Evaluation of Information Systems in Organizations in Thailand

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Abstract

Investment in computer equipment and information systems development as well as operation costs for information system utilization are expensive. The benefits to an organization obtained by using an information system can not be quantified only in terms of money. The process is always more complicated and determining the most effective method of evaluation is always a problem for an organization.

This research investigates existing concepts of evaluation of information systems. The results of the study present four categories of evaluation: system output, system usage, system impact, and system development process. This study recommends the orderly evaluation of these four categories according to the available time and budget. For each category, the criteria and key indicators, along with the input from Delphi Technique experts, are presented. The article highlights differences between information systems supporting core operations and information systems supporting supportive works. Effort was made to determine if indicators, based on the opinions of experts, can be used as indexes to measure the success of information systems. Tests were carried out on data from sample organizations. The results show, that in actual practice, some key indicators are absent. Hence, the presence of the indicators must be reconsidered. The possibility of acquiring additional indicators from existing data has to be examined.

1. Introduction

Organizations use computer applications in almost every business function. Investment in hardware, software, and system development as well as system operation costs are quite expensive. Cost-benefit analysis of the use of computer applications and information systems, then, becomes an important issue in organizations. Estimating investment costs and operating costs is a straight forward matter. Estimating benefits, however, is not so straight forward. Costs and benefits are not directly comparable.

Many information science specialists have presented interesting concepts in information system evaluation. The basic concepts involve comparing costs and benefits. Benefits are classified into tangible and intangible benefits.

Tangible benefits are measured in terms of money. Each organization needs to identify its own variables to measure intangible benefits.

In Thailand, there are relatively few studies in the area of organizational information systems. So far no study has been done to recommend information system evaluation methods which are suitable for Thai organizations.

2. Framework

This study proposes an evaluation framework which is widely applied to development projects. The projects are evaluated according to three aspects, namely outputs, process, and impacts. Outputs of an information system are the direct benefits which are usually specified in the objectives of the systems. The process of an information system means the development process of such system. The process includes the use of budget, manpower, and time as well as the solving of problems that arise during the stages of development. Impacts can be measured in terms of the effects of the use of information systems on work efficiency, personnel behavior, communication systems, organization structure and image. This study also examines system use. The proposed evaluation framework is shown in figure 1.



Figure 1 Information System Evaluation Framework

The proposed evaluation framework has two main advantages. Firstly, evaluators can evaluate information systems in phases according to available time, manpower, and budget. If resources are limited, only output evaluation should be sufficient. Secondly, in each phase, the identification of variables used for measuring benefits from the information systems was quite clear.

3. Methodology

The study used the Delphi Technique (Porter et al., 1991; Linstone and Turoff, 1975) and employed two groups of experts. The first group consisted of 39 academics in the area of computer and information technology. These experts had doctoral degrees and /or an academic rank of associate or full professor. The second group of experts consisted of 100 computer or information center administrators from private and government organizations which used advanced information technology applications (Satyarakwit et al., 1997).

Questionnaires were distributed to all in the above two groups. The first part of the questionnaire related to the following : the necessity of information systems evaluation, who should supply the data for evaluation, the time of evaluation, the areas of evaluation, and whether methods of evaluation depend upon types of organizations and types of information systems. The last part of the questionnaire listed criteria for information system evaluation in each of the four aspects. The respondents were requested to rate the importance of each criteria on a scale of 0 to 5.

4. Analysis

4.1 General Information

The survey was repeated twice. The response rate of the first survey was 40%. The response rate for academics was lower than that for administrators. The data from the first survey were analyzed in terms of frequency, median and means of scores. The results of the first survey were then reported to the respondents before they filled out the second survey. The second survey also asked whether the quantifiable indicators appropriately measured the criteria listed in the questionnaires.

The response from the second survey was about 29%. Results from the second survey agreed with that of the first survey. Almost 95% of respondents recognized the necessity for the organizations to evaluate their information systems. They identified four groups who should be responsible for supplying data for systems evaluation. These groups are the users, customers, first line managers in the departments associated with the systems, and systems controllers. Systems evaluation should be carried out six months after systems implementation.

In evaluating information systems, the experts agreed with the four aspects of evaluation as described in the study framework. The four aspects, listed in order of frequency of response, are: outputs, system use, impacts, and development process. Methods of evaluation, in the opinion of the experts, should be different according to the type of business: manufacturing, services, or trading. The evaluation methods should also differ according to the type of information systems; whether they are systems supporting core operations or supportive works.

4.1 Criteria in Systems Evaluation

The survey listed two sets of criteria for each of the four aspects of evaluation. The first set was for information systems supporting core operations of business and the second set was for information systems supporting supportive works. The experts were asked to rate the degree of importance of each criterion on a scale of 0 to 5 (0 = not important and 5 = very important). The scores were analyzed to calculate medians and interquartile ranges (IQR) for each criterion. The median measured the degree of importance while IQR measured degree of conformity among expert opinions. The interpretation of median and IQR values are shown in the following tables.

Median	Degree of Importance
s 4.61	very important
4.21 - 4.60	important
3.81 - 4.20	moderately important
< 3.81	slightly important

IQR	Degree of Conformity
0 – 0.99	high
1.00 - 1.24	moderate
1.25 - 1.49	low
s 1.50	very low / not conformed

A detailed analysis of median and IQR scores for all criteria is shown in the Appendix. For the second survey, the study set the an operational rule that a criterion of evaluation selected as an appropriate measure of systems success should have a median value of at least 3.81 and an IQR of less than 1.50.

Tables 1 and 2 show the criteria selected for information systems evaluation based on the operation rule described above. In the second survey, the study team requested the respondent opinions on the indicator for each criterion. The indicators accepted also appear in Tables 1 and 2 along with their criteria.

Aspect	Criteria	Indicator
Outputs of the	Quality of goods or services	Quality indicator
System	User satisfaction	Subjective opinion
	Financial indicators	Financial indicator
	Time of processing a transaction	Time used per transaction
	Income	Ratio of income to capital
	Resource consumed	Resource used per transaction
	Number of transactions	Number of transactions per unit of time
System Use	System reliability	Number of system failures per unit of time
	Information accuracy	Percentage of defect transaction per unit of time
	Information currency	Percentage of delayed update
	Information completeness	Percentage of change in inputs and outputs
	System security	Unauthorized access (yes, no)
	System response time	Mean response time
	Information accessibility	Subjective opinion
	Simplicity in system use	Time used for training
	Frequency in system use	Number of system use per unit of time
Impacts of the	Customer services	Customer opinion
System	Organization competitiveness	Market share
	Confidence in decision making	Percentage level of confidence
	Correctness in performing tasks	Percentage of defect per transaction
	Convenience and safety of users	Number of accidents per unit of time
	Time to perform tasks	Time used per transaction
	Communications	Average time for one-way communication
	Organization images	Public opinion
	Completeness of organization	Opinion (yes, no)
	information system architecture	
	Response to organization	Opinion (yes, no)
	objectives	
	Time to make decision	Decision making time per problem
	Improve planning process	Number of modifications per unit of time
	Change in operation systems and	Number of changes per unit of time
	administration	
	Realization of problems	Time of realization before occurrence
	Personnel learning	Opinion of administrator
	Morale of personnel	Turnover rate
	Job satisfaction	Opinion of personnel

 Table 1 : Criteria Selected for Systems Supporting Core Operations (In order of importance)

Aspect	Criteria	Indicator
System	Time used in system development	Ratio of actual time to planned time
Development	compared to time indicated in	
Process	the plan	
	Expenditure compared to	Ratio of expenditure to budget
	budget	
	Planning adjustment	Percentage of plan change
	Manpower used compared to	Ratio of man-months used to estimated
	manpower indicated in the plan	man-months

Aspect	Criteria	Indicator	
Outputs of the	User satisfaction	Subjective opinion	
System	Quality of goods or services	Quality indicator	
	Time of processing a transaction	Time used per transaction	
	Financial indicators	Financial indicator	
System Use	System reliability	Number of system failures per unit of time	
	Information accuracy	Percentage of defect transaction per unit of time	
	Information completeness	Percentage of change in inputs and outputs	
	Information currency	Percentage of delayed update	
	System security	Unauthorized access (yes , no)	
	Simplicity in system use	Time used for training	
	Information accessibility	Subjective opinion	
	System response time	Mean response time	
Impacts of the	Customer services	Customer opinion	
System	Confidence in decision making	Percentage level of confidence	
	Organization competitiveness	Market share	
	Convenience and safety of users	Number of accidents per unit of time	
	Response to organization	Opinion (yes , no)	
	objectives		
	Correctness in performing tasks	Percentage of defect per transaction	
	Communications	Average time for one-way communication	
	Change in operation systems	Number of changes per unit of time	
	and administration		
	Organization images	Public opinion	
	Completeness of organization	Opinion (yes, no)	
	information system		
	architecture		
	Realization of problems	Time of realization before occurrence	
System	Expenditure compared to budget	Ratio of expenditure to budget	
Development	Time use in system	Ratio of actual time to planned time	
Process	development compared		
	to time indicated in		
	the plan		

 Table 2 : Criteria Selected for Systems Supporting Supportive Works (In order of importance)

5. Comparative Analysis

5.1 Comparison of Responses among Types of Experts

The experts in this study can be classified into into three groups: Administrators in public organizations, administrators in private organizations, and academics. Among the forty criteria for information systems evaluation there were only nine which had different median scores among the three groups of experts in the first survey. In the second survey, there were only two criteria which had different median scores. The two criteria were financial indicator (systems supporting supportive works) and convenience and safety of users (systems supporting both core operations and supportive works). A statistical comparison was performed by using the Kruskal-Wallis Test with a 0.05 level of significance.

5.2 Change in the Response of the Experts

There were 12 experts who participated in both surveys. Nine of them came from public organizations while the remaining three came from private organizations. The median scores in the second survey that were different were all in the impacts category. They were confidence in decision making (systems supporting core operations), time to make decision (systems supporting core operations), and change in operation systems and administration (systems supporting supportive works). A comparison of scores of the 12 experts who did both surveys was done using Wilcoxon's Signed Ranks Test using a level of significance of 0.05.

5.3 Comparison of Criteria Used for Different Types of Information Systems

In the second survey, 31 respondents indicated that the criteria used for evaluation of systems used for core operations should be different from those used for supportive works. Out of a total of 40 criteria, 29 had different scores, from Wilcoxon's Signed Ranks Test at 0.05 level of significance for different types of information systems. Information systems of core operations had a higher score for all criteria compared to the systems of supportive works.

6. Test of Results

A sample of organizations was selected to test the results of the study. Questionnaires were distributed to the sample organizations. Each was asked to pick 2 systems, one used for core operations and the other used for supportive works. The systems selected had to have been implemented for at least 6 months and not more than 1 year. The first part of the questionnaire asked IT managers to select their own criteria for system evaluation from the listed criteria and to supply the indicators of those criteria. The second part of the questionnaire asked for opinions regarding qualitative indicators of selected criteria as well as the level of success of systems implementation. The second part of the questionnaire was distributed to the IT manager, 10 system users, and 10 system developers in each organization. Responses of the above three groups were analyzed. The mean scores were used as qualitative indicators of system success. Results were tested

by determining the relationship, if any, between system success level and values of indicators. If a relationship existed, the indicators could be used to evaluate system success instead of using subjective opinions.

The number of responses to the questionnaires used for testing the indicators was too few for any meaningful statistical analysis. Only 12 out of 50 organizations returned the questionnaires. There were, then, only 24 systems to be analyzed. The study could only present the indicators selected by IT managers for these 24 systems. The criteria selected which had a frequency equal to or more than half of all the responses (6) represented practical measures as they were selected to measure the real systems of the respondents' organizations. Besides, the respondents had to provide values of indicators for such criteria. Unlike the responses from the Delphi Technique, the experts selected the criteria they considered appropriate for system evaluation. The criteria with a high frequency in the survey testing the results of the study are listed in Table 3.

Agnost	Systems Supporting Core Operations	Systems Supporting Supportive
Aspect	Systems Supporting Core Operations	Works
Outputs of the	User satisfaction	User satisfaction
System	Time of processing a transaction	
System Use	Information accessibility	Information accessibility
	System security	System response time
	Simplicity in system use	Simplicity in system use
	System response time	System security
	Information completeness	
Impacts of the	Job satisfaction	Response to organization
System	Response to organization objectives	objectives
	Completeness of organization information	Completeness of organization
	system architecture	information system
	Personnel learning	architecture
System	Planning adjustment	-
Development		
Process		

 Table 3 : Criteria Selected for Practical Evaluation

For the criteria whose indicators were subjective opinion, the study had enough responses to test the relationship between scores representing level of system success and the values of such indicators. The data were analyzed by grouping the respondents into 2 groups, one for IT personnel (IT managers and system developers) and another for system users. The data were also analyzed by types of information systems. In summary, for systems supporting core operations, IT personnel thought that user satisfaction and information accessibility correlated with system success. On the other hand, users thought that response to organizational objectives and job satisfaction were important to system success. For systems supporting supportive works, the two groups of respondents correlated user satisfaction and information accessibility with system success.

The data testing the results of the study were drawn from a variety of systems and from both public and private organizations. The data should be sufficient to demonstrate the relationship between system success and subjective indicators.

7. Conclusion

The cost of information systems development and system use are high and will probably increase in the future. Information systems evaluation is therefore a necessity for every organization. It is important that methods of evaluation not be different among organizations but it would appear that evaluation methods need to differ slightly between systems depending on whether the systems are used to support core operations or supportive works. The main differences are the order of importance of indicators and the number of indicators necessary.

Evaluation should be performed in phases as time and budget allow. The phases in order of importance are outputs, system use, impacts, and development process. In practice, there should only be a few criteria used for information systems evaluation because of the limited amount of data. The study suggests that the only important criteria are system outputs. The following criteria should be used for systems supporting core operations.

<u>Criteria</u>	Indicators
Quality of goods or services	Quality indicator
User satisfaction	Subjective opinion
Financial indicators	Financial indicator
Time of processing a transaction	Time used per transaction
Income	Ratio of income to capital
Resource consumed	Resource used per transaction
Number of transactions	Number of transactions per unit of time

For systems supporting supportive works, only 4 criteria were recommended, namely; user satisfaction, quality of goods or services, time of processing a transaction, and financial indicators.

Among the indicators proposed by the study, some should be measured only after system implementation; others before and after system implementation. Administrators should set up a plan for information system evaluation. The plan should identify the indicators used for the evaluation and data should be collected for the indicators measuring changes before installing the systems. This approach will make information systems evaluation successful.

Appendix

Evaluation Criteria for Systems Supporting Core Operations

Critoria	Median		IQR	
Citteria	First Survey	Second Survey	First Survey	Second Survey
Outputs of the System				
Quality of goods or services	4.76	4.80	0.78	0.56
User Satisfaction	4.55	4.71	0.98	0.88
Financial indicators	4.57	4.38	0.98	1.22
Time of processing a transaction	4.52	4.33	1.12	1.23
Operating costs	4.35	4.25	1.63	1.55
Income	4.35	4.00	1.58	1.41
Resource consumed	4.00	3.92	1.48	1.00
Number of transactions	4.10	3.82	1.85	1.14
Change in type of goods or services	3.59	3.80	1.86	1.13
Number of personnel	3.63	3.10	1.85	1.27
System Use				
System reliability	4.97	4.95	0.53	0.16
Information accuracy	4.97	4.94	0.53	0.33
Information currency	4.93	4.94	0.53	0.33
Information completeness	4.87	4.89	0.63	0.41
System security	4.76	4.86	0.76	0.45
System response time	4.44	4.79	1.20	0.63
Information accessibility	4.58	4.68	0.98	0.85
Simplicity in system use	4.53	4.54	0.97	1.08
Frequency in system use	4.05	4.11	1.39	1.18
Impacts of the System				
Customer services	4.77	4.89	0.73	0.41
Organization competitiveness	4.62	4.79	0.96	0.64
Confidence in decision making	4.56	4.43	1.04	1.23
Correctness in performing tasks	4.50	4.38	1.15	1.18
Convenience and safety of users	4.48	4.34	1.14	0.52
Time to perform tasks	4.20	4.28	1.30	1.13
Communications	4.33	4.27	1.27	1.11
Organization images	4.44	4.26	1.20	1.10
Completeness of organization	4.00	4.21	1.50	0.97
information system architecture				
Response to organization objectives	4.32	4.18	1.33	0.99

Criteria	Median		IQR	
	First Survey	Second Survey	First Survey	Second Survey
Impacts of the System				
Time to make decision	4.33	4.14	1.27	1.25
Improve planning process	4.00	4.05	1.43	1.21
Change in operation systems and	4.17	4.02	1.34	0.73
administration				
Realization of problems	4.00	3.95	1.43	0.77
Personnel learning	3.77	3.91	1.46	1.23
Morale of personnel	3.81	3.84	1.48	1.40
Job satisfaction	3.86	3.82	1.42	1.36
System Development Process				
Time used in system development	4.36	4.30	1.34	1.08
compared to time indicated in				
the plan				
Expenditure compared to budget	4.18	4.09	1.47	1.20
Planning adjustment	4.08	3.95	1.30	1.24
Manpower used compared to	3.64	3.86	1.51	0.92
manpower indicated in the plan				

Evaluation Criteria for Systems Supporting Supportive Works

Criteria	Median		IQR	
Cintolia	First Survey	Second Survey	First Survey	Second Survey
Outputs of the System				
User satisfaction	4.46	4.54	1.21	1.09
Quality of goods or services	4.29	4.12	1.64	1.18
Time of processing a transaction	4.00	3.94	1.67	0.64
Financial indicators	4.10	3.82	1.74	0.95
Operating costs	3.93	3.79	1.84	1.33
Resource consumed	3.54	3.67	1.40	1.23
Income	3.47	3.27	2.30	1.34
Change in type of goods or services	2.94	3.22	1.76	1.19
Number of personnel	3.13	3.16	2.05	1.09
Number of transactions	3.43	3.13	2.17	1.14

Criteria	Median		IQR	
Chichia	First Survey	Second Survey	First Survey	Second Survey
System Use				
System reliability	4.90	4.92	0.64	0.43
Information accuracy	4.79	4.86	0.77	0.45
Information completeness	4.72	4.79	0.81	0.86
Information currency	4.61	4.79	0.95	0.64
System security	4.68	4.66	0.88	0.94
Simplicity in system use	4.36	4.31	1.22	1.20
Information accessibility	4.46	4.20	1.23	1.13
System response time	3.87	4.14	1.37	0.90
Frequency in system use	3.71	3.46	1.57	1.17
Impact of the System				
Customer services	4.42	4.28	1.42	1.11
Confidence in decision making	4.38	4.10	1.46	1.08
Organization competitiveness	4.18	4.10	1.51	1.06
Convenience and safety of users	4.27	4.05	1.52	1.00
Response to organization objectives	4.13	4.05	1.38	0.67
Correctness in performing tasks	4.52	4.00	1.18	1.30
Communications	3.74	3.97	1.67	1.04
Change in operation systems and	4.08	3.96	1.33	1.15
Administration				
Organization images	4.05	3.95	1.50	1.21
Completeness of organization	3.90	3.95	1.53	0.90
Information system architecture				
Realization of problems	3.78	3.91	1.40	0.89
Improve planning process	3.86	3.79	1.49	0.84
Time to make decision	3.94	3.73	1.63	1.28
Time to perform tasks	3.95	3.67	1.47	1.38
Personnel learning	3.64	3.62	1.51	1.13
Job satisfaction	3.62	3.56	1.58	1.35
Morale of personnel	3.70	3.45	1.60	1.40

Criteria	Median		IQR	
	First Survey	Second Survey	First Survey	Second Survey
System Development Process				
Expenditure Compared to budget	4.10	4.05	1.56	0.97
Time used in system development compared to time indicated in the plan	4.05	4.00	1.53	0.93
Manpower used compared to manpower indicated in the plan	3.33	3.50	1.49	1.08
Planning adjustment	3.64	3.43	1.42	1.20

Remarks : There were 31 respondents in the first survey and 26 in the second survey.

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