Analytical Hierarchy Process for Knowledge Integration

Nur Ilyana Ismarau Tajuddin, Marzanah A. Jabar, Rusli Abdullah and Yusmadi Yah Jusoh

Faculty Computer Science and Information Technology, Universiti Putra Malaysia, Malaysia, {ilyanaismarau90@gmail.com}

ABSTRACT

This paper presents the design of analytical hierarchy process for Knowledge Integration (KI) in Small Medium Enterprises (SMEs). An Analytical Hierarchy Process (AHP) was used to assist in building the model and help draw decisions. In order to illustrate the application of AHP, there are 3 main factors and 13 sub-factors that determine the decision of tools. In this study, Expert Choice™ software is used to conduct the experimental assessments. The judgments were found to be consistent, precise and justifiable with narrow marginal consistency values.

Keywords: Analytical Hierarchy Process, Knowledge Integration, Environment, Social Media, Technology, Enterprises

I INTRODUCTION

Knowledge integration is solitary of the most essential approaches of knowledge applications to attain sustainable competitive advantages and business value (Grant, 1996). Only the organization has the capabilities of integrating the inside and outside resources to innovate faster, would be able to succeed under the ultra-competitive environment (Gao Wei et al., 2007). From the time when knowledge is continually changing and depreciating, organizations cannot possess all the required knowledge by themselves. The key is to utilize expertise that is spread within the enterprise by integrating knowledge (Grant, 1996). KI is required in many situations where coherent combining of disparate sources and levels of information for some enterprise is necessary (Hustad, 2007). Technological cooperation among firms is important because a large part of the knowledge needed in innovation processes is tacit, and can be transferred through social media interactions (Raban, 2008).

According to Petter et al. (2003) the effective adoption of technologies in companies is much depending on technology characteristics, project and organizational characteristics, user and social characteristics, and task characteristics. However, in reality, these factors are much neglected by organizations, especially among small companies.

Social media tools have ability to integrate all information and knowledge that can be obtained (Fung & Hung, 2013). Even though reports suggest the social media tools enhance the development of SMEs, there is still little empirical evidence on their adoption and usage from the category of firms (Dixon, 2010) especially in the KI (Cao et al., 2013). Thus, the objective of this work is to propose the measurement of the KI factors in SMEs through the implementation of an evaluation model.

II DESIGN OF ANALYTICAL HIERACHY PROCESS

The AHP method was developed by Thomas Saaty (2000) to support decision making problems with multiple criteria. Amongst the existing methods, the analytic hierarchy process (AHP), is possibly the most well-known and used in multiple-criteria decision making (Saaty, 2005). The benefit of this method is that since judgment values from equal comparisons are based on experience, intuition, and also on physical data, the AHP may deal with the qualitative and quantitative aspects of a decision-making problem (Salgado, 2015). The AHP method is not a model for finding the correct answer, but a process that helps decision makers find the best answer (Dozic, 2014). This method's importance has been proven for academic studies and organizations. The AHP method is a powerful instrument for organizations in prospecting their own strategies and those of their competitors (Saaty, 2005). . In this study, Expert Choice™ software is used to conduct the experimental assessments.

In designing of analytical hierarchy process, there are main procedures to be generated. In this study, there are three levels has been generated. The goal, criteria, alternative, was designed in order to fulfill the objective of this study. The most critical in designing of hierarchy process is to determine the goal and the alternative solutions, due to ensure the hierarchy process provide the criteria meet the main goal. The detailed steps of using AHP are described in the literature (Saaty, 2012).

Figure 1 shows factors, sub-factors and decision options that influence selecting KI. Pairwise comparison is a fundamental of AHP steps. The decision makers have to compare each element by using the relative scale pairwise comparison and the signed value is made based on the decision makers' or users' experience and knowledge. The scale used for comparisons in AHP enables the decision maker to incorporate the experience and knowledge intuitively. The design of analytical hierarchy process for KI takes several steps. The first step is to set the goal (Level 1) of this research. The objective of this research is to determine the appropriate KI factors. In this study, the main criteria (Level 2) of technology, environment and organization have significant effect to the selecting process in order to determine the best factors/ alternative for KI. The next step is to generate the pairwise comparison of criteria with respect to overall goal. This study was conducted in conjunction to the urgency to shift the traditional paradigm in KI process, and to obtain the effective way to transfer the knowledge of the specific subject through the additional tools and application.

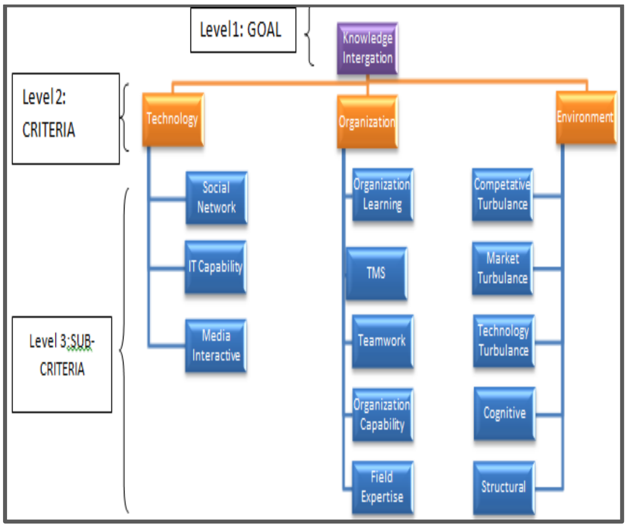

Figure 1. Decision Hierarchy for KI

The pairwise comparison is important in design of AHP process due to measure the impact of criteria with respect to the main goal (Level 1). In general, this step shows the fair comparison between the criteria and the main objective of this research. The next important process is to generate the consistency test for the main factors. This step is further enhancement of pairwise process between criteria and goal. To determine the value of pairwise comparison, the relative priority of each criterion with respect each other using a numerical scale for comparison is developed by Saaty (2012) as show in Table 1.

Table 2 shows a pairwise comparison of the main criteria with respect to an overall goal. Based on this table, the highest total column has achieved by Environment with value of 11.0. It is found that Environment has made significant effect of the goal, and followed by Technology with value of 7.33 and Organization with value of 1.31.

For the next phase of the AHP model, paired comparisons were made between the sub-criteria on the same level. The Pair Judgment Scale was used for these comparisons and the preferences for each element were, therefore, determined. Having obtained these values, comparison matrixes were generated for the sub-criteria Technology, Organization and Environment as shows in Table 3, 4 and 5.

Table 1. Saaty's pairwise comparison scale

Verbal judgment	Numeric value
Extremely important	9
	8
Very Strongly more important	7
	6
Strongly more important	5
	4
Moderately more important	3
	2
Equally important	1

Table 2. Paired comparison for the KI criteria

Goal	Technology	Organization	Environment
Technology	1	1/6	3
Organization	6	1	7
Environment	1/3	1/7	1
Total	**7.33**	**1.31**	**11.0**

Based on Table 3, IT Capability has the highest value among the Technology sub-criteria with a value of (7.0). Followed by Media Interactive (5.0) and Social Network (1.53).

Based on Table 4, Organizational Capability has the highest value among the Organizational sub-criteria with a value of (17.0). Followed by Field Expertise (9.50). The lowest value is Transactive Memory System with a value (1.63).

Based on Table 5, Technology Turbulance has the highest value among the Environment sub-criteria with a value of (21.0). Followed by Market Turbulance (19.50). The lowest values are Cognitive ad Structural with a value (2.38).

Table 3. Paired comparison for the Technology sub-criteria

Goal	Social Network	IT Capability	Media Interactive
Social Network	1	5	3
IT Capability	1/5	1	1
Media Interactive	1/3	1	1
Total	**1.53**	**7.0**	**5.0**

Table 4. Paired comparison for the Organization sub-criteria

Goal	Organization Learning	TMS	Team Identification	Organization Capability	Field Expert
Organization Learning	1	1/6	1	4	1
Transactive Memory System	6	1	6	8	6
Team Identification	1	1/6	1	2	1
Organizational Capability	1/4	1/8	1/2	1	1/2
Field Expert	1	1/6	1	2	1
Total	**9.25**	**1.63**	**9.25**	**17.0**	**9.50**

Table 5. Paired comparison for the Environment sub-criteria

Goal	Competitive Industry	Market Turbulance	Technology Turbulance	Cognitive	Structural
Competative Industry	1	2	2	1/8	1/8
Market Turbulance	1/2	1	2	1/8	1/8
Technology Turbulance	1/2	1/2	1	1/8	1/8
Cognitive	8	8	8	1	1
Structural	8	8	8	1	1
Total	**18.0**	**19.50**	**21.0**	**2.38**	**2.38**

III RESULT AND DISCUSSION

To ensure the judgments are consistent, the final operation called consistency verification must be performed. Consistency verification is considered as one of the most advantages of the AHP which is incorporated in order to measure the degree of consistency among the pairwise comparisons by computing the consistency ratio (Ho, 2008). The consistency is determined by the consistency ratio (CR). Consistency ratio (CR) is the ratio of consistency index (CI) to random index (RI) for the same order matrices. Table 6,7,8,9 shows the consistency ratio for the factors with respect to the goal in this case study. It shows that CR is less that 0.1 and the judgments are acceptable (Saaty, 2000). In general, the consistency shows the degree of relevance and relation with respect to the main factors. The detail of the calculation is described in this paper and it can explore by referring example in the literature (Saaty, 2012).

Table 10 show factors based on ranking. Transactive Memory System has the highest value (30.3%) among the other factors. The second highest are Team Identification, Field Expert and Organizational Learning with a value of (12.3%). The lowest value are Competitive industry, Market Turbulance and Technology Turbulance a value of (0.7%). It is found that Transactive Memory System of Organization criteria is preferred choice since it has highest value among the factors.

Table 6. Paired comparison for the KI criteria

Goal	Technology	Organization	Environment	Priority	Consistency index, CI = (λmax −n)/(n−1) = 0.051
Technology	0.14	0.13	0.27	17.9%	
Organization	0.82	0.76	0.64	73.9%	
Environment	0.05	0.11	0.09	8.2%	Consistency Ratio, CR = **CI/RI = 0.09**
Sum	1	1	1	100%	

Table 7. Paired comparison for the Technology criteria

Goal	Social Network	IT Capability	Media Interactive	Priority	Consistency index, CI = (λmax −n)/(n−1) = 0.015
Social Network	0.65	0.71	0.60	17.9%	
IT Capability	0.13	0.14	0.20	73.9%	Consistency Ratio, CR = CI/RI = **0.03**
Media Interactive	0.22	0.14	0.20	8.2%	
Sum	1	1	1	100%	

Table 8. Paired comparison for the Organization criteria

Goal	Organization Learning	TMS	Team Identification	Organization Capability	Field Expert	Priority (%)	Consistency index, CI =(λmax −n)/(n−1) = 0.026
Organization Learning	0.11	0.10	0.11	0.24	0.11	13.1	
Trans active Memory System	0.65	0.62	0.63	0.47	0.63	60.0	
Team Identification	0.11	0.10	0.11	0.12	0.11	10.8	Consistency Ratio, CR =CI/RI = **0.02**
Organizational Capability	0.03	0.08	0.05	0.06	0.05	5.4	
Field Expert	0.11	0.10	0.11	0.12	0.11	10.8	
Total	1	1	1	1	1	100	

Table 9. Paired comparison for the Environment criteria

Goal	Competative Industry	Market Turbulance	Technology Turbulance	Cognitive	Structural	Priority (%)	Consistency index, CI = (λmax – n)/(n–1) = 0.035
Competative Industry	0.06	0.10	0.10	0.05	0.05	7.2	
Market Turbulance	0.03	0.05	0.10	0.05	0.05	5.6	
Technology Turbulance	0.03	0.03	0.05	0.05	0.05	4.15	Consistency Ratio, CR = CI/RI = **0.03**
Cognitive	0.44	0.41	0.38	0.42	0.42	41.6	
Structural	0.44	0.41	0.38	0.42	0.42	41.6	
Total	1	1	1	1	1	10	

Table 10. Factors based on ranking

Criteria	Factors	Weight (%)	Ranking
Technology (17.9%)	Social Network	10.2	5
	IT Capability	5.1	7
	Media Interactive	2.6	8
Organization (73.9%)	Organizational Learning	12.3	4
	Transactive Memory System	30.8	1
	Team Identification	12.3	2
	Organizational Capability	6.2	6
	Field Expert	12.3	3
Environment (8.2%)	Competitive Industry	0.7	11
	Market Turbulance	0.7	12
	Technology Turbulance	0.7	13
	Cognitive	3	9
	Structural	3	10

IV CONCLUSION

This paper shows the utilization of multi-criteria methods in evaluating of KI under three criteria. The use of this type of quantitative method is very practical for evaluation purposes. By integrating the factors of KI from the perspective of Technology, Organization and Environment, this research had successfully strengthened the assessment of the current state of KI in SMEs. The results show Transactive Memory System is the most appropriate for KI because it has the highest value (30.8%) among the other factors. In addition, the measurement of the KI factors through the implementation of an evaluation model. Thus, analytical hierarchy process (AHP) shows an effective way to be applied in model developing.

The results of this study would give an idea to the management of the SMEs in their process of adaption of technology in the knowledge integration process.

REFERENCES

Ameller, D., Burguess, X., Collell, O., Costal, D., Franch, X., & Saaty, T. L. (2012). Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World. Third Revised Edition. Pittsburgh: RWS Publications.

Cao, X., Guo, X., Liu, H., & Gu, J. The role of social media in supporting knowledge integration: A social capital analysis. Information Systems Frontiers, 1–12 (2013).

Dixon, Brian E. Towards E-Government 2.0: An Assessment of Where EGovernment 2.0 Is and Where It Is Headed. Public Administration & Management, 15(2), 418-454 (2010).

Dozic,S.. Kalic, M An AHP Approach to Aircraft Selection Process. Transportation Research Procedia 2014;3: 165-174

Fung, C. K., & Hung, P. C. Information and knowledge management in online rich presence services. Information Systems Frontiers, 1–3 (2013).

Gao Wei, Wang Hengshan, N.-W. Bin. Knowledge Integration and Its Impact.In International Conference on Managment Science & Engineering. 1517–1523 (2007).

Grant, R.M. Toward a knowledge-based theory of the firm. Strategic Management Journal, 17 (S), 109- 122 (1996).

Ho, W. (2008). Integrated Analytic Hierarchy Process and Its Applications - A Literature Review. Journal of European Journal of Operation Research. 186: 211-228.

Hustad, E. A Conceptual Framework for Knowledge Integration in Distributed Networks of practice. Proceedings of the 40th Hawaii International Conference on System Sciences - 2007, 1–10 (2007).

Petter, S., DeLone, W., & McLean, E. R. Information Systems Success: The Quest for the Independent Variables. Journal of Management Information Systems, 29(4), 7-61 (2013).

Raban, Y. 12 Supporting Knowledge Integration at SMEs – Policies Profiles of KI Support Measures for SMEs. (J. K. Antonie Jetter, Ed.). Physica Verlag - A Springer Company (2008).

Saaty, TL. (2012). Decision Making for Leaders: The analytic: Hierarchy Process for Decision in a complex world. Third Revised Edition. Pittsburgh: RWS Pulication

Saaty, TL. Decision making for leaders- The Analytic Network Hierarchy Process for Decisions in complex world. Pittsburgh; 2000.

Saaty, TL. The analytic Hierarchy and Analytic Network Processes for the Measurement of Intagible Criteria ad for Decision Making. Multiple criteria decision analysis: State of the art surveys. New York: Springer 2005, p. 345-407.

Saldago, E. Salamon, VAP, Mello, C. Analytic hierarchy prioritization of new product development activities for electronics manufacturing. International Journal of Production Research 2012;50:4860-4866.