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A Concept of Information Technology Investment Evaluation Framework

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ABSTRACT

The need for the current application of Information Technology has led to an increase in corporate spending to invest in Information Technology. The most common issue for companies that want to implement systems and Information Technology is the magnitude of the risks and costs that must be incurred. IT investments have special characteristics, which are high risk, considerable cost, and the perceived benefits are largely intangible. This also applies to companies located in developing countries, especially Indonesia. A common problem that makes IT investment difficult in Indonesia is the imbalance of costs and benefits and the results are very uncertain. The existence of problems related to the difficulty of making IT investment is the reason for the need to evaluate IT investment. The IT investment evaluation is not only limited to knowing whether the investment is feasible or not, but also prioritizing the investment. Information Economics (IE) method is a comprehensive method used to analyze the feasibility of IT investment. However, in Indonesia alone there is no method that can directly prioritize IT investment with the criteria that have been set in accordance with the needs of developing countries. Based on these problems, this study aims to provide a prioritized IT investment framework that will be implemented in one company in Indonesia, which uses components in the IE method as criteria for prioritization. Using the Analytical Hierarchy Process (AHP) method to weight and compile the IT investment prioritize framework tailored to the needs of companies in Indonesia. This research uses a qualitative method and the result of this research is a prioritization hierarchy framework based on IE component. Through the prioritization of IT investment framework, it is expected to improve the accuracy of IT investment decisions to support the company's business processes, especially in Indonesia. It is also expected to answer the problems that occurred during this time related to the unbalanced funds needed and funds issued.

Keywords : Information Technology Investment, Feasibility Evaluation, Prioritization, Information Economics.

I. INTRODUCTION

Information Technology is currently one of the parts that have an important role in the company. In Indonesia, the application of Information Technology (IT) becomes a mandatory requirement for the company because it is considered to support the achievement of the company's business objectives, improve the effectiveness, efficiency, and productivity of performance through each process. This is in line with the increase in corporate spending to invest in the Information Technology sector or often referred to as IT spending. The most common issue for companies that want to implement

systems and Information Technology (IT) is the amount of investment and costs that must be incurred [1].

Data from International Data Corporation (IDC) mentions that IT spending in Indonesia in 2017 ago reached Rp.399 trillion. The amount is up from the realization of IT spending in 2016 worth Rp.320 trillion. According to IDC Indonesia's Head of Consulting Department, IT spending will continue to increase over time and the most drastic increase point is in 2020. Recorded that IT spending in Southeast Asia in 2018 has reached the US $ 62 billion and of that total, 80% of which is market share contributed by Indonesia, Singapore, Malaysia and Thailand (IDC, 2017). This shows that IT needs in Indonesia from year to year increase and can be said that IT is not only a business supporter but has become the core business drivers [2].

Some studies say that IT can have a positive impact on productivity and profit on their company. One of them is research conducted by Sircar et. al., which is "A Framework for Assessing the Relationship between Information Technology Investments and Firm Performance", which states that both investment and corporation have a strong positive relationship with sales, assets, and equity. Expenditures on IS staff are positively correlated with firm performance, even more than capital expended for computers [3]. Research by Banker et. al, entitled "Impact of Information Technology on Public Accounting Firm Productivity" which states that IT has a positive impact on the productivity of public accounting firms [4]. Another study is "An Assessment of The Effect of Information Communication Technology on Human Resource Productivity of Mobarekeh Steel Complex in Isfahan (IRAN)" which states that IT has a considerable effect on human resource productivity in the organization [5]. The research "The Impact of Enterprise Resource System and Supply Chain Practices on Indonesian Companies" by Handoko et.al., states that the efficiency and effectiveness of the implementation of ERP and SCM systems have a positive impact on competitive advantage and company performance [6].

However, on the other hand, some studies also indicate that the amount of cost required for IT investment has not been matched by the number of benefits felt by the company, especially in Indonesia as a developing country. This led to the IT Sceptics view that it was estimated that 68% of the company's IT projects could not run on time or on budget and the project did not provide support for business goals after work [7]. This is reinforced by the IT Paradox phenomenon that indicates that the existence of a mismatch or imbalance between the amount of investment spent for IT purposes with the size of the total output generated [1] and often the advantages or benefits of implementing IT in the company cannot be measured with certainty [8]. Investment in the IT field has special characteristics, namely high risk, considerable cost, and benefits are felt largely intangible / hidden. This makes IT investment difficult and the result is very uncertain [9].

The problems faced Indonesia at this time related to the imbalance of costs and the difficulty of measuring the benefits of IT is the reason why IT investment evaluation is necessary. The evaluation of IT investments is not only about determining whether the investment is feasible or not but more importantly how companies can set IT investment priorities as companies have limited resources, knowledge, time and capabilities [10]. However, in Indonesia, there is still no method that can analyse the feasibility and directly prioritize IT investment projects. An evaluation method that can analyse all the benefits in an IT investment is the Information Economics method [11]. However, in its development, Strassman [12] assessed the IE method is still subjective and limited only to the assessment of project feasibility. The IE method cannot be used to prioritize IT investment, because the result is only

a scoring and an answer to whether or not the project is being analysed.

Based on these problems, this research will be designed a prioritization framework that adjusts to the general condition of existing companies in Indonesia. Criteria on the prioritization framework adopt the component on the IE method. This is done with the aim to know which benefits a top priority for the company are. Given the IE method describes all the benefits derived from the implementation of IT. This study uses Analytical Hierarchy Process (AHP) as a method that helps in preparing the hierarchical framework of prioritization of IT projects and assigns weight to each of the IE components that become criteria in the prioritization framework.

II. LITERATURE REVIEW

A. IT Project Evaluation

In general, project evaluation is a systematic and objective assessment of ongoing or completed projects. The purpose of the project evaluation is to determine the relevance and level of achievement of the project objectives, the effectiveness, and the impacts of development sustainability. Project evaluation also provides feedback on the project decision-making process of stakeholders, including investors and partners [13]. The same thing with the evaluation of projects in the field of IT. IT projects are said to be high-risk projects because, in addition to the high cost of doing them, the benefits are often time-consuming and unclear [14].

Many techniques have been developed in evaluating IT project investments. The methods include ReturnOn Investment (ROI), Cost-Benefit Analysis (CBA), Multi-Objective, Multi-Criteria Methods (MOMC), Boundary Values, Return On Management (ROM), Information Economics (IE), Critical Success Factors (CSF), Value Analysis (VA), and Experimental Methods [1].

B. Information Economics (IE)

The Information Economics method is a set of tools to calculate the advantages and costs of an Information Technology project [11]. The IE method is one of the feasibility assessment methods used to assess the feasibility of a project developed by Parker to link business performance with Information Technology [14]. According to Parker, the purpose of Information Economics is to provide an overview and analysis of Information Technology investment based on the business potential of the company and an IT investment decision-making process based on the company's business strategy [11]. Information Economics method in practice, is actually a variant of Traditional Cost-Benefit Analysis is adjusted to answer various uncertainty and intangible factors that are often encountered in Information Technology projects. According to Indrajit, in Information Economics all things that are quantitative and tangible can easily be calculated with conventional ROI approach. But for the process is intangible and has an element of risk, applied a number of techniques by using ranking and scoring [1].

Figure 1 shows the investment appraisal framework using the IE method, which in the final stages will get a score of numbers that indicate the economic value of an IT investment. Through these images, it can be seen that IE classifies the benefits of IT into three parts, namely Tangible Benefit, Quasi Tangible Benefit and Intangible Benefit.

1) Tangible Benefit

Tangible benefit is a benefit that directly affects the company's profits. Examples increase productivity, reduce paper usage, and so on. An analysis of tangible benefits or quantitative uses calculations using the simple ROI-Traditional Cost-Benefit Analysis (TCBA) method. In doing a simple calculation ROI required three worksheets consisting of: [15]

1. Development cost worksheet, is a work sheet consisting of five rating categories, i.e.:
   a. Cost of development effort
   b. The cost of new hardware
   c. The cost of purchasing new software
   d. User training costs
   e. Additional costs
2. Ongoing expense worksheet, is a worksheet consisting of six assessment categories, namely:
   a. Cost of maintaining information technology
   b. Additional data deviation charges
   c. Added communication
   d. Rental of hardware and software
   e. Inventory, and
   f. Etc
3. Economic impact sheet, is a worksheet that describes the summary of the economic impact of an information technology investment project.

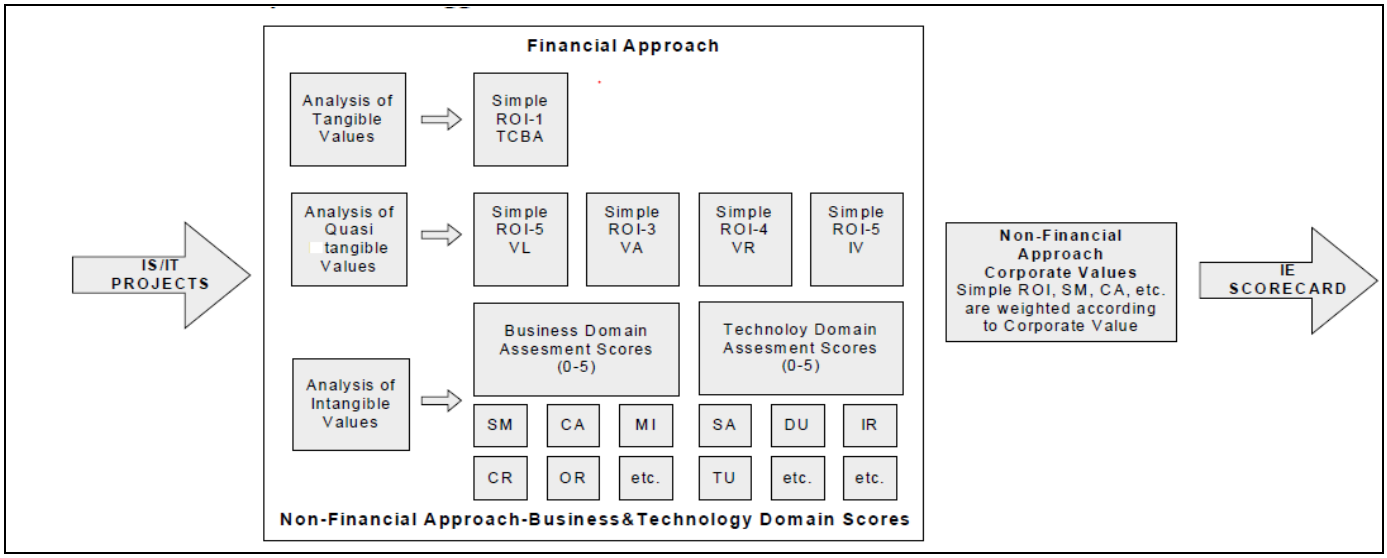

Figure1.A sample line graph using colours, which contrast, well both on screen and on a black-and-white hardcopy

2) Quasi Tangible Benefit

Quasi-tangible benefits are benefits that are in "grey" space, or information systems that directly affect profits but are hard to quantify or otherwise, not information systems directly affect profit but can be calculated. Examples are improving the planning process, improving decision-making, and so on. Analysis of quasi benefit uses calculations with: [16]

1. Value linking (VL): Used to evaluate financially the effects of performance of a function on separate functions. VL is related to the impact of IT deployment to generate revenue increment, reduced costs, accelerated growth, but no time dependency.
2. Value acceleration (VA): Used to evaluate financially the benefits of reduction/acceleration of time due to a causal relationship between two departments. This VA is closely related to time. In this analysis, the calculation is done by adding the value of inflation per year.
3. Value restructuring (VR): refers to the value associated with a job or part function; measured by the increased productivity gained from the effort on a part of the activity with lower benefits being increased higher.
4. Innovation valuation (IV): refers to whether innovative IT applications drive innovations in business strategy, products, and services, as well as business domains from organizations.

3) Intangible Benefit

The intangible benefit is an unreal or visible benefit having a positive impact on the company, but it does not directly affect profit. Examples are improving corporate image, improving employee morale, and so on. Analysis of intangible benefit using two assessment that is:

1. Business Domain

The appraisal components of the business domain are:

a. Strategic Match (SM): the benefits of information technology are measured through how much support to the achievement of the organization's strategic goals or the amount of contribution to operational activities to achieve that goal.
b. Competitive Advantage (CA): the benefits of information technology are measured through its contribution to the achievement of organizational competitive advantage.
c. Management Information Support (MI): this category assesses the contribution of information technology projects to the management needs of information in decision making.
d. Competitive Response (CR): the benefits of information technology projects are measured through how much competition risks if the project is delayed or not implemented. The more the project cannot be postponed, the higher the benefits.
e. Project or Organizational Risk (OR): explains the short-term risks related to business process redesign and organizational restructuring within a company.

2. Technology Domain

The appraisal components of the business domain are:

a. Strategic IS Architecture (IS): the benefits of an IT project are measured through the degree of conformity of the project to overall SI / IT planning.
b. Definitional Uncertainty (DU): IT project benefits are measured by how much uncertainty is due to changes in the target.
c. Technical Uncertainty (TU): IT project benefits are measured by how much project dependency on expertise, hardware, software and systems.
d. Infrastructure Risk (IR): the benefits of IT projects are measured by how important non-project investments are to accommodate this project.

From the business domain point of view, the value can be generated from the use of IT services to generate revenue, reduce costs, and increase effectiveness. While in terms of technology domain, the value of the business domain is a benefit of closing the investment costs made by giving IT service to the business domain [16].

C. IT Project Prioritization

Prioritization or selection of the right projects in investment is one thing that until now is still a challenge for the company. Doing project selection well can significantly increase the company's ability to execute strategy and improve results [6]. Therefore, not infrequently companies implement a variety of methods in the selection of IT projects. One effort that can be made to improve the effectiveness of project selection is to implement the IT project prioritization process. There are 65 different methods that have been identified and summarized in helping organizations to make IT investment decisions [17]. To simplify the understanding of these methods, these methods are summarized into six categories of rational formal methods [18], namely Ratio Method, Real Option, Economic Method, Mathematical Programming Method, Decision Theory Method and Scoring Method.

D. IT Project Prioritization

Analytical Hierarchy Process (AHP) was developed by Dr. Thomas Saaty to overcome the technical and managerial problems that often occur related to decision making. The AHP method is one of the methods that can be used in the decision-making system by taking into account the factors of perception, preference, experience, and intuition. AHP is also one of the most widely used methods of project selection because AHP combines personal judgments and values in a logical way. AHP can solve complex multicriteria problems into a hierarchy. A complex problem can be interpreted as the criteria of a multicast, the uncertainty of the problem structure, the uncertainty of opinion from the decision maker, the decision-maker of more than one person, and the inaccuracy of available data. In its application, AHP consists of 4 processes, namely:

1. Determine the hierarchical structure
2. Give weight to each criterion
3. Give value to each dimension
4. Evaluate project proposals

There are many methods of decision making in selecting projects. Some of them focus on qualitative assessment and some focus on quantitative assessment. However, AHP is a method that can combine both qualitative and quantitative assessments. The use of AHP in the evaluation and selection of projects has been widely studied by experts through different approaches. It was found that AHP is very useful, its assessment using pairwise comparison using a scale that can indicate the strength of each option.

III. RESEARCH METHODS

The methodology used in the journal search in this study refers to the review literature method developed by Kitchenham [26].

A. Research Purposes

The purpose of this study is to develop a hierarchy of prioritized IT projects that adjust to company conditions in Indonesia by AHP method. The criteria used are adopted from the domains and subdomains in the IE method. The end result of this research is a hierarchy of prioritization framework that can be implemented in subsequent research, one of the companies in Indonesia to test the validity of the pre-employment hierarchy framework that has been designed.

B. Literature Criteria

After determining the purpose of this study, the next step is to determine the criteria of previous literature searches that will be reviewed. The previous literature search began in February 2018. The literature used is published literature on electronic databases including ScienceDirect, IEEE, Emerald, and Google Scholar. Keywords used in finding literature related to IT investment prioritization method are "IT investment", "IT project prioritization", and "prioritization decision making". The following table 1 shows the results of literature searches at this stage

Table 1. Literature Search Results

Source	URL	Total of Literature
IEEE	Ieeexplore.ieee.org	34
Science Direct	sciencedirect.com	4
Emerald	emeraldinsight.com	13
GoogleScholar	scholar.google.co.id	15

C. Inclusion and Exclusion Criteria

The process of selecting relevant studies involves systematic analysis for each literature by ensuring that the literature meets the criteria of inclusion and exclusion. The inclusion criteria established in this study are the literature using English or Indonesian, in which there is a relevant discussion that discusses

the feasibility measurement, prioritization of IT investment across the country, and methods that discuss decision-making. Exclusion criteria include limited literature discussing only the evaluation of IT investments.

D. Literature Quality Assessment

Assessment of the quality of the literature is done through the identification of the journal that has been found by answering six (6) question points, while the question points are:

1. Where did the thinking flow from the journal article (a) where the research started (reasoning) - (b) the basic theories of what, and (c) what previous research would be fried by the researcher or (c) is there anything to be developed
2. What are the constructs or variables used in the study, and to answer what research problem?
3. How do researchers construct hypotheses and what are the basic theories and previous studies used?
4. What are the findings, whether the theory is supported or indisputable and how it relates to previous research?
5. What are the limitations of the study? is there any gap / opportunity to follow up on?
6. What are (a) theoretical recommendations and (b) practical recommendations for the development of science and its applications for practical purposes and for subsequent research?

E. Data Extraction and Synthesis

Data extraction is done by selecting or filtering relevant literature and in accordance with the topic of the prioritization method of IT investment. The data or literature is derived from the literature search results shown in Table 2, which results from this data extraction stage generating the literature to be discussed and used as the basis for this study. The following is the result of data extraction from the four electronic database sources used.

Table 2. The Result of Data Extraction

Source	URL	Total of Literature
IEEE	ieeexplore.ieee.org	6
Science Direct	sciencedirect.com	3
Emerald	emeraldinsight.com	3
GoogleScholar	scholar.google.co.id	8

IV. RESULT AND DISCUSSION

The results obtained through data extraction are 20 kinds of literature related to feasibility analysis along with prioritizing IT investments. At the stage of results and discussion, the results of the analysis of the 20 kinds of literature are based on the 6 points of questions that have been described in the subchapter of the quality assessment of the literature. Through this phased exposure, the recommended methods for use in the evaluation of IT investments, especially feasibility measures. However, because there is no method that can at the same time make feasibility measurement along with prioritization, hence through the result of a literature of this review also recommended decision-making method. The decision-making method will be used as a tool to assist in prioritizing IT investments.

As for the recommended method to be used in analyzing the feasibility of IT investment accordingly [15][16][17][27][28][29][30][31] is the method of Information Economics (IE). This method is the most complex IT investment feasibility analysis method, as it outlines the overall benefits received in IT implementation. As previously described on the limitations of the IE method that can only perform feasibility analysis, the recommended method by

[32][33][34][35][36][37][38][39] in prioritization is the Analytical Hierarchy Process (AHP) method. AHP method is one of the most popular decision-making methods recommended by previous research and high accuracy. In addition, this method also uses a hierarchical structure in which there are criteria that can be weighted in accordance with the needs of the company. This is in line with what is needed to prioritize an IT investment project. Table in Appendix 1 is the result of a review literature analysis related to feasibility analysis as well as prioritizing IT investments.

A. Data Extraction and Synthesis

In this section, we illustrate the description of the IE method and the AHP hierarchy framework, in which each criterion will be weighted to adopt domains and subdomains in the IE method. The methods of IE and AHP are chosen based on the literature review that has been done and described in the previous stage, considering the purpose of this study is to design a conceptual hierarchy of prioritization of IT investments. In the implementation, will be weighted to each of these criteria and sub-criteria with the given weight must adjust from the benefit which is a priority in the company's business objectives. Of course, each company has different interests, therefore in the process of weighing needs to do focus group discussion to determine the weight to be given to each criterion and sub-criteria.

The company that will be the objective of implementing this prioritization framework is devoted to companies located in Indonesia. It should be remembered that this research only describes the process of designing a prioritized hierarchy by combining IE and AHP methods, so the weights given to each criterion have not been included. Weighting process is done when this prioritization framework is implemented in a company.

V. CONCLUSION AND FURTHER RESEARCH

Based on the 20 literature reviews that have been conducted on feasibility analysis and prioritization of IT investments, the conclusion can be drawn is the most complete and comprehensive method to evaluate IT investment, especially in the feasibility analysis is Information Economics (IE). This is because the method developed by Parker is, until now still the complete method for describing the overall benefits derived from the application of IT in a company. However, because the evaluation in this study is the feasibility and prioritization of IT investments, so the IE method has not been fully able to provide solutions to the existing problems. This is because the IE method is only limited to feasibility analysis and the results given are only on a feasible or unfeasible investment. Therefore, a decision-making method is needed to assist in the prioritization stage of IT investment.

The Analytical Hierarchy Process (AHP) method is the recommended method to assist in the prioritization phase of IT investment. AHP is selected on the recommendation of the review literature that has been done before. AHP is also selected on the basis of the high accuracy results provided when using it. Through the advantages of both methods, this study aims to split the hierarchical framework of prioritizing IT investments. In the design, the domain and subdomain of the IE method are used as criteria that will be assigned weight for the prioritization process using the AHP method. It is hoped that the design by combining the advantages of both methods can help companies who want to prioritize IT investment.

This study still has limitations, ie no implementation of hierarchy that has been designed. For further research, it is necessary to implement to an institution or company that has several IT projects, especially those located in Indonesia to do prioritization to test the validation and accuracy of

the hierarchy framework that has been designed. Prioritization framework is also expected to answer the problem about the phenomenon of IT paradox that rife in Indonesia.

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APPENDIX

Appendix 1. The Result Analysis of Evaluation Method and It Investment Prioritization

Title and Reference	(a) Reasoning, (b) Something to be developed	Variable	Basic Theory	The theory of the hypothesis is supported / refuted	Limitations of Research	(a) theoritical recommendations and (b) pratical recommendations
Prioritization of Key Performance Indicators [25]	(a) The number of risks encountered in the goal setting or goal setting. (b) propose a new approach to prioritize KPIs based on AHP integration and SMART goal setting, which provides an effective problem-solving approach.	Specific, Measurable, Attainable, Realistic dan Timely	AHP and SMART Goal Setting	Theory is supported, as it succeeds in creating a new approach which includes step by step guides for decision makers to undertake the SMI KPI priority process. The case study highlights the application of the proposed approach and the calculation process to prioritize KPIs.	A new approach which includes step-by-step guidance for decision makers to undertake the SMI KPI priority process. The case study highlights the application of the proposed approach and the calculation process to prioritize KPIs.	(a) Further investigation of the methodology part of this study is required, given that the AHP method is limited by complex calculations. (b) This research has not yet presented guidance in overcoming the deficiencies found, therefore a guide should be developed in overcoming the deficiencies found in the prioritization process of KPIs.
Evaluation of Knowledge Management Tools Using AHP [26]	(a) Provide a framework that adopts an analytical hierarchy (AHP) process to assist decision-making in evaluating KM tools, implemented through case studies (b) This method adopts a multi-criteria approach that can be used to analyze and compare KM tools in the software market.	Cost, Functionally, Document Management, Collaboration, Communication, Measurement.	AHP and Knowledge Management	The theory is supported because this model has been developed and implemented in leading IT & T companies in Hong Kong. The management and team members of the SAAB department agreed that it is easy to use KMS to seek knowledge and KMS provides them with the latest collaborative and knowledgeable environment.	There is no budgetary limitation with AHP. In addition, utility values can be integrated into capital rationing models. The AHP model is not yet complete enough, to evaluate the rapidly changing KM tools.	(a) A budget restriction with AHP is required. It needs to integrate utility values into the model. Further research is needed on AHP, because the AHP model is not complete enough to evaluate KM tools. (b) Renewal of the criteria list is required. Evaluation criteria can be further refined so that KM tools can be evaluated for various environments.

Title and Reference	(b) Reasoning, (b) Something to be developed	Variable	Basic Theory	The theory of the hypothesis is supported / refuted	Limitations of Research	(a) theoritical recommendations and (b) pratical recommendations
Evaluating and Selecting E-commerce Software and Communication Systems for a Supply Chain [27]	(a) Introduce various factors and present a decision framework that will assist in determining the most appropriate media and electronic commerce technology. (b) This study provides a new approach for decision makers seeking to evaluate and select interorganizational information systems in a number of organizations.	Internal and External Software System Selection Purposes.	AHP and SCM	-	The model is very intensive on data and requires substantial managerial input.	(a) Can add additional factors or see the interrelationship between factors (such as network process approach with feedback or analysis system). (b) Need further development on the role of the supply chain before the implementation of this practice model can be managed.
An Intelligent Approach to ERP Software Selection Through Fuzzy ANP [28]	(a) Many companies have encountered some problems during ERP implementation. (b) Propose a fuzzy and ANP-based methodology that uses fuzzy logic ANP and Zadeh saaty.	Competitive Advantage, Productivity, and Profitability	ERP, AHP, ANP and Metode Fuzzy	The theory is supported, because this study can prove that using Fuzzy ANP results obtained more accurately than Fuzzy AHP.	-	(a) Can be integrated with a knowledge-based knowledge system (expert) or expert system (ES) to help decision makers make fuzzy fuzz axes and interpret results at each ANP bias step. (b) By integrating KB or ES, it can be applied and successfully support various decisions.
A New Preference Scale of Intuitionistic Fuzzy Analytic Hierarchy Process in Multi Criteria Decision Making Problems [29]	(a) The order of the AHP structure remains uncertain and unclear. Thus, the theory of intuitive fuzzy sets (IFS) is integrated to address the uncertainty and uncertainty of this AHP. (b) Proposed a new intuitive fuzzy analytic hierarchy (IF-AHP) method.	Environmental Impact, Cost, and Technical Feasibility.	Fuzzy AHP	Theory is supported, because the ranking results done by this method is almost close to the ranking result being used as an example.	This method is not completely perfect in overcoming the problem of inconsistency.	(a) A new validation mechanism such as sensitivity analysis can be used to investigate the stability of this method.
Combining Boolean Consistent Fuzzy Logic and AHP Illustrated on The Web Service Selection Problem [30]	(a) Previous research has suggested that AHP can be expanded by applying fuzzy logic. This suggests that a conventional and consistent fuzzy approach can really lead to different options. (b) Develop two different application scenarios and illustrate the problem of choosing web services.	Response Time, Availability, Reliability, Security, Encryption.	Fuzzy AHP	Theory is supported because it is successfully applied to two different scenarios by showing that the proposed approach can be used at different levels of the AHP hierarchy model.	Although conventional fuzzy logic can be applied to problems in case study 1, in some cases, it may lead to worse alternative choices. The fact that there is no conventional fuzzy set theory exists in the Boolean framework that causes the alternatives to be less consistent	(a) Applying another approach that also uses fuzzy preferences.
A Fuzzy AHP and BSC Approach for Evaluating Performance of IT Department in The Manufacturing Industry in Taiwan [31]	(a) Because IT departments perform many tasks that can not be measured only by monetary units. (b) Establish an approach based on the fuzzy analytical hierarchy (FAHP) and balanced scorecard (BSC) processes to evaluate IT departments in manufacturing industries in Taiwan.	Financial, Customer, Internal Business and Learning and Growth.	Fuzzy AHP and BSC	This theory is supported because it has successfully evaluated the performance of IT departments in the manufacturing industry in Taiwan.	-	(a) Can be modified logic to adopt different FAHP models.

Title and Reference	(b) Reasoning, (b) Something to be developed	Variable	Basic Theory	The theory of the hypothesis is supported / refuted	Limitations of Research	(a) theoritical recommendations and (b) pratical recommendations
A Framework for Water Loss Management in Developing Countries Under Fuzzy Environment: Integration of Fuzzy AHP with Fuzzy TOPSIS [32]	(a) There are many challenges, manifested in various choices, complexities, multiple evaluation criteria, inherent uncertainties and conflicting goals and interests of different stakeholders. (b) Develop the effectiveness of the multi criteria criteria analysis approach (MCDA) to support decisions on these complex topics.	Generation of revenue, costs of implementation, operation and maintanance, period of benefit, water persevation and reduction of waste, saving of energy, reliability of supply, flexibility potential, affordability and water quality.	Fuzzy AHP, Fuzzy TOPSIS.	The theory is supported because this methodology has been applied to prioritize a set of options suggested to NWDS in Palestine.	-	(a) A CBA method is required. (b) This method can be improved to develop a sorting model in calculating the missing water performance indicators
Determination of Investment Priority Field of Information Technology Using Fuzzy Multi Criteria Decision Making Method (Case Study of Polytechnic of Caltex Riau)[10]	(a) Increased IT spending and business competition are the reasons for the evaluation of investment decisions in IT (b) Using Fuzzy Multi Criteria Decision Making by combining several methods; BSC, CBA and FAHP.	Financial, operational, customer, knowledge.	AHP, BSC, CBA	Theory is supported, because in the implementation results, the model designed successfully provides accurate results.	-	-
Why Do Information Technology Projects Fail? [9]	(a) There are still many failures in IT projects (b) Identify gaps in the literature with regard to the exact definition of project successes and failures	Ecosystem survival, implementation, project management practices	Grounded Theory	Theory is supported because it has been applied to two case studies involving public service sector projects in the United States and the United Kingdom	-	(a) Need to be explored to understand why the project could fail? (b) How failure can be turned into an opportunity in learning? (c) Whether the lessons learned can be implemented to further research?
The Use of Balanced Scorecard for The Evaluation of Information and Communication Technology Projects [13]	(a) ICT investments have special characteristics (high risk, LT-return, large proportion of hidden / intangible / hidden costs) that make the use of traditional evaluation techniques (NPV, ROI) reliability uncertain. Efforts were made to find a more appropriate technique. (b) Develop new justification methods	-	Traditional evaluation methods, such as PP, ROI, IRR, NPV and CIAT	The theory has not been supported because there is no proof of implementation of the theory	Not yet implemented the designed theory	(a) It needs to be implemented in some cases to prove that the theory is valid
Does Decentralized Decision Making Increase Company Performance Through its Information Technology Infrastructure Investment? [33]	(a) explore the relationship between IT investment in the company and its performance. (b) Measure performance with BSC.	Infrastructure, finance, internal business processes, innovation & learning, customer, decentralized decision making.	BSC and System Resource Theory	(a) Hypothesis H1a, H1b, H1c, H1d, and H2d are supported (b) The hypotheses H2a, H2b, H2c, and H2d are rejected	Limitations on the sample area are too small and the difficulty to convince informants in answering the questionnaire.	It needs to be implemented on a larger sample area and more people to become informants
Software Requirements Selection and Prioritization using SBSE Approaches: A Systematic Review and Mapping of the Literature [34]	(a) Presenting a systematic review and mapping that investigates, analyzes clustering and clarifying the SBSE approach to meeting	(a) The number of studies using the Multi Objective Formulation problem is recent and increasing trends	Software requirements selection and framework	Hypotheses 1 and 2 are supported	-	(a) Insertion of statistical inference tests that can support the results obtained (b) Formal presentation of hypotheses for a better understanding of desired

Title and Reference	(b) Reasoning, (b) Something to be developed	Variable	Basic Theory	The theory of the hypothesis is supported / refuted	Limitations of Research	(a) theoritical recommendations and (b) pratical recommendations
	software selection requirements and priority issues.. (b) Understand what has been proposed to solve problems related to the selection of priority use of SearchBased Software Engineering	compared to the number of studies conducted in the sole purpose. (b) Meta-heuristic techniques are the most widely used research to solve the problem of software requirements and priorities (c) Within the SBSE area, consensus on the use of search techniques does not exist				outcomes (c) Adopt examples of real-world events and large-scale data until closer to the reality of the software industry
Implementation of Information Economics (IE) Method to Analyze the Benefits of USNI's Invasion of System and Information Technology [14]	(a) There is often difficulty in calculating the benefits obtained, the tendency to reduce costs or solutions to be cheaper but with lower capabilities than required and lead to slow time-to-market). (b) Evaluating investments with IE	Tangible benefit, Quasi benefit, and Intangible benefit	Information Economics	Theory is supported because with the IE method, USNI know how IT investment is best for the future	-	-
Measuring Economic Benefits of ATM Monitoring Application System with Information Economics Method: Case Study of PT. Bank XYZ TBK [22]	The study discusses the methods of information economics to measure benefits economical from the application of information technology.	Tangible benefit, Quasi benefit, and Intangible benefit	Information Economics	The theory is not yet supported because its implementation is still unclear	-	-
Financial Feasibility Analysis of Application of Financial Information System using IE Method on CV. Rinjani Argo Sentosa [23]	Calculating the investment of a company that decides to invest in information technology (IT)	Tangible benefit, Quasi benefit, and Intangible benefit	Information Economics	Theory is supported because it has been implemented in companies that have IT investment	-	-
Implementation of Decision Support System for Assessment of Information Technology Investment Plan with IE Method [24]	(a) Because IT benefits are more often nonfinancial, so the assessment method is developed by experts considering both financial and non-financial benefits. (b) This study produces an InTI SPK (IT investment) to simulate an alternative to assess those alternatives and compare between alternative IT investment plans to determine the priority of IT investment	Tangible benefit, Quasi benefit, and Intangible benefit	Information Economics and SPK.	Theory is supported because the application that has been made has been tested the truth with a manual counting tool and the results are the same.	-	-
Framework for Implementation Project Portfolio Selection Decision in Shipping Company [35]	(a) Create a framework / model in portfolio selection based on strategic analysis stage, and financial and risk analysis by considering criteria, both for qualitative	Strategic analysis, cost and risk analysis, optimal project portfolio selection analysis and project portfolio evaluation analysis.	The Determination of Decision Models of Project Portfolio Selection, AHP, Monte Carlo Simulation and Integer Linear Programming	Theory is supported	There is still uncertainty during the project selection / prioritization stage.	(a) Examine deeper what techniques are clearer in ensuring project selection, given previous techniques with AHP and ILP, appear not to provide accurate certainty.

Title and Reference	(b) Reasoning, (b) Something to be developed	Variable	Basic Theory	The theory of the hypothesis is supported / refuted	Limitations of Research	(a) theoritical recommendations and (b) pratical recommendations
	and quantitative evaluation. (b)Develop an optimal multi-criteria decision model with an AHP model integrated with the ILP model		(ILP).			(b) Conduct implementation to several companies to prove whether the method is feasible to use and can help achieve the overall goal of portfolio management
Using Analytic Network Process and Goal Programming for Interdependent Information System Project Selection [36]	The existence of a gap on existing methods for the selection of IS projects	Variables in this study are criteria or alternatives that have dependence on other criteria used in the SI project.	Analytic Network Process (ANP) and Zero One Goal Programming (ZOGP)	The theory is indisputable	The researchers did not consider the widely used sensitivity analysis of project problems.	(a) Added sensitivity analysis to the methodology proposed in this study, since sensitivity analysis is an important factor in the project selection process and has not been developed in this study. (b) Test this methodology on some companies that have an IS project so the accuracy of this methodology can be proven.
A New Method for Information System Selection [37]	(a) Many methods to evaluate the performance of information systems are developed, but rarely emphasize how much knowledge about user training about information systems affect system performance. (b) Develop and explain new methods for evaluation of information system performance, capable of guiding rational decision making on the application of new information systems.	Financial, Customer, Internal Business Process and Learning and Growth.	TOPSIS and BSC	The theory is indisputable because there is no implementation that states that the theory has been successful	-	(a) implements the method in the case study.

Appendix 2. The Result Analysis of Evaluation Method and It Investment Prioritization