

Measuring the Effect of Customization in Influencing the Success of ERP Implementation

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Abstract– In implementing ERP, customization sometimes can not be avoided due to the need of filling up the gap between organization requirements and ERP package. Even though many studies suggested minimum customization, the amount of allowed customization is still remained unclear. This study proposes a measurement framework to investigate the relationship between ERP customization and ERP implementation success level. The measurement is performed by employing correlation analysis between the degree of customization (DOC) and ERP implementation success level. Beforehand, the measurement of DOC is carried out using the complexity matrix while the implementation success level is assessed through the dimension of satisfaction, individual impact, organizational impact and intended business performance improvement. This measurement framework is expected to be able to explain whether the customization has positive impact, no correlation or negative impact to the ERP success level, but it cannot be used to detect the change of success level when there is the change in degree of customization. However, the measurement result can be utilized to estimate the range of allowed customization level.

Keywords — ERP implementation, customization, correlation

I. INTRODUCTION

Competitive business environment is endlessly forcing business organizations to find the more effective and efficient operation. Organizations are continuously re-adjusting and re-aligning their operation to be more outward looking, market-oriented and knowledge driven [1]. Integration becomes the key factor to support this condition. Integration of all organizational mechanisms will support organization to take quick reaction to competitive pressures and market

opportunities [2]. Enterprise Resource Planning (ERP), with the ability to integrate and optimize business processes in corporation has been developed to answer this challenge [3]. Reference [4] explained that ERP works to integrate all corporate information in one central database, so that all information can be easily retrieved from any department. Reference [2] confirmed that implementing ERP is the most effective way toward traceability and enterprise integration.

In almost 20 years, ERP has been implemented and developed widely. Worldwide market of ERP packages was estimated as growing at an annual growth rate of 4.8% and may exceed \$21 billion in 2010 [5]. In 2006, ARC Advisory Group was calculating that total ERP market was \$18.4 billion and the annual growth of the market was predicted in the level of 6.7 %. Based on that prediction, they estimated that by 2011 the value of the market will reach \$24 billion.

Even though ERP sounds promising, its implementation project is not a trivial issue. In information systems development perspective, ERP implementation project is different from a traditional system implementation. References [3,6] noted that ERP implementation is closely linked to the change in business process in organization. According to reference [7], ERP implementation leads the organizations to change the way they perform their tasks. Moreover, ERP project is a risky project for an organization. From the economic point of view, it is high cost and hard to estimate the project. This complexity has attracted academicians to do research in this area. It was found that 40% of 313 ERP research articles published from 2000-2006 contain the explanation of ERP implementation [3].

Generally, ERP implementation project consists of many complicated tasks to accomplish. Those complicated tasks, in some cases, leads to failure of ERP implementation. Reference [8] reported that 70 percent of all ERP projects fail to be fully implemented even after three years. According to reference [9] after reviewing 134 articles, there are 26 categories of critical success factors related to ERP implementation. It implies that there is no single reason for ERP success or failure.

Based on that review, it was found that only a few past researches tried to associate the success of ERP to the technical factor, particularly customization. In fact, customization is something crucial to fill the mismatch between enterprise needs and ERP system [10]. Reference [9] clarified that the basic version of ERP with no or minimal customization is a category of ERP critical success factors. While another reference [11] recommended the limit of customization level to guaranty the success of ERP implementation.

Although reference [11] recommended the maximum amount of 30% customization as the limit for ERP implementation, with an inadequate explanation, the level of customization is still a non-representational thing. In other word, it still leaves a question about how the customization of ERP can influence the success of its implementation. This question needs to be answered to get a more complete view of ERP implementation. Further study to investigate the relationship between ERP customization and the success of ERP implementation is considered a necessary action. Moreover it is also necessary to find out how far that ERP can be customized without significant impact to the implementation success.

II. ERP IMPLEMENTATION& ERP CUSTOMIZATION

A. ERP Successes and Failures

Despite ERP implementation has been investigated for long time, definition of ERP success or failures is still vague. Many studies discussed the critical success factors of ERP implementation without sharply defined the condition of ERP success. However, some alternatives can be considered in categorizing the level of the success ERP implementation. For example, reference [8] explained ERP implementation can be categorized as complete success when everything goes off without a hitch; partial success when there are few alignment problems resulting minor inconvenience or minor downtime; partial failure when there are tenuous of adjustment process that creating disruption in daily operation; and complete failure when the project was scuttled before implementation or failed so miserably that the company suffered significant long-term financial damage.

Other reference [2] explained the success of ERP implementation by associating it to the benefits of the ERP system. It explained that when ERP is implemented successfully, it will give some benefits to the company. Those benefits are categorized to 5 groups as follow:

- Operational: cost reduction, cycle time reduction, productivity improvement, quality improvement, customer services improvement
- Managerial: better resource management, improved decision making and planning, and performance improvement
- Strategic: concerning business growth, supporting business alliance, building business innovation, building cost leadership, generating product differentiation and building external linkages
- IT infrastructure: involving building business flexibility, IT cost reduction, increased IT infrastructure capability
- Organizational: supporting organizational changes, facilitating business learning, empowering and building common visions

In different approach, elaborated from previous research, reference [12] proposed a measurement model of successful ERP Implementation which consists of four dimensions as follows:

- User satisfaction: the extent to which users believe that the information system available to them and meets their information requirements
- Individual impact: improved individual productivity, task performance improvement, decision effectiveness and quality, time to make decision.
- Organizational impact: related to organization's operating cost, overall productivity, customer service level, realization of specific ERP implementation objectives.
- Intended business performance improvement: predefine performance objectives of the ERP project including cost reduction, business process integration, time, cost, etc.

Basically, it can be said that ERP is successfully implemented if it can perform well in term of satisfying user, giving positive impact to both individual and organization to perform business activity and improving the particular business performance as planned.

B. ERP Implementation Model

Since the company structure and business process vary from one to another, implementation characteristics also differs. It depends on the characteristic of the organization and the ERP itself. References [13] explain the implementation characteristic by following criteria:

- Physical scope
- BPR scope
- Technical scope
- Module implementation strategy
- Resource allocation scope

All these characteristics are then simplified by reference [14] into the measurable variables as shown in Table 1.

TABLE I. MEASUREMENT VARIABLES OF ERP IMPLEMENTATION CHARACTERISTICS

Variable Name	Measurement Units
Project length	# months
Project efforts	# man-months
Project budget	US\$
ERP customization	extent of modification done to ERP to customize the software (1-10)
ERP breadth	single site (1), multiple sites in one state (2), multiple sites in multiple states (3), international multiple sites (4)
ERP depth	# user of ERP
Business process automation increase	(% of processes that are automated after ERP) – (% of processes that were automated before ERP)
BPR magnitude	(% of activities in reengineered processes that were modified) * (extent of modification 1-10)
BPR depth	(# of employees whose activities changed)
BPR breadth	small number of people within a dept. (1); a department (2); more than one department (3); a region (4); more than one region (5)

Considering those scope of implementation, there is no guaranty that the ERP can be implemented using the same method. In order to assure that ERP will work appropriately, scholars tried to design a systematic approach to implement an ERP system. They tend to make a proper integration of all ERP components (software, process flow, customer mindset, and change management) [15]. Because of the different approaches, scholars have proposed varying implementation models. For examples, six-stage model [16], five-stage model [15], three-stage user oriented model [17] and the comprehensive five-stage model [18]. All of these models, principally, consist of three stages: pre-implementation (preparation), implementation (realization) and post-implementation stage.

C. Customization as Part of ERP Implementation

In the marketplace, ERP as a packaged-software was designed by considering best practice process from the specific industry to support typical business process in the entire industrial field [19]. It was designed by an organization but used by others. Since the designer and user are two independent organizations, misalignment between users need and the software design are often happened. Reference [20] reported that the gap between functionality of the package and the organization's requirement is frequently happened. It brings the implication for the organizations to customize their ERP package to make it fit with their specific needs. It is then become an important step in implementing ERP system.

ERP customization refers to the modification of the ERP package or its functionality, it may include modifications to user interfaces, reports, messages or even program codes [19,21]. This activity is usually taken in ERP implementation as an effort to align the system with the specific need. Therefore, this activity has been considered within various implementation models.

References [16,17,18] highlighted the customization as an integral part of implementation although it was named differently. In the six-stage ERP implementation model [16], customization takes place in adaptation stage. It was clearly stated that organization need to customize their ERP package to suit their specific requirement. In this model, customization was finished when the system are available for the end users.

Five-stage implementation model [18] describes customization as the part of realization whereas technical development and conference room pilot project take places. In this stage, they suggested technical development (modification, interfacing and data conversion) to work concurrently with conference room pilot project (prototyping and final adjustment). Similarly, three-stage implementation model [17] set apart the customization in the stage of realization which they called implementation stage. Nevertheless, at the end they found that customization has to be made minimally to ensure the system will work properly in longer time horizon.

D. Degree of Customization

Customization is one of the distinctive parameter to define the ERP implementation characteristics [5,13]. It is because in the real world, organization made various ERP customizations due to different requirement. As the implication, there are various types and amount of customizations have been done. Even though many studies [8,11,13,14,21,22] suggested the minimum customization to implement ERP successfully, the degree of customization is still unclear.

A study [19] tried to formulate the customization matrix that can be used in real world practice. The study collected data from some companies about the objects that have been modified and their development time range. Modified objects were grouped into several types of customization while development time ranges were classified into several classes to represent their complexities. For each class in every types of customization, the range of development time, average and standard deviation were calculated. Finally, the complexity indices were defined using the average of development time. Entire complexity indices are provided in Table II.

TABLE II. CUSTOMIZATION COMPLEXITY MATRIX [19]

Customization types	Complexity			
	Simple	Medium	Complex	Very complex
Reports	0 < dt ≤ 56 i = 31	56 < dt ≤ 84 i = 66	84 < dt ≤ 157 i = 121	157 < dt i = 292
Interfaces	0 < dt ≤ 44 i = 33	44 < dt ≤ 166 i = 66	166 < dt i = 213	-
Extensions	0 < dt ≤ 44 i = 21	44 < dt ≤ 103 i = 65	103 < dt ≤ 227 i = 179	227 < dt i = 281
Conversions	0 < dt ≤ 90 i = 56	90 < dt ≤ 212 i = 124	212 < dt i = 300	-
Workflows	0 < dt ≤ 57 i = 49	57 < dt ≤ 71 i = 64	71 < dt i = 77	-

dt = development time (hour)

i = complexity index

III. EFFECT OF CUSTOMIZATION TO ERP IMPLEMENTATION SUCCESS

A. Effect of Customization to the Daily Operation & Maintainability

In order to serve daily business operation smoothly, ERP customization processes are hardly to avoid. Customization is projected to fill up functionality gaps, satisfy user requirement and cover user's demands in post implementation stage [21]. Reference [23] proved that greater customization implies better business operation in term of coordination improvements. This perspective suggests a large numbers customization processes to ensure users satisfaction in daily business operation.

In contrast, references [8,11,13,14,21,22] recommended the minimum level of customization. It is related to the maintenance issue of the ERP system after customizations have been made. Reference [24] reported that the increased customization complexity will amplify maintenance efforts. Customization can also increase the risks and cost of maintenance while it creates difficulties for further development [21].

ERP customizations have contradictory implications. From the daily operation perspectives customization must be made in maximum level to satisfy users' need. However, it brings negatives implication regarding the cost, risk of implementation and maintainability of the systems. Therefore, customization can be seen as a tradeoff between the ease of use and its maintainability.

B. Measurement Framework

In order to find out the effect of customization to the success of ERP implementation, some measurements are needed. Generally, entire measurement process can be described as the process of measuring degree of customization, as the relationship between the degree of customization and followed by assessing the implementation success level and followed by examining the relationship between them. Entire measurement processes are shown in Figure 1.

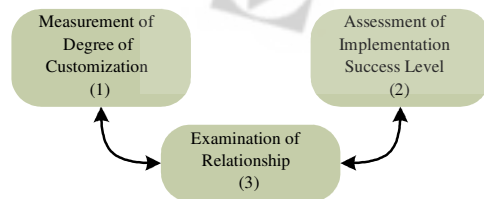


Figure 1. Framework of measurement process

The detail measurement framework is explained in the some steps below:

1) *Measurement of Degree of Customization:* measurement can be performed by observing all modifications that have been made. All the modified objects then being categorized and converted to their complexity index using customization complexity index as show in Table II. Finally, the total complexity can be calculated.

This

2) *Assessment of Implementation Success Level:* To perform this measurement, first the dimensions of ERP success level have to be defined. Although the four dimensions measurement model [12] can be employed for this purpose, the implementation success level still cannot be measured. For this purpose, as suggested by reference [25], these four dimensions have to be decomposed into some measurable variables. In this case, accumulation of these variables reflects the complete concept of implementation success level. Hence, this assessment can be performed by measuring the variables.

3) *Examination of Relationship:* When some data about degree of customization and level of success ERP implementation in an adequate sample size are provided, correlation analysis can be employed to examine their relationships.

IV. MEASURING CUSTOMIZATION EFFECT

A. Relationship between ERP Customization and Successful ERP Implementation

To measure the effect of ERP customization to successful ERP implementation has the same meaning with the examination of their relationship. Here the ERP customization is represented by the degree of customization value. As the concept of successful implementation is non-representational, it has to be represented by something else. Reference [25] suggested that operational definition of a concept should be described by its dimensions or typical characteristics which are able to be described by some measurable elements. In this case the successful ERP implementation is described by dimensions of user satisfaction, individual impact, organizational impact and intended business performance improvement. Therefore, this relationship can be represented those four dimensions. As shown in Figure 2, the degree of customization is related directly to the four dimensions, while those four dimensions are related directly to the successful ERP implementation. It can be assumed that degree of customizations is indirectly related to the successful ERP implementation.

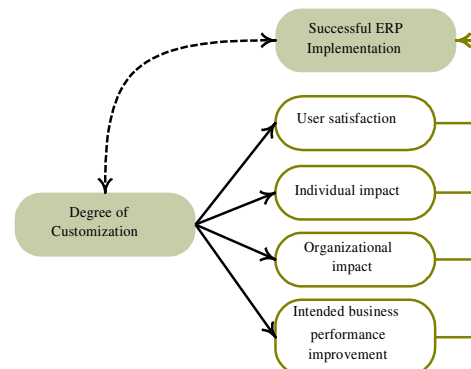


Figure 2. Relationship between ERP customization and the successful ERP implementation

B. Measurement Setting

This measurement uses selected ERP user companies as the unit of analysis. Therefore, it needs a set of data collected from some sample companies. To determine the numbers of sample companies, reference [26] can be considered for further analysis. Measurement processes are explained below.

1) Notation

Following notations are used here:

- O_i i th customization object
- dt_i development time to modify i th object
- CI_i complexity index for i th object
- DOC degree of customization
- v_{ab} b th variable for a th dimension of ERP success level
- f_k k th factor for ERP success level

2) Degree of Customization Measurement:

The objective of this measurement is to find out the degree of customizations that have been made in each sample company. Steps in measuring degree of customization for each sample company are explained as below:

- *Step 1:* make a list of modified objects
- *Step 2:* assign O_i to the type of customization; check whether it belongs to reports, interfaces, extensions, conversion or workflows category
- *Step 3:* refer to Table II, find the class of O_i based on dt_i
- *Step 4:* convert O_i to CI_i
- *Step 5:* calculate DOC for every sample using customization complexity formulation [19]:

TABLE III shows the example of DOC measurement in a company. TABLE III consists of 4 columns; modified object (column A), category (column B), development time (column C), and customization index (column D). Column A is filled by the name of objects that have been modified. Column B is filled by the category (reports, interfaces, extensions, conversion or workflows) of the corresponding modified object. Time needed to develop each object is stated in column C. Column D is filled by the customization index for each modified object based on customization complexity matrix [19]. Finally, the DOC of this company can be measured by summing up the customization indices. These steps have to be repeated for all sample companies.

TABLE III. EXAMPLE OF DOC MEASUREMENT

A	B	C	D
Modified Object	Category	Development Time	Customization Index
O_1		dt_1	CI_1
O_2		dt_2	CI_2
O_n		dt_n	CI_n
Total			

3) Assessment of ERP Success

The ERP success is assessed through its dimension; user satisfaction, individual impact, organizational impact and intended business performance improvement. Each dimension is assessed through the assessment of some measurable variables which are reflected that dimensions. For example, the dimension of user satisfaction is measured by assessing the user perception about the availability of the system, the ease of information retrieval from the system, and so on. After all measurable variables are provided, the complete assessment can be proceeded. The assessment steps are explained below:

- *Step 1:* measure the value of v_{ab}
- *Step 2:* set groups of variables using confirmatory factor analysis so the level of success can be measured through the factors (f_k). f_k are representing the dimensions of implementation success level. Further explanation of confirmatory factor analysis can be found in statistic references.
- *Step 3:* calculate f_k for every sample

4) Correlation

After the DOC and f_k value of every sample are measured, the new dataset is established as shown in Table IV. Column A consists of the number of sample companies. Column B is filled by the DOC (degree of customization) of each corresponding company. Column C is filled by the value of the first factor (user satisfaction) of each corresponding company. Column D reflects the value of —individual impact—, column E reflects the value of —organizational impact—, and column F reflects the value of —intended business performance improvement— in each sample company.

TABLE IV. EXAMPLE OF DOC AND ERP SUCCESS DIMENSIONS

A	B	C	D	E	F
Company No.	DOC	f_1	f_2	f_3	f_4
1	DOC ₁	$f_{1.1}$	$f_{2.1}$	$f_{3.1}$	$f_{4.1}$
2	DOC ₂	$f_{1.2}$	$f_{2.2}$	$f_{3.2}$	$f_{4.2}$
3	DOC ₃	$f_{1.3}$	$f_{2.2}$	$f_{3.3}$	$f_{4.3}$
n	DOC _n	$f_{1.n}$	$f_{2.n}$	$f_{3.n}$	$f_{4.n}$

From dataset as shown in Table IV, the relationships between DOC and each f_k can be examined by employing correlation analysis. The result of correlation analysis can be utilized to determine how DOC can influence every dimensions of ERP success.

V. CONCLUDING REMARKS

This measurement framework is proposed to examine how customization can influence the success of ERP implementation. Using some companies as samples, the effect of customization can be examined through the analysis of the relationship between customization level and ERP success level. Customization levels are measured in term of degree of

customization (DOC) by employing the complexity index. The success of ERP implementation is assessed through its dimensions, which are user satisfaction, individual impact, organizational impact and intended business performance improvement.

To determine the relevant factors to ERP success level, this study will employ the confirmatory factor analysis. In using confirmatory factor analysis, there are some potential miscalculation problems. It could happen when all extracted factors cannot represent the entire ERP implementation level. In this case, there are some unknown factors related to the success level of ERP implementation.

In examining the relationship, correlation analysis can explain whether the customization has positive impact, no correlation or negative impact to the ERP success level. However, in this method, the amount of change in the degree of customization cannot be utilized to detect the change of ERP success level. The range of allowed degree of customization can be estimated by setting up the desired level of ERP success. This method is satisfying when interdependency among factors is not existed. When interdependencies among factor are existed, some multivariate statistics method can be used for further analysis.

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