International Journal of Innovation in Enterprise System, Volume 2, Issue 01, January 2018, pp. 45-49

Analyzing Success Factors of Enterprise Resource Planning Adoption using Analytical Hierarchy Process

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Received: 11 October 2017, Revised: 18 December 2017, Accepted: 19 December 2017, Published: 17 January 2018

***Abstract*—** Successful Enterprise Resorce Planning ERP system adoption in the company is one of the keys for the continuity of the company's business. On ERP adoption, there a lot of financials, time and human resources are invested on ERP adoption, so there must be an evaluation of ERP system to assess whether the ERP system adoption is successful or not. Some models have been developed by some researchers to assess the evaluation of ERP success. Each model has important factors used to assess the success of ERP. This study analyzes several factors that measure ERP success derived from several ERP success models to identify the important degree of each factor. The method used in this research is Analytical Hierarchy Process (AHP) with the assessment data obtained from 3 experts who have the competence and experience regarding ERP system. The results of this study found that the benefit of use, organizational impact, and user satisfaction are the 3 main subfactors with the highest important degree values.

Keywords—Analytical Hierarchy Process, ERP success factors, ERP success model

I. INTRODUCTION

Enterprise Resource Planning (ERP) is an Information System (IS) that can integrate all the company applications to the center of data storage in real-time and is accessible to all the departments[1]. Succes in adopting ERP system in the company is one of the keys of successful bussiness in company. Since there are a lot of financials, time and human resources are invested on ERP adoption process, there must be an evaluation of ERP system to assess whether the ERP system adoption is successful or not [2].

Some models have been developed by some researchers to assess the evaluation of ERP success. Some of IS success models can be used to assess ERP success. The most quoted IS model for ERP success assessment is the DeLone and McLean (DM) model [3]. Other models are innovated or adapted from DM model. There are Updated DeLone and McLean model [4], Revised IS Success Model [5], ERP Success Model [6], Modified ERP System Success Model [7] and others.

Each model has important factors used to assess the success of ERP system. Each factors in model has different importance degree that contribute in evaluation of ERP success. One method that can be used to measure the important degree is Analytical Hierarchy Process (AHP). AHP has principal to simplify a subject that are both complex and unstructured into a hierarchy structure [8]. AHP simplify the subject by dividing it into several levels. The highest level is the most general, while further down, the subject is more spesific.

This study analyzes several factors that measure ERP success derived from several ERP success evaluation models to identify the important degree of each factor. The method used in this research is AHP with the assessment data obtained from 3 experts who have the competence and experience regarding ERP system.

II. LITERATURE REVIEW

A. Enterprise Resource Planning

ERP is a system which allow companies to integrate business process across organization functions and locations, all variant best practices business and has only one real-time data storage [9]. ERP system needs a lot of cost to be adopted, but company will get many benefits from well adopted ERP. The benefits are improved customer service, better production scheduling, and actual production cost [10]. ERP has several vendors, but there are 3 vendors with the most favourable rate according to survey [11]. The vendors are SAP (20.3%), Oracle (13.9%), and Microsoft Dynamics (9.4%). Those vendors control about 43.6% of the total market share.

B. ERP Success Model

Some success models have been developed by researcher to assess ERP success. The most quoted model for success assessment is DM model [3]. DM model has 6 factors that contribute on assessing ERP success. There are system quality, information quality, use, user satisfaction, individual impact and organizational impact. Several years later, some models have been developed by referring 6 factors from DM model .

Some of them are Updated DeLone and McLean model [4], Revised IS Success Model [5], ERP Success Model [6], Modified ERP System Success

Model [7]. Each model has factors or subfactors that can be seen on Table 1.

TABLE 1
ERP SUCESS MODELS

Model	Author	Factors
DeLone and McLean (1992)	DeLone and McLean	1. System quality, 2. information quality, 3. use, 4. user satisfaction, 5. individual impact, 6.organizational impact
Updated	DeLone and	1. System quality, 2. information quality, 3. service quality, 4. user satisfaction, 5. intention to use and use, 6.net benefit
Revised IS		1. Quality dimensions, 1.1. system quality, 1.2. information quality, 1.3. service quality, 2. use dimension, 2.1. intention to use, 2.2. user satisfaction, 3. Benefits of ERP, 3.1. benefit to use, 3.2. business value
ERP Success Model (2008)	Boo Young Chung *et al*	1. Intent to use, 2. Project success, 2.1. project on budget, 2.2. project on time
	Wen-Hsien	1. Quality dimensions, 1.1. system quality, 1.2. information quality, 1.3. service quality, 2. User benefits, 2.1. benefit of use, 2.2. usefulness, 3.3. attitude, 3.4. intention to use, 4. Net business benefits, 4.1. business value

C. Analytical Hierarchy Process

AHP is an effective method to solve complex decision making and to help the expert determine the importance degree to make the best decision. AHP establishes weight on each criteria based on expert opinion using pairwise comparison [8]. According to Saaty in 1983 [12], the best scale in expressing opinions is represented in number 1 until 9. Qualitative opinion scores and descriptions of the Saaty [12] comparison scale can be seen in Table 2. To set priority of decision element each level in hiererchy can be obtained by using mathematical equations such as vertical processing in weight matrix *A* to obtain eigenvectors (ω). Eigenvectors represent the important degree of criteria. We also find eigenvalue (λ) by using Equation (1). Matrix *A* can be obtained from experts judgement, the size of matrix *A* are related by the number of factors or subfactors that being judged. Eigenvectors can be obtained by geometric mean of every row in matrix *A*.

$$A \cdot \omega = \lambda \max \omega$$

Human judgement is not always consistent, but AHP allows some small consistency [13]. In order to verify consistency of comparison matrix, Consistency Index (CI) must be obatained first using Equation (2), while *N* is number of criteria in matrix comparison. After CI value has obtained, find Consistency Ratio (CR). Expertise judgment is consistent if the value of CR less than or equal to 0.1. The value of Index Ratio (IR) [12] has been decided by Saaty and depended on *N* value.

TABLE 2.
RELATIVES SCORE OF JUDGEMENT

Score	Interpretation
1	Criteria A and criteria B are equally important
3	Criteria A is slightly more important than criteria B
5	Criteria A is more important than criteria B
7	Criteria A is strongly more important than criteria B
9	Criteria A is absolutely more important than criteria B

$$= \frac{\lambda \max -}{}$$

$$= \frac{}{}$$

III. METHODOLOGY

The research methodology used in this research is shown in Figure 1. There are several steps that must be done starting from analyzed factors and subfactors until analyzed the judgment comparison from experts.

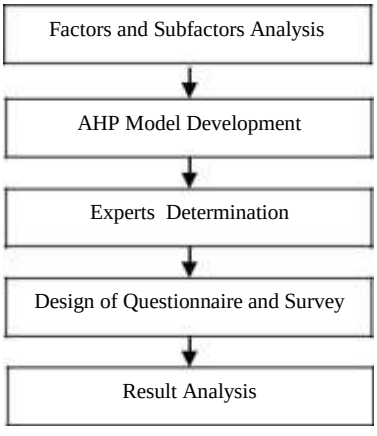

Fig. 1 Research Methodolgy Steps

A. Factors and Subfactors Analysis

At this stage, factors and subfactors from ERP success models were identified and determined. These factors and subfactors were selected from various ERP success models.The chosen models based on Table 1. were chosen because DM models are known as most quoted success model, while other models are adapted or inovated from 6 DM factors. The next step is categorized factors and subfactors distinctly so there are no factors or subfactors that have same meaning.

B. AHP Model Development

After factors and subfactors had been categorized, AHP model was developed which consisted of 3 levels. First level was the objective function, which is the scope of this research. This AHP model is used only to get and analyze the important degree of each factors and subfactors which have been grouped, not given some alternative solutions. The second level contains 5 selected factors, and the third level contains 13 selected subfactors.

C. Experts Determination

In order to give judgement for factors and subfactors in AHP model, 3 experts were chosen. These experts had different capabilities and experiences on ERP. They were a key user, an IT internal and an IT consultant. They were chosen using purposive sampling method, based on their competent, experiences and integrity.

D. Design of Questionnaire and Survey

At this stage, a questionnaire has been designed that contains the experts profiles, AHP model, factors and subfactors followed by their descriptions and references, as well as a comparison tabel designed using Microsoft Excel and had AHP formula to obtain the importance degree for each factor and subfactor. After the questionnaire had been designed completely, it was sent to each experts using e-mail.

IV. EXPERIMENTAL RESULT

A. AHP Model Analysis

This AHP model consists of 3 level. First level is objective function, which is an ERP success factor. Second level contains 5 factors as seen on Table 3, Each factor contains some subfactors on third level, with the total of whole subfactors is 13 as seen on Table 4. Figure 2. shows the AHP model. i

Fig. 2 AHP Model of ERP Success Evaluation Factors

TABLE 3. FACTORS AHP MODEL WITH DESCRIPTION

Factor	Description
Quality dimensions (A_1)	Consist of system quality, information quality and service quality
User benefits (A_2)	Benefit and satisfaction of user
Behavioral model of ERP use (A_3)	User behavior, perception and attitude on ERP
Net benefit (A_4)	Capture the balance of positive and negative
Project success (A_5)	Success of project based on budget and time

TABLE 4. SUB FACTORS AHP MODEL WITH DESCRIPTION

Factor	Subfactor	Description
Quality dimensions	System quality (A_{11}) [3],[4],[7]	Adaptability, availability, reliability, response time, usability [4], data accuracy, system efficiency and response time [7]
	Information quality (A_{12}) [3],[4],[7]	Completeness, ease of understanding, personalization, relevance, security [4], currency and reliability [7]
	Service quality (A_{13}) [4],[7]	Assurance, empathy, responsiveness, tangible and reliability [4]
User Benefits (A2)	Benefit of use (A_{21}) [5],[7]	Be perceived as the preferred supplier of ERP products and services, establish and maintain a good image and reputation with end-users, establish good relattionships with the user community [7]
	User satisfaction (A_{22}) [3],[4],[5]	Repeat purchases, repeat visits, user survey [4] and satisfaction of interface [7]
Behavioral model of ERP use (A3	Perceived ease of use (A_{31}) [7]	The degree to which a person believes that using a particular system would be free of effort [6]
	Perceived usefulness (A_{32}) [7]	The degree to which a person believes that using a particular system would enhance his or her job performance [6]
	Attitude (A_{33}) [7]	Attitude in using ERP system
	Intention to use (A_{34}) [6],[7]	User behavior in intention to use and actual system use [6]
Net benefit (A_4)	Organizational impact (A_{41}) [3]	Decreasing in operating cost, savings in labor costs, and growth profits [7]
	Individual impact (A_{42}) [3]	Quality of work environment, decision-making performance, job performance and job effectiveness [4]
Project success (A_5)	Project on budget (A_{51}) [6]	The degree to which the implementation project was completed within the budget as initially planned [6]
	Project on time (A_{52}) [6]	The degree to which the implementation project was completed on time [6]

B. Experts Description

The survey was conducted for 3 experts working in meat processing company, including key user, IT internal, and IT consultant. They play an important role for implementing ERP in the company. The questionnaire was given to the experts by e-mail. The

experts were described in 3 categories: gender, education, and experiences.

According to gender category, all of experts are male. All of them has passed Masters education, and one of them has graduated from doctoral program. They have been working in ERP, especially in SAP around 16 to 20 years..

C. Consistency Ratio Analysis

Before analyzing the importance degree for each factor and subfactor, the expert's judgements must be identified whether it consistent or not by looking at CR value. According to Table 5, the CR from all experts are 100% consistent. There are 6 criteria matrix comparison which being judged by experts, but only 3 matrix need CR value. User benefits, net benefit and project succes don't need CR value because there contain only 2 subfactors each so they must be consistent.

TABLE 5 CR VALUES OF MATRIX COMPARISON

	Consistency Ratio (CR)		
Factors on level 2	0.09	0.10	0.10
Quality Dimensions	0.00	0.03	0.03
ERP Use			
Net Benefit			
Project Success			

D. The Important Degree of ERP Success Factors

According to the results of the comparison judgment by experts, eigenvectors for each factor can be seen in Table 6. Because the experts are more than one person, geometric mean was used to combine their eigenvectors. Eventhough, the perspective of important degree factors from each expert can be seen. Key user chose user benefits as the most important factor that contribute to evaluation of ERP success. In key user perspective, user benefits of ERP are more important than other factors. Key user is user who has ability above average users in business process of company, while the user is a person who has ID to
operate ERP system.

TABLE 6. EIGENVECTORS OF ERP SUCCESS FACTORS

Factor	Expert			Total Eigen-	Rank
A_2	0.48	0.25	0.31	0.33	1
A_4	0.16	0.50	0.07	0.18	2
A_1	0.16	0.07	0.44	0.17	3
A_3	0.07	0.13	0.10	0.09	4
A_5	0.13	0.05	0.08	0.08	5

Net benefit has the highest eigenvectors from IT internal perspective. Net benefit is the total benefit gained by company. IT internal is a connector between users and IT consultant. IT internal must know business process of company and also must have the ability to configure ERP system while IT consultant leave the company. So IT internal are more focused on how the benefit is gained overall.

From IT consultant perspective, quality dimensions has the highest score of importance degree. That means IT consultant pay more attention on quality of ERP, whether quality of system, quality of information, or quality of service. Quality dimensions seems the most importance to IT consultant because IT consultant has role to configure the ERP system while ERP implementation. So IT consultant know well about the quality of ERP system.

E. The Important Degree of ERP Success Subfactors

Subfactors from each factor also have been compared overall by multiply eigenvectors gained from matrix comparison for each factor with eigenvectors of it's factor. The result can be seen on Table 7 following by it's rank. The three highest subfactor are benefit of use, organizational impact and user satisfaction. Each expert also has different perspective about the importance degree of subfactors. Table 8 shows the five subfactors with highest importance degree. The highest importance degree of subfactor from key user perspective is benefit of use.

TABLE 7. EIGENVECTORS OF ERP SUCCESS SUBFACTORS

Level 2		Level 3		Eigenvectors Overall	
	(a)		*(b)*	(b)	
A_1	0.17	A_{11}	0.52	0.088	4
		A_{12}	0.19	0.032	9
		A_{13}	0.24	0.041	6
		A_{21}	0.68	0.224	1
		A_{31}	0.11	0.010	13
		A_{32}	0.48	0.043	5
		A_{34}	0.19	0.017	11
		A_{41}	0.83	0.149	2
		A_{51}	0.50	0.040	8

Key user pay more attention on how much benefit will be received. Key user does not care about system

quality and company benefit. IT internal care more about the net benefit received by company because he knows about both company business and ERP system. While IT consultant pay more attention on system quality of ERP, because his task is to configure the ERP system.

TABLE 8. EXPERTS PERSPECTIVE OF ERP SUCCESS SUBFACTORS

	Key User		IT Internal		IT Consultant	
	Sub-factor	*Eigen-vectors*	*Sub-factor*	*Eigen-vectors*	*Sub-factor*	*Eigenvectors*
1	A_{21}	0.398	A_{41}	0.415	A_{11}	0.290
2	A_{41}	0.133	A_{21}	0.125	A_{21}	0.233
3	A_{22}	0.082	A_{42}	0.085	A_{12}	0.084
4	A_{51}	0.065	A_{32}	0.074	A_{22}	0.078
5	A_{52}	0.065	A_{11}	0.045	A_{13}	0.070

Every expert has different perspective based on hisexpertise field and his experiences.. Overall, all of the experts agreed that benefit of use is the important subfactor that contributes to ERP success evaluation, because it's importance degree are not significant different for each expert.

V. CONCLUSION

This research identifies the importance degree of ERP success factors and subfactors. Three factors with the highest importance degree include user benefits, net benefit and quality dimensions. Three subfactors with the highest importance degree are include user benefits, organizational impact and user satisfaction. Each expert has his own perspective based on his expertise field and experiences. Key user pay more attention on how much benefit that will be received. IT internal care more about the net benefit which will be received by company, while IT consultant pay more attention on system quality of ERP.

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