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Study of Factors Affecting Implementation of Knowledge Managementfor Technological Innovation

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Abstract:*This article emphasizes that technologicalinnovation originates from knowledge creation for high-tech industries, which is affected by knowledge management. However, according to investigation from related literatures, a high percentage of high-tech industries failed to achieve objective of knowledge management and knowledge creation that makes technological innovation. For this reason, this article is to study what factors essentially affectimplementation of knowledge management through questionnaire survey with 28 experts in knowledge management practices using ISM-fuzzy MICMAC approach in terms of 5 dimensions: the application, function, system construction, supporting leadership, and employee's acceptance of knowledge management, and their corresponding criteria. The meanings of related dimensions and criteria are reviewed from literaturesthat are critical to knowledge management, knowledge creation, and technological innovation.Through analysis of ISM-fuzzy MICMAC approach, it is determined that the application and function are main factors dominating implementation of knowledge management systemas opposed to other factors.*

Keywords-*knowledge management, knowledge creation, technological innovation, ISM-fuzzy MICMAC*

I. INTRODUCTION

Under policy of "design and build ships and aircraft at home", Taiwan has been increasingly developing high-tech industries and accomplishing considerable achievements to date. As it is known, high-tech industrial products development lies in knowledge creation that makes technological innovation, for which a knowledge management system (KMS) is an imperative to implement [1].

Knowledge management (KM) with respect to technological innovation has attracted attention for more than two decades [2]. Ever-increasing research on knowledge management reveals that knowledge is central to technological innovation [3]. Knowledge management in innovation literatures is a critical part to out-innovate for an organization. Knowledge management system for knowledge creation and technological innovation is indisputably valuable to be created, applied, and developed [3-4].

However, according to extant literatures, they have shown that most of high-tech industries are ignorant of importance of knowledge management and technological innovation. This study mainly investigates what factors that affect the implementation of knowledge management to create an organized conceptual framework for industrial reference.

Properly implementing knowledge management will significantly maximize knowledge to achieve competitive advantage for an organization. Before taking on analyzing factors that affect implementation of knowledge management, for which the critical success factors (CSF) will be first investigated [5]. From them, a framework through questionnaire of ISM-fuzzy MICMAC approach is constructed to analyze and eventually determine that the application and function of a knowledge management system are the main factors that affect the implementation of knowledge management obtained from all relevant dimensions and corresponding criteria of KM. It would provide high-tech industries with a guideline for knowledge management implementation.

II. LITERATURE REVIEW

2.1 Critical Success Factors of Knowledge management implementation

Critical success factors (CSFs) of Knowledge management implementationare critical for continual success of high-tech industries that they must be paid attention for achieving successful implementation of knowledge management and sustainable competitive advantage [6-7].

From the literatures, CSFs of knowledge management implementation include: (1) organization's members, for example, the employee's acceptance, (2) existing organizational culture, such as leadership supporting, (3) inadequate understanding of knowledge management for its efficiency and effectiveness, and (4) appropriate application to performance supporting [8].

2.2 Knowledge Management Application and Function

For an organization, it is needed to acquire knowledge for technological innovation, especially for high-tech industries [9-11]. The knowledge management implementation will enhance organizational capability to innovate [12-13]. From a strategic perspective, the application and function of knowledge management play key roles in determining use of knowledge for innovation[14-15].

The technological environment is volatile that it is required to emphasize and technological innovation by successively accumulating and completely using knowledge [14]. Consequently, for high-tech industries that are intended to achieve competitive advantages, the function and application of knowledge management are as well crucial to technological innovation [16-17].

2.3 Knowledge Management Effectiveness and Efficiency

The effectiveness of a knowledge management system is referring to its function; and the efficiency is intimately connected with how the system is constructed. KMS is a system designed to manage organizational knowledge developed to enhance the knowledge creation for innovation. As such, a final goal of a KMS is to support knowledge creation.

By literature review, there are approaches for efficiently and effectively building a KMS and its construction process.They are focused on the function improvement of KMS throughout the organization to develop a complete KMS for effective use of knowledge[18].

In addition, leadership supporting on implementation of knowledge management will ensure the success and effective use once a KMS is implemented [19]. To stimulate managers and leaders to focus on KM activities, the measurement of KMS effectiveness or success is key to the construction of knowledge management system and for us to understand how it should be built and implemented to provide KMS developers with guideline [20].

III. ISM-FUZZY MICMACAPPROACH

3.1 Research Framework

The research framework for the factor evaluation of dimensions and criteria associated with implementation of knowledge management is constructed through the above literature reviews. As a result, the factorsaffecting implementation of knowledge management are synthesized into five dimensions and twenty criteria, four criteria for each dimension as Table 1 shown.

Through ISM-fuzzy MICMAC approach,we conduct the group decision making for experts and scholars who are good atknowledge management from related industries and academic institutionsin central areas of Taiwan. First, the dimension and criteria items were explained to scholars and experts. Then, 40 ISM questionnaires were issued, and 28 of them were validly completed in one month.

Table 1. Factors affecting implementation of KM

1. **D1**-Dimension on application: referring to application of knowledge management. The evaluation criteria is as follows:
   (1) Education and training: providing specific knowledge or technique for education and training
   (2) E-Learning: building knowledge management system for e-Learning.
   (3) Organizational learning: systematically providing knowledge base for organization learning
   (4) Organizational instruction: providing experienced employees with instruction system for on-the-job training

2. **D2**-Dimension on function: referring to function of knowledge management. The evaluation criteria is as follows.
   (1) Knowledge storage: for knowledge acquisition and knowledge storage
   (2) Knowledge innovation: out-innovating existing knowledge
   (3) Knowledge accumulation: accumulating knowledge to build knowledge base by successive knowledge storage
   (4) Knowledge inheritance: transferring and inheriting knowledge through generation by generation

3. **D3**-Dimension on construction of KMS: referring to construction of knowledge management system. The evaluation criteria is as follows:
   (1) On-the-job Training and Apprenticeship: employee training by on-the-job training instead of knowledge management system
   (2) Purchase of KMS: purchasing developed package of knowledge management system
   (3) Self-building KMS: self-building KMS by information technology staff.
   (4) Building KMS by implementing e-learning: building the KMS simultaneously while implementing e-learning on demand, formulating the KMS by storing e-learning materials, and which in turn used for the next e-training.

4. **D4**-Dimension on supporting leadership: referring to supporting leadership for KM. The evaluation criteria is as follows:
   (1) KM orientation of leaders: KM orientation of KM for leaders or managers of an organization
   (2) Leaders attitude to KM: the attitude of leaders of an organization to value the KMS
   (3) Leadership in KM: the implementation ability of leaders or managers
   (4) Involvement in KM: aside from leadership of KM, how is the involvement of leaders in KM implementation

5. **D5**-Dimension on employee’s acceptance: referring to the employee’s acceptance of KM. The evaluation criteria is as follows:
   (1) Willingness to use KM: making employees to realize the needs of KM
   (2) Motivation to use KM: inspiring employees to intend using KM
   (3) Culture building: nurturing a culture of using KM
   (4) Duration of use: a KMS can be used for a sufficiently long period of time

3.2 ISM and MICMAC

3.2.1 Interpretive structuralmodelling

Interpretive structuralmodelling (ISM) is a well-established methodology for identifying relationships between specific items that define a problem or an issue [21]. We conduct the process of creating a digraph, which is then converted to a structural model, inspected, and revised to capture the user’s best perceptions of the situation.

The ISM includes seven steps:

Step 1: Defining a set of variables affecting the system.

Step2: Developingself-structural interaction matrix and establishing a contextual relationship between these variables.
Step 3: Developingreachability matrix and checking the matrix for transitivity.
Step 4: Partitioning reachability matrix into different levels.
Step 5: Forming a canonical form of matrix.
Step 6: Drawing a directed graph and removing the transitive links.
Step 7: Converting the resultant digraph into an ISM by replacing variable nodes with statements.

3.2.2 MICMAC

MICMAC stands for Matriced' Impacts Croisés Multiplication Appliquée á un Classement. It is a systematic analysis tool for categorizing variables based on hidden and indirect relationships, assessing the extent to which they influence each other [22].

The primary goal of MICMAC is to analyze the driving power and dependence for each variable. The driving power refers to the degree of influence that one variable affecting another. Dependence is defined as the extent to which one variable is influenced by others.

MICMAC includes four steps:
Step 1: Developing fuzzy direct relationship matrix.
Step 2: Fuzzyindirect relationship analysis.
Step 3: Stabilizing fuzzy matrix.
Step 4: Drawing driving-dependence power graph.

3.3 Using ISM-Fuzzy MICMAC Approach

This study uses ISM-Fuzzy MICMAC approach to analyzethe 5 dimensions and 20 criteria for evaluation of knowledge management, including interacting relationships and strength between dimensions and criteria.

The research units includerelated industries and academic institutions at Taichung and Changhua areas in Taiwan aiming to the research scholars and practical experts specialized in knowledge management. The questionnaires were explained and then issued, 28 of which were validly completed in one month.

We obtain the structural self-interaction matrix (SSIM) as Table 2. Four symbols: V, A, X, O, are used to establish the contextual relationship between variables.

"V" means that variable i influences variable j;
"A" means that variable i is influenced by variable j;
"X"means that variables i and j are influencedby each other;
"O"means that barriers i and j do not influence each other.
D1, D2, D3, D4, D5 are 5 dimensions mentioned as Table 1.

Table 2. Structural self-interaction matrix (SSIM)

	D_5	D_4	D_3	D_2	D_1
D_1	O	V	V	A	
D_2	O	O	V		
D_3	O	V			
D_4	O				
D_5					

3.3.1 Reachability Matrix

By computing the initial reachability matrix and final reachability matrix,we transform the SSIMinto the initial reachability matrix with binary digits as Table 3.

The (i,j) entry in the SSIM is V, (i,j) entry in the reachability matrix will be 1 and (j,i) entry will be 0

The (i,j) entry in the SSIM is A, (i,j) entry in the reachability matrix will be 0 and (j,i) entry will be 1
The (i,j)entry in the SSIM is X, (i,j) entry in the reachability matrix will be i and (j,i) entry will also be 1
The (i,j) entry in the SSIM is O, (i,j) entry in the reachability matrix will be 0 and (j,i) entry will also be 0

Table 3. The initial reachability matrix

	D_1	D_2	D_3	D_4	D_5
D_1	1	0	1	1	0
D_2	1	1	1	0	0
D_3	0	0	1	0	0
D_4	0	0	0	1	0
D_5	0	0	0	0	1

3.3.2 The Final Reachability Matrix

Incorporating the transitivity in the initial teachability matrix, the driving power and dependence power are calculated using fuzzy MICMAC approach, as Table 4, and the partition of reachability matrix is obtained as Table 5.

Table 4. The finalreachability matrix

	D_1	D_2	D_3	D_4	D_5	Driving Power
D_1	1	0	1	1	0	3
D_2	1	1	1	1*	0	4
D_3	0	0	1	0	0	1
D_4	0	0	0	1	0	1
D_5	0	0	0	0	1	1
Dependence Power	2	1	3	3	1	

Table 5. Partition of reachability matrix

D_i	Reachability Set	Antecedents Set	Intersection Set	Level(L_i)
D_1	1,3,4	1,2	1	L_2
D_2	1,2,3,4	2	2	L_3
D_3	3	1,2,3	3	L_1
D_4	4	1,3,4	4	L_1
D_5	5	5	5	L_1

3.3.3 The Conical Matrix

Clubbing all dimensions based on their levels across the columns and rows of the final reachability matrix, as Table 5, ranks are calculated for all dimensions, and the highest ranks are given the number 1s in the rows and columns.

The final digraph and structural model are obtained as Table 6.

Table 6. The conical matrix

	D_5	D_3	D_4	D_1	D_2	Driving Power
D_5	1	0	0	0	0	1
D_3	0	1	0	0	0	1
D_4	0	0	1	0	0	1
D_1	0	1	1	1	0	3
D_2	0	1	1	1	1	4
Dependence Power	1	3	3	2	1	

3.3.4 The ISM-based Model

Based on the conical form of reachability matrix, an initial digraph including transitivity links is generated by nodes and lines of the edges.

The top-level dimension is placed at the top of the digraph and the next level dimension is placed at the second position and so on, until the bottom level is placed at the lowest position in the digraph.

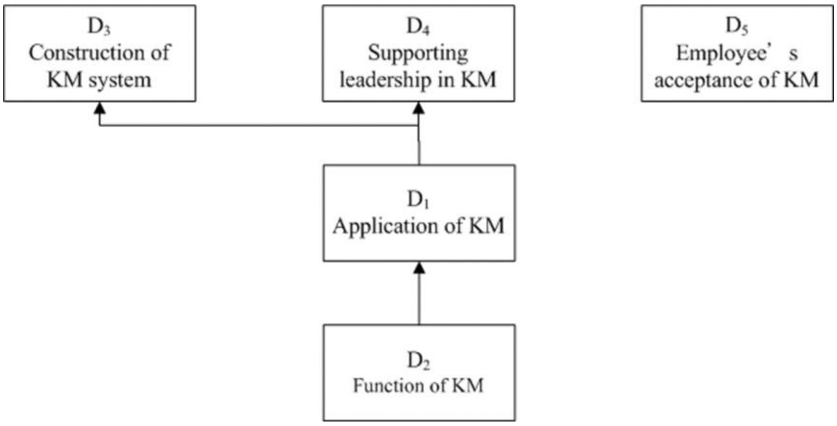

Fig. 1The ISM-based model

3.3.5 Fuzzy Direct Relationship Matrix (FDRM)

The MICMAC considers only binary types of relationships. Using fuzzy set theory, the earlier sensitivity will be increased. With fuzzy MICMAC, an additional input of possible interactions among the criteria is established. The possibility of interaction is defined by a qualitative consideration on a 0 to 1 as Table 7.

Table 7. Fuzzy scale

Possibility of Reachability	Value
No	0
Negligible	0.1
Low	0.3
Medium	0.5
High	0.7
Very High	0.9
Full	1.0

The possibility of the numerical value of reachability is covered up on the DRM to obtain a “Binary”direct reachability matrix (FDRM), and “Fuzzy” direct reachability matrix, as Table 8, 9 respectively.

Table 8. Binary direct reachability matrix(Binary DRM)

	D_1	D_2	D_3	D_4	D_5
D_1	0	0	1	1	0
D_2	1	0	1	1	0
D_3	0	0	0	0	0
D_4	0	0	0	0	0
D_5	0	0	0	0	0

Table 9. Fuzzy direct reachability matrix (Fuzzy DRM)

	D_1	D_2	D_3	D_4	D_5
D_1	0	0.5	0.5	0.7	0
D_2	0.5	0	0.5	0	0
D_3	0	0	0	0	0
D_4	0	0	0.7	0	0
D_5	0	0	0	0	0

3.3.6 Fuzzy Direct Relationship Matrix (FDRM)

Through fuzzy indirect relationship analysis, we obtain the fuzzy set C by product of fuzzy set A and B as follows:

$C=A*B= \max k[\min(a_{ik}, b_{kj})]$, where $A= (a_{ik})$ and $B=(b_{kj})$ are two fuzzy matrice*s*

3.3.7 Stabilization of Fuzzy Matrix

The FDRM process and matrix multiplication are used to stabilize the matrix. This classification of the dimensions is to analyze the driving and dependence power of all dimensions that influence each other, as Table 10.

Table 10. Stabilization of Fuzzy Matrix

	D_1	D_2	D_3	D_4	D_5	Driving Power	Rank
D_1	0.5	0	0.7	0	0	1.2	2
D_2	0	0.5	0.5	0.5	0	1.5	1
D_3	0	0	0	0	0	0	3
D_4	0	0	0	0	0	0	3
D_5	0	0	0	0	0	0	3
Dependence Power	0.5	0.5	1.2	0.5	0		
Rank	2	2	1	2	5		

3.3.8 Key Indicators

Based on the information derived from the Fuzzy MICMAC stabilized matrix, the indicators were classified into four sectors in the Driving-Dependence Graph.

The indicators with the greatest driving power in the stabilized matrix are the key indicators: Function of KM (D_2).

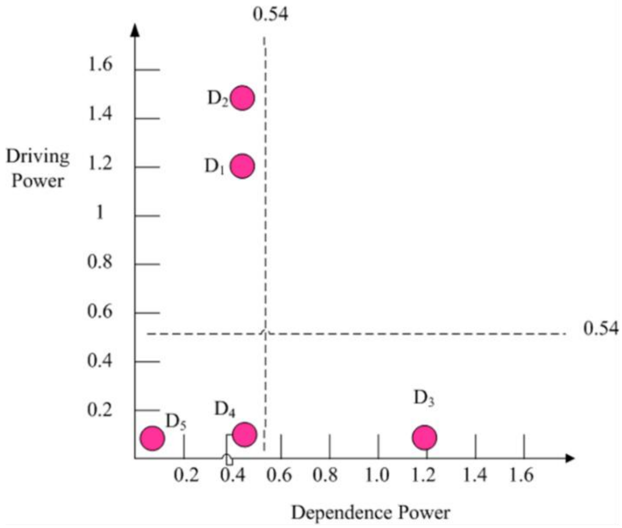

Fig. 2 Key factors

IV. RESULTS AND DISCUSSION

From the approach of ISM-fuzzy MICMAC, we can clearly distinguish the influence of all dimensions and that by each other that are provided to understand the factors affecting the implementation of knowledge management.

By ISM-based Model, the Function of KM (D_2) is the most crucial dimensions as it comes at the bottom of the ISM hierarchy. Construction of KM system (D_3) and Supporting leadership in KM (D_4) appeared at the top which indicate they will influence the entire process of knowledge management. The D_2 lead to Application of knowledge management (D_1), D_1lead to Construction of KM system (D_3) and Supporting leadership in KM (D_4).

This articleinvestigatesfactors and criteria of knowledge management implementation, providing high-tech industries and government agents with a relation model for consideration of knowledge management implementation.

Besides, from fuzzy MICMAC stabilized matrix, we obtain the model produced and the key factors. Function of knowledge management (D_2) and Application of knowledge management (D_1) dimensions have higher driving power factors, whichare critical dimensions. Application of knowledge management (D_1) and Function of knowledge management (D_2) will directly affect Construction of KM system (D_3) and Supporting leadership in KM (D_4), (D_1, D_2) are precedent factors.

V. CONCLUSIONS

We might ever believe that the failure of knowledge management implementation is due to the leadership or employee's resistance to that. After the ISM-fuzzy MICMAC approach, we learned the actual factors that affect the knowledge management implementation. We can only fully understand the cause of events by research rather than by intuitive judgments.

We eventually realize that the Application and Function of knowledge management are critical factors affecting knowledgemanagement implementation. Accordingly, Function of knowledge management can further affect application of knowledge management, construction of knowledge management and Supporting leadership in knowledge management. They are as well essential elements for a successful knowledge managementimplementation providing high-tech industries with a guideline for reference.

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