e. there is one hardship with two reliefs, so one hardship cannot overcome two reliefs).”

– QS. Insyirah : 5-6

“Then which of the favors of your Lord will you deny?”

– QS. Ar-Rahman

“Life is like riding a bicycle. To keep your balance, you must keep moving.”

– Albert Einstein

PREFACE

Assalamu'alaikum Wr. Wb.

Alhamdulillahirrobbilalamin and gratitude are presented to Allah the Highest, while blessings and greetings mahabbah are also delegated to the Prophet Muhammad. With all humility let the Author to express my gratitude and highest appreciation to all those who have been support and motivating in order to complete this Thesis. The Author would like to say thanks to:

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The author realize this report is not perfect. Thus, suggestions and critics are fully expected.

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Yogyakarta, August 2017

Azizah Nur Ilmi

ABSTRACT

Enterprise Resource Planning (ERP) system is technology of information system, which designed to provide useful information to support strategy, operations, management analysis, and decision-making functions in an organization. ERP integrates primary business processes. Nowadays, ERP is already used by a wide range of sectors, including education sector, especially higher education or university. Lots of advantages would gain by the company that implement ERP system, such as can improve the internal communications between departments or divisions and eliminate the manual processes. On the other hand, implement ERP also has high risk to be failed. Whereas, implement ERP takes lots of time and money. Universitas Islam Indonesia (UII) is one of the university in Indonesia that implement ERP in their system. UII using three modules in ERP, which including the Material Management, Financial Accounting and Controlling module. This research using Fuzzy Analytical Network Process method to assess the risks of implementation ERP in Universitas Islam Indonesia order to make the organization successfully implement the ERP system. The result shows that there are 16 risks that can be identified, with the highest risk factor is 'Lack of knowledge while implement ERP SAP' with weight of 0.099. The second risk is 'Top management provide inadequate resources'. While 'Top Management less understand with ERP system' become the third highest factor. Followed by 'Lack of testing' as the fourth risk factor. The last highest fifth rank is 'Less discipline while execution process'. In the risk evaluation, the forth and the fifth rank, categories as a high risk level, which should needs attention from the senior management.

Keywords : FANP, Risk Assessment, ERP

TABLE OF CONTENT

AUTHENTICITY STATEMENT	ii
THESIS APPROVAL OF SUPERVISOR	iii
THESIS APPROVAL OF EXAMINATION COMMITTEE	iv
DEDICATION	v
MOTTO	vi
PREFACE	vii
ABSTRACT	viii
TABLE OF CONTENT	ix
LIST OF TABLES	xi
LIST OF FIGURES	xiv
CHAPTER I: INTRODUCTION	1
1.1 Background	1
1.2 Problem Formulation	5
1.3 Objectives of Research	5
1.4 Scope of Problem	5
1.5 Benefits of Research	6
1.6 Systematical Writing	6
CHAPTER II: LITERATURE REVIEW	8
2.1 Inductive Study	8
2.2 Deductive Study	15
2.2.1 Evolution of Enterprise Resources Planning	15
2.2.2 Enterprise Resources Planning	16
2.2.3 Risk Management	16
2.2.4 Knowledge Management	18
2.2.5 Fuzzy Logic	18
2.2.6 Fuzzy Set Theory	19
2.2.7 Triangular Fuzzy Number	20
2.2.8 Analytic Network Process	21
2.2.9 Analytical Network Process Steps	27
2.2.10 Fuzzy Analytical Network Process Step	28

CHAPTER III	30
3.1 Problem Identification.....	30
3.2 Problem Formulation	30
3.3 Literature Review.....	31
3.4 Data Collection.....	31
3.5 Data Processing.....	32
3.6 Discussion	33
3.7 Conclusion and Recommendation.....	33
CHAPTER IV	34
4.1 Data Collection.....	34
4.1.1 Network of Analytical Network Process	35
4.1.2 First Expert.....	37
4.1.3 Second Expert	41
4.2 Data Processing.....	44
4.2.1 Super Decision	44
4.2.2 Fuzzy Analytical Network Process	45
CHAPTER V	94
5.1 Risk Factors Identification in ERP Implementation	94
5.2 Level of Risks Priority in ERP Implementation	95
5.3 Risks Evaluation	97
CHAPTER VI.....	99
6.1 Conclusion	99
6.2 Suggestions	100
REFERENCES	101

LIST OF TABLES

Table 2.1. Research Position.....	13
Table 2.2. Triangular Fuzzy Number Scale.....	21
Table 4.1 Criteria and Sub Criteria Risk of ERP Implementation.....	35
Table 4.2 Matrix of Pairwise Comparison Criteria with No Dependency.....	38
Table 4.3 Matrix of Pairwise Comparison Criteria with Respect to Knowledge Management	38
Table 4.4 Matrix of Pairwise Comparison Criteria with Respect to Management & Execution	38
Table 4.5 Matrix of Pairwise Comparison Criteria with Respect to Software System	38
Table 4.6 Matrix of Pairwise Comparison Criteria with Respect to Technology Planning .	39
Table 4.7 Matrix of Pairwise Comparison Criteria with Respect to User	39
Table 4.8 Matrix of Pairwise Comparison Sub Criteria with Respect to KM.....	39
Table 4.9 Matrix of Pairwise Comparison Sub Criteria with Respect to Management and Execution	40
Table 4.10 Matrix of Pairwise Comparison Sub Criteria with Respect to Software System	40
Table 4.11 Matrix of Pairwise Comparison Sub Criteria with Respect to Technology Planning	40
Table 4.12 Matrix of Pairwise Comparison Sub Criteria with Respect to User.....	40
Table 4.13 Matrix of Pairwise Comparison Criteria with No Dependency.....	41
Table 4.14 Matrix of Pairwise Comparison Criteria with Respect to KM	41
Table 4.15 Matrix of Pairwise Comparison Criteria with Respect to Management & Execution	42
Table 4.16 Matrix of Pairwise Comparison Criteria with Respect to Software System	42
Table 4.17 Matrix of Pairwise Comparison Criteria with Respect to Technology Planning	42
Table 4.18 Matrix of Pairwise Comparison Criteria with Respect to User	43
Table 4.19 Matrix of Pairwise Comparison Sub Criteria with Respect to KM.....	43
Table 4.20 Matrix of Pairwise Comparison Sub Criteria with Respect to Management & Execution	43
Table 4.21 Matrix of Pairwise Comparison Sub Criteria with Respect to Software System	44
Table 4.22 Matrix of Pairwise Comparison Sub Criteria with Respect to Technology Planning	44
Table 4.23 Matrix of Pairwise Comparison Sub Criteria with Respect to User.....	44
Table 4.24 Recapitulation of Consistency Test	45
Table 4.25 Matrix of Criteria Pairwise Comparison TFN scale (First Expert)	46
Table 4.26 Matrix of Criteria Pairwise Comparison TFN scale (Second Expert).....	46
Table 4.27 Geometric Mean Matrix of Criteria Pairwise Comparison TFN scale	47
Table 4.28 Value of Total Row and Column.....	47
Table 4.29 Invers Value of Total Column	48
Table 4.30 Value of Synthesis Fuzzy	48
Table 4.31 Vector Value.....	49
Table 4.32 Weight of Each Criteria	50
Table 4.33 Pairwise Comparison of Sub Criteria wrt KM (First Expert).....	51
Table 4.34 Pairwise Comparison of Sub Criteria wrt KM (Second Expert)	51
Table 4.35 Geometric Mean of Pairwise Comparison Sub Criteria with Respect to KM....	52

Table 4.36 Synthesis Fuzzy for Sub Criteria in KM.....	52
Table 4.37 Vector Value of Sub Criteria in KM.....	53
Table 4.38 Pairwise Comparison Sub Criteria with Respect to ME (First Expert).....	54
Table 4.39 Pairwise Comparison Sub Criteria with Respect to ME (Second Expert).....	54
Table 4.40 Geometric Mean of Pairwise Comparison Sub Criteria with Respect to ME	54
Table 4.41 Synthesis Fuzzy for Sub Criteria in ME.....	55
Table 4.42 Vector Value of Sub Criteria in ME.....	55
Table 4.43 Pairwise Comparison Sub Criteria with Respect to SS (First Expert).....	56
Table 4.44 Pairwise Comparison Sub Criteria with Respect to SS (Second Expert).....	57
Table 4.45 Geometric Mean Pairwise Comparison Sub Criteria with Respect to SS	57
Table 4.46 Synthesis Fuzzy for Sub Criteria in SS.....	58
Table 4.47 Vector Value of Sub Criteria in SS.....	58
Table 4.48 Pairwise Comparison Sub Criteria with Respect to TP (First Expert)	59
Table 4.49 Pairwise Comparison Sub Criteria with Respect to TP (Second Expert).....	59
Table 4.50 Geometric Mean Pairwise Comparison Sub Criteria with Respect to TP.....	59
Table 4.51 Synthesis Fuzzy for Sub Criteria in TP	60
Table 4.52 Vector Value of Sub Criteria in TP	60
Table 4.53 Pairwise Comparison Sub Criteria with Respect to U (First Expert)	62
Table 4.54 Pairwise Comparison Sub Criteria with Respect to U (Second Expert).....	62
Table 4.55 Geometric Mean Pairwise Comparison Sub Criteria with Respect to U.....	62
Table 4.56 Total Column and Row.....	63
Table 4.57 Synthesis Fuzzy for Sub Criteria in U	63
Table 4.58 Vector Value of Sub Criteria in U	64
Table 4.59 Summary of Weight in Each Sub Criteria	65
Table 4.60 Matrix of Pairwise Comparison Criteria with Respect to KM (First Expert).....	66
Table 4.61 Matrix of Pairwise Comparison Criteria with Respect to KM (Second Expert)	66
Table 4.62 Geometric Mean of Pairwise Comparison Criteria wrt KM TFN Scale	66
Table 4.63 Value of Total Row and Column.....	67
Table 4.64 Invers Value of Total Column	67
Table 4.65 Value of Synthesis Fuzzy	68
Table 4.66 Vector Value.....	68
Table 4.67 Weight of Each Criteria	70
Table 4.68 Matrix of Pairwise Comparison Criteria with Respect to ME (First Expert)	70
Table 4.69 Matrix of Pairwise Comparison Criteria with Respect to ME (Second Expert).....	70
Table 4.70 Geometric Mean Pairwise Comparison Criteria wrt ME in TFN Scale	71
Table 4.71 Value of Total Row and Column.....	71
Table 4.72 Invers Value of Total Column	72
Table 4.73 Value of Synthesis Fuzzy	72
Table 4.74 Vector Value.....	73
Table 4.75 Weight of Each Criteria	74
Table 4.76 Matrix of Pairwise Comparison Criteria with Respect to SS (First Expert).....	74
Table 4.77 Matrix of Pairwise Comparison Criteria with Respect to SS (Second Expert)	75
Table 4.78 Geometric Mean Pairwise Comparison Criteria with Respect to SS in TFN Scale	75
Table 4.79 Value of Total Row and Column.....	76
Table 4.80 Invers Value of Total Column	76
Table 4.81 Value of Synthesis Fuzzy	77

Table 4.82 Vector Value.....	77
Table 4.83 Weight of Each Criteria.....	78
Table 4.84 Matrix of Pairwise Comparison Criteria with Respect to TP (First Expert)	79
Table 4.85 Matrix of Pairwise Comparison Criteria with Respect to TP (Second Expert)..	79
Table 4.86 Geometric Mean Pairwise Comparison Criteria wrt TP in TFN Scale	79
Table 4.87 Value of Total Row and Column.....	80
Table 4.88 Invers Value of Total Column.....	80
Table 4.89 Value of Synthesis Fuzzy	81
Table 4.90 Vector Value.....	81
Table 4.91 Weight of Each Criteria.....	83
Table 4.92 Matrix of Pairwise Comparison Criteria with Respect to U (First Expert)	83
Table 4.93 Matrix of Pairwise Comparison Criteria with Respect to U (Second Expert)....	84
Table 4.94 Geometric Mean Pairwise Comparison Criteria with Respect to U in TFN Scale	84
Table 4.95 Value of Total Row and Column.....	85
Table 4.96 Invers Value of Total Column.....	85
Table 4.97 Value of Synthesis Fuzzy	86
Table 4.98 Vector Value.....	86
Table 4.99 Weight of Each Criteria.....	87
Table 4.100 Global Weight Sub Criteria	88
Table 4.101 Impact Scale.....	89
Table 4.102 Impact of Risk.....	90
Table 4.103 Likelihood Scale	90
Table 4.104 Likelihood of Risk.....	91
Table 4.105 Matrix of Risk Evaluation	91
Table 4.106 Result of Risk Evaluation	92

LIST OF FIGURES

Figure 2.1 Evolution of ERP System.....	15
Figure 2.2 Risk Management Process	17
Figure 2.3. Fuzzy set graph.....	20
Figure 2.4 Difference between Hierarchy Structure and Network Structure	23
Figure 2.5 Interdependence.....	25
Figure 2.6 Supermatrix of Network.....	26
Figure 2.7 Supermatrix Component of Network	26
Figure 3.1. Flowchart of Research.....	32
Figure 4.1 Network Structure of ANP.....	37

CHAPTER I

INTRODUCTION

1.1 Background

Information Systems (IS) is interrelated components, such as hardware, software, data, people and process that working together (Bourgeois, 2014). Enterprise Resource Planning (ERP) system is technology of information system, which designed to provide useful information to support strategy, operations, management analysis, and decision-making functions in an organization. ERP integrates primary business processes including manufacturing, distribution, accounting, financial, human resource management, project management and inventory management (Helo, 2011).

Nowadays, ERP is already used by a wide range of sectors. It is not only for trading and service company but also for education sector, especially higher education or university. As a business, university also has its own organizational structure with various divisions to complete its business process task. There are several divisions in university, such as academic, financial, purchasing, inventory, human resources, marketing and partnership. Thus, with the help of ERP, all the information can be integrated and updated in a real time.

Lots of advantages would be gained by the company that implements ERP system. It is including the integrated business processes as it mentioned before. Another reason is, ERP can improve the internal communications between departments or divisions. Since ERP system is an information system, it will reduce and eliminate the manual processes.

Besides, it also can enhance the strategic decision making and planning capabilities, which lead to sophisticated data analysis. Also can improve the self-service environment.

Since ERP system has great advantages, it means that it also has high risks while implementing the system. Every company that failed in implementing the ERP system has its own type and different level. As it already listed by Widiyanti (2013), there are several companies that failed in implementing the ERP system, such as The Hersey that lost 27% of its market because of the distribution problem. While one of the biggest pharmacy company in the world, Fox Meyer Drug, has to shut down the company in 1996 because of the failure in implementing the ERP system that they ran. Lutovac & Manojlov (2012) said that in Indonesia, there are more than 80% of the companies were unsuccessful in implementing the ERP system. While in the world, more than 50% of the companies were failed to gain the optimal return value after the ERP system implemented.

The fact above shows that, when the implementation of ERP system failed, it may cause several drawbacks, such as loss in term of time and money. ERP implementation needs lots of time and money. However, with the potential failure that might happen, the company cannot just reject the ERP system and leave the potential opportunities offered by ERP system. Every decision making in business has its own risk. There is no safe path in business. Even, by not implementing ERP, it will cause other risks. Therefore, risk assessment of ERP implementation need to be done in order to make the organization successfully implement the ERP system.

ERP already implemented in several sectors, one of the sectors is education, especially for university. Universitas Islam Indonesia (UII) is one of the universities that already implement it. UII already implemented 3 modules of ERP SAP, which are Material Management, Financial Accounting and Controlling for two departments under UII's rectorate, namely Direktorat Sarana Prasarana (DSP) and Direktorat Keuangan dan Anggaran (DKA). During its implementation, there is no assessment that done by the top management yet, especially about the risk that might be happened. Hence, the top management only familiar that UII implements ERP and does not know about what the

end-users have experienced each day. By conducting the risk assessment, it can be created the awareness not only among the end users but also among the top management and whole organizations. Furthermore, it is a proactive action that the management can perform, that will cut the cost, instead of waiting the appearance of risks.

There are three steps in risk assessment, which are risk identification, risk analysis and risk evaluation (Hosseini et al., 2011). Risk identification is identifying the potential risk that might occur, that can be determined from any possible scenarios. Then, risk analysis should be done to prioritize the risks that already determined before. The next step is risk evaluation. In risk evaluation, there are five types of actions that can overcome the risks of ERP implementation, such as accept the risk, avoid the risk, transfers the risk, mitigate the risk and exploit the risk. Those actions depend on how crucial the risks are based on the result of the risk analysis.

Ahmadi et al. (2015) examined the readiness of the relevant activities before ERP was implemented. The method that being used in this research is fuzzy cognitive maps (FCMs) and fuzzy analytical hierarchy process (FAHP). FCMs use to represent all possible causal relationship between activities. While, FAHP was used later to determine the contribution's weights and the conclusion from FCMs result was used to include the feedback between the activities.

Aloini et al. (2012) studied about the risk analysis of ERP project. From this study, there are four major classifications of IT project risk factors, which are process failure, expectation failure, interaction failure and correspondence failure. This research applied Interpretive Structural Modeling (ISM) to analyze the risk. It was stated that this study has not quantifying yet and neglected the risk effects.

Chang et al. (2015) evaluated the risk of ERP implementation in different industries, for both intra-organizational cultures. This research employed Fuzzy Analytic Network Process (FANP) method, which categorized into four different dimensions, such as management and execution, software system, users, and technology planning.

Er (2015) studied about the importance of knowledge management for successful ERP implementation. This study proposed process for transferring knowledge from external organizations into organizations. There are four processes, called as SECI process or model, which are combination, socialization, externalization and internalization. The author used a systematical literature review approach. For the further research, the researchers suggested to assess its effectiveness of the proposed mechanism that implemented.

Jayawickrama et al. (2016) studied about knowledge management which is crucial for ERP system implementation. It is found from the empirical study that to achieve successful ERP implementation, integrative knowledge competence should be done, such as key component of knowledge types, knowledge layers and knowledge management lifecycle. The measurements of its success are information quality, system quality, individual impact and organizational impact.

Hence, based on the previous researches, risk assessment is required for ERP implementation in UII, especially in DSP and DKA department by using Fuzzy Analytic Network Process method which integrates the Fuzzy Set Theory (FST) with Analytic Network Process (ANP) to address the imprecise nature of the vague problems. In this study, the ANP method is used for assessing risks while firms implement ERP system, addresses with the imprecise and uncertain nature of human comparison judgments by natural language in perception from experts. Then, the vagueness will be evaluated using fuzzy method. Fuzzy Analytical Network Process being used in this research to get the priority of the criteria and its risks as a preventive action before the risk might be appeared and fail the implementation that will lead to loss in term of money.

1.2 Problem Formulation

Based on the description in the background above, the problem that come up in the research would be formulated and generates a research question as follows:

1. How many and what are the risk factors that may occur in implementation of ERP system?
2. How are the levels of risks priority in the implementation of ERP system using Fuzzy Analytical Network Process?
3. How are the evaluations of each risk in the implementation of ERP system?

1.3 Objectives of Research

Based on the problem formulation above, the objectives of research can be arranged as follows:

1. Identifying the risk factors that occur in expected company that implements ERP.
2. Prioritize the risks that occur in expected company that implement ERP.
3. Evaluate the risks that occur in expected company that implement ERP.

1.4 Scope of Problem

Every research requires the directed scope and focus of the study. Therefore, this research should be given the restriction, so it can be focused and produce good research. Scope of the problem in this research as follows:

1. This research does not include the financial risk, whereas it is only about the operational risk.
2. Assessment that would be conduct refers to the implementation of ERP during the last 5 years of implementation.

3. This research will only investigate the process business of finance and material management department, not in all departments that may cover up by ERP.

1.5 Benefits of Research

This research has several benefits, such as increasing the knowledge, especially in risk assessment, enterprise resources planning and fuzzy analytical network process.

1.6 Systematical Writing

Writing this study was based on the rules of scientific writing in accordance with the systematics as follows:

CHAPTER I INTRODUCTION

This chapter contains a preliminary description of research activities, on the background of the problem, formulation of the problem, the objectives to be achieved, the benefits of research and systematic writing

CHAPTER II LITERATURE REVIEW

In this chapter elaborated on the theories of reference books and journals as well as the results of previous research related to the research problem which is used as reference for problem solving

CHAPTER III RESEARCH METHODOLOGY

It contains the description of the framework and lines of inquiry, the research object to be studied and the methods used in the study.

CHAPTER IV COLLECTION AND PROCESSING DATA

Contains the data obtained during the research and how to analyze the data. Data processing result is displayed either in the form of tables and graphs. What is meant by processing the data also includes

analysis of the results obtained. In this section is a reference to the discussion of the results to be written in Chapter V.

CHAPTER V

DISCUSSION

It contains discussion on the results of data processing that have been performed in research. Compatibility with the objectives of research so as to produce a recommendation.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Contains the conclusion of the analysis and any recommendations or suggestions on the results based on potential identified problems during the study, so it needs to be assessed in the future studies.

REFERENCES

APPENDIX

CHAPTER II

LITERATURE REVIEW

In this chapter, it will be explained about the literature studies which are divided into two, inductive and deductive. Inductive study is a study from previous research that already has reputation. Besides, deductive study is study that would explain about the basic theories that related with research, which are derived from the text books, etc. Inductive and deductive study need to be carried out to find out the gap between previous study and the recent research and also designated to avoid the plagiarism. This literature review will be divided into several sub chapters.

2.1 Inductive Study

Risk assessment in the implementation of enterprise resources planning is an important process that should be performed in a company. It is because, the company can identify the risks that might happened related to the hazard, later on it can be decided what step that should be taken to eliminate the risks. So, the appropriate risk assessment should be perform for the implementation of enterprise resources planning system.

Lots of researches about implementation of enterprise resources planning system are already carried out by the previous researchers, such as Aloini et al. (2012) assessed the relationship between risk factors with ERP project in multinational company using Interpretive Structural Modeling (ISM). From this research, it is found that this method is an effective method that can be conducted in preliminary stage for the decision makers in

quantifying the inputs to define the paths of risk factors, estimating the probability of the occurrence and their impacts on final outcomes, and finally facilitating the suitable strategies to overcome the risks.

Iskanius (2009) assessed the failure rate of enterprise resource planning project in three manufacturing small and medium size enterprises (SMEs) by using company-specific risk and characteristic analysis method. From this research, the researcher provided recommendation that ERP project should be divided into manageable sub projects, such as company A should take the next step in the ERP project. While company B, should enhancing the system and adopt new modules and company C should decide what ERP system that would take.

In & Nafkha (2014) examined the failures of the ERP system implementation and the risk level as well as additional cost related to the preventive action. The method that was used in this research is by spreading questionnaire for 50 different companies. Then, the correspondent should fulfill about the impact of threats (schedule, budget, quality, etc.) using scale of 1 to 5 to get the comparative analysis. The result is there is no verifiable methods that will accurately determine the system implementation failure or success likelihood, but the interval of each task is located might be determined.

Khaparde (2012) analyzed the barrier of ERP implementation from analytical literature review. It is found that there are several barriers that needed to be addressed, such as huge capital incurred for software, poor planning and management, lack of perfection, lack of approach, lack of support, etc. To overcome the barriers AHP methodology might be applied to analyze and solve ERP implementation issues. So, later on, the enterprises would be more productive.

Garg & Garg (2014) explored strategic, technological, people and project management factors that influence the successful of ERP implementation in Indian retail

sector. The method that used in this study is empirical study by spreading the questionnaire to corresponding practitioner using a web-based system and there were 175 questionnaires that being analyzed. After that, the statistical method such as correlation and regression analysis was conducted to validate the relationship between factor that influenced the ERP implementation and the successful of ERP implementation in Indian retail sector. The result of this study has empirically verified that the four factors, which are strategic, technological, people and project management are positively influence the successful of ERP implementation.

Luiç et al. (2011) studied about the implementation of ERP system in academic environment such as university. It is said that the integration become an aspect that should be concerned. This study used Integrated Business-Information System (IBIS) method, which would link the academic and business strategy. This study stated that there are several ERP solutions that should be used in higher education, such as grant and fund management, financial management, budgeting and planning and human capital management. Salmeron & Lopez (2010) said that after implementing ERP system, maintenance is needed. Then, the researchers analyze the risk factors of ERP system maintenance. It is divided into 7 phases of ERP maintenance, which are problem/modification identification, analysis, design, implementation, test, acceptance and delivery. From these 7 phases, it is breakdown into 30 risks. This study was evaluated by using AHP method. The result of the study stated that the most critical stage in ERP maintenance was the first phase which included receives, identifies, classifies and ranks software modification.

Zschieck et al. (2016) studied about broaden the point of view on ERP education by linking critical success factor to sustainability considerations. The method that was being used in this study was literature review of a case study in developing country, Africa. From the study, it is found that there were four dimensions involved, which were cultural characteristics, administrative structures, technical and infrastructural features, academic customs and practices and curricular content.

Garg & Khurana (2017) analyzed the impact of the risk factors in ERP implementation. The project was taken place in Indian retail. The aim of the study was to identify the key risk factors in ERP implementation using Structural Equation Model (SEM) approach. From the study, it is found that the user risk, project management risk, technological risk, team risk, organizational risk and project performance risk factor are positively as an impact of the successful ERP implementation.

Li et al. (2017) analyzed the Critical Success Factors (CSFs) of ERP system in information technology governance (ITG) perspective. The aim of this study was to identify the CSFs and how to mitigate the risk in ERP system. The CSFs were classified into five phases of ERP. The method was to identify the CSFs by using the systematical literature review. From the study, it can be concluded that ITG can be enforced by controlling the relevance between CSFs for ERP system. These CSFs used for aligning organizational strategies to achieve success in ERP system implementation.

Xie et al. (2014) developed an integrated decision support system for ERP implementation to facilitate the time, budget and risk analysis. The method that being used in this study is an analytical regression model developed from the survey result that spread to 400 SMEs that implement ERP system that already validated by using simulation model. The result of the study are valid to be used in SMEs with 50-150 employees and addressed the CSFs in ERP implementations such as project management, top management, IT infrastructure, user and vendor support. ERP implementation cost is increasing along the time. SMEs should put more concerns in effort and resources to achieve the goal while optimize the resources utilization.

Hooshang (Koenig, 2012) et al. (2014) investigated the factors that will contribute to the successful ERP implementation. The method is using qualitative method, which used the questionnaire that spread to 6 different manufacturing firms in Virginia. From the research, it was found that there are several critical success factors, which were different.

Five out of six firms said that the key of successful ERP implementation is interdepartmental communication. This study also found why the firms implement ERP system. The top four reasons are for upgrading the technology, improving productivity reducing the operational cost and requesting from the top management.

Er (2015) studied about the importance of knowledge management for successful ERP implementation. This study proposed process for transferring knowledge from external organizations into organizations. There are four processes, called as SECI process or model, which are combination, socialization, externalization and internalization. The author used a systematical literature review approach. For the further research, the researchers suggested to assess its effectiveness of the proposed mechanism that implemented. Jayawickrama et al. (2016) studied about knowledge management which is crucial for ERP system implementation. It is found from the empirical study that to achieve successful ERP implementation, integrative knowledge competence should be conducted, such as key component of knowledge types, knowledge layers and knowledge management lifecycle. The measurements of its success are information quality, system quality, individual impact and organizational impact.

Chang et al. (2015) evaluated the risk of ERP implementation in computer part manufacturer, solar energy Battery Company and Food Company, for both intra-organizational cultures. This research use Fuzzy Analytic Network Process (FANP) method, which categorized four different dimensions, such as management and execution, software system, users, and technology planning. The data were obtained from 20 ERP experts. It is found that “lack of management support and assistance” is vital risk for a successful ERP implementation. Top management’s support and involvement are crucial and essential factors to the success of a firm’s ERP implementation. “Ineffective communication with users” was found to be the second highest risk factor. The benefits of using the FANP method for evaluating the risk factors come from the clear priority weights between alternatives.

Table 2.1. Research Position

Researchers	Research Focus				Case Study			Methods				
	ERP	Risk Assessment	KM	CSF	Manufacture	Service	AHP	ANP	Fuzzy	ISM	Literature Review	Others
Aloini et al. (2012)	v	V			v					v		
Iskanius (2009)	v	V			v							Characteristic Analysis Method
In & Nafkha (2014)	v	V			v	v						Questionnaire
Kharpade (2012)	v										v	
Garg & Garg (2014)	v			v		v					v	Questionnaire
Luiç et al. (2011)	v					v						IBIS
Salmeron & Lopez (2010)	v	V				v	v					
Zschieck et al. (2016)	v					v					v	
Garg & Khurana (2017)	v	V			v							Structural Equation Model
Li et al. (2017)	v			v	v	v					v	

Researchers	Research Focus				Case Study			Methods				
	ERP	Risk Assessment	KM	CSF	Manufacture	Service	AHP	ANP	Fuzzy	ISM	Literature Review	Others
Xie et al. (2014)	v			v	v	v					v	Decision Support System
Beheshti et al. (2014)	v			v	v							Questionnaire (Qualitative)
Er (2015)	v		v	v	v						v	
Jayawickrama et al. (2016)	v		v	v	v						V	
Chang et al. (2015)	v	V			v	v		v	v			

From the inductive study that already done, finally found the state of the art that would be used in this research, by using Fuzzy Analytic Network Process to assess the risk in a company that implement ERP system. This method integrates the Fuzzy Set Theory (FST) with Analytic Network Process (ANP) to address the imprecise nature of the vague problems. In this study, the ANP method is used for assessing risks while firms that implement ERP system is addressed with the imprecise and uncertain nature of human comparison judgments by natural language in perception from experts. Then, the vagueness will be evaluated using fuzzy method. Fuzzy Analytical Network Process being used in this research to get the priority of the criteria and its risks.

2.2 Deductive Study

2.2.1 Evolution of Enterprise Resources Planning

The evolution of Enterprise Resources Planning (ERP) systems closely followed with the spectacular developments in the field of computer hardware and software system. Below is the figure 2.1 that shows the evolution of ERP system based on Rashid et al. (2002):

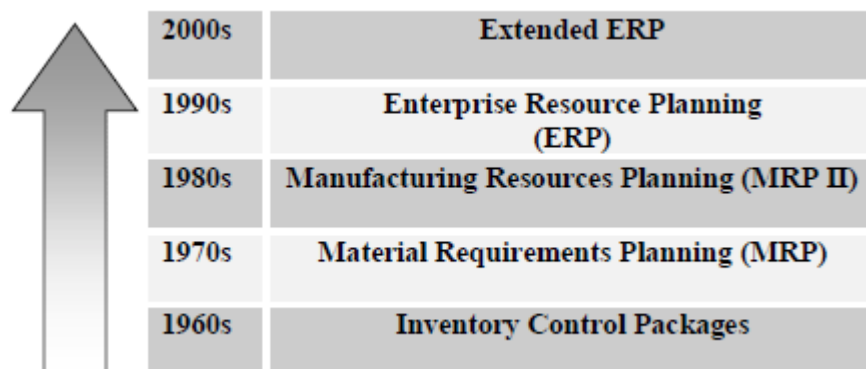


Figure 2.1 Evolution of ERP System

Source: Rashid et al. (2002)

In 1960s, most of the organizations designed, developed and implemented centralized computing system. To control the inventory, most companies automated it by using inventory control packages (IC). The system based on programming languages such as COBOL, ALGOL and FORTRAN. After that, the system developed into Material Requirements Planning (MRP) in 1970s. It is involved product planning or parts requirements according to the master production schedule. Then, in 1980s there was a new software system that following MRP, which was called Manufacturing Resources Planning (MRP II). It emphasized on optimizing manufacturing processes by synchronizing the materials with production requirements. The area that included in MRP II was shop floor and distribution management, project management, finance, human resource and engineering. In the late of 1980s, ERP system was first appeared.

2.2.2 Enterprise Resources Planning

Based on the technological foundation from previous system before ERP, which is MRP and MRP II, ERP system integrates primary business processes including manufacturing, distribution, accounting, financial, human resource management, project management and inventory management. Based on Helo (2011), ERP is an enterprise information system to enhance the efficiency and maintain the competitive position by integrate and optimize the business processes and transaction in corporation.

2.2.3 Risk Management

Based on AS/NZS ISO 31000:2009, Risk Management is the systematic application of management policies, procedures and practices to the tasks of establishing the context, identifying, analyzing, assessing, treating, monitoring and communicating. Below is figure that illustrates risk management process Hossein et al. (2011):

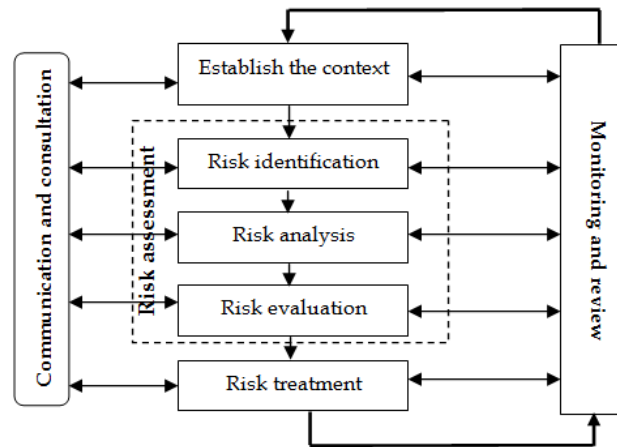


Figure 2.2 Risk Management Process

Source: Hossein et al. (2011)

As it is shown, risk assessment includes risk identification, risk analysis and risk evaluation. So, first we should recognize hazard factors by gathering suitable data and then analyze risk and use it for decision making. While all of the processes of risk assessment need monitoring and review and also communication and consultation.

In risk management, there are so many types of risks. There are several risks that often be met in a company, such as financial risk, operational risk and strategic risk.

a. Financial Risk

Financial risk might occur in a company. The reason these type of risk is occur, it is because of financial factors such as price, interest rate and currency.

b. Operational Risk

While for operational risk is about the non-financial factors, such as human, internal processes and technology.

c. Strategic Risk

Strategic risk is about the company that has low strategic planning.

Among those three risks, the operational risk tends to be the most risks that likely to occur. It is because operational risk is a day-to-day operation. Hence, if it is happened, it will disturb the processes or system, which will make it ineffective.

2.2.4 Knowledge Management

Knowledge management is the process of capturing, distributing, and effectively using knowledge (Koenig, 2012). According to Quast, 2012, there are three key reasons why knowledge management is important to a company's success, such as:

1. Facilitates decision-making capabilities
2. Builds learning organizations by making learning routine, and
3. Stimulates cultural change and innovation.

Based on Swanson et al., 2005, there are two factors in successful implementation of a packaged business software, such as know-why and know-how. From the research, it concludes that know-why and know-how factors that influence most are:

1. Enable to work better with suppliers or customers
2. Facilitates user communication across department
3. Top management provides necessary resources and understand the cost to implement and maintain its package.

2.2.5 Fuzzy Logic

Fuzzy logic is a proper way to map the input space into an output chamber Kusumadewi (2003). This concept was introduced by Lotfi A. Zadeh, a professor at the University of California at Berkeley in 1965. Fuzzy logic works by using a degree of membership of a value which is then used to determine the desired results.

Fuzzy logic can accommodate a degree of membership in the calculation of the data in the uncertain conditions in which the answer cannot be determined absolutely "yes" or "no" and "right" or "wrong". Reason uses fuzzy logic according to Kusumadewi & Purnomo (2004) are:

- a. The concept of fuzzy logic is easy to understand because it uses mathematical concepts underlying the fuzzy reasoning is simple
- b. Fuzzy logic is very flexible, meaning able to adapt to changes and uncertainty that accompanies the problem
- c. Fuzzy logic is tolerant of data improper
- d. Fuzzy logic functions able to model non-linear very complex
- e. Fuzzy logic can develop and apply the experiences of experts directly without having to go through the training process
- f. Fuzzy logic is based on natural language
- g. Fuzzy logic can work with conventional control techniques

2.2.6 Fuzzy Set Theory

According to Kusumadewi (2003) fuzzy set is a set of objects x where each object has a membership function " μ " or also called truth value. If X is a set of objects and members represented by x then the fuzzy set of A in X is the set with a pair of members or can be expressed by:

$$A = \{A(x) \mid x: x \in X, A(x) \in [0,1] \in \mathfrak{R}\} \quad (2.1)$$

For example, A = "number which is closer to 10" where: $A = \{(x, \mu_A(x)) \mid \mu_A(x) = (1+(x-10)^2)^{-1}\}$ $A = \{(0, 0.01), \dots, (5, 0.04), \dots, (10, 1), \dots, (15, 0.04), \dots\}$. The graph that represents the value $\mu_A(x)$ is as shown in Figure 2.3 below:

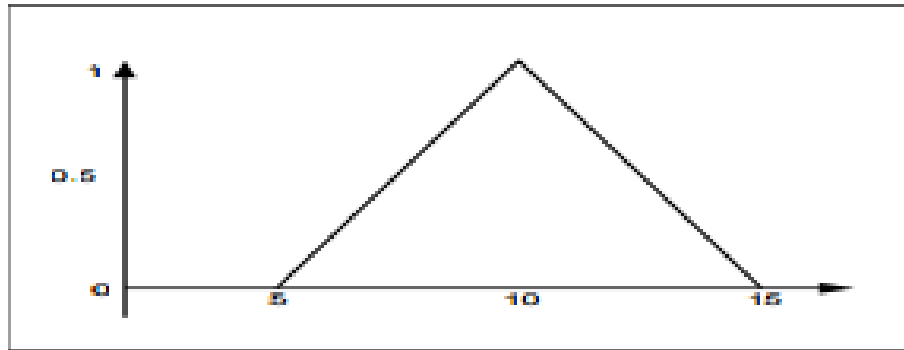


Figure 2.3. Fuzzy set graph

Source: Kusumadewi (2003)

Suppose that the automotive industry would design 10 models of car that will comfort a big family. 10 models are described in the variable $X = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}\}$, with x_i is the i -th car design. Fuzzy set, \hat{A} , which is a set: the car is comfortable to use for a large family can be written as $\hat{A} = \{(1; 0.6); (2; 0.3); (3; 0.8); (4; 0.2); (5; 0.1)\}$ Kusumadewi & Hartati (2006).

2.2.7 Triangular Fuzzy Number

Triangular Fuzzy Number (TFN) is a fuzzy set theory which help in the measurement of human subjective assessment uses the language or linguistics. In the approach used Fuzzy ANP it is used Triangular Fuzzy Number (TFN) to do fuzzification process of comparison matrix that is crisp. Each membership function is defined in three parameters namely l , m and u . Where l is the lowest possible value, m is the possible value of the middle and u is a possible value of the top interval decision maker or expert judgment. The value of l , m , and u can also be determined by the decision makers themselves. TFN and linguistic variables corresponding Saaty scale shown in Table 2.1:

Table 2.2. Triangular Fuzzy Number Scale

Definition	Saaty Scale	TFN
Equally important	1	(1/2, 1, 3/2)
Moderately more important	3	(1, 3/2, 2)
Strongly more important	5	(3/2, 2, 5/2)
Very strongly more important	7	(2, 5/2, 3)
Extremely more important	9	(5/2, 3, 7/2)

2.2.8 Analytic Network Process

In general, many people make decisions based only on a simple hierarchical structure that is the goal, criteria and alternatives. But to solve complex problems, according to Saaty by using Analytical Hierarchy Process (AHP) model, there are still many factors that unable to support decision making. Saaty & Roozan has developed Analytic Network Process (ANP). Based on (Saaty, 1999), ANP is a theory that is used to reduce the ratio of the composite priorities that reflect the scale of the individual ratios relative measurement of the influence of elements which interact with respect to the control criteria. ANP method is one of the methods that developed from the previous method which is AHP. ANP also can fix deficiencies of AHP where its ability to accommodate the interconnection between the criteria or alternatives (Saaty, 2005).

There are three main principles of ANP:

1. Decomposition

Problem that collected from the field study is a complex problem. To structure those problems, it should be decomposed into a network in a form of components, such as cluster, sub cluster and alternative. Decomposing is modelling the problems into ANP network.

2. Comparative judgement

This principle applied to see the pairwise comparison of all the networks or relationship or the influence that formed in the network. These relationships could interact between elements in different cluster or in a same cluster. This pairwise comparison used to get the local priority from the elements in a cluster seen from the main cluster.

3. Synthesis of priority

This principle is applied to multiply local priorities of elements in cluster with global priority from the main element that will produce the global priorities throughout the hierarchy and add them to produce global priorities for the lowest element level (alternative).

There are 2 linkages in ANP method which are linkages in a set of elements (inner dependence) and the linkages between the different elements (outer dependence).

The existence of these linkages will cause ANP method more complex than AHP. ANP is a mathematical theory that allows one to treat dependence and feedback that can systematically capture and combine the factors tangible and intangible. ANP is one of the new theories in the decision-making process that provides a common framework in treating decisions without making assumptions about the independence of the elements at higher levels of the elements on the lower level and on the independence of the elements in a level.

By feedback, the alternatives can be dependent on criteria such as the hierarchy but can also dependent on each other alternatives. Meanwhile, feedback increases priorities derived from the judgments and make more accurate predictions. Therefore, the results of the ANP are expected to be more stable.

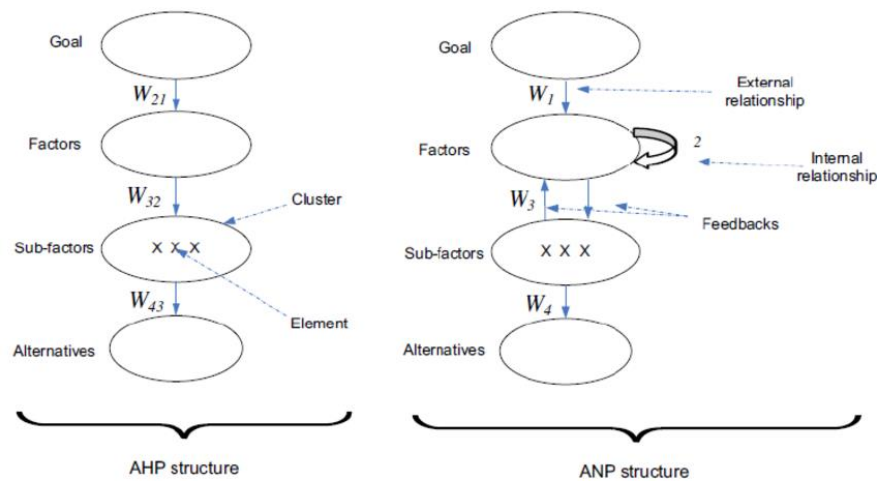


Figure 2.4 Difference between Hierarchy Structure and Network Structure

Source: Saaty (1999)

ANP is desired in knowing the overall effect of all the elements. Therefore, all the criteria must be set up and made a priority within the framework of the control hierarchy or network, perform comparisons and synthesis to obtain the order of priority of this set of criteria. Then we derive the influence of elements in the feedback system with attention to each criterion. Finally, the results of this effect is weighted by the importance of the criteria, and added to obtain the overall effect of each element.

ANP is a combination of two parts. The first part consists of a hierarchy of control or network of criteria and sub-criteria that control the interaction. The second part is a network of influences between elements and clusters.

AHP and ANP are both using the scale ratio. Priorities in a ratio scale is a fundamental figure that allows to do basic arithmetic calculations such as addition and subtraction in the same scale, multiplication and division of a different scale, and combining them with appropriate weighting and adding different scales to obtain a scale of one dimensions. Keep in mind that the scale ratio is also an absolute scale. Both scales were obtained from pairwise comparison (paired comparisons) using the ratio of dominance

judgments or partner by using actual measurements. In terms of the use of judgments, in AHP someone asked: "Which is more preferable or more important?", While the ANP someone asked: "Which has a bigger influence?" The last question clearly requires a factual observation and knowledge to produce answers valid, which makes the second question is more objective than the first question.

According to Ascarya (Tanjung & Devi, 2013) there are three main functions of the ANP, namely:

i. Structuring Complexity

Complex problems if not structured properly will be difficult to decipher it. As in everything and anything as complex as the problems encountered, ANP assist in structuring the problem

ii. Measurement on the Ratio Scale

Measurements in this ratio scale are necessary to reflect proportions. Each method with hierarchical structure should use a ratio scale priorities for elements above the lowest level of the hierarchy. This is important because the priorities (weights) of elements at any level of the hierarchy are determined by multiplying the priority of the parent element. Since the result of the multiplication of two mathematically interval level measurement has no meaning, the ratio scale is required for this multiplication. ANP uses the scale ratio in all the lowest level of the hierarchy / network, including the lowest level (alternative choice model). Ratio scale is becoming increasingly important if the priority is not only used for the application of choice, but for other applications, such as applications for resource allocation.

iii. Synthesis

Synthesis means to unite all the parts into a single unit. Because of the complexity, the situation is important decisions, or forecasts, or the allocation of resources, often involve too many dimensions for humans to be able to perform synthesis intuitively, we need a way

to do a synthesis of many dimensions. More important function in the ANP is its ability to assist decision makers in making measurements and synthesis of a number of factors in the hierarchy or network.

Based on (Saaty, 1996), ANP method is the development of AHP. ANP is a measurement theory which usually applies to the dominance of influence among some stakeholders or alternatives with respect to an attribute or criterion. ANP network structure is described by the arrow two lines (arcs) that present the interdependence of grouping or if in the levels of the same factors will form a loop. Directions arc indicates dependence. Arc derived from control attributes that connect with other attributes that can affect each other. The relative importance of the element / elements is measured by the ratio scale. ANP is able to handle the interdependence of elements with a combined weight gain through the development of super matrix. Saaty (2005) described the concept as parallel super matrix on Markov Chain process. Picture 2.6 is a form of interdependence of the various components in the structure of the ANP.

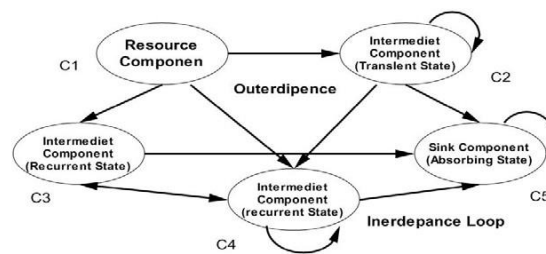


Figure 2.5 Interdependence

Source: Saaty (2005)

In a system with N components that consist of elements that will provide mutual influence, can be denoted that the component C is symbolized by the number $N C_h$ where $h = 1, 2, 3, \dots, N$. Elements Owned by the component will be denoted by $e_{h1}, e_{h2}, \dots, e_{hn}$. Value of super matrix given as a result of assessment of the priority scale derived from pairwise comparisons such as the AHP. The relationship between the elements is represented by the vector-derived priorities in AHP pairwise comparisons. Matrix prepared to describe the flow of interest between both components of the inner and outer

dependence. In general, the relationship between the interests of the elements in a network with other elements in the network can be represented follow super matrix, as follows:

$$W = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_N \end{matrix} \\ \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_N \end{matrix} & \begin{bmatrix} e_{11}e_{12} \dots e_{1n_1} & e_{21}e_{22} \dots e_{2n_2} & \dots & e_{N1}e_{N2} \dots e_{Nn_N} \\ W_{11} & W_{12} & \dots & W_{1N} \\ W_{21} & W_{22} & \dots & W_{2N} \\ \vdots & \vdots & \dots & \vdots \\ W_{N1} & W_{N2} & \dots & W_{NN} \end{bmatrix} \end{matrix}$$

Figure 2.6 Supermatrix of Network
Source: Saaty (2005)

Form of W_{ij} in super matrix is called as super matrix block and followed by matrix as follows:

$$W_{ij} = \begin{bmatrix} W_{i1}^{(j_1)} & W_{i1}^{(j_2)} & \dots & W_{i1}^{(j_{n_j})} \\ W_{i2}^{(j_1)} & W_{i2}^{(j_2)} & \dots & W_{i2}^{(j_{n_j})} \\ \vdots & \vdots & \dots & \vdots \\ W_{in_i}^{(j_1)} & W_{in_i}^{(j_2)} & \dots & W_{in_i}^{(j_{n_j})} \end{bmatrix}$$

Figure 2.7 Supermatrix Component of Network
Source: Saaty (2005)

Each column on W_{ij} is eigen vectors show the interest of the elements in the i -th component of the network on an element in the j -th component. Some entries that show the zero relationship on elements mean there is no interest in such elements. If this happens then the element is not used in pairwise comparisons to lower eigen vector. So things to be used are the elements that generate the interest is not zero.

Each criterion is taken into consideration as it has some advantages and disadvantage for the decision makers. Some of these criteria could be something definite or even uncertain occurrence. That is why, in general, a definite advantage for something called benefits while the disadvantage is cost. While the advantages for something that is not definitely known as opportunities (opportunities) while its disadvantage is called as risk which refers to something that is uncertain and likely to be faced by decision makers. A simple form of network analysis of *Benefit, Cost, Opportunity, and Risk* (BCOR) is a network effect (impact network) as the form of ANP network in general. This network has two separate networks in the chart, which for positive influence, and for the negative influence (Tanjung and Devi, 2013).

2.2.9 Analytical Network Process Steps

Fuzzy Analytical Network Process is a generalization of the Analytic Hierarchy Process (AHP) which can take the inner and outer dependencies among multiple criteria into consideration. The ANP method is presented step-by-step as follows based on (Saaty, 2005):

Step 1. Construct the network structure.

Step 2. Calculate the weight of each element. This step includes consistent by finding the value of maximum eigen value (λ_{\max}), Consistency Index (CI) and Consistency Ratio (CR).

Step 3. After all of the matrix from the expert assessment is consistent, all the value being converted to Triangular Fuzzy Number (TFN) Scale.

Step 4. Result of pairwise comparison from experts gathered using geometric mean pass through the experts assessment.

2.2.10 Fuzzy Analytical Network Process Step

To do the calculation of fuzzy with ANP approach, the researchers adapt the method from Chang's extent analysis with respect to the i th object (Chang et al., 2015) is define as followed.

Step 1. Calculate the value of fuzzy synthesis for i -th object that define as follow:

$$S_i = \sum_{j=1}^m M_{gi}^j \otimes \left[\sum_{i=1}^n \sum_{i=0}^m M_{gi}^j \right]^{-1} \quad (2.2)$$

To get the M_{gi}^j , operation of calculation of synthesis fuzzy value m in the matrix pairwise comparison:

$$\sum_{j=1}^m M_{gi}^j = \left(\sum_{j=1}^m l_i, \sum_{j=1}^m m_i, \sum_{j=1}^m u_i \right) \quad (2.3)$$

To get $\left[\sum_{i=1}^n \sum_{i=0}^m M_{gi}^j \right]^{-1}$, the operation of fuzzy from value M_{gi}^j ($j = 1, 2, \dots, m$) were done.

$$\sum_{i=1}^n \sum_{i=0}^m M_{gi}^j = \left(\sum_{j=1}^m l_i, \sum_{j=1}^m m_i, \sum_{j=1}^m u_i \right) \quad (2.4)$$

To calculate the invers from equation (3) above as is follow:

$$\left[\sum_{i=1}^n \sum_{i=0}^m M_{gi}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right) \quad (2.5)$$

Step 2. Calculate the degree of possibility from $M_1(l_1, m_1, u_1) \geq M_2 = (l_2, m_2, u_2)$ can be defined as:

$$V(M_1 \geq M_2) = \left\{ \begin{array}{ll} 1, & m_1 \geq m_2 \\ \frac{l_2 - u_1}{(m_1 - u_1) - (m_2 - l_2)}, & m_1 < m_2, u_1 \geq l_2 \\ 0, & otherwise \end{array} \right\} \quad (2.6)$$

Step 3. The degree of possibility of a convex fuzzy number greater than k in the convex fuzzy numbers M_k and $k = 1, 2, 3, \dots, K$ can be defined as:

$$(M \geq M_1, M_2, \dots, M_k) = \min_{k=1,2,\dots,k} V(M \geq M_k) \quad (2.7)$$

Assume that,

$$d'(A_p) = \min V(S_p \geq S_k), p \in \{1, 2, \dots, k, \dots, K\} \quad (2.8)$$

Then, the vector of weights can be calculated as:

$$w' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T \quad (2.9)$$

Step 4. The normalized weight vectors can be defined as follows:

$$w = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (2.10)$$

CHAPTER III

RESEARCH METHODOLOGY

3.1 Problem Identification

This research was taken place in Universitas Islam Indonesia. It is located in Jl. Kaliurang KM. 14.5, Yogyakarta. Universitas Islam Indonesia is already implement ERP system in its finance, material management and inventory. Financial Accounting and Controlling (FICO) module has been implemented in *Direktorat Keuangan dan Anggaran* (DKA) while for the Material Management (MM) module has been implemented in *Direktorat Sarana dan Prasarana* (DSP). During the implementation of ERP SAP in UII, there are several risks that might come up that can make the implementation failed. Hence, this research aims to know the potential risks that influence the implementation of ERP in UII using Fuzzy Analytical Network Process and give the recommendation on how to overcome the risks, especially the operational risk. The result of this research is the rank of each risk and recommendation of real action that should be taken to overcome the risks in implementing the ERP SAP in UII.

3.2 Problem Formulation

This research focuses on assessing the risk of implementation ERP system in UII. Later after identifying the problem, problem formulation can be resumed. Problem formulation is being used to direct the solution from the problem and as a foundation to make a conclusion.

3.3 Literature Review

Deductive and inductive studies were performed for the literature review. Deductive study was carried out to gain the basic concept of this research. Then, it is followed by conducting the inductive study to gain the information of related research, to identify the difference and position of this research among the other or previous researches.

3.4 Data Collection

The data that are being used in this research is a primer data which derived from the result of brainstorming, questionnaire and interview. Brainstorming is designated to obtain the risk that suitable with the current case study. Questionnaire is subjected for fulfilling the pairwise comparison matrix of criteria and sub criteria. While, the interview is purposed to identify the occurrence of the risks. There are two subjects in this research, named Mr. Cahyo and Mr. Furqon. Both are the experts in MM and FICO modules respectively in Universitas Islam Indonesia. Data that collected are the risks of ERP implementation, comparison between criteria and sub criteria.

3.5 Data Processing

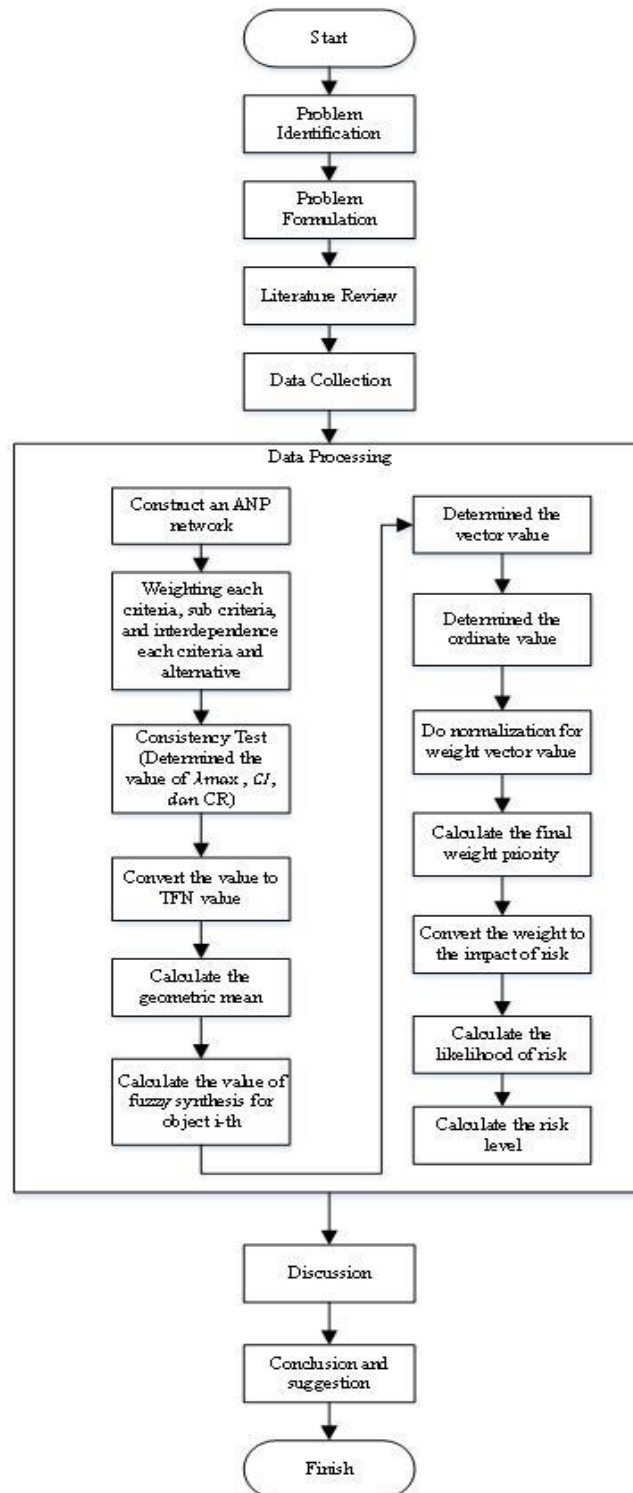


Figure 3.1. Flowchart of Research

3.6 Discussion

After all the data processing finished, then discussion was conducted starting from the result of calculation using Fuzzy Analytical Network Process (FANP) method until the global weight are calculated and then, the result from ANP would be data for the risk evaluation.

3.7 Conclusion and Recommendation

This chapter would be briefly explaining the answers of all the problem formulations that already formulated in the beginning of the research. Besides, there are several suggestions that can be used by the institution and further research.

CHAPTER IV

DATA COLLECTION AND PROCESSING

4.1 Data Collection

This research was taken place in *Direktorat Sarana dan Prasarana* (DSP) and *Direktorat Keuangan dan Anggaran* (DKA) of Universitas Islam Indonesia (UII). DSP UII has function to do procurement and inventory management. While, DKA has function in controlling the financial in UII. In this research, it will be conducted a risk assessment. Therefore, the risk that will be discussed should be defined first. Operational risk will be selected as the main of the risk in this research. Hence, to support the risk assessment, the researcher needs data that would support the risk identification, analysis and evaluation. For the risk identification, data were collected from literature review and brainstorming with experts. Then to analyze the risk, should be conducted interview questionnaire with the experts. The questionnaire that given is pairwise comparison of alternatives to overcome the risk, criteria and sub-criteria of risks that may be occurred. While for the evaluation, the data that would be obtained is data about the likelihood of the risk that already identify. There are two experts provided for this research, the first one is staff in DSP that has expertise in handling SAP in MM module. The second expert is staff in DKA that has expertise in executing SAP in FI-CO module.

4.1.1 Network of Analytical Network Process

To define each sub criteria of the ANP which is the risk itself, the researcher defines the type of risk that would be done in this research. Actually, there are many kinds of risks that might occur in a company, and one of them is called operational risk. It is the prospect of loss resulting from inadequate or failed procedures, systems or policies, such as employee errors, systems failures, fraud or other criminal activity and any event that disrupts business processes. Hence, based on previous study and brainstorming with the experts, the researchers conclude the criteria, sub criteria and alternatives for risk of ERP implementation in UII. The criteria of ‘Knowledge Management’ are adopted from Jayawickrama, 2016¹ and its sub criteria are adopted from Quast, 2012². While, the rest are adopted from Chang et al, 2015³. Table 4.1 below is the list criteria and sub criteria of ERP implementation in UII:

Table 4.1 Criteria and Sub Criteria Risk of ERP Implementation

Criteria	Sub Criteria	Ref.
Knowledge Management	R1 Top management provide inadequate resources	2
	R2 Lack of knowledge end-user	Expert
	R3 Top Management less understand with ERP system	Expert
Management & Execution	R4 Less discipline while execution process	Expert
	R5 Less management support and assistance	3
	R6 Lack of knowledge while implement ERP SAP	Expert
Software System	R7 Failed in customize SAP system	3
	R8 Complex interface	3
	R9 Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	Expert
Technology Planning	R10 Less integration	3
	R11 Lack of testing	3
	R12 Lack of module that implement	3
User	R13 Fast job rotation	Expert
	R14 Communication between admin and end-user ineffective	Expert
	R15 Lack of training and refreshment	3
	R16 Lack of Human Resources	Expert

In Knowledge Management criteria, there are three sub criteria, which are 'Top management provide inadequate resources', 'Lack of knowledge end-user' and 'Top Management less understand with ERP system'. 'Top management provides inadequate resources' means top management does not fulfill the resources to make the software of ERP implement well, for example like internal consultant. 'Lack of knowledge end-user' means the end-user which operate the system has lack of knowledge of its system, 'Top Management less understand with ERP system' means the top management not fully understand the ERP system.

While in the second criteria, Management and Execution, there are also three sub criteria. 'Less discipline while execution process' means sometimes the execution is not in line with the procedure, 'Less management support and assistance' means sometimes the admin is less responsive when there is problem in end-user level, 'Lack of knowledge while implement ERP SAP' means both top management and end users have little knowledge about ERP SAP package software during the implementation,

In Software system criteria, 'Failed in customize SAP system' means the SAP software does not customize well as expected, 'Complex interface' means the interface of the software is confusing sometimes, and 'Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP' means the internal software cannot integrate directly to the ERP SAP software because the software is always updated while the internal software is not.

While in the fourth criteria, Technology planning, 'Less integration' means there is lack of integration between each department and between the historical data in internal software and the ERP SAP software, 'Lack of testing' means in the first implementation of ERP SAP there is not done fully testing, 'Lack of module that implement' means not all department implement ERP SAP software module.

In the last criterion which is User, there are four sub criteria. 'Fast job rotation' means high job rotation among end-user, 'Communication between admin and end-user ineffective' means there is a gap between admin and end-user that makes the communication is ineffective, 'Lack of training and refreshment' means the user not get

intensive or regular training about the ERP SAP, and ‘Lack of Human Resources’ means the end-user that can operates the ERP SAP software is not many.

After that, the ANP network for the risk of ERP implementation in UII especially was constructed using Super Decision software. Figure 4.1 below is the network of ANP:

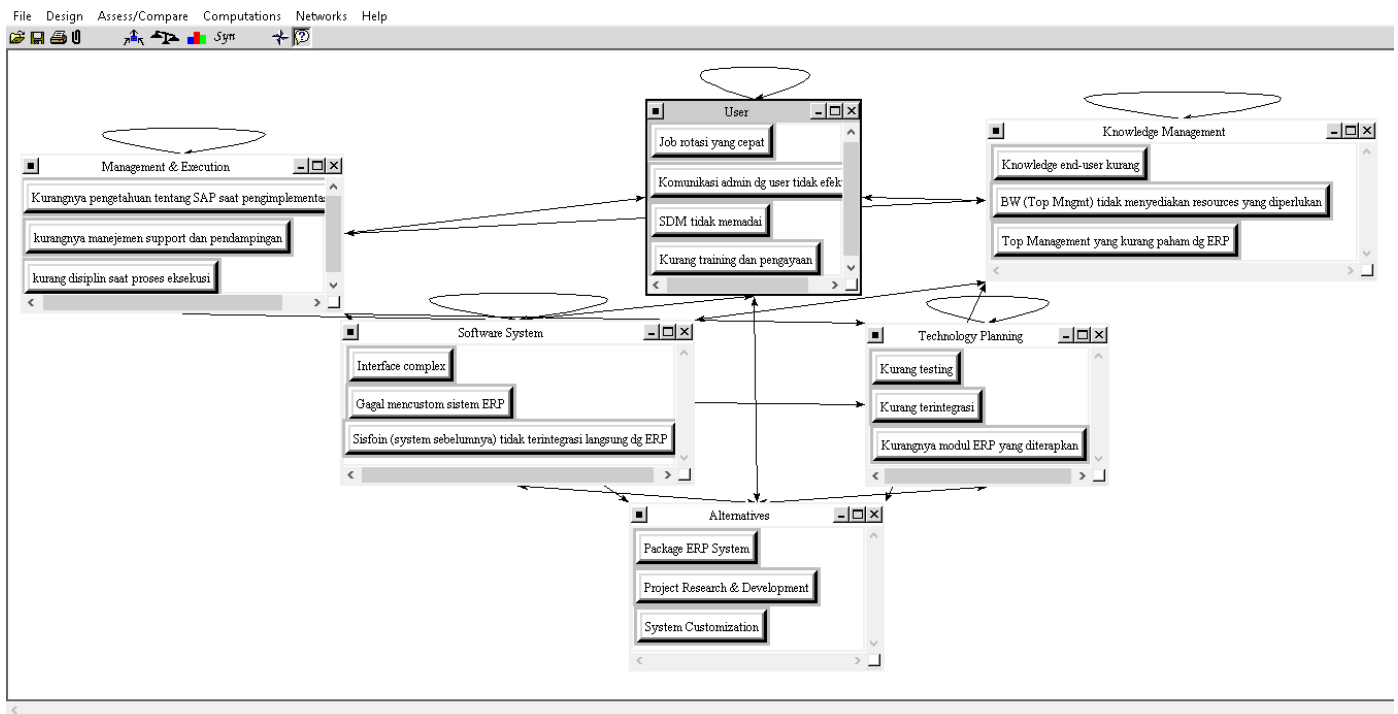


Figure 4.1 Network Structure of ANP

The figure 4.1 above, seen that there are five criteria that would impact the implementation of ERP in UII. The five criteria are Management & Execution, Software System, User, Technology Planning and Knowledge Management.

4.1.2 First Expert

After the ANP structure was constructed, then the researcher done the interview with the expert. Table 4.2-Table 4.12 below are the result of the questionnaire from the first expert.

Table 4.2 Matrix of Pairwise Comparison Criteria with No Dependency

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	1/3	3	1/5	3
Management & Execution	3	1	5	1/3	3
Software System	1/3	1/5	1	1/5	3
Technology Planning	5	3	5	1	7
User	1/3	1/3	1/3	1/7	1

Table 4.3 Matrix of Pairwise Comparison Criteria with Respect to Knowledge Management

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	1/3	3	1/3	3
Management & Execution	3	1	5	1/3	3
Software System	1/3	1/5	1	1/5	1/3
Technology Planning	3	3	5	1	5
User	1/3	1/3	3	1/5	1

Table 4.4 Matrix of Pairwise Comparison Criteria with Respect to Management & Execution

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	1/5	3	1/5	3
Management & Execution	5	1	5	1/3	5
Software System	1/3	1/5	1	1/7	1/3
Technology Planning	5	3	7	1.00	5
User	1/3	1/5	3	1/5	1

Table 4.5 Matrix of Pairwise Comparison Criteria with Respect to Software System

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	3	1/3	3	5
Management & Execution	1/3	1	1/3	3	5
Software System	3	3	1	5	5
Technology Planning	1/3	1/3	1/5	1	3
User	1/5	1/5	1/5	1/3	1

Table 4.6 Matrix of Pairwise Comparison Criteria with Respect to Technology Planning

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	5	3	1/5	5
Management & Execution	1/5	1	1/3	1/7	1/3
Software System	1/3	3	1	1/3	3
Technology Planning	5	7	3	1	7
User	1/5	3	1/3	1/7	1

Table 4.7 Matrix of Pairwise Comparison Criteria with Respect to User

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	3	5	5	3
Management & Execution	1/3	1	3	5	1/3
Software System	1/5	1/3	1	3	1/3
Technology Planning	1/5	1/5	1/3	1	1/3
User	1/3	3	3	3	1

Table 4.8 Matrix of Pairwise Comparison Sub Criteria with Respect to KM

	Top management provide inadequate resources	Lack of knowledge end-user	Top Management less understand with ERP system
Top management provide inadequate resources	1.00	5.00	3.00
Lack of knowledge end-user	1/5	1.00	1/3
Top Management less understand with ERP system	1/3	3.00	1.00

Table 4.9 Matrix of Pairwise Comparison Sub Criteria with Respect to Management and Execution

	Less discipline while execution process	Less management support and assistance	Lack of knowledge while implement ERP SAP
Less discipline while execution process	1.00	5.00	3.00
Less management support and assistance	1/5	1.00	1/3
Lack of knowledge while implement ERP SAP	1/3	3.00	1.00

Table 4.10 Matrix of Pairwise Comparison Sub Criteria with Respect to Software System

	Failed in customize SAP system	Complex interface	Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP
Failed in customize SAP system	1.00	3.00	0.33
Complex interface	1/3	1.00	1/5
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	3	5.00	1.00

Table 4.11 Matrix of Pairwise Comparison Sub Criteria with Respect to Technology Planning

	Less integration	Lack of testing	Lack of module that implement
Less integration	1.00	1/3	1/5
Lack of testing	3	1.00	1/3
Lack of module that implement	5	3.00	1.00

Table 4.12 Matrix of Pairwise Comparison Sub Criteria with Respect to User

	Fast job rotation	Communication between admin and end-user ineffective	Lack of training and refreshment	Lack of Human Resources
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	Fast job rotation	Communication between admin and end-user ineffective	Lack of training and refreshment	Lack of Human Resources
Fast job rotation	1	5	3	3
Communication between admin and end-user ineffective	1/5	1	1/5	1/3
Lack of training and refreshment	1/3	5	1	3
Lack of Human Resources	1/3	3	1/3	1

4.1.3 Second Expert

The researcher also done the interview with another expert. Table 4.13-Table 4.23 below are the result of the questionnaire from the second expert.

Table 4.13 Matrix of Pairwise Comparison Criteria with No Dependency

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	3	1/3	5	5
Management & Execution	1/3	1	1/3	3	5
Software System	3	3	1	7	7
Technology Planning	1/5	1/3	1/7	1	1/3
User	1/5	1/5	1/7	3	1

Table 4.14 Matrix of Pairwise Comparison Criteria with Respect to KM

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	3	5	5	3
Management & Execution	1/3	1	3	5	3
Software System	1/5	1/3	1	3	3
Technology Planning	1/5	1/5	1/3	1	1/3
User	1/3	1/3	1/3	3	1

Table 4.15 Matrix of Pairwise Comparison Criteria with Respect to Management & Execution

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	3	5	5	1/3
Management & Execution	1/3	1	3	5	1/3
Software System	1/5	1/3	1	3	1/5
Technology Planning	1/5	1/5	1/3	1	1/5
User	3	3	5	5	1

Table 4.16 Matrix of Pairwise Comparison Criteria with Respect to Software System

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	1/5	1/5	3	1/3
Management & Execution	5	1	3	5	3
Software System	5	1/3	1	5	3
Technology Planning	1/3	1/5	1/5	1	1/3
User	3	1/3	1/3	3	1

Table 4.17 Matrix of Pairwise Comparison Criteria with Respect to Technology Planning

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	1/3	3	1/5	5
Management & Execution	3	1	3	1/3	5
Software System	1/3	1/3	1	1/5	3
Technology Planning	5	3	5	1	5
User	1/5	1/5	1/3	1/5	1

Table 4.18 Matrix of Pairwise Comparison Criteria with Respect to User

	Knowledge Management	Management & Execution	Software System	Technology Planning	User
Knowledge Management	1	1/3	1/5	1/3	1/7
Management & Execution	3	1	1/3	3	1/5
Software System	5	3	1	5	1/3
Technology Planning	3	1/3	1/5	1	1/5
User	7	5	3	5	1

Table 4.19 Matrix of Pairwise Comparison Sub Criteria with Respect to KM

	Top management provide inadequate resources	Lack of knowledge end-user	Top Management less understand with ERP system
Top management provide inadequate resources	1.00	0.33	0.20
Lack of knowledge end-user	3	1.00	1/3
Top Management less understand with ERP system	5	3.00	1.00

Table 4.20 Matrix of Pairwise Comparison Sub Criteria with Respect to Management & Execution

	Less discipline while execution process	Less management support and assistance	Lack of knowledge while implement ERP SAP
Less discipline while execution process	1	1/3	1/5
Less management support and assistance	3	1	1/3
Lack of knowledge while implement ERP SAP	5	3	1

Table 4.21 Matrix of Pairwise Comparison Sub Criteria with Respect to Software System

	Failed in customize SAP system	Complex interface	Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP
Failed in customize SAP system	1	1/3	3
Complex interface	3	1	5
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	1/3	1/5	1

Table 4.22 Matrix of Pairwise Comparison Sub Criteria with Respect to Technology Planning

	Less integration	Lack of testing	Lack of module that implement
Less integration	1.00	1/3	3
Lack of testing	3	1.00	5
Lack of module that implement	1/3	0.20	1.00

Table 4.23 Matrix of Pairwise Comparison Sub Criteria with Respect to User

	Fast job rotation	Communication between admin and end-user ineffective	Lack of training and refreshment	Lack of Human Resources
Fast job rotation	1	1/3	3	1/5
Communication between admin and end-user ineffective	3	1	5	1/3
Lack of training and refreshment	1/3	1/5	1	1/5
Lack of Human Resources	5	3	5	1

4.2 Data Processing

4.2.1 Super Decision

Super Decision is being used to construct the network that already agreed between researcher and experts. By Using Super Decision software, the matrix of pairwise

comparison was generated. After that, the data that already collected from both experts were inputted to the software. This step is addressed to see whether the data already consistent or not. The pairwise comparison matrix is consistent if the value of inconsistency is less than or equal to 0.1 (≤ 0.1). If the consistency ratio is ≤ 0.1 then the result of the calculation data is accepted. All the matrixes of pairwise comparison in this research are already consistent. Table 4.24 below is the recapitulation data of the super decision software:

Table 4.24 Recapitulation of Consistency Test

Pairwise Comparison	First Expert	Second Expert
criteria with no dependency	0.08575	0.08877
criteria wrt KM	0.07111	0.09238
criteria wrt ME	0.09371	0.08726
criteria wrt SS	0.07933	0.06942
criteria wrt TP	0.09544	0.09238
criteria wrt U	0.09238	0.07933
sub criteria wrt KM	0.03703	0.03703
sub criteria wrt ME	0.03703	0.03703
sub criteria wrt SS	0.03703	0.06239
sub criteria wrt TP	0.03703	0.03703
sub criteria wrt U	0.07418	0.07418

4.2.2 Fuzzy Analytical Network Process

After all the result of the pairwise comparison are consistent, the next step is fuzzification ANP scale of criteria (no dependency), sub criteria and criteria with inner dependency pairwise comparison to Triangular Fuzzy Number scale.

A. Weight of Criteria (No Dependency) Calculation

First, assume that there is no dependency between criteria. Table 4.25 and 4.26 below are results of conversion from both experts that using numeric scale to be the TFN scale:

Table 4.25 Matrix of Criteria Pairwise Comparison TFN scale (First Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
KM	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00	0.40	0.50	0.67	1.00	1.50	2.00
ME	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50	0.50	0.67	1.00	1.00	1.50	2.00
SS	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00	0.40	0.50	0.67	1.00	1.50	2.00
TP	1.50	2.00	2.50	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.00	1.00	2.00	2.50	3.00
U	0.50	0.67	1.00	0.50	0.67	1.00	0.50	0.67	1.00	0.33	0.40	0.50	1.00	1.00	1.00

Table 4.26 Matrix of Criteria Pairwise Comparison TFN scale (Second Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
KM	1.00	1.00	1.00	1.00	1.50	2.00	1.00	1.50	2.00	1.50	2.00	2.50	1.50	2.00	2.50
ME	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	1.00	1.50	2.00	1.50	2.00	2.50
SS	1.00	1.50	2.00	1.00	1.50	2.00	1.00	1.00	1.00	2.00	2.50	3.00	2.00	2.50	3.00
TP	0.40	0.50	0.67	0.50	0.67	1.00	0.33	0.40	0.50	1.00	1.00	1.00	0.50	0.67	1.00
U	0.40	0.50	0.67	0.40	0.50	0.67	0.33	0.40	0.50	1.00	1.50	2.00	1.00	1.00	1.00

To make it more reliable, the geometric mean should be calculated to know how well the consistency of the pairwise comparison are. Geometric mean calculates from equation 4.1 below:

$$\left(\prod_{i=1}^n a_i \right)^{1/n} = \sqrt[n]{a_1 \cdot a_2 \cdot \dots \cdot a_n} \quad (4.1)$$

While the consistency test done by observed the value of l , m and u . If the value of $l \leq m \leq u$, then the fuzzy calculation is consistent. Table 4.27 below is the result of the geometric mean:

Table 4.27 Geometric Mean Matrix of Criteria Pairwise Comparison TFN scale

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
KM	1.00	1.00	1.00	0.71	1.00	1.41	1.00	1.50	2.00	0.77	1.00	1.29	1.22	1.73	2.24
ME	0.71	1.00	1.41	1.00	1.00	1.00	1.22	1.73	2.24	0.71	1.00	1.41	1.22	1.73	2.24
SS	0.71	1.00	1.41	0.63	0.87	1.15	1.00	1.00	1.00	0.89	1.12	1.41	1.41	1.94	2.45
TP	0.77	1.00	1.29	0.71	1.00	1.41	0.71	0.89	1.12	1.00	1.00	1.00	1.00	1.29	1.73
U	0.45	0.58	0.82	0.45	0.58	0.82	0.41	0.52	0.71	0.58	0.77	1.00	1.00	1.00	1.00

From matrix pairwise comparison above, seen that in each criteria the value of $l \leq m \leq u$. Hence, it is indicated that the fuzzy number is consistent. After the fuzzy number consistent, then it is ready to calculate the weight of each criterion.

- i. Calculate the value of fuzzy synthesis

From table 4.27 value of all row and column were calculated. The value of l , m and u were calculated by sum the total value of l , m and u in each criterion, respectively.

Table 4.28 below is the result:

Table 4.28 Value of Total Row and Column

Total Row and Column Value		
l	m	u
4.71	6.23	7.94
4.86	6.46	8.30
4.65	5.92	7.43
4.19	5.19	6.56
2.88	3.45	4.34
21.29	27.25	34.57

After the value of total row and column were calculated, then the invers value of total column value was calculated. The invers value for l is obtained from 1 divided by total row of u. m^{-1} value obtained from 1 divided by the total m. While u^{-1} value obtained from 1 divided by 21.29 or the total of l. Table 4.29 below is the result value of invers:

Table 4.29 Invers Value of Total Column

Invers Value of Total Column		
l	m	u
0.03	0.04	0.05

It is shown that the invers values of total column are 0.03, 0.04 and 0.05 respectively. Then, the synthesis of fuzzy was calculated by multiply the total column of each value with invers of total column.

$$S_{km} = (4.71, 6.23, 7.94) \times (0.03, 0.04, 0.05)$$

$$= (0.14, 0.23, 0.37)$$

$$S_{me} = (4.86, 6.46, 8.30) \times (0.03, 0.04, 0.05)$$

$$= (0.14, 0.24, 0.39)$$

$$S_{ss} = (4.65, 5.92, 7.43) \times (0.03, 0.04, 0.05)$$

$$= (0.13, 0.22, 0.35)$$

$$S_{tp} = (4.19, 5.19, 6.56) \times (0.03, 0.04, 0.05)$$

$$= (0.12, 0.19, 0.31)$$

$$S_u = (2.88, 3.45, 4.34) \times (0.03, 0.04, 0.05)$$

$$= (0.08, 0.13, 0.20)$$

Table 4.30 Value of Synthesis Fuzzy

Criteria	Value of Synthesis Fuzzy		
	l	m	u
Knowledge Management (KM)	0.136	0.229	0.373
Management & Execution (ME)	0.141	0.237	0.390
Software System (SS)	0.134	0.217	0.349
Technology Planning (TP)	0.121	0.190	0.308
User (U)	0.083	0.126	0.204

ii. Determine the vector value

To determine the value of the vector, then it calculated using the equation (2.6). The vector value equal to 1, if $m_2 \geq m_1$. If $l_1 \geq u_2$, then the value is 0, then otherwise.

Table 4.31 below show the result of vector value:

Table 4.31 Vector Value

	Vector Value
$V(S_{km} \geq S_{me})$	0.965
$V(S_{km} \geq S_{ss})$	1.000
$V(S_{km} \geq S_{tp})$	1.000
$V(S_{km} \geq S_u)$	1.000
$V(S_{me} \geq S_{km})$	1.000
$V(S_{me} \geq S_{ss})$	1.000
$V(S_{me} \geq S_{tp})$	1.000
$V(S_{me} \geq S_u)$	1.000
$V(S_{ss} \geq S_{km})$	0.949
$V(S_{ss} \geq S_{me})$	0.913
$V(S_{ss} \geq S_{tp})$	1.000
$V(S_{ss} \geq S_u)$	1.000
$V(S_{tp} \geq S_{km})$	0.817
$V(S_{tp} \geq S_{me})$	0.781
$V(S_{tp} \geq S_{ss})$	0.865
$V(S_{tp} \geq S_u)$	1.000
$V(S_u \geq S_{km})$	0.398
$V(S_u \geq S_{me})$	0.363
$V(S_u \geq S_{ss})$	0.433
$V(S_u \geq S_{tp})$	0.564

iii. Determine the ordinate value

To determine the ordinate value, the minimum value in each criterion was calculated using equation (2.9). It was gained as follow:

$$\begin{aligned} d'(S_{km}) &= \min(0.965, 1, 1, 1) \\ &= 0.965 \end{aligned}$$

$$\begin{aligned} d'(S_{me}) &= \min(1, 1, 1, 1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{ss}) &= \min(0.949, 0.913, 1, 1) \\ &= 0.913 \end{aligned}$$

$$\begin{aligned} d'(S_{tp}) &= \min(0.817, 0.781, 0.865, 1) \\ &= 0.781 \end{aligned}$$

$$\begin{aligned} d'(S_u) &= \min(0.398, 0.363, 0.433, 0.564) \\ &= 0.393 \end{aligned}$$

Hence, the ordinate value can be determined as follow.

$$W_c' = (0.965, 1, 0.913, 0.781, 0.393)^T$$

iv. Vector normalization

Normalize the weight of the vector value can be gained from every element of weight vector divided by the weight of the vector itself using equation 2.10. The total weight of normalized vector value is equal to 1.

$$W_c = (0.240, 0.249, 0.227, 0.194, 0.090)^T$$

Table 4.32 below is representation of matrix W_c , which shown the weight of each criteria:

Table 4.32 Weight of Each Criteria

Criteria	Weight
Knowledge Management	0.240
Management & Execution	0.249
Software System	0.227
Technology Planning	0.194
User	0.090

B. Weight of Sub Criteria Calculation

Second, the researcher calculates the weight of sub criteria in each criterion. In each criterion, each sub criteria was compared the degree of importance to control its criteria. From the data that already taken from experts, then it is converted to TFN scale and calculate the geometric mean.

i. Sub Criteria in Criteria Knowledge Management (KM)

Table 4.33 Pairwise Comparison of Sub Criteria wrt KM (First Expert)

	Top management provide inadequate resources			Lack of knowledge end-user			Top Management less understand with ERP system		
	l	m	u	l	m	u	l	m	u
TM provide inadequate resources	1.00	1.00	1.00	1.50	2.00	2.50	1.00	1.50	2.00
Lack of knowledge end-user	0.40	0.50	0.67	1.00	1.00	1.00	0.50	0.67	1.00
TM provide inadequate resources	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.34 Pairwise Comparison of Sub Criteria wrt KM (Second Expert)

	Top management provide inadequate resources			Lack of knowledge end-user			Top Management less understand with ERP system		
	l	m	u	l	m	u	l	m	u
TM provide inadequate resources	1.00	1.00	1.00	0.50	0.67	1.00	2.00	2.50	3.00
Lack of knowledge end-user	1.00	1.50	2.00	1.00	1.00	1.00	0.50	0.67	1.00
TM provide inadequate resources	1.50	2.00	2.50	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.35 Geometric Mean of Pairwise Comparison Sub Criteria with Respect to KM

	Top management provide inadequate resources			Lack of knowledge end-user			Top Management less understand with ERP system			Total Column		
	l	m	u	l	m	u	l	m	u	l	m	u
TM provide inadequate resources	1.00	1.00	1.00	0.87	1.15	1.58	1.41	1.94	2.45	3.28	4.09	5.03
Lack of knowledge end-user	0.63	0.87	1.15	1.00	1.00	1.00	0.50	0.67	1.00	2.13	2.53	3.15
Top Management less understand ERP system	0.87	1.15	1.58	1.00	1.50	2.00	1.00	1.00	1.00	2.87	3.65	4.58
										8.28	10.28	12.77

After that, the fuzzy synthesis were calculated by multiplying the l, m and u value of total column in each sub criteria with the invers value of the total row.

$$S_{R1} = (3.28, 4.09, 5.03) \times (0.08, 0.10, 0.12)$$

$$= (0.26, 0.40, 0.61)$$

$$S_{R2} = (2.13, 2.53, 3.15) \times (0.08, 0.10, 0.12)$$

$$= (0.17, 0.25, 0.38)$$

$$S_{R3} = (2.87, 3.65, 4.58) \times (0.08, 0.10, 0.12)$$

$$= (0.22, 0.36, 0.55)$$

From the calculation above, the synthesis of fuzzy number are summaries in Table 4.36 below:

Table 4.36 Synthesis Fuzzy for Sub Criteria in KM

Sub Criteria	Nilai Sintesis Fuzzy		
	l	m	u
Top management provide inadequate resources (R1)	0.257	0.398	0.608
Lack of knowledge end-user (R2)	0.167	0.246	0.381
Top Management less understand with ERP system (R3)	0.224	0.356	0.553

Then, the vector value was calculated. Table 4.37 below is the result of the value:

Table 4.37 Vector Value of Sub Criteria in KM

	Vector Value
$V (S_{R1} \geq S_{R2})$	1.000
$V (S_{R1} \geq S_{R3})$	1.000
$V (S_{R2} \geq S_{R1})$	0.450
$V (S_{R2} \geq S_{R3})$	0.589
$V (S_{R3} \geq S_{R1})$	0.875
$V (S_{R3} \geq S_{R2})$	1.000

Next step is determined the minimum value, to know the weight of the vector.

$$\begin{aligned} d' (S_{R1}) &= \min(1,1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d' (S_{R2}) &= \min(0.450,0.589) \\ &= 0.450 \end{aligned}$$

$$\begin{aligned} d' (S_{R3}) &= \min(0.875,1) \\ &= 0.875 \end{aligned}$$

Hence, the weight of the ordinate values is calculated as follows:

$$W_{SC1}' = (1,0.450,0.875)^T$$

The last step is normalize the weight of the vector value which derived from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1. After being calculate, the result is as follow:

$$W_{SC1} = (0.430,0.194,0.376)^T$$

ii. Sub Criteria in Criteria Management & Execution (ME)

Table 4.38 Pairwise Comparison Sub Criteria with Respect to ME (First Expert)

	Less discipline while execution process			Less management support and assistance			Lack of knowledge while implement ERP SAP		
	l	m	u	l	m	u	l	m	u
Less discipline while execution process	1.00	1.00	1.00	1.50	2.00	2.50	1.00	1.50	2.00
Less management support and assistance	0.40	0.50	0.67	1.00	1.00	1.00	0.50	0.67	1.00
Lack of knowledge while implement ERP SAP	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.39 Pairwise Comparison Sub Criteria with Respect to ME (Second Expert)

	Less discipline while execution process			Less management support and assistance			Lack of knowledge while implement ERP SAP		
	l	m	u	l	m	u	l	m	u
Less discipline while execution process	1.00	1.00	1.00	0.50	0.67	1.00	0.40	0.50	0.67
Less management support and assistance	1.00	1.50	2.00	1.00	1.00	1.00	0.50	0.67	1.00
Lack of knowledge while implement ERP SAP	1.50	2.00	2.50	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.40 Geometric Mean of Pairwise Comparison Sub Criteria with Respect to ME

	Less discipline while execution process			Less management support and assistance			Lack of knowledge while implement ERP SAP			Total Column		
	l	m	u	l	m	u	l	m	u	l	m	u
Less discipline while execution process	1.00	1.00	1.00	0.87	1.15	1.58	0.63	0.87	1.15	2.50	3.02	3.74
Less management support and assistance	0.63	0.87	1.15	1.00	1.00	1.00	0.50	0.67	1.00	2.13	2.53	3.15
Lack of knowledge while implement ERP SAP	0.87	1.15	1.58	1.00	1.50	2.00	1.00	1.00	1.00	2.87	3.65	4.58
										7.50	9.21	11.47

After the geometric mean are calculated, the fuzzy synthesis were calculated by multiplying the l, m and u value of total column in each sub criteria with the invers value of the total row.

$$\begin{aligned} S_{R1} &= (2.50, 3.02, 3.74) \times (0.09, 0.11, 0.13) \\ &= (0.22, 0.33, 0.50) \end{aligned}$$

$$\begin{aligned} S_{R2} &= (2.13, 2.53, 3.15) \times (0.09, 0.11, 0.13) \\ &= (0.19, 0.28, 0.42) \end{aligned}$$

$$\begin{aligned} S_{R3} &= (2.87, 3.65, 4.58) \times (0.09, 0.11, 0.13) \\ &= (0.25, 0.40, 0.61) \end{aligned}$$

From the calculation above, the synthesis of fuzzy number are summaries in Table 4.41 below:

Table 4.41 Synthesis Fuzzy for Sub Criteria in ME

Sub Criteria	Synthesis Fuzzy		
	l	m	u
Less discipline while execution process (R4)	0.218	0.328	0.498
Less management support and assistance (R5)	0.186	0.275	0.421
Lack of knowledge while implement ERP SAP (R6)	0.250	0.397	0.611

Then, the vector value was calculated. Table 4.42 below is the result of the value:

Table 4.42 Vector Value of Sub Criteria in ME

	Vector Value
$V(S_{R4} \geq S_{R5})$	1.000
$V(S_{R4} \geq S_{R6})$	0.783
$V(S_{R5} \geq S_{R4})$	0.793
$V(S_{R5} \geq S_{R6})$	0.584
$V(S_{R6} \geq S_{R4})$	1.000
$V(S_{R6} \geq S_{R5})$	1.000

Next step is determining the minimum value, to know the weight of the vector.

$$\begin{aligned}d'(S_{R4}) &= \min(1, 0.783) \\ &= 0.783\end{aligned}$$

$$\begin{aligned}d'(S_{R5}) &= \min(0.793, 0.584) \\ &= 0.584\end{aligned}$$

$$\begin{aligned}d'(S_{R6}) &= \min(1, 1) \\ &= 1\end{aligned}$$

Hence, the weight of the ordinate values is formulated as follows:

$$W_{SC2'} = (0.783, 0.584, 1)^T$$

The last step is normalize the weight of the vector value which derived from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1. After being calculate, the result is as follow:

$$W_{SC2} = (0.331, 0.247, 0.422)^T$$

iii. Sub Criteria in Criteria Software System (SS)

Table 4.43 Pairwise Comparison Sub Criteria with Respect to SS (First Expert)

	Failed in customize SAP system			Complex interface			Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP		
	l	m	u	l	m	u	l	m	u
Failed in customize SAP system	1.00	1.00	1.00	1.00	1.50	2.00	0.50	0.67	1.00
Complex interface	0.50	0.67	1.00	1.00	1.00	1.00	0.40	0.50	0.67
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.00	1.00

Table 4.44 Pairwise Comparison Sub Criteria with Respect to SS (Second Expert)

	Failed in customize SAP system			Complex interface			Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP		
	l	m	u	l	m	u	l	m	u
Failed in customize SAP system	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00
Complex interface	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00

Table 4.45 Geometric Mean Pairwise Comparison Sub Criteria with Respect to SS

	Failed in customize SAP system			Complex interface			Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP			Total Column		
	l	m	u	l	m	u	l	m	u	l	m	u
Failed in customize SAP system	1.00	1.00	1.00	0.71	1.00	1.41	0.71	1.00	1.41	2.41	3.00	3.83
Complex interface	0.71	1.00	1.41	1.00	1.00	1.00	0.77	1.00	1.29	2.48	3.00	3.71
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	0.71	1.00	1.41	0.77	1.00	1.29	1.00	1.00	1.00	2.48	3.00	3.71
										7.38	9.00	11.24

After the geometric mean are calculated, the fuzzy synthesis were calculated by multiply the l, m and u value of total column in each sub criteria with the invers value of the total row.

$$\begin{aligned} S_{R1} &= (2.41, 3.00, 3.83) \times (0.09, 0.11, 0.14) \\ &= (0.21, 0.33, 0.52) \end{aligned}$$

$$\begin{aligned} S_{R2} &= (2.48, 3.00, 3.71) \times (0.09, 0.11, 0.14) \\ &= (0.22, 0.33, 0.50) \end{aligned}$$

$$\begin{aligned} S_{R3} &= (2.48, 3.00, 3.71) \times (0.09, 0.11, 0.14) \\ &= (0.22, 0.33, 0.50) \end{aligned}$$

From the calculation above, the synthesis of fuzzy number are summaries in Table 4.46 below:

Table 4.46 Synthesis Fuzzy for Sub Criteria in SS

Sub Criteria	Synthesis Fuzzy		
	l	m	u
Failed in customize SAP system (R7)	0.215	0.333	0.519
Complex interface (R8)	0.221	0.333	0.502
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP (R9)	0.221	0.333	0.502

Then, the vector value was calculated. Table 4.47 below is the result of the value:

Table 4.47 Vector Value of Sub Criteria in SS

	Vector Value
$V(S_{R7} \geq S_{R8})$	1.000
$V(S_{R7} \geq S_{R9})$	1.000
$V(S_{R8} \geq S_{R7})$	1.000
$V(S_{R8} \geq S_{R9})$	1.000
$V(S_{R9} \geq S_{R7})$	1.000
$V(S_{R9} \geq S_{R8})$	1.000

Next step is determined the minimum value, to know the weight of the vector.

$$\begin{aligned} d'(S_{R7}) &= \min(1,1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{R8}) &= \min(1,1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{R9}) &= \min(1,1) \\ &= 1 \end{aligned}$$

Hence, the weight of the ordinate values are as follows:

$$W_{SC3}' = (1,1,1)^T$$

The last step is normalize the weight of the vector value which derived from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1. After being calculate, the result is as follow:

$$W_{SC3} = (0.333, 0.333, 0.333)^T$$

iv. Sub Criteria in Criteria Technology Planning (TP)

Table 4.48 Pairwise Comparison Sub Criteria with Respect to TP (First Expert)

	Less integration			Lack of testing			Lack of module that implement		
	l	m	u	l	m	u	l	m	u
Less integration	1.00	1.00	1.00	0.50	0.67	1.00	0.40	0.50	0.67
Lack of testing	1.00	1.50	2.00	1.00	1.00	1.00	0.50	0.67	1.00
Lack of module that implement	1.50	2.00	2.50	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.49 Pairwise Comparison Sub Criteria with Respect to TP (Second Expert)

	Less integration			Lack of testing			Lack of module that implement		
	l	m	u	l	m	u	l	m	u
Less integration	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00
Lack of testing	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50
Lack of module that implement	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00

Table 4.50 Geometric Mean Pairwise Comparison Sub Criteria with Respect to TP

	Less integration			Lack of testing			Lack of module that implement			Total Column		
	l	m	u	l	m	u	l	m	u	l	m	u
Less integration	1.00	1.00	1.00	0.50	0.67	1.00	0.63	0.87	1.15	2.13	2.53	3.15
Lack of testing	1.00	1.50	2.00	1.00	1.00	1.00	0.87	1.15	1.58	2.87	3.65	4.58
Lack of module that implement	0.87	1.15	1.58	0.63	0.87	1.15	1.00	1.00	1.00	2.50	3.02	3.74
										7.50	9.21	11.47

After the geometric mean are calculated, the fuzzy synthesis were calculated by multiplying the l, m and u value of total column in each sub criteria with the invers value of the total row.

$$\begin{aligned} S_{R10} &= (2.13, 2.53, 3.15) \times (0.09, 0.11, 0.13) \\ &= (0.19, 0.28, 0.42) \end{aligned}$$

$$\begin{aligned} S_{R11} &= (2.87, 3.65, 4.58) \times (0.09, 0.11, 0.13) \\ &= (0.25, 0.40, 0.61) \end{aligned}$$

$$\begin{aligned} S_{R12} &= (2.50, 3.02, 3.74) \times (0.09, 0.11, 0.13) \\ &= (0.22, 0.33, 0.50) \end{aligned}$$

From the calculation above, the synthesis of fuzzy number are summaries in Table 4.51 below:

Table 4.51 Synthesis Fuzzy for Sub Criteria in TP

Sub Criteria	Synthesis Fuzzy		
	l	m	u
Less integration (R10)	0.186	0.275	0.421
Lack of testing (R11)	0.250	0.397	0.611
Lack of module that implement (R12)	0.218	0.328	0.498

Then, vector value was calculated. Table 4.52 below is the result of the value:

Table 4.52 Vector Value of Sub Criteria in TP

	Vector Value
$V(S_{R10} \geq S_{R11})$	0.584
$V(S_{R10} \geq S_{R12})$	0.793
$V(S_{R11} \geq S_{R10})$	1.000
$V(S_{R11} \geq S_{R12})$	1.000
$V(S_{R12} \geq S_{R10})$	1.000
$V(S_{R12} \geq S_{R11})$	0.783

Next step is determining the minimum value, to know the weight of the vector.

$$\begin{aligned}d'(S_{R10}) &= \min(0.584, 0.793) \\ &= 0.584\end{aligned}$$

$$\begin{aligned}d'(S_{R11}) &= \min(1, 1) \\ &= 1\end{aligned}$$

$$\begin{aligned}d'(S_{R12}) &= \min(1, 0.783) \\ &= 0.783\end{aligned}$$

Hence, the weight of the ordinate values is formulated as follows:

$$W_{SC4'} = (0.584, 1, 0.783)^T$$

The last step is normalize the weight of the vector value which derived from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1. After being calculate, the result is as follow:

$$W_{SC4} = (0.247, 0.422, 0.331)^T$$

v. Sub Criteria in Criteria User (U)

Table 4.53 Pairwise Comparison Sub Criteria with Respect to U (First Expert)

	Fast job rotation			Communication between admin and end-user ineffective			Lack of training and refreshment			Lack of Human Resources		
	l	m	u	l	m	u	l	m	u	l	m	u
Fast job rotation	1.00	1.00	1.00	1.50	2.00	2.50	1.00	1.50	2.00	1.00	1.50	2.00
Communication between admin and end-user ineffective	0.40	0.50	0.67	1.00	1.00	1.00	0.40	0.50	0.67	0.50	0.67	1.00
Lack of training and refreshment	0.50	0.67	1.00	1.50	2.00	2.50	1.00	1.00	1.00	1.00	1.50	2.00
Lack of Human Resources	0.50	0.67	1.00	1.00	1.50	2.00	0.50	0.67	1.00	1.00	1.00	1.00

Table 4.54 Pairwise Comparison Sub Criteria with Respect to U (Second Expert)

	Fast job rotation			Communication between admin and end-user ineffective			Lack of training and refreshment			Lack of Human Resources		
	l	m	u	l	m	u	l	m	u	l	m	u
Fast job rotation	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00	0.40	0.50	0.67
Communication between admin and end-user ineffective	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50	0.50	0.67	1.00
Lack of training and refreshment	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00	0.40	0.50	0.67
Lack of Human Resources	1.50	2.00	2.50	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.00	1.00

Table 4.55 Geometric Mean Pairwise Comparison Sub Criteria with Respect to U

	Fast job rotation			Communication between admin and end-user ineffective			Lack of training and refreshment			Lack of Human Resources		
	l	m	u	l	m	u	l	m	u	l	m	u
Fast job rotation	1.00	1.00	1.00	0.87	1.15	1.58	1.00	1.50	2.00	0.63	0.87	1.15
Communication between admin and end-user ineffective	0.63	0.87	1.15	1.00	1.00	1.00	0.77	1.00	1.29	0.50	0.67	1.00
Lack of training and refreshment	0.50	0.67	1.00	0.77	1.00	1.29	1.00	1.00	1.00	0.63	0.87	1.15
Lack of Human Resources	0.87	1.15	1.58	1.00	1.50	2.00	0.87	1.15	1.58	1.00	1.00	1.00

Table 4.56 Total Column and Row

Total Column		
l	m	u
3.50	4.52	5.74
2.91	3.53	4.45
2.91	3.53	4.45
3.73	4.81	6.16
13.04	16.40	20.79

After the geometric mean are calculate, the fuzzy synthesis were calculated by multiply the l, m and u value of total column in each sub criteria (Table 4.56) with the invers value of the total row.

$$S_{R13} = (3.50, 4.52, 5.74) \times (0.05, 0.06, 0.08) \\ = (0.17, 0.28, 0.44)$$

$$S_{R14} = (2.91, 3.53, 4.45) \times (0.05, 0.06, 0.08) \\ = (0.14, 0.22, 0.34)$$

$$S_{R15} = (2.91, 3.53, 4.45) \times (0.05, 0.06, 0.08) \\ = (0.14, 0.22, 0.34)$$

$$S_{R16} = (3.73, 4.81, 6.16) \times (0.05, 0.06, 0.08) \\ = (0.18, 0.29, 0.47)$$

From the calculation above, the synthesis of fuzzy number are summaries in Table 4.57 below:

Table 4.57 Synthesis Fuzzy for Sub Criteria in U

Sub Criteria	Synthesis Fuzzy		
	l	m	u
Fast job rotation (R13)	0.168	0.276	0.440
Communication between admin and end-user ineffective (R14)	0.140	0.215	0.341
Lack of training and refreshment (R15)	0.140	0.215	0.341
Lack of Human Resources (R16)	0.180	0.293	0.472

Then, the vector value was calculated. Table 4.58 below is the result of the value:

Table 4.58 Vector Value of Sub Criteria in U

	Vector Value
$V(S_{R13} \geq S_{R14})$	1.000
$V(S_{R13} \geq S_{R15})$	1.000
$V(S_{R13} \geq S_{R16})$	0.937
$V(S_{R14} \geq S_{R13})$	0.741
$V(S_{R14} \geq S_{R15})$	1.000
$V(S_{R14} \geq S_{R16})$	0.674
$V(S_{R15} \geq S_{R13})$	0.741
$V(S_{R15} \geq S_{R14})$	1.000
$V(S_{R15} \geq S_{R16})$	0.674
$V(S_{R16} \geq S_{R13})$	1.000
$V(S_{R16} \geq S_{R14})$	1.000
$V(S_{R16} \geq S_{R15})$	1.000

Next step is determining the minimum value, to know the weight of the vector.

$$\begin{aligned} d'(S_{R13}) &= \min(1,1,0.937) \\ &= 0.937 \end{aligned}$$

$$\begin{aligned} d'(S_{R14}) &= \min(0.741,1,0.674) \\ &= 0.674 \end{aligned}$$

$$\begin{aligned} d'(S_{R15}) &= \min(0.741,1,0.674) \\ &= 0.674 \end{aligned}$$

$$\begin{aligned} d'(S_{R16}) &= \min(1,1,1) \\ &= 1 \end{aligned}$$

Hence, the weight of the ordinate values is calculated as follows:

$$W_{SC4}' = (0.937,0.674,0.674,1)^T$$

The last step is normalize the weight of the vector value which derived from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1. After being calculate, the result is as follow:

$$W_{SC4} = (0.285, 0.205, 0.205, 0.304)^T$$

Result of the weight between each sub criteria for each criterion shown in Table 4.59 below:

Table 4.59 Summary of Weight in Each Sub Criteria

Criteria	Sub Criteria	Weight
Knowledge Management	Top management provide inadequate resources	0.4301
	Lack of knowledge end-user	0.1936
	Top Management less understand with ERP system	0.3762
Management & Execution	Less discipline while execution process	0.3308
	Less management support and assistance	0.2467
	Lack of knowledge while implement ERP SAP	0.4225
Software System	Failed in customize SAP system	0.3333
	Complex interface	0.3333
	Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	0.3333
Technology Planning	Less integration	0.2467
	Lack of testing	0.4225
	Lack of module that implement	0.3308
User	Fast job rotation	0.2851
	Communication between admin and end-user ineffective	0.2053
	Lack of training and refreshment	0.2053
	Lack of Human Resources	0.3044

C. Weight of Criteria with Dependency

i. Weight of Criteria with respect to Knowledge Management

Table 4.60 Matrix of Pairwise Comparison Criteria with Respect to KM (First Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00	0.50	0.67	1.00	1.00	1.50	2.00
Management & Execution	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50	0.50	0.67	1.00	1.00	1.50	2.00
Software System	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00	0.40	0.50	0.67	0.50	0.67	1.00
Technology Planning	1.00	1.50	2.00	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.00	1.00	1.50	2.00	2.50
User	0.50	0.67	1.00	0.50	0.67	1.00	1.00	1.50	2.00	0.40	0.50	0.67	1.00	1.00	1.00

Table 4.61 Matrix of Pairwise Comparison Criteria with Respect to KM (Second Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	1.50	2.00	2.50	1.00	1.50	2.00
Management & Execution	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.50	2.00
Software System	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	1.00	1.50	2.00
Technology Planning	0.40	0.50	0.67	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00	0.50	0.67	1.00
User	0.50	0.67	1.00	0.50	0.67	1.00	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.62 Geometric Mean of Pairwise Comparison Criteria wrt KM TFN Scale

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.71	1.00	1.41	1.22	1.73	2.24	0.87	1.15	1.58	1.00	1.50	2.00
Management & Execution	0.71	1.00	1.41	1.00	1.00	1.00	1.22	1.73	2.24	0.87	1.15	1.58	1.00	1.50	2.00
Software System	0.45	0.58	0.82	0.45	0.58	0.82	1.00	1.00	1.00	0.63	0.87	1.15	0.71	1.00	1.41
Technology Planning	0.63	0.87	1.15	0.63	0.87	1.15	0.87	1.15	1.58	1.00	1.00	1.00	0.87	1.15	1.58
User	0.50	0.67	1.00	0.50	0.67	1.00	0.71	1.00	1.41	0.63	0.87	1.15	1.00	1.00	1.00

From matrix pairwise comparison above, seen that in each criteria the value of $l \leq m \leq u$. Hence, it is indicated that the fuzzy number is consistent. After the fuzzy number consistent, then it is ready to calculate the weight of each criterion. First, the researcher calculates the synthesis fuzzy. From table 4.61 value of all row and column were calculated. Table 4.62 below is the result:

Table 4.63 Value of Total Row and Column

Total Row and Column Value		
l	m	u
4.80	6.39	8.23
4.80	6.39	8.23
3.23	4.02	5.20
4.00	5.04	6.47
3.34	4.20	5.57
20.17	26.04	33.71

After the value of total row and column where calculated, then the invers value of total column value was calculated. Table 4.64 below is the value of invers:

Table 4.64 Invers Value of Total Column

Invers Value of Total Column		
l	m	u
0.03	0.04	0.05

It is shown that the invers values of total column are 0.03, 0.04 and 0.05 respectively. Then, the synthesis of fuzzy was calculated by multiply the total column of each value with invers of total column.

$$\begin{aligned}
 S_{km} &= (4.80, 6.39, 8.23) \times (0.03, 0.04, 0.05) \\
 &= (0.14, 0.25, 0.41) \\
 S_{me} &= (4.80, 6.39, 8.23) \times (0.03, 0.04, 0.05) \\
 &= (0.14, 0.25, 0.41)
 \end{aligned}$$

$$S_{ss} = (3.23, 4.02, 6.47) \times (0.03, 0.04, 0.05)$$

$$= (0.10, 0.15, 0.26)$$

$$S_{tp} = (4.00, 5.04, 6.47) \times (0.03, 0.04, 0.05)$$

$$= (0.12, 0.19, 0.32)$$

$$S_u = (3.34, 4.20, 5.57) \times (0.03, 0.04, 0.05)$$

$$= (0.10, 0.16, 0.28)$$

Table 4.65 Value of Synthesis Fuzzy

Criteria	Value of Synthesis Fuzzy		
	l	m	u
Knowledge Management (KM)	0.142	0.245	0.408
Management & Execution (ME)	0.142	0.245	0.408
Software System (SS)	0.096	0.154	0.258
Technology Planning (TP)	0.119	0.194	0.321
User (U)	0.099	0.161	0.276

Based on the equation 2.6, vector value is calculated. Table 4.66 below show the result of vector value:

Table 4.66 Vector Value

	Vector Value
$V(S_{km} \geq S_{me})$	1.000
$V(S_{km} \geq S_{ss})$	1.000
$V(S_{km} \geq S_{tp})$	1.000
$V(S_{km} \geq S_u)$	1.000
$V(S_{me} \geq S_{km})$	1.000
$V(S_{me} \geq S_{ss})$	1.000
$V(S_{me} \geq S_{tp})$	1.000
$V(S_{me} \geq S_u)$	1.000
$V(S_{ss} \geq S_{km})$	0.560
$V(S_{ss} \geq S_{me})$	0.560
$V(S_{ss} \geq S_{tp})$	0.780
$V(S_{ss} \geq S_u)$	0.959
$V(S_{tp} \geq S_{km})$	0.776

Vector Value	
$V(S_{tp} \geq S_{me})$	0.776
$V(S_{tp} \geq S_{ss})$	1.000
$V(S_{tp} \geq S_u)$	1.000
$V(S_u \geq S_{km})$	0.614
$V(S_u \geq S_{me})$	0.614
$V(S_u \geq S_{ss})$	1.000
$V(S_u \geq S_{tp})$	0.830

After that, using the equation 2.9, ordinate value was gained as follow:

$$\begin{aligned} d'(S_{km}) &= \min(1,1,1,1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{me}) &= \min(1,1,1,1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{ss}) &= \min(0.560,0.560,0.780,0.959) \\ &= 0.560 \end{aligned}$$

$$\begin{aligned} d'(S_{tp}) &= \min(0.776,0.776,1,1) \\ &= 0.781 \end{aligned}$$

$$\begin{aligned} d'(S_u) &= \min(0.614,0.614,1,0.830) \\ &= 0.614 \end{aligned}$$

Hence, the ordinate value can be determined as follow.

$$W_{c1}' = (1,1,0.560,0.781,0.614)^T$$

Normalize the weight of the vector value can be gained from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1.

$$W_{c1} = (0.240,0.249,0.227,0.194,0.090)^T$$

Table 4.67 below is representation of matrix W_{c1} , which shows the weight of each criterion that inner dependent with respect to knowledge management:

Table 4.67 Weight of Each Criteria wrt Knowledge Management

Criteria	Weight
Knowledge Management	0.253
Management & Execution	0.253
Software System	0.142
Technology Planning	0.196
User	0.156

ii. Weight of Criteria with respect to Management & Execution

Table 4.68 Matrix of Pairwise Comparison Criteria with Respect to ME (First Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.40	0.50	0.67	1.00	1.50	2.00	0.40	0.50	0.67	1.00	1.50	2.00
Management & Execution	1.50	2.00	2.50	1.00	1.00	1.00	1.50	2.00	2.50	0.50	0.67	1.00	1.50	2.00	2.50
Software System	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00	0.33	0.40	0.50	0.50	0.67	1.00
Technology Planning	1.50	2.00	2.50	1.00	1.50	2.00	2.00	2.50	3.00	1.00	1.00	1.00	1.50	2.00	2.50
User	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.50	2.00	0.40	0.50	0.67	1.00	1.00	1.00

Table 4.69 Matrix of Pairwise Comparison Criteria with Respect to ME (Second Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	1.50	2.00	2.50	0.50	0.67	1.00
Management & Execution	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	0.50	0.67	1.00
Software System	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	0.40	0.50	0.67
Technology Planning	0.40	0.50	0.67	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00	0.40	0.50	0.67
User	1.00	1.50	2.00	1.00	1.50	2.00	1.50	2.00	2.50	1.50	2.00	2.50	1.00	1.00	1.00

Table 4.70 Geometric Mean Pairwise Comparison Criteria wrt ME in TFN Scale

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.63	0.87	1.15	1.22	1.73	2.24	0.77	1.00	1.29	0.71	1.00	1.41
Management & Execution	0.87	1.15	1.58	1.00	1.00	1.00	1.22	1.73	2.24	0.87	1.15	1.58	0.87	1.15	1.58
Software System	0.45	0.58	0.82	0.45	0.58	0.82	1.00	1.00	1.00	0.58	0.77	1.00	0.45	0.58	0.82
Technology Planning	0.77	1.00	1.29	0.63	0.87	1.15	1.00	1.29	1.73	1.00	1.00	1.00	0.77	1.00	1.29
User	0.71	1.00	1.41	0.63	0.87	1.15	1.22	1.73	2.24	0.77	1.00	1.29	1.00	1.00	1.00

From matrix pairwise comparison above, seen that in each criteria the value of $l \leq m \leq u$. Hence, it is indicated that the fuzzy number is consistent. After the fuzzy number consistent, then it is ready to calculate the weight of each criterion. First, the researcher calculate the synthesis fuzzy. From table 4.70 value of all row and column were calculated. Table 4.71 below is the result:

Table 4.71 Value of Total Row and Column

Total Row and Column Value		
l	m	u
4.34	5.60	7.10
4.82	6.20	7.98
2.92	3.51	4.45
4.18	5.16	6.47
4.34	5.60	7.10
20.60	26.06	33.09

After the value of total row and column where calculated, then the invers value of total column value was calculated. Table 4.72 below is the value of invers:

Table 4.72 Invers Value of Total Column

Invers Value of Total Column		
l	m	u
0.03	0.04	0.05

It is shown that the invers value of total column are 0.03, 0.04 and 0.05 respectively. Then, the synthesis of fuzzy was calculated by multiply the total column of each value with invers of total column.

$$S_{km} = (4.34, 5.60, 7.10) \times (0.03, 0.04, 0.05) \\ = (0.13, 0.21, 0.34)$$

$$S_{me} = (4.82, 6.20, 7.98) \times (0.03, 0.04, 0.05) \\ = (0.15, 0.24, 0.39)$$

$$S_{ss} = (2.92, 3.15, 4.45) \times (0.03, 0.04, 0.05) \\ = (0.09, 0.13, 0.22)$$

$$S_{tp} = (4.18, 5.16, 6.47) \times (0.03, 0.04, 0.05) \\ = (0.13, 0.20, 0.31)$$

$$S_u = (4.34, 5.60, 7.10) \times (0.03, 0.04, 0.05) \\ = (0.13, 0.21, 0.34)$$

Table 4.73 Value of Synthesis Fuzzy

Criteria	Value of Synthesis Fuzzy		
	l	m	u
Knowledge Management (KM)	0.131	0.215	0.344
Management & Execution (ME)	0.146	0.238	0.387
Software System (SS)	0.088	0.135	0.216
Technology Planning (TP)	0.126	0.198	0.314
User (U)	0.131	0.215	0.344

Based on the calculation using equation 2.6. Table 4.74 below shows the result of vector value:

Table 4.74 Vector Value

	Vector Value
$V(S_{km} \geq S_{me})$	0.896
$V(S_{km} \geq S_{ss})$	1.000
$V(S_{km} \geq S_{tp})$	1.000
$V(S_{km} \geq S_u)$	1.000
$V(S_{me} \geq S_{km})$	1.000
$V(S_{me} \geq S_{ss})$	1.000
$V(S_{me} \geq S_{tp})$	1.000
$V(S_{me} \geq S_u)$	1.000
$V(S_{ss} \geq S_{km})$	0.514
$V(S_{ss} \geq S_{me})$	0.405
$V(S_{ss} \geq S_{tp})$	0.586
$V(S_{ss} \geq S_u)$	0.514
$V(S_{tp} \geq S_{km})$	0.915
$V(S_{tp} \geq S_{me})$	0.808
$V(S_{tp} \geq S_{ss})$	1.000
$V(S_{tp} \geq S_u)$	1.000
$V(S_u \geq S_{km})$	1.000
$V(S_u \geq S_{me})$	0.896
$V(S_u \geq S_{ss})$	1.000
$V(S_u \geq S_{tp})$	1.000

Based on the formula, equation 2.9, ordinate value was gained as follow:

$$\begin{aligned} d'(S_{km}) &= \min(0.896, 1, 1, 1) \\ &= 0.896 \end{aligned}$$

$$\begin{aligned} d'(S_{me}) &= \min(1, 1, 1, 1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{ss}) &= \min(0.514, 0.405, 0.586, 0.514) \\ &= 0.405 \end{aligned}$$

$$\begin{aligned} d'(S_{tp}) &= \min(0.915, 0.808, 1, 1) \\ &= 0.781 \end{aligned}$$

$$d'(S_u) = \min(1, 0.896, 1, 1) \\ = 0.614$$

Hence, the ordinate value can be determined as follow.

$$W_{c2}' = (0.896, 1, 0.405, 0.781, 0.614)^T$$

Normalize the weight of the vector value can be gained from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1.

$$W_{c2} = (0.224, 0.250, 0.101, 0.202, 0.224)^T$$

Table 4.75 below is representation of matrix W_{c1} , which shows the weight of each criteria that inner dependent with respect to management & execution:

Table 4.75 Weight of Each Criteria Management & Execution

Criteria	Weight
Knowledge Management	0.224
Management & Execution	0.250
Software System	0.101
Technology Planning	0.202
User	0.224

iii. Weight of Criteria with respect to Software System

Table 4.76 Matrix of Pairwise Comparison Criteria with Respect to SS (First Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	1.00	1.50	2.00	0.50	0.67	1.00	1.00	1.50	2.00	1.50	2.00	2.50
Management & Execution	0.50	0.67	1.00	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00	1.50	2.00	2.50
Software System	1.00	1.50	2.00	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50	1.50	2.00	2.50
Technology Planning	0.50	0.67	1.00	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00	1.00	1.50	2.00
User	0.40	0.50	0.67	0.40	0.50	0.67	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00

Table 4.77 Matrix of Pairwise Comparison Criteria with Respect to SS (Second Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.40	0.50	0.67	0.40	0.50	0.67	1.00	1.50	2.00	0.50	0.67	1.00
Management & Execution	1.50	2.00	2.50	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.50	2.00
Software System	1.50	2.00	2.50	0.50	0.67	1.00	1.00	1.00	1.00	1.50	2.00	2.50	1.00	1.50	2.00
Technology Planning	0.50	0.67	1.00	0.40	0.50	0.67	0.40	0.50	0.67	1.00	1.00	1.00	0.50	0.67	1.00
User	1.00	1.50	2.00	0.50	0.67	1.00	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.78 Geometric Mean Pairwise Comparison Criteria with Respect to SS in TFN Scale

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.63	0.87	1.15	0.45	0.58	0.82	1.00	1.50	2.00	0.87	1.15	1.58
Management & Execution	0.87	1.15	1.58	1.00	1.00	1.00	0.71	1.00	1.41	1.22	1.73	2.24	1.22	1.73	2.24
Software System	1.22	1.73	2.24	0.71	1.00	1.41	1.00	1.00	1.00	1.50	2.00	2.50	1.22	1.73	2.24
Technology Planning	0.50	0.67	1.00	0.45	0.58	0.82	0.40	0.50	0.67	1.00	1.00	1.00	0.71	1.00	1.41
User	0.63	0.87	1.15	0.45	0.58	0.82	0.45	0.58	0.82	0.71	1.00	1.41	1.00	1.00	1.00

From matrix pairwise comparison above, seen that in each criteria the value of $l \leq m \leq u$. Hence, it is indicate that the fuzzy number is consistent. After the fuzzy number consistent, then it is ready to calculate the weight of each criterion. First, the researcher calculate the synthesis fuzzy. From table 4.78 value of all row and column were calculated. Table 4.79 below is the result:

Table 4.79 Value of Total Row and Column

Total Row and Column Value		
l	m	u
3.95	5.10	6.55
5.02	6.62	8.47
5.66	7.46	9.39
3.05	3.74	4.90
3.23	4.02	5.20
20.91	26.95	34.51

After the value of total row and column where calculated, then the invers value of total column value was calculated. Table 4.80 below is the value of invers:

Table 4.80 Invers Value of Total Column

Invers Value of Total Column		
l	m	u
0.03	0.04	0.05

It is shown that the invers value of total column are 0.03, 0.04 and 0.05 respectively. Then, the synthesis of fuzzy was calculated by multiply the total column of each value with invers of total column.

$$S_{km} = (3.95, 5.10, 6.55) \times (0.03, 0.04, 0.05) \\ = (0.11, 0.19, 0.31)$$

$$S_{me} = (5.02, 6.62, 8.47) \times (0.03, 0.04, 0.05) \\ = (0.15, 0.25, 0.40)$$

$$S_{ss} = (5.66, 7.46, 9.39) \times (0.03, 0.04, 0.05) \\ = (0.16, 0.28, 0.45)$$

$$S_{tp} = (3.05, 3.74, 4.90) \times (0.03, 0.04, 0.05) \\ = (0.09, 0.14, 0.23)$$

$$S_u = (3.23, 4.02, 5.20) \times (0.03, 0.04, 0.05) \\ = (0.09, 0.15, 0.25)$$

Table 4.81 Value of Synthesis Fuzzy

Criteria	Value of Synthesis Fuzzy		
	l	m	u
Knowledge Management (KM)	0.114	0.189	0.313
Management & Execution (ME)	0.146	0.246	0.405
Software System (SS)	0.164	0.277	0.449
Technology Planning (TP)	0.089	0.139	0.234
User (U)	0.094	0.149	0.249

Based on the equation 2.6, table 4.82 below shows the result of vector value:

Table 4.82 Vector Value

	Vector Value
$V(S_{km} \geq S_{me})$	0.748
$V(S_{km} \geq S_{ss})$	0.630
$V(S_{km} \geq S_{tp})$	1.000
$V(S_{km} \geq S_u)$	1.000
$V(S_{me} \geq S_{km})$	1.000
$V(S_{me} \geq S_{ss})$	0.885
$V(S_{me} \geq S_{tp})$	1.000
$V(S_{me} \geq S_u)$	1.000
$V(S_{ss} \geq S_{km})$	1.000
$V(S_{ss} \geq S_{me})$	1.000
$V(S_{ss} \geq S_{tp})$	1.000
$V(S_{ss} \geq S_u)$	1.000
$V(S_{tp} \geq S_{km})$	0.705
$V(S_{tp} \geq S_{me})$	0.454
$V(S_{tp} \geq S_{ss})$	0.337
$V(S_{tp} \geq S_u)$	1.000
$V(S_u \geq S_{km})$	0.771
$V(S_u \geq S_{me})$	0.517
$V(S_u \geq S_{ss})$	0.399
$V(S_u \geq S_{tp})$	1.000

Based on the equation 2.9, ordinate value was gained as follow:

$$\begin{aligned} d'(S_{km}) &= \min(0.748, 0.630, 1, 1) \\ &= 0.630 \end{aligned}$$

$$\begin{aligned} d'(S_{me}) &= \min(1, 0.885, 1, 1) \\ &= 0.885 \end{aligned}$$

$$\begin{aligned} d'(S_{ss}) &= \min(1, 1, 1, 1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_{tp}) &= \min(0.705, 0.454, 0.337, 1) \\ &= 0.337 \end{aligned}$$

$$\begin{aligned} d'(S_u) &= \min(0.771, 0.517, 0.399, 1) \\ &= 0.399 \end{aligned}$$

Hence, the ordinate value can be determined as follow.

$$W_{c3}' = (0.630, 0.885, 1, 0.337, 0.399)^T$$

Normalize the weight of the vector value can gained from every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1.

$$W_{c3} = (0.194, 0.272, 0.308, 0.104, 0.123)^T$$

Table 4.83 below is representation of matrix W_{c3} , which shows the weight of each criteria that inner dependent with respect to Software System:

Table 4.83 Weight of Each Criteria wrt Software System

Criteria	Weight
Knowledge Management	0.194
Management & Execution	0.272
Software System	0.308
Technology Planning	0.104
User	0.123

iv. Weight of Criteria with respect to Technology Planning

Table 4.84 Matrix of Pairwise Comparison Criteria with Respect to TP (First Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	U	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	1.50	2.00	2.50	1.00	1.50	2.00	0.40	0.50	0.67	1.50	2.00	2.50
Management & Execution	0.40	0.50	0.67	1.00	1.00	1.00	0.50	0.67	1.00	0.33	0.40	0.50	0.50	0.67	1.00
Software System	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00
Technology Planning	1.50	2.00	2.50	2.00	2.50	3.00	1.00	1.50	2.00	1.00	1.00	1.00	0.33	0.40	0.50
User	0.40	0.50	0.67	0.50	0.67	1.00	0.50	0.67	1.00	0.33	0.40	0.50	1.00	1.00	1.00

Table 4.85 Matrix of Pairwise Comparison Criteria with Respect to TP (Second Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	U	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00	0.40	0.50	0.67	1.50	2.00	2.50
Management & Execution	1.00	1.50	2.00	1.00	1.00	1.00	1.00	1.50	2.00	0.50	0.67	1.00	1.50	2.00	2.50
Software System	0.50	0.67	1.00	0.50	0.67	1.00	1.00	1.00	1.00	0.40	0.50	0.67	1.00	1.50	2.00
Technology Planning	1.50	2.00	2.50	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.00	1.00	1.50	2.00	2.50
User	0.40	0.50	0.67	0.40	0.50	0.67	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00

Table 4.86 Geometric Mean Pairwise Comparison Criteria wrt TP in TFN Scale

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	U	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	0.87	1.15	1.58	1.00	1.50	2.00	0.40	0.50	0.67	1.50	2.00	2.50
Management & Execution	0.63	0.87	1.15	1.00	1.00	1.00	0.71	1.00	1.41	0.41	0.52	0.71	0.87	1.15	1.58
Software System	0.50	0.67	1.00	0.71	1.00	1.41	1.00	1.00	1.00	0.45	0.58	0.82	1.00	1.50	2.00
Technology Planning	1.50	2.00	2.50	1.41	1.94	2.45	1.22	1.73	2.24	1.00	1.00	1.00	0.71	0.89	1.12
User	0.40	0.50	0.67	0.45	0.58	0.82	0.50	0.67	1.00	0.37	0.45	0.58	1.00	1.00	1.00

From matrix pairwise comparison above, seen that in each criteria the value of $l \leq m \leq u$. Hence, it is indicate that the fuzzy number is consistent. After the fuzzy number consistent, then it is ready to calculate the weight of each criterion. First, the researcher calculate the synthesis fuzzy. From table 4.86 value of all row and column were calculated. Table 4.87 below is the result:

Table 4.87 Value of Total Row and Column

Total Row and Column Value		
l	m	u
4.77	6.15	7.75
3.61	4.54	5.86
3.65	4.74	6.23
5.85	7.56	9.30
2.71	3.19	4.06
20.59	26.19	33.20

After the value of total row and column where calculated, then the invers value of total column value was calculated. Table 4.88 below is the value of invers:

Table 4.88 Invers Value of Total Column

Invers Value of Total Column		
l	m	u
0.03	0.04	0.05

It is shown that the invers value of total column are 0.03, 0.04 and 0.05 respectively. Then, the synthesis of fuzzy was calculated by multiply the total column of each value with invers of total column.

$$\begin{aligned}
 S_{km} &= (4.77, 6.15, 7.75) \times (0.03, 0.04, 0.05) \\
 &= (0.14, 0.24, 0.38)
 \end{aligned}$$

$$S_{me} = (3.61, 4.54, 5.86) \times (0.03, 0.04, 0.05)$$

$$= (0.11, 0.17, 0.28)$$

$$S_{ss} = (3.65, 4.74, 6.23) \times (0.03, 0.04, 0.05)$$

$$= (0.11, 0.18, 0.30)$$

$$S_{tp} = (5.85, 7.56, 9.30) \times (0.03, 0.04, 0.05)$$

$$= (0.18, 0.29, 0.45)$$

$$S_u = (2.71, 3.19, 4.06) \times (0.03, 0.04, 0.05)$$

$$= (0.08, 0.12, 0.20)$$

Table 4.89 Value of Synthesis Fuzzy

Criteria	Value of Synthesis Fuzzy		
	I	M	u
Knowledge Management (KM)	0.144	0.235	0.376
Management & Execution (ME)	0.109	0.173	0.284
Software System (SS)	0.110	0.181	0.303
Technology Planning (TP)	0.176	0.289	0.452
User (U)	0.082	0.122	0.197

Based on the equation 2.6, table 4.90 below shows the result of vector value:

Table 4.90 Vector Value

	Vector Value
$V(S_{km} \geq S_{me})$	1.000
$V(S_{km} \geq S_{ss})$	1.000
$V(S_{km} \geq S_{tp})$	0.788
$V(S_{km} \geq S_u)$	1.000
$V(S_{me} \geq S_{km})$	0.695
$V(S_{me} \geq S_{ss})$	0.957
$V(S_{me} \geq S_{tp})$	0.484
$V(S_{me} \geq S_u)$	1.000
$V(S_{ss} \geq S_{km})$	0.747
$V(S_{ss} \geq S_{me})$	1.000
$V(S_{ss} \geq S_{tp})$	0.540
$V(S_{ss} \geq S_u)$	1.000

	Vector Value
$V(S_{tp} \geq S_{km})$	1.000
$V(S_{tp} \geq S_{me})$	1.000
$V(S_{tp} \geq S_{ss})$	1.000
$V(S_{tp} \geq S_u)$	1.000
$V(S_u \geq S_{km})$	1.000
$V(S_u \geq S_{me})$	1.000
$V(S_u \geq S_{ss})$	0.788
$V(S_u \geq S_{tp})$	1.000

Based on the calculation of equation 2.9, ordinate value was gained as follow:

$$\begin{aligned} d'(S_{km}) &= \min(1, 1, 0.788, 1) \\ &= 0.788 \end{aligned}$$

$$\begin{aligned} d'(S_{me}) &= \min(0.695, 0.957, 0.484, 1) \\ &= 0.484 \end{aligned}$$

$$\begin{aligned} d'(S_{ss}) &= \min(0.747, 1, 0.540, 1) \\ &= 0.540 \end{aligned}$$

$$\begin{aligned} d'(S_{tp}) &= \min(1, 1, 1, 1) \\ &= 1 \end{aligned}$$

$$\begin{aligned} d'(S_u) &= \min(0.322, 0.632, 0.595, 0.112) \\ &= 0.112 \end{aligned}$$

Hence, the ordinate value can be determined as follow.

$$W_{c4}' = (0.788, 0.484, 0.540, 1, 0.112)^T$$

Normalize the weight of the vector value can be gained from the every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1.

$$W_{c4} = (0.270, 0.165, 0.185, 0.342, 0.038)^T$$

Table 4.91 below is representation of matrix W_{c4} , which shows the weight of each criteria that inner dependent with respect to technology planning:

Table 4.91 Weight of Each Criteria wrt Technology Planning

Criteria	Weight
Knowledge Management	0.270
Management & Execution	0.165
Software System	0.185
Technology Planning	0.342
User	0.038

v. Weight of Criteria with respect to User

Table 4.92 Matrix of Pairwise Comparison Criteria with Respect to U (First Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
Knowledge Management	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	1.50	2.00	2.50	1.00	1.50	2.00
Management & Execution	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	1.50	2.00	2.50	0.50	0.67	1.00
Software System	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.50	2.00	0.50	0.67	1.00
Technology Planning	0.40	0.50	0.67	0.40	0.50	0.67	0.50	0.67	1.00	1.00	1.00	1.00	0.50	0.67	1.00
User	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.50	2.00	1.00	1.50	2.00	1.00	1.00	1.00

Table 4.93 Matrix of Pairwise Comparison Criteria with Respect to U (Second Expert)

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
KM	1.00	1.00	1.00	0.50	0.67	1.00	0.40	0.50	0.67	0.50	0.67	1.00	0.33	0.40	0.50
ME	1.00	1.50	2.00	1.00	1.00	1.00	0.50	0.67	1.00	1.00	1.50	2.00	0.40	0.50	0.67
SS	1.50	2.00	2.50	1.00	1.50	2.00	1.00	1.00	1.00	1.50	2.00	2.50	0.50	0.67	1.00
TP	1.00	1.50	2.00	0.50	0.67	1.00	0.40	0.50	0.67	1.00	1.00	1.00	0.40	0.50	0.67
U	2.00	2.50	3.00	1.50	2.00	2.50	1.00	1.50	2.00	1.50	2.00	2.50	1.00	1.00	1.00

Table 4.94 Geometric Mean Pairwise Comparison Criteria with Respect to U in TFN Scale

	Knowledge Management			Management & Execution			Software System			Technology Planning			User		
	l	m	u	l	m	u	l	m	u	l	m	u	l	m	u
KM	1.00	1.00	1.00	0.71	1.00	1.41	0.77	1.00	1.29	0.87	1.15	1.58	0.58	0.77	1.00
ME	0.71	1.00	1.41	1.00	1.00	1.00	0.71	1.00	1.41	1.22	1.73	2.24	0.45	0.58	0.82
SS	0.77	1.00	1.29	0.71	1.00	1.41	1.00	1.00	1.00	1.22	1.73	2.24	0.50	0.67	1.00
TP	0.63	0.87	1.15	0.45	0.58	0.82	0.45	0.58	0.82	1.00	1.00	1.00	0.45	0.58	0.82
U	1.00	1.29	1.73	1.22	1.73	2.24	1.00	1.50	2.00	1.22	1.73	2.24	1.00	1.00	1.00

From matrix pairwise comparison above, seen that in each criteria the value of $l \leq m \leq u$. Hence, it is indicate that the fuzzy number is consistent. After the fuzzy number consistent, then it is ready to calculate the weight of each criterion. First, the researcher calculate the synthesis fuzzy. From table 4.94 value of all row and column were calculated. Table 4.95 below is the result:

Table 4.95 Value of Total Row and Column

Total Row and Column Value		
l	m	u
3.93	4.93	6.29
4.09	5.31	6.88
4.21	5.40	6.94
2.97	3.60	4.60
5.45	7.26	9.20
20.64	26.49	33.92

After the value of total row and column where calculated, then the invers value of total column value was calculated. Table 4.96 below is the value of invers:

Table 4.96 Invers Value of Total Column

Invers Value of Total Column		
l	m	u
0.03	0.04	0.05

It is shown that the invers value of total column are 0.03, 0.04 and 0.05 respectively. Then, the synthesis of fuzzy was calculated by multiply the total column of each value with invers of total column.

$$S_{km} = (3.93, 4.39, 6.29) \times (0.03, 0.04, 0.05) \\ = (0.12, 0.19, 0.30)$$

$$S_{me} = (4.09, 5.13, 6.88) \times (0.03, 0.04, 0.05) \\ = (0.12, 0.20, 0.33)$$

$$S_{ss} = (4.21, 5.40, 6.94) \times (0.03, 0.04, 0.05) \\ = (0.12, 0.20, 0.34)$$

$$S_{tp} = (2.97, 3.60, 4.60) \times (0.03, 0.04, 0.05) \\ = (0.09, 0.14, 0.22)$$

$$S_u = (5.45, 7.26, 9.20) \times (0.03, 0.04, 0.05) \\ = (0.16, 0.27, 0.45)$$

Table 4.97 Value of Synthesis Fuzzy

Criteria	Value of Synthesis Fuzzy		
	l	m	u
Knowledge Management (KM)	0.116	0.186	0.305
Management & Execution (ME)	0.120	0.200	0.333
Software System (SS)	0.124	0.204	0.336
Technology Planning (TP)	0.088	0.136	0.223
User (U)	0.161	0.274	0.446

Based on the equation 2.6, table 4.98 below shows the result of vector value:

Table 4.98 Vector Value

	Vector Value
$V(S_{km} \geq S_{me})$	0.928
$V(S_{km} \geq S_{ss})$	0.911
$V(S_{km} \geq S_{tp})$	1.000
$V(S_{km} \geq S_u)$	0.621
$V(S_{me} \geq S_{km})$	1.000
$V(S_{me} \geq S_{ss})$	0.984
$V(S_{me} \geq S_{tp})$	1.000
$V(S_{me} \geq S_u)$	0.702
$V(S_{ss} \geq S_{km})$	1.000
$V(S_{ss} \geq S_{me})$	1.000
$V(S_{ss} \geq S_{tp})$	1.000
$V(S_{ss} \geq S_u)$	0.715
$V(S_{tp} \geq S_{km})$	0.681
$V(S_{tp} \geq S_{me})$	0.614
$V(S_{tp} \geq S_{ss})$	0.593
$V(S_{tp} \geq S_u)$	1.000
$V(S_u \geq S_{km})$	1.000
$V(S_u \geq S_{me})$	1.000
$V(S_u \geq S_{ss})$	1.000
$V(S_u \geq S_{tp})$	1.000

Based on the equation 2.9, ordinate value was gained as follow:

$$\begin{aligned} d'(S_{km}) &= \min(0.928, 0.911, 1, 0.621) \\ &= 0.621 \end{aligned}$$

$$\begin{aligned} d'(S_{me}) &= \min(1, 0.984, 1, 0.702) \\ &= 0.702 \end{aligned}$$

$$\begin{aligned} d'(S_{ss}) &= \min(1, 1, 1, 0.715) \\ &= 0.715 \end{aligned}$$

$$\begin{aligned} d'(S_{tp}) &= \min(0.681, 0.614, 0.593, 1) \\ &= 0.593 \end{aligned}$$

$$\begin{aligned} d'(S_u) &= \min(1, 1, 1, 1) \\ &= 1 \end{aligned}$$

Hence, the ordinate value can be determined as follow.

$$W_{c5}' = (0.621, 0.702, 0.715, 0.593, 1)^T$$

Normalize the weight of the vector value can be gained from the every element of weight vector divided by the weight of the vector itself. The total weight of normalized vector value is equal to 1.

$$W_5 = (0.171, 0.193, 0.197, 0.163, 0.275)^T$$

Table 4.99 below is representation of matrix W_{c5} , which shows the weight of each criteria that inner dependent with respect to user:

Table 4.99 Weight of Each Criteria wrt User

Criteria	Weight
Knowledge Management	0.171
Management & Execution	0.193
Software System	0.197
Technology Planning	0.163
User	0.275

D. Global Weight Calculation

Global weight of the priority being used for determined the rank of each element. Final weight of criteria generate by considering the degree of importance between criteria and degree of dependencies with another criteria. Final weight of criteria was gained by multiply weight of criteria (with no dependency) with matrix of weight of criteria with inner dependent. Below is the final weight of criteria calculation:

$$W_{GC} = \begin{bmatrix} 0.253 & 0.224 & 0.194 & 0.270 & 0.171 \\ 0.253 & 0.250 & 0.272 & 0.165 & 0.193 \\ 0.142 & 0.101 & 0.308 & 0.185 & 0.197 \\ 0.196 & 0.202 & 0.104 & 0.342 & 0.163 \\ 0.156 & 0.224 & 0.123 & 0.038 & 0.275 \end{bmatrix} \times \begin{bmatrix} 0.240 \\ 0.249 \\ 0.227 \\ 0.194 \\ 0.09 \end{bmatrix} = \begin{bmatrix} 0.228 \\ 0.234 \\ 0.183 \\ 0.202 \\ 0.153 \end{bmatrix}$$

Then, after the final weight of criteria was calculated, then the global weight of sub criteria can be calculated. The step to calculate the global weight by multiply the final weight of criteria with weight of sub criteria in each criterion in Table 4.59. Table 4.100 below shown the global weight of sub criteria that already calculated:

Table 4.100 Global Weight Sub Criteria

Criteria	Sub Criteria	Weight	Global Weight	Rank
Knowledge Management (0.228)	Top management provide inadequate resources	0.430	0.098	2
	Lack of knowledge end-user	0.194	0.044	13
	Top Management less understand with ERP system	0.376	0.086	3
Management & Execution (0.234)	Less discipline while execution process	0.331	0.077	5
	Less management support and assistance	0.247	0.058	10
	Lack of knowledge while implement ERP SAP	0.422	0.099	1
Software System (0.183)	Failed in customize SAP system	0.333	0.061	7
	Complex interface	0.333	0.061	7
	Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	0.333	0.061	7

Criteria	Sub Criteria	Weight	Global Weight	Rank
Technology Planning (0.202)	Less integration	0.247	0.050	11
	Lack of testing	0.422	0.085	4
	Lack of module that implement	0.331	0.067	6
User (0.153)	Fast job rotation	0.285	0.044	14
	Communication between admin and end-user ineffective	0.205	0.031	16
	Lack of training and refreshment	0.205	0.031	15
	Lack of Human Resources	0.304	0.047	12

E. Risk Evaluation

Risk evaluation need to be done during the risk assessment. This step include comparing the estimated risk against given risk criteria to determine the significance of the risk. There are three levels of risks, such as high, medium and low. These levels of risks gained from the likelihood of the risk multiplied by the impact of the risk itself.

From the risks that already identified and assess, it can said that the impact was vary, but the distance is not that far. Hence, the researcher divided into three scale of impact, which are high, medium and low. From the weight that calculated with ANP, scale impact of risk was formulated in Table 4.101 below:

Table 4.101 Impact Scale

Range	Scale	Numeric Scale
0 – 0.033	Low	1
0.034 – 0.066	Medium	2
0.067 – 0.099	High	3

The scale above gained from the range of weight of ANP, which is 0 to 1. It is because ANP is how the risk is effected to the ERP implementation. Then the researcher got the result of the impact of risk below in Table 4.102:

Table 4.102 Impact of Risk

Risk	Weight	Impact
Lack of knowledge while implement ERP SAP	0.099	3
Top management provide inadequate resources	0.098	3
Top Management less understand with ERP system	0.086	3
Lack of testing	0.085	3
Less discipline while execution process	0.077	3
Lack of module that implement	0.067	3
Failed in customize SAP system	0.061	2
Complex interface	0.061	2
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	0.061	2
Less management support and assistance	0.058	2
Less integration	0.050	2
Lack of Human Resources	0.047	2
Lack of knowledge end-user	0.044	2
Fast job rotation	0.044	2
Lack of training and refreshment	0.031	1
Communication between admin and end-user ineffective	0.031	1

While, for the likelihood of risk, it is scored based on the interview with the experts, that also as the end-user of ERP SAP in UII. The scale that being used for this risk likelihood is in the Table 4.103 below:

Table 4.103 Likelihood Scale

Likelihood of Risk	Scale	Criteria
High	3	Likely to happen
Medium	2	Fairly likely to happen
Low	1	Unlikely to happen

Then, after knowing the scale, the risk of likelihood were transform into the provided scale, which shown in Table 4.104 below as the result:

Table 4.104 Likelihood of Risk

Risk	Likelihood
Lack of knowledge while implement ERP SAP	1
Top management provide inadequate resources	1
Top Management less understand with ERP system	1
Lack of testing	2
Less discipline while execution process	2
Lack of module that implement	1
Failed in customize SAP system	1
Complex interface	3
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	1
Less management support and assistance	1
Less integration	1
Lack of Human Resources	2
Lack of knowledge end-user	2
Fast job rotation	3
Lack of training and refreshment	2
Communication between admin and end-user ineffective	3

To sum up the risk evaluation, then the impact of the risk were multiplied by the risk likelihood. After that, it will be converted to the scale that provided in Table 4.105 below:

Table 4.105 Matrix of Risk Evaluation

Likelihood	Consequences		
	Low	Medium	High
High	Medium	High	High
Medium	Low	Medium	High
Low	Low	Low	Medium

Table 4.106 below is the result of the risk level:

Table 4.106 Result of Risk Evaluation

Risk	Consequences	Likelihood	Result	Risk Level
Lack of knowledge while implement ERP SAP	3	1	3	Medium
Top management provide inadequate resources	3	1	3	Medium
Top Management less understand with ERP system	3	1	3	Medium
Lack of testing	3	2	6	High
Less discipline while execution process	3	2	6	High
Lack of module that implement	3	1	3	Medium
Failed in customize SAP system	2	2	4	Medium
Complex interface	2	3	6	High
Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP	2	2	2	Medium
Less management support and assistance	2	2	4	Medium
Less integration	2	1	2	Low
Lack of Human Resources	2	2	4	Medium
Lack of knowledge end-user	2	2	4	Medium
Fast job rotation	2	3	6	High
Lack of training and refreshment	1	2	2	Low
Communication between admin and end-user ineffective	1	3	3	Medium

From the table above, there are 4 risks that need to be evaluated urgently. Table 4.107 below is the technical action that can be done:

Table 4.107 Recommendation

No	Risk	Recommendation Action
1	Lack of testing	Top management should done testing for the next 5 years instead of year by year testing or evaluating. The testing should also involve the end-user, to know what they experienced during the implementation testing.
2	Less discipline while execution process	Top management should always train and refresh the end-user and all the human resources that involve in the implementation of ERP SAP about its business processes regularly. Besides, it can be done some controlling by the top management, then if there is something going on not in the right path, it must be disciplined.
3	Complex interface	Recommendation for this risk is interception between recommendation action for the number 2 and 4. If the job rotation is low and there is a regular training, the end-user will be more aware and familiar with the interface of the software.
4	Fast job rotation	Decrease the job rotation. Unless, give the job to skillful end-user, at least the one who easy to learn new things, such as the system and the software of ERP.

CHAPTER V

DISCUSSION

5.1 Risk Factors Identification in ERP Implementation

In this research, to identify the risk factors in the implementation of ERP in Universitas Islam Indonesia (UII), brainstorming with the experts has been conducted. At first, the criteria and risk factors were collected from the previous study. Then, it consulted with the experts based on the case study in UII. After that, the risk factors were identified and be fixed. There are five criteria which are Knowledge Management, Management and Execution, Software System, Technology Planning and User. From each criterion, it will be breakdown into several risk factors.

Knowledge Management criteria related to how to manage the knowledge in UII especially that relates to the implementation of ERP, whether individually or collectively. It has three risks, such as, top management provide inadequate resources, lack of knowledge end-user, and top management that has less understanding with ERP system. There are lots of resources in this case, for example like the human resources, the admin that know ERP SAP well, and the internal ERP consultant in UII.

While in Management and Execution, it is related on how the management or the end-user doing during the execution process. There are also three risks, which are, less discipline while conducting execution. It means that the stakeholder sometimes still do not

follow the current business process. Besides, the risk is less management support and assistance. This is like the fast accompaniment or response from the admin when there are some errors in the end-user level. There is also lack of knowledge while implementing ERP SAP.

In Software System, it is about how the performance of the software itself. This criterion also has three risks, which are failed in customize SAP system, complex interface and Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP. Sisfoin, Simkeu Bank and SIM RKAT are the internal software to manage the internal assets or finance.

Technology Planning criteria is related to pre-implementation and how the development of the project. It also has three risks below the criteria, such as less integration, lack of testing and lack of module that implement. Less integration here related to the module that implement in UII, which only MM and FI-CO. While lack of testing means the planning at first.

User criteria, which about how the performance of the end-user. It has four risks below the criteria, such as fast job rotation, ineffective communication between admin and end-user, lack of training and refreshment and lack of Human Resources.

5.2 Level of Risks Priority in ERP Implementation

After the risks being identified, the next step is to find out the priority of risks using Fuzzy Analytical Network Process method. In this step, the experts asked to fulfill the questionnaire matrix of pairwise comparison. There are several questionnaires, such as matrix pairwise comparison of criteria with no dependency, criteria with inner dependent and sub criteria. There are two experts that being the respondents, which experts in module Material Management and Financial Accounting and Controlling.

From the results of questionnaires that fulfilled by experts, the data were converted to TFN scale and calculated using FANP method. First, the weight of criteria with no dependency was calculated. Then, followed by the weight of each sub criteria and criteria with dependency. From the calculation, the researcher obtained the weight of each sub criteria that already determined before. Later, the weight of each sub criteria can be ranked.

The first rank goes to sub criteria 'lack of knowledge while implement ERP SAP', with global weight of 0.099. 'Top management provide inadequate resources' sub criteria is in the second rank, with global weight of 0.098. Followed by 'Top Management less understand with ERP system' in the third rank, with 0.086. Those three prior risks of sub criteria related to the 4th rank (0.085), which is 'lack of testing'. These four risks are the foundation in the implementation of ERP. As it was mentioned in the very beginning stated that implementing ERP SAP is not a simple thing. The investment is high and the business process should be managed and customized as is the real case. Hence, if there is inadequate testing at first, it might affect the implementation later on. The 5th rank, which is also vital risk to a success implementation of ERP is 'less discipline while execution process', with 0.077 of weight. This is a vital risk because if the process of ERP is undisciplined, then the ERP is not that integrate or it can be said that the ERP is not utilized well. The expert said that sometimes, in UII, the business process is not followed as it is. The sixth rank is 'lack of module that implement' with 0.067 of weight. If the module is inadequate, the ERP system is not maximum utilize. The main objective of ERP is integrate several business processes in a company. Then, there are three risks that ranked 7th, which are 'failed in customize SAP system', 'complex interface' and 'sisfoin, simkeu Bank, SIM RKAT not integrate directly with ERP SAP'. Those three risks were weighted 0.061 and in the same criteria which is software system. It is indicated that software system also quite crucial risk factors. The 10th rank is 'less management support and assistance'. Sometimes, the enterprise only implement without giving assistance especially to the end-user. While the one who facing or executing is the end-user. That is why the support and assistance should be maintained. Then, the risk 'less integration' being the 11th rank. Followed by 'lack of human resources' in the 12th rank. 'Lack of knowledge end-user' is in the 13th rank. It is

followed by ‘fast job rotation’ and ‘lack of training and refreshment’ in 14th and 15th rank, respectively. These risks also related to each other. Usually, when the rotation of job is fast, then the end-user that already study and understand the knowledge has to be replaced by someone else that know nothing. It is make the new end-user has lack of knowledge. The last rank is ‘ineffective communication between admin and end-user’.

5.3 Risks Evaluation

Last step of the risk assessment is risk evaluation. To evaluate the risk, it should be multiplied the impact of the risk with the likelihood of the risk might appear. For the impact of the risk, the researcher use result from the global weight that already obtained in the previous step. It is because, from the FANP method, it obtained how crucial the risk is. Hence, the higher the weight is the more it effected to the implementation of ERP in DSP and DKA of UII.

From the calculation, it found that there are 2 risks that have low level of risks. The risks are ‘Less integration’ and ‘Lack of training and refreshment’. Even though the management can accept these risks, but it should ensure controls are maintained. The management must be careful and maintain, to keep the risk unlikely to happen by always make a regular schedule for train the end-user and do control while implementing ERP SAP in both, DSP and DKA UII.

Another 10 risks are included in the medium risk level. Some of the risks have high impact, but the likelihood is low, especially for risk that ranked in the first until the third in the global weight. While some of them have moderate likelihood and also impact, that is why the level of risk is moderate. This includes some of the risks that related to software system, technology planning and user criteria. For the risk that categorize as medium risk level, means that it needs to specify management responsibility to decrease the risk level.

While for the high risk level, there are four risks listed. The risk that includes in the high level of risks are ‘lack of testing’, ‘less discipline while execution process’, ‘complex

interface' and 'fast job rotation'. High level of risk needs senior management attention or immediate action before it turns out as disadvantages to the company.

There are several actions that can be done, for example for the 'lack of testing' risk. In this risk, the top management should pay more attention. It is because this risk is include in the technology planning criteria, which might appear in the beginning of the project until the process of development of the project itself. The top management should done testing for the next 5 years instead of year by year testing or evaluating, then, the testing should also involve the end-user, to know what they experienced during the implementation testing. By doing this, it will decrease the other risks that might happen during the implementation.

While for 'less discipline while execution process', it is also categorize as the high level of risk. It might be crucial to be evaluate, especially the execution process. The less discipline that happen, it can be because of the end-user and the upper ordinate, the one who authorized, that are not familiar or may be do not know or forget with its business processes. Hence, the top management should always train and refresh the end-user and all the human resources that involve in the implementation of ERP SAP about its business processes regularly. Besides, it can be done some controlling by the top management, then if there is something going not in the right path, it must be disciplined.

Another example is 'complex interface'. This risk related to the 'fast job rotation' risk actually. Its complexity depends on how the end-user operates the software. While if the job rotation is high, then the end-user will be less familiar with the interface of the software. The thing that the top management can do is for example decrease the job rotation, especially in the department or the people who involve in the implementation of ERP SAP in UII. If it is cannot, then the top management should deal with the very basic training, and it should done regularly, so the new end-user or the person who is new in getting involve can catch up fast. Another thing is, management can hire the skill person to avoid the basic training. In consequences, the top management should expense more.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Based on the research results, below are several conclusions that obtained from this study:

1. There are 16 risks that might appear in expected company, such as ‘Top management provide inadequate resources’, ‘Lack of knowledge end-user’, ‘Top Management less understand with ERP system’, ‘Less discipline while execution process’, ‘Less management support and assistance’, ‘Lack of knowledge while implement ERP SAP’, ‘Failed in customize SAP system’, ‘Complex interface’, ‘Sisfoin, Simkeu Bank, SIM RKAT not integrate directly with ERP SAP’, ‘Less integration’, ‘Lack of testing’, ‘Lack of module that implement’, ‘Fast job rotation’, ‘Communication between admin and end-user ineffective’, ‘Lack of training and refreshment’, and ‘Lack of Human Resources’.
2. Based on the calculation and research using Fuzzy Analytical Network Process method that already done, the risks are ranked based on how crucial the rank is. The highest risk factor is Lack of knowledge while implement ERP SAP with weight of 0.099. The second risk is “Top management provide inadequate resources”. While “Top Management less understand with ERP system” become the third highest factor. Followed by “Lack of testing” as the fourth risk factor. The last highest fifth rank is “Less discipline while execution process”.
3. From the risks that have already evaluated, there are 3 types of risk level that obtained, which are low, moderate and high. There are 2 risks for low level, 10 for

medium level and 4 risks for high level. Low level is acceptable risks, but should be ensure that controls are maintained. For the moderate level, the risk needs to specify management responsibility, even though it is still tolerable. While for the high level, the risk needs senior management attention, because the risk is unacceptable.

6.2 Suggestions

The suggestion that can be given from the results of this research for the company and further researches are:

1. DSP and DKA of UII should aware and pay more attention to the high level of risks by performing several things, such as:
 - Planning or projecting the test for the next five years, instead of year by year and involve all of the end-user,
 - Conducting training and refreshment regularly to maintain the end-user and all the people authorized disciplined, and
 - Decreasing the job rotation.
2. Those risks in implementation of ERP in university can be used for another university that would like to implement ERP. Hence, the other universities can be aware and much pay more attention to the risks that might appear and familiar on how to prevent the risks before it might come up.
3. For the further research, conducting a risks treatment might help the company to evaluate the crucial risks that might be happened in the future.

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