

# Evaluation of Key Success Factors in Project Management of Information Systems and Selection of Operators using Analytical Hierarchy Process

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## Abstract

This research is aimed at investigating the key success on project management in information system implementation. The objectives of the study are to evaluate the key success on project management in information system and to prioritize service providers of information system by using weighting values with the analytic hierarchy technique. The data were collected with the methods of focus groups and the questionnaire. The questionnaire informants included specialists in project management in information system. These informants were in charge of managers or equivalent with work experience more than five years, from 15 companies. Then, the data from the questionnaires were analyzed for decision-making process by using Analytic Hierarchy Process (AHP). The results of the study revealed that key successes on project management in information system implementation were in 6 dimensions: customers, cost, company teamwork, duration, quality and flexibility respectively in a descending order. In addition, the results of prioritizing the alternatives for decision-making identified 5 companies with high success on project management: Company C, Company D, Company E, Company B, and Company A respectively in a descending order.

**Keywords:** Decision-Making Process, Analytic Hierarchy Process, Project Management

## INTRODUCTION

At present, information system is the system that consists of various components: computer system including hardware and software, network system, databases, system developers, system users, related staff, and specialists. All of these components work together to determine, collect, and process data for developing an information system to support users when working with information. Therefore, information technology becomes a system which is very important for organization development (Rodkraw, 2012)[1]. Nowadays, information system is closely related to businesses and organizations because it can be used as a tool for supporting their operation in every level and every sector, by optimizing the organization's agility, operation, productivity, cost reduction, management decision-making, and creating competitive advantages on regional and global scales (Aiumsiriwong, 2011)[2]. To support the optimization of an organization, the information system should be developed to be up-to-date and useable. The key success for the information system development is the completeness of the system. Management should have good attitudes and value the

information system, and the designers and the developers should be capable for developing an advanced system and solving various problems possibly occurring at any time (Phattanakul, 2010)[3]. Information and communication technology (ICT) is a part of information system.

ICT industry is currently important for national economy development because this type of industry can add more economic value and constantly increase the national revenue at high rate. Therefore, the promotion for the investment and business development on ICT as well as the potential development is the main key success for driving and enabling Thai ICT industry to compete in the world market.

The implementation of project management enables an organization to obtain full benefit. This method can be used as an important tool for developing capability of an organization such as in planning, staff development, and effective budgeting management. At present, business is increasingly competitive, leading to high product production and service whereas consumers increasingly expect the organization to respond to their demands. Organizations have to improve their performance on structural strategies and organizational cultures to be flexible, agile, and responsive to possible changes. As a result, the planning and management system in the form of project management is applied for managing changes as well as for supporting and enhancing the processes of planning and operation control in general in order to achieve the organization's objectives in time with limited budget.

To implement the project management approach, the project manager should possess knowledge and understanding on the project background, definitions, differences between the project management and other projects, advantages, and the expected achievement from the project etc. in order to fulfill the objectives and goals of the project management.

In this paper, the project management is defined as the management and control of resources including time, materials, personnel, and costs in order to achieve the objectives and goals of the project. Apart from these four factors to implement the project management successfully, the project managers should also be aware of 7 principles for project management: 1. Do the project planning by basing on scope definitions and project definitions; 2. In the plan, clearly specify the period of performance through the end, the expected outcome on qualitative and quantitative deliverables; 3. Prepare various related planning; 4. Manage and follow-up the use of budget and time to monitor the progress of the project implementation; 5. Be aware of the parts that are not

in accordance with the plan; 6. Manage the scope of the project; and 7. Solve the problems (Aungsakun, and Chaopreecha, 2015)[4].

Due to the importance of information technology and the necessity of project management as mentioned above, the researcher is interested in evaluating the key success of the project management in information system. The results of the study will provide useful information for IT entrepreneurs the key success of the project management in information system, and enable them to improve and develop their project management successfully both in domestic and international levels in the future.

## LITERATURE REVIEW

### A. Concept and theory

Analytic Hierarchy Process (AHP) developed by Saaty (1990) [14]. AHP transforms quantifiable quantitative uncertainties into quantitative ones by setting standards in the consideration section to provide a rational answer to the purpose, and creating the structure of the problem. Consider a hierarchical chart (Hierarchy), respectively, of the criteria layer from primary to secondary, down to the actual choice. Alternatively, the factors in each level are compared by each factor according to the mathematical process. Let's consider the components of the problem as a whole and compare the problem for every reason. The results of the decision were concise. (Witoon Tanasiri Kongol, 1999)[8].

The AHP method consists of the following important steps (Dyer & Forman, 1992)[11].

#### 1. Problem isolation and hierarchy generation AHP

The AHP method begins with the separation of complex problems into elements of the hierarchy. The highest level (level 1) consists of a criterion about overall purpose submissions that influence decision making are referred to as sub-criteria. The lowest level of the hierarchy is called the choice of decision (see Figure 1). The significance level of the criterion does not depend on the subsets below that threshold (Saaty, 1990)[14].

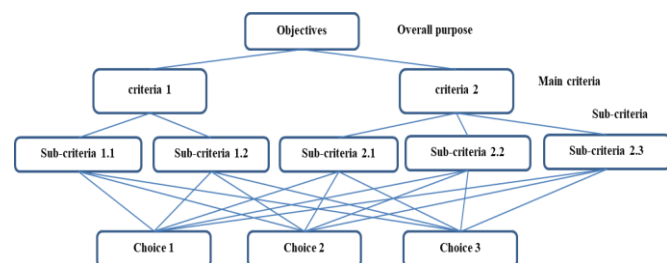


Figure 1: Structure of the process hierarchy AHP

#### 2. Comparative judgment to calculate priorities

Comparative Judgment for Prioritization Step 2 is divided into 3 sub-steps: Pairwise Comparisons, Weight Calculation, and Consistency Check.

### Pairwise Comparisons

When a hierarchy is created, the next step is to compare the pair to find the comparative significance of Subdivisions In each level, the scale used for comparison is the AHP 1-9 baseline (see Table 1). This pairwise comparison or pairing will start from the bottom. (Alternative level) and ends at the second level. (Forman & Selly, 2001)[12] after all subsections have been met. The pairwise comparison is given by scale 1-9, and then the matrix is created.

Table 1: AHP Baseline Scale 1-9 (Saaty, 1996)[16].

Verbal Judgments	criterion
Equal Importance	1
Moderate Importance	3
Strong Importance	5
Very Strongly Importance	7
Extreme Importance	9
Median	2, 4, 6, 8

### Weight calculation

After creating a pairwise comparison matrix the next step is to use a mathematical process to calculate the characteristic vector (Eigenvector) and the Largest Eigenvalue of each matrix vector. The specificity will give priority (weight value). The characteristic value can be used as a gauge to determine the consistency of the calculation method. And specific values can be obtained from Saaty (1990)[14].

### Check the consistency of the discretion.

The AHP method can measure the degree of consistency of each set of judgments. Calculate the Consistency Ratio (C.R.) in each matrix. The consistency ratio, if zero, will mean that the set of discretion is perfectly consistent. If the consistency ratio is one (or 100%) it means that the discrepancy is equivalent to the discretion of the random. If the consistency ratio is very high (Critical value is 0.1) the discretion is unreliable. The acceptable range of C.R. depends on the size of the matrix. For example, if a matrix size of 3x3 C.R. should not exceed 0.05 if the 4x4 C.R. matrix should not exceed 0.08 C.R. should not exceed 0.1 (Saaty, 1994)[15]. If the valuer's judgment in C.R. exceeds the required level appraisers should review their judgment (Saaty, 1994)[15].

### SYNTHESIS TO OBTAIN SIGNIFICANCE

By considering all the priorities from the comparison, what choices should be selected for the analysis process of AHP. As shown in equation (1).

### Matrix analysis

$$\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_n \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (1)$$

**Geometric Mean Method**

Geometric meanings are derived by multiplying the mean of the numbers. Then take the product to root the number. As shown in equation (2).

$$V_i = \left( \prod_{j=1}^n a_{ij} \right)^{1/n} \tag{2}$$

When  $a_i$  = a numeric value in a matrix table

$V_i$  = geometric mean

$n$  = number of digits to find the mean

**Weight value analysis of alternative formats**

The analysis of the weight of each alternative format is based on the synthesis of alternative forms of data, as in Equation (3).

$$W_i = \frac{V_i}{\sum_{i=1}^n V_i} \quad \sum_{i=1}^n W_i = 1 \tag{3}$$

When  $W_i$  = weight of each criterion

$V_i$  = geometric mean

$n$  = number of digits to find the mean

**Conformity Analysis**

How to calculate the consistency of the reason for rating by using a metric comparison, all of the criteria are determined by taking the sum of the diagnostic values for each rule in a row. Each row is multiplied by the sum of the average values in each row and then the resulting multiples. The result is equal to the total number of criteria being compared. This sum is called the maximum eigenvalues ( $\lambda$  max)

$$\lambda \max = \sum_{i=1}^n \left[ \sum_{j=1}^n a_{ij} W_j \right] \tag{4}$$

- If the matrix has a 100%

$\lambda \max$  = the number of rules to be compared (n)

- If the matrix is not consistent.

$\lambda \max >$  the number of criteria being compared

**Consistency Index (CI)**

$$CI = \frac{(\lambda \max - n)}{(n-1)} \tag{5}$$

$n$  = number of criteria

**Consistency Ratio (CR)**

$$CR = \frac{CI}{RI} \tag{6}$$

CR not exceeding 10%

Random Index (RI) The sample was sampled from a 64,000 matrix. Saaty (1980)[13] Table 2.

**Table 2:** Consistency index (Saaty, 1980)[13].

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

**B. Factors Affecting Success in Project Management of Information Systems**

**Table 3:** Factors Affecting Success in Project Management of Information Systems

Researcher	Study method	Criteria					
		Customer	Cost	Period	Quality	Company Team	Flexibility
Farzad Tahiri et al., (2008)	AHP	X	X		X	X	
C. Elanchezian et al., (2010)	AHP	X	X	X	X	X	X
Devendra Singh Verma et al., (2013)	AHP	X	X	X	X	X	X
Supakit Laksanasiri et al., (2015)	AHP		X	X	X		
Gottschalk et al., (2005)	AHP	X	X				
Gonzalez et al., (2005)	AHP	X	X			X	
Melvor, (2000)	AHP	X	X				
Stewart, (2001)	AHPFA		X				
Reed, Norman, and Jennings, (2002)	AHPFA	X					
Soliman, (2003)	AHPFA	X					
Chen and Perry, (2003)	AHPFA		X			X	X
Murthy, (2004)	AHPFA	X				X	
Perrons and Platts, (2004)	AHPFA				X		
Khurram S Bhutta, (2000)	AHP		X				
Dickson (1966) Pullman (1998)	AHP		X	X		X	
Welber, Current and Benton (1991)	AHP		X	X	X		X
Zhang, Lei, Cao, Ng (2003)	AHP		X	X	X		
Tullous and Munson (1991)	AHP		X	X	X		
Bross and Zhao (2004)	AHP	X	X		X		
Rohaizan Ramlan and Lee Wen Qiang (2014)	AHP	X	X		X		
Fabio De Felice et al., (2015)	AHP	X	X	X	X	X	X
Yusuff, Poh Yee & Hashmi, (2001)	AHP		X	X	X	X	
Yaser N. Alsuwehri, (2011)	AHP		X	X	X	X	
Frequency		12	19	10	13	10	5

The main key successes are derived from the researcher's literature review and related studies as well as from the focus group. The summary of the primary factors and the secondary factors which affect the key success of the project management in information system is shown in Table 3. The popular key successes of the project management in information system is summarized and synthesized.

### 1. Main Criteria

The main criteria are 6 factors is Customer, Cost, Period, Quality, Flexibility and IT Company Team

### 2. Sub Criteria

The sub criteria are 22 factor is Clarity in IT requirements, Collaboration in work, Product Satisfaction, Company Satisfaction, Cost of suppliers, Human Resources Development, Operating costs, Order Time, Delivery, Warranty, Response, Quality of products, Supplier Credibility, Quality of installation, Operation of product, Working plan, Scope of work, Problem solving plan, Products Knowledge, The ability to communicate, Customer relationships and Reliability of company.

### 3. Option

Option of decision selected IT service providers are have 5 choice consist company A, company B, company C, company D and company E.

## METHODOLOGY

Regarding the research procedure, the researcher firstly determines research questions, and then reviews the literature and related studies concerning the key successes of the project managements in information system. After that, the focus group is conducted and the questionnaire is used to collect additional data. The data from the questionnaire are analyzed by using the method of analytic hierarchy process.

### A. Forming the problem model

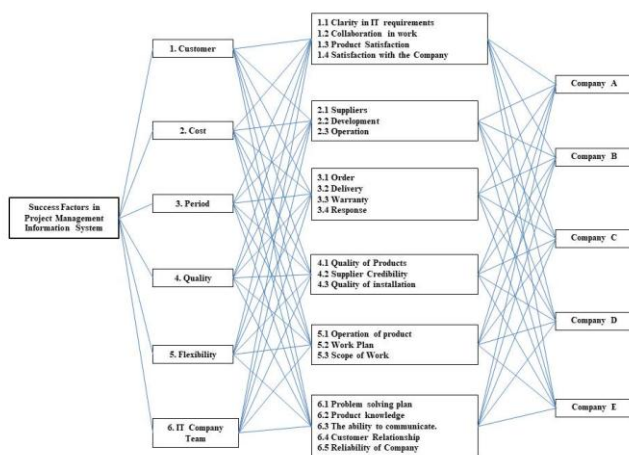


Figure 2: Hierarchical structure pattern

From Figure 1, this structure diagram includes decision-making components or factors in a hierarchical order according to the degree of complexity of the decision-making as described below.

Level 1 consists of the key successes in the project management in information system.

Level 2 consists of primary key successes in the project management in information system i.e. customers, costs, time, quality, flexibility, company teamwork.

Level 3 consists of the secondary key successes, the subordinate of the primary key successes, in the project management in information system: customers includes explicit demand for IT system, operational collaboration, product satisfactory, and company satisfactory; costs includes product cost from suppliers, cost for staff development, and operating cost; time includes ordering period, delivery time, warranty period, and quick response; quality includes product quality from suppliers, reliability of suppliers, and quality of installation; flexibility includes use of equipment, operational plan, and operational scope; and company teamwork includes good planning and problem solving, knowledge of company products, communication proficiency, good relationship with customers, and reliability of the company.

Level 4 consists of 5 alternatives for decision-making or the selected IT service providers: Company A, Company B, Company C, Company D, and Company E respectively.

### B. Data collection

The sample of the study consists of key staff who are directly responsible for the project management in information system. They are experienced specialists in the project management in information system from 15 companies.

### C. Instrument for data collection

The instrument for data collection is the questionnaire with four main parts:

Part 1: Description of research objectives

Part 2: Personal details of the informants

Part 3: Questionnaire items for determine the prioritized comparison of the primary factors and the secondary factors.

The criteria for score weighting are designed by consulting and interviewing the experts as detailed in Table 1.

### D. Data analysis

1. *Weighted-score analysis of Analytic Hierarchy Process for the primary factors and the secondary factors*

After collecting the data from the related respondents, the data are analyzed by using a tool and a method for supporting decision-making with Microsoft Excel in order to process the data quickly, accurately and easily for decision-making. This

processing method for decision-making is useful for analyzing the weighted scores of each factor and for examining the consistency of the data for decision-making.

2. *Weighted-score analysis of Analytic Hierarchy Process for the alternatives*

Regarding the decision for alternatives, the researcher calculates by using specific gravity from the AHP and the obtained scores from the model criteria. The criteria are developed from the details of the questionnaire concerning the primary factors and the secondary factors of the project management in information system in the form of 5-point Likert Scale.

**RESULT**

**A. Evaluation of key factors of success in project management of information systems.**

Main Criteria	Score Main Criteria	Sub-Criteria	Score Sub-Criteria	Score Main Criteria, Sub-Criteria	Priority
Customer	0.361	Clarity in IT requirements	0.436	0.157	1
		Collaboration in work	0.265	0.096	3
		Product Satisfaction	0.111	0.04	9
		Company Satisfaction	0.191	0.069	5
Cost	0.235	Cost of suppliers	0.626	0.147	2
		Human Resources Development	0.121	0.029	12
		Operating costs	0.242	0.057	7
IT Company Team	0.158	Problem solving plan	0.255	0.04	9
		Product Knowledge	0.094	0.015	16
		The ability to communicate	0.156	0.025	13
		Customer relationships	0.441	0.07	4
Period	0.113	Reliability of company	0.054	0.008	20
		Order	0.511	0.058	6
		Delivery	0.275	0.031	11
		Warranty	0.092	0.01	18
Quality	0.072	Response	0.122	0.014	17
		Quality of products	0.643	0.046	8
		Supplier Credibility	0.128	0.009	19
Flexibility	0.055	Quality of installation	0.229	0.016	15
		Operation of product	0.309	0.017	14
		Working plan	0.575	0.032	10
		Scope of work	0.115	0.006	21
				1	

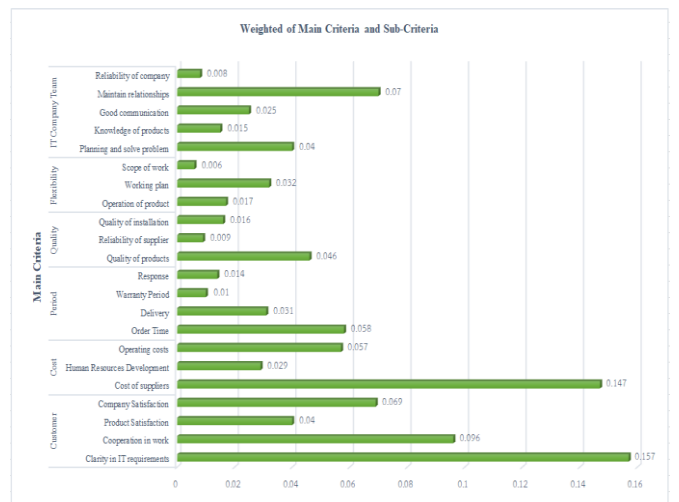
**Table 4:** Evaluation of key factors of success in project management of information systems

No.	Criteria	Performance Score															Sum	Eigen-vector	Priority
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
1	Customer	0.38	0.37	0.35	0.37	0.34	0.34	0.41	0.34	0.38	0.37	0.39	0.35	0.37	0.29	0.37	5.42	0.361	1
2	Cost	0.25	0.26	0.24	0.21	0.21	0.21	0.19	0.25	0.26	0.25	0.21	0.23	0.18	0.31	0.26	3.52	0.235	2
3	Period	0.1	0.11	0.1	0.11	0.12	0.12	0.13	0.11	0.1	0.11	0.1	0.14	0.11	0.12	0.11	1.69	0.113	4
4	Quality	0.07	0.07	0.06	0.07	0.08	0.08	0.08	0.08	0.07	0.06	0.06	0.08	0.08	0.07	0.07	1.08	0.072	5
5	Flexibility	0.04	0.05	0.05	0.06	0.07	0.07	0.05	0.05	0.05	0.04	0.06	0.07	0.07	0.05	0.05	0.83	0.055	6
6	IT Company Team	0.16	0.15	0.19	0.19	0.19	0.19	0.13	0.17	0.14	0.16	0.08	0.13	0.19	0.16	0.14	2.37	0.158	3
	Consistency Ratio: CR	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01			

From Table 4, Processing from the consistency program (Consistency Ration : CR) Has a consistency of less than 0.10. It can be concluded that the decision maker has made a comparison of the factors. And the importance of each factor is consistent. And it shows that the main factor is the number one priority is the customer has a high score of 0.361. The second is cost has a score of 0.235. The third is the IT company team has a score of 0.158. Fourth, is the period has a score of 0.113. The fifth is quality has a score of 0.072. And last factor is flexibility has a score of 0.055.

**B. Summary of Success Factors in Project Management of Information Systems with Hierarchical Analysis Process**

**Table 5:** Summary of Factors of Success in Project Management of Information System It covers both primary factors, secondary factors.



**Figure 3:** Summary of Factors of Success in Project Management of Information System It covers both primary factors, secondary factors.

From Table 5 and Figure 3 It can be seen that success factors in project management of information systems consider all levels. Priority can be set as follows: The first one is Clarity in IT requirements has a score of 0.157, Cost of supplier has a score of 0.147, Collaboration in work has a score of 0.096, Customer relationships has a score of 0.070, Company satisfaction has a score of 0.069, Order has a score of 0.058, Operating cost has a score of 0.057, Quality of product has a score of 0.046, Product satisfaction and Problem solving plan has a score of 0.040, Working plan has a score of 0.032, Delivery has a score of 0.031, Human resources development has a score of 0.029, The ability to communicate has a score of 0.025, Operation of product has a score of 0.017, Quality of installation has a score of 0.016, Product knowledge has a



score of 0.015, Response has a score of 0.014, Warranty has a score of 0.010, Supplier credibility has a score of 0.009, Reliability of company has a score of 0.008 And last, Scope of work has a score of 0.006 respectively.

**C. Results of the evaluation of alternative factors in selection of information technology service companies.**

**Table 6:** Evaluation results of alternative factors.

Criteria	Value of importance				
	Company A	Company B	Company C	Company D	Company E
Clarity in IT requirements	0.785	0.785	0.785	0.785	0.785
Collaboration in work	0.384	0.384	0.384	0.48	0.384
Product Satisfaction	0.12	0.16	0.384	0.288	0.384
Company Satisfaction	0.207	0.207	0.276	0.276	0.207
Cost of suppliers	0.588	0.588	0.735	0.735	0.588
Human Resources Development	0.116	0.116	0.145	0.087	0.058
Operating costs	0.228	0.228	0.228	0.228	0.228
Order	0.232	0.232	0.29	0.29	0.29
Delivery	0.124	0.124	0.093	0.124	0.093
Warranty	0.04	0.03	0.04	0.04	0.03
Response	0.056	0.042	0.056	0.042	0.042
Quality of products	0.138	0.138	0.138	0.138	0.138
Supplier Credibility	0.036	0.036	0.036	0.036	0.036
Quality of installation	0.064	0.064	0.064	0.08	0.064
Operation of product	0.051	0.051	0.032	0.064	0.048
Working plan	0.096	0.128	0.096	0.096	0.128
Scope of work	0.024	0.03	0.024	0.024	0.03
Problem solving plan	0.16	0.16	0.16	0.16	0.16
Product Knowledge	0.045	0.06	0.045	0.045	0.06
The ability to communicate	0.075	0.1	0.1	0.075	0.1
Customer relationships	0.35	0.35	0.35	0.35	0.28
Reliability of company	0.032	0.032	0.032	0.024	0.032
<b>Total Weighted</b>	<b>0.18</b>	<b>0.184</b>	<b>0.204</b>	<b>0.203</b>	<b>0.189</b>
No.	5	4	1	2	3

From table 6, Show priority score of each choice. Found company C has the highest score of 0.204, company D has a score of 0.203, company E has a score of 0.189, company B has a score of 0.184 and company A has a score of 0.180 respectively.

**CONCLUSION**

**A. The primary key success of the project management in information system**

The primary factors affecting the achievement of the project management in information systems, when considered in each aspect in a descending order, were customers, cost, company teamwork, time, quality, and flexibility respectively.

**B. The secondary key success of the project management in information system**

The secondary factors affecting the achievement of the project management in information systems, when considered in each

aspect in a descending order, were explicit demand for IT system, product cost from suppliers, operational collaboration, good relationship with customers, company satisfactory, ordering period, operating cost, product quality from suppliers, product satisfactory, good planning and problem solving, operational plan, delivery time, cost for staff development, communication proficiency, use of equipment, quality of installation, knowledge of company products, quick response, warranty period, reliability of suppliers, reliability of company, and operational scope respectively.

**C. Summary of prioritized alternatives**

The prioritized alternatives for the companies which implement the project management successfully were summarized respectively in a descending order: Company C, Company D, Company E, Company B, and Company A respectively.

**D. Discussion of the study**

This research was conducted successfully in prioritizing the primary key successes and the secondary key successes of the project management in information system. The results contribute to the support of systematic decision-making by using Analytic Hierarchy Process based on the concepts and previous related studies such as Farzad Tahiri et al., (2008)[19] which indicates that the key success of the project management should consider customers as the top priority. This result is consistent with the studies of Devendra Singh Verma et al., (2013)[20]; and Rohaizan Ramlan and Lee Wen Oiang (2014)[21].

**E. Suggestions**

1. For interested people to apply the method of Analytic Hierarchy Process:

- 1.1 More alternatives for decision-making should be included in prioritizing the hierarchy for the decision-making of IT service providers when selecting an appropriate company to implement the project management successfully.
- 1.2 The clear description of each factor and the example for completing the questionnaire should be included in the questionnaire concerning Pair Comparisons in order for the respondents to easily weight the score in short time without confusion.
- 1.3 The questionnaire items can be completed by interviewing each item in order for the interviewer to explain details more clearly.

2. For further research: The informants in this study included only the staff from the IT companies. Further research may also include information system users.

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