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BARRIERS OF TECHNOLOGY MANAGEMENT: AN ISM APPROACH

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Abstract— *The management of technology is acquiring a distinctive character and increasingly being recognized as an activity that complements other managerial functions in providing the necessary inputs to the decision-making process. The factors harmful in the implementation of technology management are known as barriers. The objective of this paper is to develop the relationships among the identified TM barriers. Further, this paper is also helpful to understand mutual influence of barriers and identify those barriers which support other barriers (driving barriers) and also those barriers which are most influenced by other barriers (dependent barriers). The Interpretive Structure Modeling (ISM) methodology is used to evolve mutual relationship among these barriers. TM barriers have been classified, based on their driving power and dependence power.*

Keywords: Technology Management (TM), Barriers, Interpretive Structural Modeling (ISM), D*riving barrier, Dependent barrier, Driving power*, *Dependence power.*

1 INTRODUCTION

The present study attempts to develop the relationships among the identified barriers using interpretive structural modeling (ISM) and classify theses barriers depending upon their driving and dependence power. ISM is a well established methodology for identifying relationships among specific items which define a problem or an issue (A. Sage, 1977, J. Warfield., 2005). The opinions from group of experts are used in developing the relationship matrix, which was later used in the development of the ISM model. These barriers are derived theoretically from various literature sources, and expert's discussion.

1.1 Problem Statement

This paper addresses a problem which focuses on the identification of barriers pertaining to the implementation of technology management processes in order to establish a relationship in terms of dependency and driving power of the identified barriers.

1.2 Methodology of Study

The present study does an extensive review of literature on technology management concepts for the identification of key issues and strategic risks involved in it. An ISM model has been developed based on the outcome of the literature review and validated through the opinion of the field experts. Based on the literature review, the authors have identified seven barriers to technology management process. These barriers are further explained in the following sub-sections.

2. TECHNOLOGY MANAGEMENT BARRIERS.

2.1 Lack of Top Management Support

Lack of top management is the most critical barrier for a successful implementation, in knowledge creation and sharing. It is also responsible for identifying organizational strength and weaknesses as well as analyzing the opportunities and threats in the external environment (Goll, et al., 2007).

2.2 Lack of awareness

Lack of awareness hindrances benefits about the new technology, new process and available Resources (Greiner and Franza, 2003; Riege, 2005).

2.3 Lack of communication

An effective communication process at all levels in the organization is prerequisite, in order to implement new technology, organization needs e.g. Communication with suppliers, communication among the organization.

2.4 Cultural Barriers

In order to achieve successful technology transfer process, the culture difference must be considered especially for technology transfer implementation. Culture may have undesirable effect on technology transfer (Calantone et al. 1990).

2.5 Investment cost

The most crucial barrier for SMEs in choosing appropriate technology is the high cost of acquisition and installation of technology (Contractor and; Saad et al, 2002; Chaudhuri, 1980).

2.6 Excessive government intervention and regulation

Limited incentives by government to buy technology, inadequate support in technology transfer process. Delays in getting approvals and certifications Long delays in getting government approvals and certifications Excessive interference by government often adds to problems (Jagoda and Ramanathan, 2007).

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2.7 Lack of infrastructure

Lack of technological infrastructure (TI) is one of the barriers in implementation of Knowledge management (KM). TI provides a stronger platform to KM and enhances its impact in an organization, by helping and leveraging its knowledge systematically and actively (Singh, Kant, (2007).

3 ISM METHODOLOGY

3.1 Structural Self-Interaction Matrix (SSIM)

Structural self interaction matrix is developed by the use of expert opinions. Pair wise comparison is done among the factors to know the direction of their relationship. Four symbols are used to denote the direction of relationship between the criterion (*i* and *j*):
V: criterion *i* will help to achieve criterion *j*;
A: criterion *i* will be achieved by criterion *j*;
X: criterion *i* and *j* will help to achieve each other
O: criterion *i* and *j* are unrelated.

3.2 Reachability Matrix

The SSIM has been converted into a binary matrix, called the reachability matrix by substituting X, A, V and O by 1 and 0. Then, its transitivity is checked. If factor *i* leads to factor *j* and factor *j* leads to factor *k*, then factor i would lead to factor *k*. By embedding transitivity, a modified reachability matrix is obtained. The situation may be shown as follows:
• if the entry in the SSIM is V, then (*i*, *j*) entry in the reachability matrix becomes 1 and the (*j*, *i*) entry becomes 0
• if the entry in the SSIM is A, then (*i*, *j*) entry in the reachability matrix becomes 0 and the (*j*, *i*) entry becomes 1
• if the entry in the SSIM is X, then (*i*, *j*) entry in the reachability matrix becomes 1 and the (*j*, *i*) entry becomes 1
• if the entry in the SSIM is O, then (*i*, *j*) entry in the reachability matrix becomes 0 and the (*j*, *i*) entry becomes 0.
Following these rules, an initial reachability matrix for the factors is prepared. This matrix is further iterated into a final reachability matrix and is shown in Table 3. The final reachability matrix is obtained by incorporating the transitivity. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if an barrier A is related to B and B is related to C, then A is necessarily related to C. Table 4 shows the final reachability matrix with the transitivity.

3.3 Level Partitioning

Components of a structure can be aggregated into levels. A level is itself a set, composed of those factors that lie in the same relative position in a structure. This designation into levels is of great assistance when discussing the relationships in a hierarchy, using the hierarchy itself as a visual aid to the discussion. From the final reachability matrix (Table 3), the reachability set and antecedent set for each factor has been determined. The reachability set consisted of the factor itself and other factors, which it may help to achieve, whereas the antecedent set consists of the factor itself and the other factors, which may help in achieving it. Subsequently, the intersection of these sets is derived for all the factors. The factor for which the reachability and intersection sets were the same is the top-level factor in the ISM hierarchy. The top-level factor in the hierarchy would not help achieve any other factor above its own level. Once the top-level factor is identified, it is separated from the other factors. Then, with the same process, we find the next level of a factor. This process continues till the levels of each factor are identified. These identified levels help in building the digraph and hence the final model. In the present case, the factors along with their reachability set, antecedent set, intersection set and levels are shown in Tables 4–7. The process was completed in four iterations.
In table 3, the driving power and dependence of each factor are also shown. Driving power for each factor is the total number of factors (including itself), which it may help achieve. On the other hand, dependence is the total number of factors (including itself), which may help in achieving it. An ISM model is thus generated by putting the factors according to their levels in a directed graph shown in Figure 1.The factors categorized at level I are put at the lowest hierarchy in the ISM model and the higher level factors are placed at higher hierarchy the model. The factors at the lowest level in the ISM are the factors with highest driving powers and the factors which are at the upper level in the ISM model are the factors with low driving power.
From the ISM model it is observed that the factor lack of awareness is highly dependent factors and it does not drive any other factor in the system, instead it is driven by other factors. These factors are totally dependent on other factors. On the other hand the factors like lack of top management support are at the lower levels of hierarchy which means that they are highly driving factors, they do not depend on other factors and the drive all other factors in the system. The factors which are at the intermediate hierarchy level are the factors which are both dependent and driving in nature.

Table 1: Structural Self-Interaction Matrix for Barriers

S.NO.	Barriers Code	Barriers for Technology Management	B7	B6	B5	B4	B3	B2
1	**B1**	Lack of Top Management Support	V	**X**	**V**	**V**	**V**	**V**
2	**B2**	Lack of awareness	**O**	**O**	**O**	**A**	**A**	
3	**B3**	Lackof communication	**O**	**O**	**O**	**A**		
4	**B4**	Cultural Barriers	**O**	**O**	**O**			
5	**B5**	Investment Cost	**V**	**A**				
6	**B6**	Excessive government intervention and regulation	**O**					
7	**B7**	Lack of infrastructure						

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Table 2: Initial Reachability Matrix for Barriers

Bar-riers	Barriers' Code	B 1	B 2	B 3	B 4	B5	B6	B7
1	B1	1	1	1	1	1	0	1
2	B2	0	1	0	0	0	0	0
3	B3	0	1	1	0	0	0	0
4	B4	0	1	1	1	0	0	0
5	B5	0	0	0	0	1	0	0
6	B6	1	0	0	0	1	1	0
7	B7	0	0	0	0	0	0	1

Table 3: Final Reachability Matrix for Barriers

S.NO.	Bar-ri-ers' Code	B 1	B 2	B 3	B 4	B5	B 6	B 7	Driv-ing power
1	B1	1	1	1	1	1	1	1	7
2	B2	0	1	0	0	0	0	0	1
3	B3	0	1	1	0	0	0	0	2
4	B4	0	1	1	1	0	0	0	3
5	B5	0	0	0	0	1	0	1	2
6	B6	1	1 *	1 *	1 *	1	1	1 *	7
7	B7	0	0	0	0	0	0	1	1
Dependence power		2	5	4	3	3	2	4	

Table 4: Partition of Reachability Matrix: First Iteration

Barriers	Reachability set	Antecedent set	Intersection	Level
B1	1,2,3,4,5,6,7	1,6	1,6	
B2	2	1,2,3,4,6	2	I
B3	2,3	1,3,4,6	3	
B4	2,3,4	1,4,6	4	
B5	5,7	1,5,6	5	
B6	1,2,3,4,5,6,7	1,6	1	
B7	7	1,5,6,7	7	I

Table 5: Partition of Reachability Matrix: Second Iteration

Barriers	Reachability set	Antecedent set	Intersection	Level
B1	1,3,4,5,6	1,6	1,6	
B3	3	1,3,4,6	3	II
B4	3,4	1,4,6	4	
B5	5	1,5,6	5	II
B6	1,3,4,5,6	1,6	1,6	

Table 6: Partition of Reachability Matrix: Third Iteration

Barriers	Reachability set	Antecedent set	Intersection	Level
B1	1,4,6	1,6	1,6	
B4	4	1,4,6	4	III
B6	1,4,6	1,6	1,6	

Table 7: Partition of Reachability Matrix: Fourth iteration

Barriers	Reachability set	Antecedent set	Intersection	Level
B1	1,6	1,6	1,6	IV
B6	1,6	1,6	1,6	IV

Table 8: Levels of Barriers

Barriers	Reachability Set	Antecedent Set	Intersection Set	Level
B1	1,6	1,6	1,6	IV
B2	2	1,2,3,4,6	2	I
B3	3	1,3,4,6	3	II
B4	4	1,4,6	4	III
B5	5	1,5,6	5	II
B6	1,6	1,6	1,6	IV
B7	7	1,5,6,7	7	I

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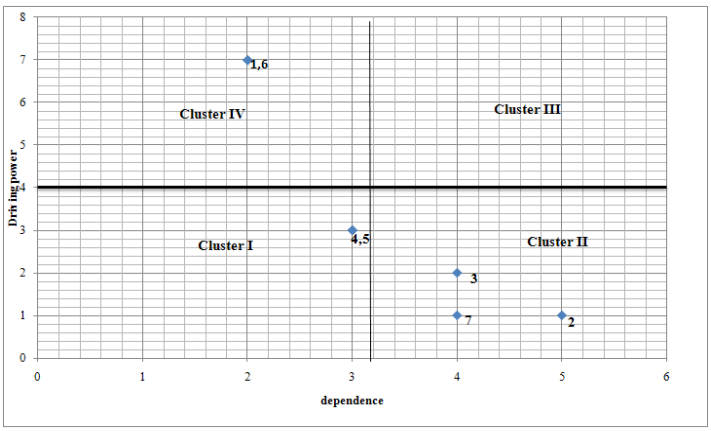

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Figure 2 Driving power and Dependence Graph for Barriers

4. classifications of barriers

Barriers have been classified into four categories, which are shown in Figure 2.1All Barriers have been classified, based on their driving power and dependence power, into four categories as autonomous Barriers, dependent Barriers, linkage Barriers, and independent Barriers. These classifications of Barriers are similar to classification used by Mandal and Deshmuk, 1994.

• **Cluster I (Autonomous)**. These are the Barriers with weak driver and dependent powers. They are located nearest to the origin and relatively disconnected from the system. These neither influence the system much nor are they influenced by the system. In the present case, there are two autonomous Barriers that are 4 (Cultural Barriers), 5 (Investment cost).

• **Cluster II (Dependent)**. They are mainly dependent Barriers. They are identified by their weak Driving power. In the present case, Barriers 3-Lack of communication, 7-Lack of infrastructure, 2-Lack of awareness is in the category of dependent Barriers.

• **Cluster III (Linkage).** The third category has the linkage variables that have strong driving power and dependence. In this case, there is no linkage Barrier.

•**Cluster IV (Independent)**. The fourth category includes independent variables with strong drivers and weak dependence. In this case there are 1-Lack of Top Management Support, 6-excessive government intervention and regulation independent Barriers.

5. ISM Model

ISM Model is devided in to following fou levels:

Level 1(Top Level):

(a) Lack of awareness **(b)** Lack of infrastructure

Level 2(Upper Middle Level):

(a) Lack of communication **(b**) Investment cost

Level 3(Lower Middle Level):

(a) Cultural barriers

Level 4(Lower Level):

(a) Lack of top management support

(b) Excceive government intervation & regulation

6. CONCLUSION

The levels of barriers are important in understanding of successful TM implementation lack of top management support, excessive government intervation & regulation are the most important barriers due to its high driving power and low dependence among all the identified TM barriers. These barriers are positioned at the lowest level in the hierarchy of the ISM-based model. The barriers lack of awareness, lack of infrastructure at the highest level in the ISM-based model due to its high dependence power and low driving power.

The model presented in this paper can provide management involved in technology management and decisions-makers to identify and classify the barriers that have either strong dependence or strong driving power or both strong dependence and driving power that ultimately enhanced the process of technology management.

7. REFERENCES

- [1] Calantone, R., Lee, M.T., Gross, A.C., (1990). Evaluating International Technology Transfer. Proceedings of the International Conference on Comparative Management, Taipei: pp.198-208.
- [2] Chaudhuri, S. (1980). Acquisition and Assimilation of Technology in the Tractor Industry in India: The Strategic Perspective. Doctoral Thesis, Indian Institute of Management, India. In: Ramanathan, 2007
- [3] Contractor, F.J. and Sagafi-Nejad. (1981). International technology transfer: Major issues and policy responses. Journal of International Business Studies, Fall: 101-14. In: Manimala and Thomas.
- [4] Goll, I., Johnson, N., & Rasheed, A. (2007). Knowledge capability, strategic change, and firm performance: The moderating role of the environment. Management Decision, 2007, 45(2): 161 –179.
- [5] Greiner, M., and Franza, R.M. (2003). Barriers and bridges for successful environmental technology transfer. Journal of Technology Transfer, 28(2): 167-177.
- [6] Jagoda, and Ramanathan, K., (2007). Critical Success and Failure Factors in Planning and Implementing International Technology Transfer: A Case Study from Sri Lanka, Refereed Proceedings (in CD-ROM) of the Portland International Conference on Management of Engineering and Technology - PICMET 05, Portland, Oregon, U.S.A, July 31-August 4.

ISSN 2278-7763

- [7] Riege. A. (2005). Three-dozen knowledge-sharing barriers managers must consider. Journal of Knowledge Management, 9(3): 18–35.
- [8] Saad, M., Cicil, S., and Greenwood, M. (2002). Technology transfer projects in developing countries: Furthering the project management perspectives. International Journal of Project Management, 20:617-25.
- [9] Sage, Y.A. (1977). Interpretive Structural Modeling: Methodology for Large-scale Systems, 91–164. McGraw-Hill, New York.
- [10] Singh, M., Kant, R. (2007). Knowledge management enablers: An interpretive structural Modeling approach. In: Proc. Of the 8th European Conference on Knowledge Management, Barcelona, Spain, pp.915-923.
.
- [11] Warfield, J., (2005). Developing interconnection matrices in structural modeling. IEEE Transaction sons on Systems, Man and Cybernetics, 4(1): 81–67.

