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A Combined ANP, TOPSIS and MCGP Approach to Select Knowledge Transfer Strategy: A Case Study in Indonesian SMEs ERP System Implementation

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Abstract. In order to enhance business sustainability and become more competitive in the international market, many Indonesian Small and Medium Enterprises (SMEs) have attempted to implement Enterprise Resource Planning (ERP) System albeit with some problems. This research draws from the relevant literature of information system success models, knowledge management and user behaviour, to develop an integrated model to select various factors of knowledge transfer strategy in ERP implementation within Indonesian SMEs. The research model includes specific constructs and paths which affect the evaluation of a successful knowledge transfer strategy. Multiple Criteria Decision Making and Goal Programming were used to select the most appropriate knowledge transfer strategy in an adopting company. The study found that knowledge sharing culture depends on absorptive capacity and consulting companies capability. The study also found that the proposed model can assist Indonesian SMEs in knowledge transfer strategy selection and decision during their ERP system implementation project.

1. Introduction

Enterprise Resource Planning (ERP) system is a group of computer applications or modules that integrates and coordinates various business processes both across and within a company [1]. In recent years, ERP vendors have expanded their market segment to SMEs since almost all of the large enterprises have already implemented ERP systems and the market has become close-to-saturation [2].

The SMEs sector in Indonesia is regarded as one of the main drivers of the Indonesian economy. Reference [3] underlined the significant role of SMEs that form the backbone of world economies to ensure growth with equity among countries. In this regard, data from BPS survey in 2013 shows that the SME sector in Indonesia constitutes more than 99.98 % of all Indonesian enterprises and employs 97.2 per cent of the total workforce [4]. With respect to the GDP contribution, Indonesian SMEs have recently contributed around 57 per cent to Indonesian GDP [5].

For many SMEs, demand for better service by business partners or customers often provide the impetus for IT implementation. Studies about IT adoption in SMEs reveal that the small firms often decide to implement IT in order to fulfill their suppliers and customers demands by delivering quality service and effective communication [6]. The efficiency of ERP system-based communication in supply chains at large enterprises has motivated SMEs to implement ERP application to develop supply networks with their business partners [7].

Indonesian SMEs have also begun to implement ERP in their operations, the systems remain under-utilised in these firms and many are yet to experience the ERP systems' benefits. The studies of ERP adoption in Indonesian SMEs reveal that the problems in under-utilisation of ERP stem from a considerable knowledge gap between ERP vendors, consultants and recipient companies [8] [9]. The critical role of knowledge for ERP success is often mentioned in the broader literature on ERP

implementation, where authors generally agree that an effective knowledge transfer facilitates corporate investment to adopt ERP system, in particular, to capture, elevate and retain ERP system knowledge among their employees [10] [11] [12].

The question of what causes the success or failure of adoption of IS in an organisation has become an interesting topic for researchers. Research in end user's training for IT implementation projects support the notion that knowledge transfer plays an essential role for successful IT system implementation [13] [14]. In the ERP implementation projects, the knowledge transfer process during the projects is considered as one of the significant support factors for ensuring a successful and beneficial ERP project [15]. Since ERP systems are expensive, competent external experts are important to increase the ERP implementation success probability. Many organisations have inadequate IT personnel who has expertise to carry out ERP system implementation, and often those organisations acquire the required expertise by hiring consulting companies to guide them through the whole implementation process [16].

Research data on ERP implementation in Indonesian SMEs shows that 70% of ERP projects experience delays and spend more costs than what originally estimated [17]. Reference [17] argues that knowledge management plays an important role in evaluating the sources of knowledge transfer problems and solving the most important barriers in ERP system projects. ERP success is not merely a matter of logistic in implementation of the technology, but is determined by the way the organisation is able to disseminate knowledge about the usage and benefits of IS among its employees. The process of knowledge transfer involves exchange of knowledge and its application between the knowledge source and its recipient. According to [18], knowledge transfer occurs when the experience of a person or an organisational unit influences another person or unit in that organisation which then brings transformation in the person or recipient unit's knowledge repository and practices.

Interest has then grown in examining how knowledge is acquired and maintained during ERP system implementation projects but this has not been investigated in depth in the ERP projects of smaller firms. Moreover, there appears to be little research emphasizing on knowledge transfer process in Indonesian SMEs' ERP system implementation projects, challenges that their managers face in managing the process, and how to address those challenges. To that end, this paper reports on a quantitative research to examine various factors' contribution that influence the knowledge transfer strategies selection in Indonesian SMEs' ERP projects. The proposed model in this paper describes the problem related to the selection of knowledge transfer strategies in a hierarchical form and integrates the criteria of knowledge transfer with various knowledge transfer strategy options. It also incorporates explicit constraints such as tangible and intangible measures of the available strategy choices and formulate a multiple criteria goal programming model to identify the best knowledge transfer strategy.

2. Literature Review

2.1 Knowledge Transfer Strategies

A vast literature of knowledge management research has examined many range of knowledge transfer strategies, and attempted to classify them. One strategy classification is system-based strategy which emphasizes on the capability to make, save, share, and utilize an organization's documented knowledge through advanced ITs [19]. Another classification focuses on the belief that tacit knowledge which existing in peoples' heads is the most valuable knowledge and should be transferred through direct contacts and social relationships [20]. This strategy is classified as human-oriented strategy. Knowledge transfer process using human-oriented strategy is considered time consuming, expensive and slow. Therefore, tacit knowledge transfer process requires an efficient codification into explicit media [21].

An organization needs to understand which knowledge transfer strategies better suited to their circumstances. Some authors suggest a combination of knowledge transfer strategies while others argue that knowledge transfer strategies should be implemented solely. However, other researchers argued that organizations should pursue a balanced approach which calls for the combination of knowledge transfer strategies appropriately [19]. Reference [22] showed that combination set of system-based and human-oriented strategies resulted in better knowledge transfer performance. Reference [23] suggested a dynamic strategy as a combination of both knowledge management strategies. The dynamic strategy combines the concept of human-

oriented and system-based knowledge transfer strategies and emphasizes on both tacit and explicit [23]. Organizations should consider their decision criteria when selecting their strategies. Therefore, it is necessary to evaluate different criteria in the practice of choosing the appropriate knowledge transfer strategy.

2.2 Knowledge Transfer Criteria

After reviewing the literature on the dynamic relationships between ERP Systems, knowledge management and organisational characteristics, many of criteria in DeLone and McLean IS Success Model [24] and Knowledge Management System Success (KMS) framework [25] found to be the most relevant for this study. Reference [26] modified DeLone and McLean IS success model by adding the factor of external IT experts to measure the success of computerisation in SMEs. Many studies have underlined consultant involvement as one of the major determinants of successful ERP systems implementation [27][28][29]. In accordance with reference [30], the present study contends that consultant or external source credibility relates to the degree to which their knowledge source is considered to be reliable and knowledgeable.

Knowledge management practice will contribute anything to the organizations' goals only if it receives support from their own employees. Reference [25] asserts that the commitment of the management to provide both monetary and non-monetary rewards can improve employee efforts to share and reuse knowledge. Motivation factors or rewards are required to motivate employees to generate and contribute their knowledge to knowledge repositories in the organisation rather than hoard it for their individual benefit. In the context of ERP systems, many studies of ERP projects have proved that rewards and incentives have a significant relation with employee participation to support the new system and reduce any resistance to the ERP project [31][32].

An organisation with good leadership stands out from its competition because it provides a rewarding work environment where the employees at all levels are encouraged to create business value work with others who have same state of mind and experience accomplishment in their work. Reference [8] recognised that Indonesian SMEs are likely to have a owner manager and immediate family member influence which designates the final decision in every organisational aspects. This situation, where the entrepreneur or owner manager acts as dominant decision maker and facilitates innovative business process, is reflected in this study as SME's Owner Leadership construct.

The effectiveness of knowledge transfer process is dependent on whether the firm has sufficient absorptive capacity before that ERP project is implemented. Therefore, it is necessary to define the term absorptive capacity to understand organisational innovation and best practices from a knowledge management perspective. Reference [30] studied knowledge transfer process from ERP consulting company to an organisation and found that the organisations' absorptive capacity and preceding knowledge of ERP systems influence the knowledge transfer between their employees and consultants. Absorptive Capacity is regarded as the recipients' capability to value, assimilate and apply knowledge of ERP system in their business activities [33].

Reference [14] shows that organisational culture influences knowledge transfer as it shapes assumptions held by the employees in an organisation about knowledge worth exchanging. They further argue that organisational culture defines the relationship between knowledge source and recipients, develops social interaction where knowledge sharing can happen and shapes the knowledge foundation and distribution process in organisations. In the ERP system implementation case, the team members must know what the others do, gather information from end-users about their business processes and, in return, inform the end-users and their managers about the new process being implemented.

The abovementioned literature review of knowledge transfer criteria has established a groundwork for developing a conceptual model that can be employed to analyse the knowledge transfer in ERP system implementation. There are five criteria that the model on this study taken from literature review and group decision-making results. The proposed model's criteria includes SME owner leadership (OL), Incentives (I), absorptive capability (AC), knowledge sharing culture (KC), and ERP vendor capability (VC), as knowledge transfer strategy evaluation criteria.

3. Methodology

A survey questionnaire, developed from the research model was distributed to a sample frame drawn from State Ministry of Cooperative and SMEs database and mailing list of Indonesian small and medium firms and ERP user members' directories. The invitations to participate in survey questionnaires were sent by e-mail and the survey link was posted online; the criteria assessment and a set of knowledge transfer strategies were determined; any criterion with minimal score of four out of 5-point Likert scale was included in the final list of criteria. There were 56 responses received, producing more than the minimum threshold of 50. In terms of the proportion of the receive responses against the overall targeted sample, the response rate of 56 completed responses from 355 invitations made a response rate of 16%. Since the response rate for survey research in industrial studies typically fall between 15-30% [34], the response rate of this study is acceptable by those general norms.

This study exercises an evaluation of knowledge transfer strategy selection for SMEs to successfully implement their ERP system. This study employs multiple criteria decision making (MCDM) methods, Analytic Network Process (ANP) [35][36], Technique for order preference by similarity to an ideal solution (TOPSIS) [37] and Multiple Criteria Goal Programming (MCGP) to illustrate the application and the effectiveness of the proposed model. The model was applied to evaluate knowledge transfer strategy selection in a medium manufacturer in Indonesia as a case study. First, the selected company's employees were asked about the evaluation criteria for knowledge transfer strategy and invited to participate in a survey to provide their answers. The survey results were then evaluated with experts and practitioners who experienced about knowledge transfer strategy.

4. Results and Discussion

The knowledge transfer strategy evaluation process in ERP system implementation of Indonesian SMEs is demonstrated as follows:

Step 1. Based on the literature review and interview with the company's practitioners, three knowledge transfer strategies were selected for further examination. The network relationship among criteria was determined as follows; the criterion's attributes of OL are related with criteria KC and I, and the criterion's attributes of VC are related with criteria I and AC. Moreover, the criterion's attributes of KC have relations with criteria I and VC; the criterion's attributes of VC influences criterion OL. Since the type of relationship network depends on the judgement of their users, a group discussion among company's practitioners and experts was formed. The group's main task was to check network relationship and structure of the considered criteria. Figure 1 depicts the network relationship among the evaluation criteria, as the results of the group discussion.

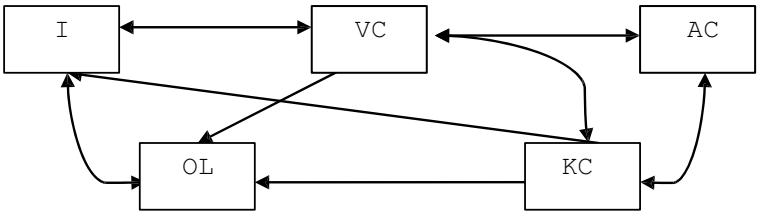

Figure 1. The interdependence relationship among evaluation criteria: SME owner leadership (OL), Incentives (I), absorptive capability (AC), knowledge sharing culture (KC), Vendor capability (VC)

Step 2. The team members evaluated all of the proposed criteria pairwise assuming that there are interdependences among them. The result as presented in Table 1 was obtained by calculating a geometric mean of the pairwise comparison values from the team members' evaluation. The normalized weights matrix (***w1***) of the proposed criteria is shown below:

$$w_1 = \begin{pmatrix} KC \\ I \\ VC \\ AC \\ OL \end{pmatrix} = \begin{pmatrix} 0.244 \\ 0.199 \\ 0.182 \\ 0.135 \\ 0.241 \end{pmatrix}$$

which reflects these related criteria's local priority.

Table 1. Criteria pairwise comparison matrix

	KC	I	VC	AC	OL	W_1
KC	1	2.728	1.213	4.369	0.428	0.244
I	0.367	1	1.853	2.358	0.739	0.199
VC	0.824	0.540	1	2.115	0.572	0.182
AC	0.229	0.424	0.473	1	0.249	0.135
OL	2.336	1.353	1.748	4.016	1	0.241

Note: SME owner leadership (OL), Incentives (I), absorptive capability (AC), knowledge sharing culture (KC), and ERP vendor capability (VC)

Step 3. After that, the relationship between the evaluation criteria was determined. Using pairwise comparison, the company's team evaluated the impact of all criteria. Table 2 presents the calculation of normalized eigenvectors for the pairwise comparison matrices. The zero values of eigenvector weights in table 2 indicate that some of evaluation criteria are independent to each other. The rest of the values in Table 2 show the level of the relative influence for each evaluation criterion.

Table 2. The evaluation criteria interdependence matrix

w_3	KC	I	VC	AC	OL
KC	0.471	0.241	0.249	0.154	0.241
I	0	0.197	0.245	0.201	0.203
VC	0.274	0.183	0.343	0.233	0.214
AC	0.255	0.134	0.164	0.197	0.189
OL	0	0.244	0	0.215	0.153

Note: SME owner leadership (OL), Incentives (I), absorptive capability (AC), knowledge sharing culture (KC), and ERP vendor capability (VC)

Step 4. Next, the calculation of relative importance considering interdependence among criteria can be exercised. $\mathbf{w_c}$ was obtained by synthesizing the calculation results from previous steps: $\mathbf{w_c} = \mathbf{w_3} \times \mathbf{w_1}$. The value of obtained relative importance for knowledge sharing culture (KC) = 0.288; Incentives (I) = 0.161; ERP vendor capability (VC) = 0.247; absorptive capability (AC) = 0.190 and SMEs owner leadership (OL) = 0.115, shown as follows:

$$\mathbf{w_c} = \mathbf{w_3} \times \mathbf{w_1} = \begin{pmatrix} 0.288 \\ 0.161 \\ 0.246 \\ 0.190 \\ 0.115 \end{pmatrix}$$

Step 5. In order to proceed with decision making procedure, the team members compared the knowledge strategy alternatives under each of the individual criteria to establish the decision matrix. In addition, all team members were asked to give their valuation within the range from 1 to 10 to evaluate each alternative's performance with respect to each criterion. Table 3 presents the normalized decision matrix of the knowledge transfer strategy options after the team members' decision matrix was constructed.

Table 3. The normalized weights decision matrix

w_p	KC	I	VC	AC	OL
HOS	0.448	0.507	0.346	0.553	0.620
SBS	0.333	0.314	0.193	0.201	0.192
DKS	0.218	0.179	0.640	0.247	0.187

Note: * The knowledge transfer strategies such as HOS = Human-oriented strategy, SBS = System-based strategy, and DKS = Dynamic strategy.

Then, the overall priorities for the preferred knowledge transfer strategies $\mathbf{w_{ANP}}$ are determined by multiplying $\mathbf{w_P}$ by $\mathbf{w_c}$.

$$W_{ANP} = W_p \times W_c = \begin{pmatrix} 0.472 \\ 0.255 \\ 0.320 \end{pmatrix}$$

It is demonstrated in this step that the calculation using ANP method are (HOS, SBS, DKS) = (0.472, 0.255,0.320)^T. Therefore, 0.472 as the highest weights value in the human-oriented strategy (HPS) will be selected under consideration to ANP method.

Step 6. The final ranking procedure determines the positive-ideal and negative-ideal solutions of the knowledge transfer strategies selection problem. The results of positive-ideal and negative-ideal calculation are shown below:

A^* = (0.447, 0.506, 0.642, 0.551, 0.621),
A^- = (0.219, 0.178, 0.192, 0.202, 0.186).

TOPSIS formula was employed to calculate the ranges of each knowledge transfer strategy to the positive-ideal solution (S_i^+) and the negative-ideal solution (S_i^-), as well as determine each of the strategy's closeness coefficient (RC_j^*). Table 4 presents the calculation of S_i^+ S_i^- and RC_j^*. The table shows that 0. 433 is the highest RC_j value and it belongs to the HOS. Therefore based on the TOPSIS calculation, the human-oriented strategy will be chosen

Table 4. Calculation results of s_i s_i^- and RC_j

w_p	S_i^+	S_i^-	RC_j^*
HOS	1.276	0.978	0.433
SBS	1.018	0.418	0.279
DKS	0.952	0.584	0.380

Step 7. Based on the calculation results from step 6, the relative closeness coefficients for each knowledge transfer strategy were determined. Then, the MCGP model was formulated based on the situation experienced by a medium-sized manufacturer company in Indonesia. The model consists of the range of the strategy alternatives and specific resources constraints related to each of the strategy, as presented in Table 5. In order to assign resources among the knowledge transfer strategies, the objective function uses RC_j (e.g., HOS = 0.433, SBS = 0.279, DKS = 0.380) as the weights (equation 1 ($0.433s_4^- + 0.279s_5^- + 0.380s_6^-$))

Table 5. Resources constraints of knowledge transfer strategies

Strategies	Cost	Hours	Employees
HOS	3000	1056	22
SBS	8000	864	18
DKS	6500	960	20

The goal programming model formulation to select a knowledge transfer strategy is shown as follows

$$\text{Min } Z = (s1+) + (s2+) + (s3+) + 0.434\ s_4 + 0.292\ s_5 + 0.381 s_6 \quad (1)$$

Subject to:

$$3000X_1 + 8000X_2 + 6500X_3 + s_1^- - s_1^+ = 8000 \quad (2)$$
$$1056X_1 + 864X_2 + 960X_3 + s_2^- - s_2^+ = 1200 \quad (3)$$
$$22X_1 + 18X_2 + 20X_3 + s_3 - s_3 \doteq 25 \quad (4)$$
$$X_1 + s_4^- = 1 \quad (5)$$
$$X_2 + s_5^- = 1 \quad (6)$$
$$X_3 + s_6^- = 1 \quad (7)$$
$$X_1 + X_2 + X_3 = 1 \quad (8)$$
$$Xj = 0 \text{ or } 1,\ j = 1,2,3$$

Using the goal programming model, the problem of knowledge transfer strategy selection was solved by LINGO software on a AMD Athlon II-X4 CPU 3.00 GHz-based personal computer processor. The calculation results are: x_1=1, x_2= x_3=0. This means that the solutions are optimum and the goals are fully achieved. Therefore, the company under study shall select human-oriented strategy as the knowledge transfer strategy in their ERP system implementation project.

5. Conclusion

When a firm is going to implement an ERP system, managers are always puzzled with selecting the right strategy to facilitate the implementation. The knowledge transfer strategy adopted also determines whether an ERP system implementation would succeed or fail. In order to reach this goal, management members should find accurate criteria and employ the proper method to evaluate and solve the problem of knowledge transfer strategy selection. This paper demonstrates how the MCDM and MCGP model can be applied to support Indonesian SMEs in implementing their ERP system. Using this model, a medium-size company was able to resolve the optimum knowledge transfer strategy for their ERP system project. Results show that the human oriented strategy is the best choice for the company. This finding also suggests that human oriented strategy is more appropriate for improving knowledge sharing culture, absorptive capacity, SMEs owner leadership and vendor involvement within the company.

Indonesian SMEs can achieve strategic benefits in ERP system implementation through focusing on effective knowledge transfer strategy. While the aforementioned methods may resolve multiple criteria problems in ERP system projects, the knowledge content quality and business requirements of company stakeholders on the evaluating criteria have not put into the consideration. As a matter of fact, the weightings of knowledge transfer evaluating criteria heavily depend on business strategies and priorities. Whereas the owner manager of SMEs sometimes subjectively and arbitrarily assigns their own weightings without discussing with the other stakeholders in the company, the selected strategy may not reflect what that company really needs.

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