

Investigating Technical Barriers to Green Supply Chain Management Using the Interpretive Structural Modelling Technique

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Abstract: Handling the issue of “Greening” the supply chain becomes a must in the recent literatures of the Supply Chain Management (SCM). Indeed, several practical studies have been implemented to show that better performance can be linked with “Greening” SCM practices. Consequently, several studies have also discussed numerous issues related to the technical barriers of practicing Green SCM (GSCM). The purpose of this paper is to investigate these Technical Barriers (TBs) using the Interpretive Structural Modelling (ISM) within the context of Saudi Arabian dairy food industry. It is found that the difficulty in transforming positive environmental attitude into practical initiatives represents one of the issue. However, it is an issue that is, in fact, resulted from the existence of other barriers that are negatively influencing GSCM within the context Saudi Arabian dairy food industry.

Keywords: Supply Chain Management, Interpretive Structural Modelling, Technical Barriers, Environmental Attitude.

Introduction

Handling the issue of “Greening” supply chain becomes a must in the recent literatures of the Supply Chain Management (SCM). Indeed, several practical studies have been implemented to show that better performance can be linked with “Greening” SCM practices (Björklund *et al.*, 2012). However, there are also several studies that handled the issue related to the barriers of “Greening” SCM such as the work of Mudgal *et al.* (2010). More specifically, several studies discussed the issue related to the technical barriers of practicing Green SCM (Beamon, 19999; Revell & Rutherford, 2003; Hillary, 2004; Rao, & Holt, 2005). Based on an extensive literature review, Govindan *et al.* (2014) identified seven Technical Barriers for Green SCM (GSCM):

1. Fear of failure.
2. Lack of human resources.
3. Difficulty in transforming positive environmental attitudes into action.
4. Lack of technical expertise.
5. Complexity of design to reduce consumption of resource/energy.
6. Current practice lack flexibility to switch over to new system.
7. Lack of new technology, materials and process.

The purpose of this paper is to investigate these Technical Barriers (TBs) using the Interpretive Structural Modelling (ISM) within the context of Saudi Arabian dairy food industry. Such a study is very important for understanding the role of the environmental attitudes in the manufacturing as well as in the service industries.

The Application of ISM

ISM is a well-known quantitative method that enables understanding complicated relationships between elements or factors in order to facilitate the decision making process for the decision makers Kanungo, S., & Bhatnagar (2002). Several studies have presented the steps of implementing ISM in details such as the work of Alidrisi (2014) and Alidrisi (2015). In order to identify the contextual relationships among the TBs as shown in Table 1, four symbols were used by the experts for signify the direction of the relationships among the TBs:

- V: if TB i leads to TB j.
- A: if TB j leads to TB i.
- X: if both, TB i and TB j, leads to each other.
- O: if there is no relation between TB i and TB j.

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Table 1. The Structural Self-Interaction Matrix (SSIM) for TBs

TBs	TB 7	TB 6	TB5	TB 4	TB 3	TB 2	TB 1
TB1	A	A	A	A	A	V	
TB2	O	O	O	X	O		
TB3	A	A	A	A			
TB4	V	V	V				
TB5	V	V					
TB6	V						
TB7							

The next step is to convert the SSIM into a binary matrix, known as the initial reachability matrix as shown in Table 2. The initial reachability matrix is developed according to following substitution rules:

- If the (i, j) input in the SSIM is V, the (i, j) input in the reachability matrix becomes 1 and the (j, i) input becomes 0.
- If the (i, j) input in the SSIM is A, the (i, j) input in the reachability matrix becomes 0 and the (j, i) input becomes 1.
- If the (i, j) input in the SSIM is X, the (i, j) input in the reachability matrix becomes 1 and the (j, i) input also becomes 1.
- If the (i, j) input in the SSIM is O, the (i, j) input in the reachability matrix becomes 0 and the (j, i) input also becomes 0.

Table 2: Initial Reachability Matrix (IRM) for the TBs

TBs	TB1	TB2	TB3	TB4	TB5	TB6	TB7
TB1	1	1	0	0	0	0	0
TB2	0	1	0	1	0	0	0
TB3	1	0	1	0	0	0	0
TB4	1	1	1	1	1	1	1
TB5	1	0	1	0	1	1	1
TB6	1	0	1	0	0	1	1
TB7	1	0	1	0	0	0	1

Then, the process of transitivity check is executed through considering the assumption that if TB1 leads to TB2, and TB2 leads to TB3, then TB1 leads to TB3. Consequently, some inputs in the initial reachability matrix are converted from 0 to 1 in the final reachability matrix. The converted inputs are labeled by “*” as shown in the final reachability matrix (Table 3).

Table 3: Final Reachability Matrix (FRM) for the TBs

TBs	TB1	TB2	TB3	TB4	TB5	TB6	TB7	Driving Power
TB1	1	1	0	1*	0	0	0	3
TB2	1*	1	1*	1	1*	1*	1*	7
TB3	1	1*	1	0	0	0	0	3
TB4	1	1	1	1	1	1	1	7
TB5	1	1	1	0	1	1	1	6
TB6	1	1	1	0	0	1	1	5
TB7	1	1	1	0	0	0	1	4
Dependency Power	7	7	6	3	3	4	5	

The next step is to classify the TBs into different levels. In this step, three terms should be clearly explained: reachability set, antecedent set, and intersection. As shown in Table 4, the reachability set for each TB(i) represents the TB (i) itself and all other TBs that are influenced directly or indirectly (i.e. after the process of transitivity check) by TB (i). The antecedent set is the reversal of the reachability set in a sense that antecedent set includes all TBs that have a direct or indirect influence on a certain TB (i), including TB (i) itself. The column of intersection for each TB (i) contains any TB that exists in both the reachability set and the antecedent set.

The first ISM iteration is developed in Table 4. In order to identify the level of each TB, any TB that has Reachability set similar to the Intersection is considered as level I. Once the first level is identified, the remaining levels can be determined by following the same procedure as mentioned. The remaining iterations are shown in Tables 5, 6, 7, 8, and 9.

The graphical representation in Figure 1 illustrates the TBs clustering and their driving and dependency power. TB4 and TB5 appear to be classified as independent barriers (Drivers). TB2, TB6, and TB7 are the linkage barriers among the set. TB1 and TB3 are considered as dependent barrier. Finally, ISM model can be structured based on the identified four levels as shown in Figure 2.

Table 4: Levels of TBs – 1st Iteration

TBs	Reachability Set	Antecedent Set	Intersection	Level
TB1	1,2,4	1,2,3,4,5,6,7	1,2,4	I
TB2	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	I
TB3	1,2,3,	2,3,4,5,6,7	2,3,	
TB4	1,2,3,4,5,6,7	1,2, 4,	1,2 ,4,	
TB5	1,2,3 ,5,6,7	2,4,5	2, 5	
TB6	1,2,3, 6,7	2,4,5,6	2 ,6	
TB7	1,2,3, 7	2,4,5,6,7	2, 7	

Table 5: Levels of TBs – 2nd Iteration

TBs	Reachability Set	Antecedent Set	Intersection	Level
TB1	1,2,4	1,2,3,4,5,6,7	1,2,4	I
TB2	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	I
TB3	3,	3,4,5,6,7	3,	II
TB4	3,4,5,6,7	4,	4,	
TB5	3 ,5,6,7	4,5	5	
TB6	3, 6,7	4,5,6	6	
TB7	3, 7	4,5,6,7	7	

Table 6: Levels of TBs – 3rd Iteration

TBs	Reachability Set	Antecedent Set	Intersection	Level
TB1	1,2,4	1,2,3,4,5,6,7	1,2,4	I
TB2	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	I
TB3	3,	3,4,5,6,7	3,	II
TB4	4,5,6,7	4,	4,	
TB5	5,6,7	4,5	5	
TB6	6,7	4,5,6	6	
TB7	7	4,5,6,7	7	III

Table 7: Levels of TBs – 4th Iteration

TBs	Reachability Set	Antecedent Set	Intersection	Level
TB1	1,2,4	1,2,3,4,5,6,7	1,2,4	I
TB2	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	I
TB3	3,	3,4,5,6,7	3,	II
TB4	4,5,6,	4,	4,	
TB5	5,6,	4,5	5	
TB6	6,	4,5,6	6	IV
TB7	7	4,5,6,7	7	III

Table 8: Levels of TBs – 5th Iteration

TBs	Reachability Set	Antecedent Set	Intersection	Level
TB1	1,2,4	1,2,3,4,5,6,7	1,2,4	I
TB2	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	I
TB3	3,	3,4,5,6,7	3,	II
TB4	4,5,	4,	4,	
TB5	5,	4,5	5	V
TB6	6,	4,5,6	6	IV
TB7	7	4,5,6,7	7	III

Table 9: Levels of TBs – the Final Iteration

TBs	Reachability Set	Antecedent Set	Intersection	Level
TB1	1,2,4	1,2,3,4,5,6,7	1,2,4	I
TB2	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	I
TB3	3,	3,4,5,6,7	3,	II
TB4	4,	4,	4,	VI
TB5	5,	4,5	5	V
TB6	6,	4,5,6	6	IV
TB7	7	4,5,6,7	7	III

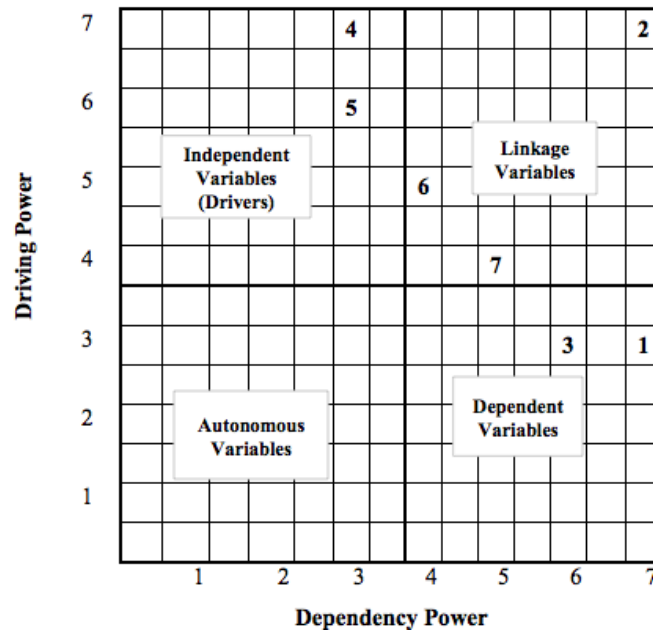


Figure 1. Clusters of TBs

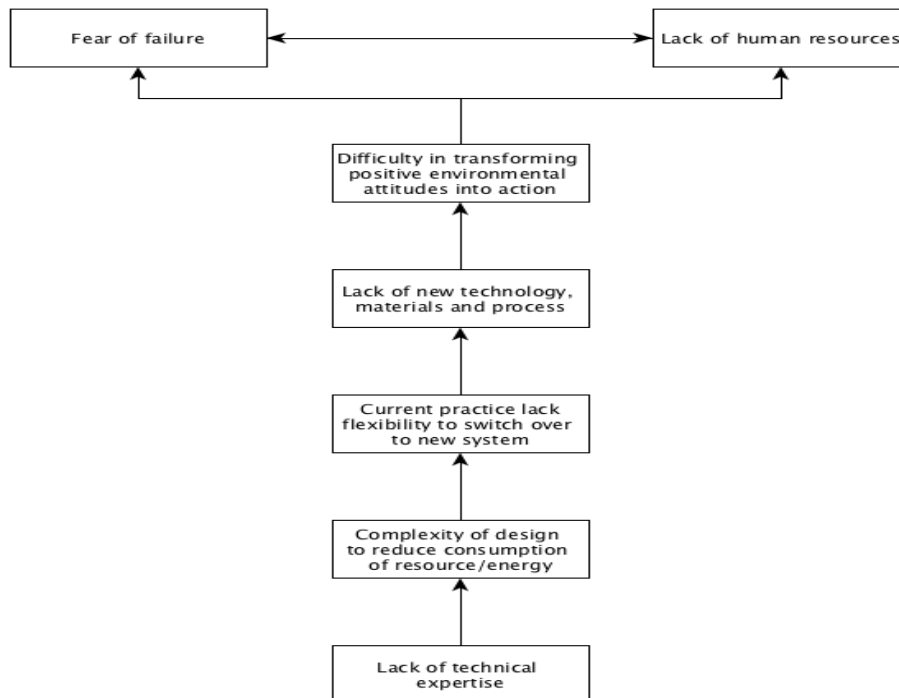


Figure 2. The Final Digraph of the TBs – (The Developed ISM Model)

Conclusion

In conclusion, TBs of GSCM are categorized as a linkage, independent, and dependent barriers. The environmental attitude, specifically, is considered as a dependent barrier. It is found that the difficulty in transforming positive environmental attitude into practical initiatives represents one of the issues. However, it is an issue that is, in fact, resulted from the existence of other barriers that are negatively influencing GSCM within the context Saudi Arabian dairy food industry.

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