Analyzing Pharmaceutical Reverse Logistics Barriers

An Interpretive Structural Modeling Approach

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Purpose

Reselling expired pharmaceuticals in Egypt is an increasing problem with severe consequences (Ramadan, 2014; RASSD, 2015). To reduce this problem, Kabir (2013) and Kwateng et al. (2014) suggest extended focus on reverse logistics applications. There are however several barriers which hinder or prevent such applications. The purpose of this paper is to explore these barriers at a leading pharmaceutical manufacturer in Egypt. The methodological approach of Interpretive Structural Modeling (ISM) is applied to study mutual influences across barriers listed by a preliminary case analysis, and to identify the "driving" barriers which may worsen other barriers, and "dependent" barriers influenced by the driving barriers. Managerial implications of this research will be discussed.

Keywords: *Reverse logistics barriers; Pharmaceuticals industry; Interpretive Structural Modeling*

The ISM Methodological Approach

ISM is a methodology designed to develop understanding of a complex problem by the interactions across the individual elements forming the system. Attri et al. (2013), Luthra et al. (2011) and Ravi and Shankar (2005) summarized the ISM methodology by eight steps**:** (1) Identify the elements which are relevant to the problem; (2) Establish a contextual relationship between elements with respect to which pairs of elements would be examined; (3) Develop a structural self-interaction matrix (SSIM) for variables, which indicate pairwise relationship among elements of the system; (4) Develop a reachability matrix by converting the SSIM into a binary matrix and check this matrix for transitivity; (5) Partition the reachability matrix into different levels; (6) Draw a directed graph based on the relationship given in reachability matrix and remove transitive links; (7) Convert the resultant digraph into an ISM based model by replacing element nodes with the statements. (8) Review the model to check for conceptual inconsistency and make the necessary modifications.

Analysis

A preliminary list of 17 barriers that hinder the company to implement reverse logistics practices is generated by a literature review and semi-structured interviews in the organization. To develop the SSIM matrix with contextual relationships across the barriers of types "*leads to*", a set of closed-ended questions were answered by company representatives. The SSIM matrix has been than converted into a *binary matrix*, and the final reachability matrix is obtained after adding transitivity[1], as shown by Table 1. The *driving power* of a particular barrier is defined by the total number of barriers which it influences, including the barrier itself. The *dependence* of a particular barrier is the total number of barriers including itself which may influence it.

Table 1 Final Reachability Matrix

Barriers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Driving Power
1	1	1	**1^t**	1	1	0	**1^t**	1	1	**1^t**	0	0	0	0	**1^t**	**1^t**	**1^t**	**12**
2	**1^t**	1	**1^t**	1	1	0	1	**1^t**	1	**1^t**	0	0	0	0	**1^t**	**1^t**	1	**12**
3	0	0	1	1	1	0	0	**1^t**	**1^t**	1	0	0	0	0	**1^t**	1	1	**9**
4	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	**3**
5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	**2**
6	1	1	1	**1^t**	1	1	1	1	1	1	0	0	0	0	1	**1^t**	**1^t**	**13**
7	1	**1^t**	1	1	1	0	1	1	1	1	0	0	0	0	1	**1^t**	**1^t**	**12**
8	0	0	0	**1^t**	1	0	0	1	**1^t**	**1^t**	0	0	0	0	1	1	**1^t**	**8**
9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	**2**
10	0	0	0	1	**1^t**	0	0	**1^t**	**1^t**	1	0	0	0	0	1	1	1	**8**
11	1	**1^t**	**1^t**	**1^t**	1	**1^t**	1	1	1	**1^t**	1	**1^t**	1	1	1	**1^t**	**1^t**	**17**
12	1	**1^t**	**1^t**	1	**1^t**	1	1	1	1	**1^t**	0	1	0	1	1	**1^t**	**1^t**	**15**
13	1	**1^t**	**1^t**	**1^t**	**1^t**	**1^t**	1	1	**1^t**	**1^t**	1	1	1	**1^t**	1	**1^t**	**1^t**	**17**
14	0	0	0	**1^t**	**1^t**	0	0	1	**1^t**	1	0	0	0	1	1	1	**1^t**	**9**
15	0	0	0	**1^t**	**1^t**	0	0	1	**1^t**	1	0	0	0	0	1	1	**1^t**	**8**
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
17	0	0	0	1	0	0	0	0	**1^t**	0	0	0	0	0	0	**1^t**	1	**4**
Dependence Power	7	7	**8**	**14**	**13**	**4**	7	**12**	**15**	**12**	**2**	**3**	**2**	**4**	**12**	**17**	**13**	**152/152**

In a next step, the *reachability-* and *antecedent sets* are developed. The *reachability set* for a particular barrier consists of the barrier itself and the other barriers which it influences. The *antecedent set* consists of the barrier itself and other barriers which may influence it. Finally, the *intersection* between these two sets is given. The barrier with overlapping reachability- and intersection sets is assigned as top level barrier in the ISM hierarchy, or level 1, as shown by Table 2. Level 1 is then discarded from the list of barriers, and the iterative process is continued until further levels are identified. The final ISM model consists of 10 levels, as indicated by Table 2.

[1] (1^t) means value after applying Transitivity.
Transitivity was calculated using the web-based program http://www.cs.nmsu.edu/~ipivkina/TransClosure/

Table 2. Iterations Summary Result

Barriers	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,7,8,9,10,15,16,17	1,2,6,7,11,12,13	1,2,7	**Level 7**
2	1,2,3,4,5,7,8,9,10,15,16,17	1,2,6,7,11,12,13	1,2,7	**Level 7**
3	3,4,5,8,9,10,15,16,17	1,2,3,6,7,11,12,13	3	**Level 6**
4	4,9,16	1,2,3,4,6,7,8,10,11,12,13,14,15,17	4	**Level 3**
5	5,16	1,2,3,5,6,7,8,10,11,12,13,14,15	5	**Level 2**
6	1,2,3,4,5,6,7,8,9,10,15,16,17	6,11,12,13	6	**Level 8**
7	1,2,3,4,5,7,8,9,10,15,16,17	1,2,6,7,11,12,13	1,2,7	**Level 7**
8	4,5,8,9,10,15,16,17	1,2,3,6,7,8,10,11,12,13,14,15	8,10,15	**Level 5**
9	9,16	1,2,3,4,6,7,8,9,10,11,12,13,14,15,17	9	**Level 2**
10	4,5,8,9,10,15,16,17	1,2,3,6,7,8,10,11,12,13,14,15	8,10,15	**Level 5**
11	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	11,13	11,13	**Level 10**
12	1,2,3,4,5,6,7,8,9,10,12,14,15,16,17	11,12,13	12	**Level 9**
13	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	11,13	11,13	**level 10**
14	4,5,8,9,10,14,15,16,17	11,12,13,14	14	**Level 6**
15	4,5,8,9,10,15,16,17	1,2,3,6,7,8,10,11,12,13,14,15	8,10,15	**Level 5**
16	16	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	16	**Level 1**
17	4,9,16,17	1,2,3,6,7,8,10,11,12,13,14,15,17	17	**Level 4**

Findings

The ISM-based model for the interrelation across barriers of reverse logistics at the case company is given on Figure 1. The barriers with strong driving power and significant influence over the other are indicated on the lower side of the model, while the upper part shows strongly dependent barriers.

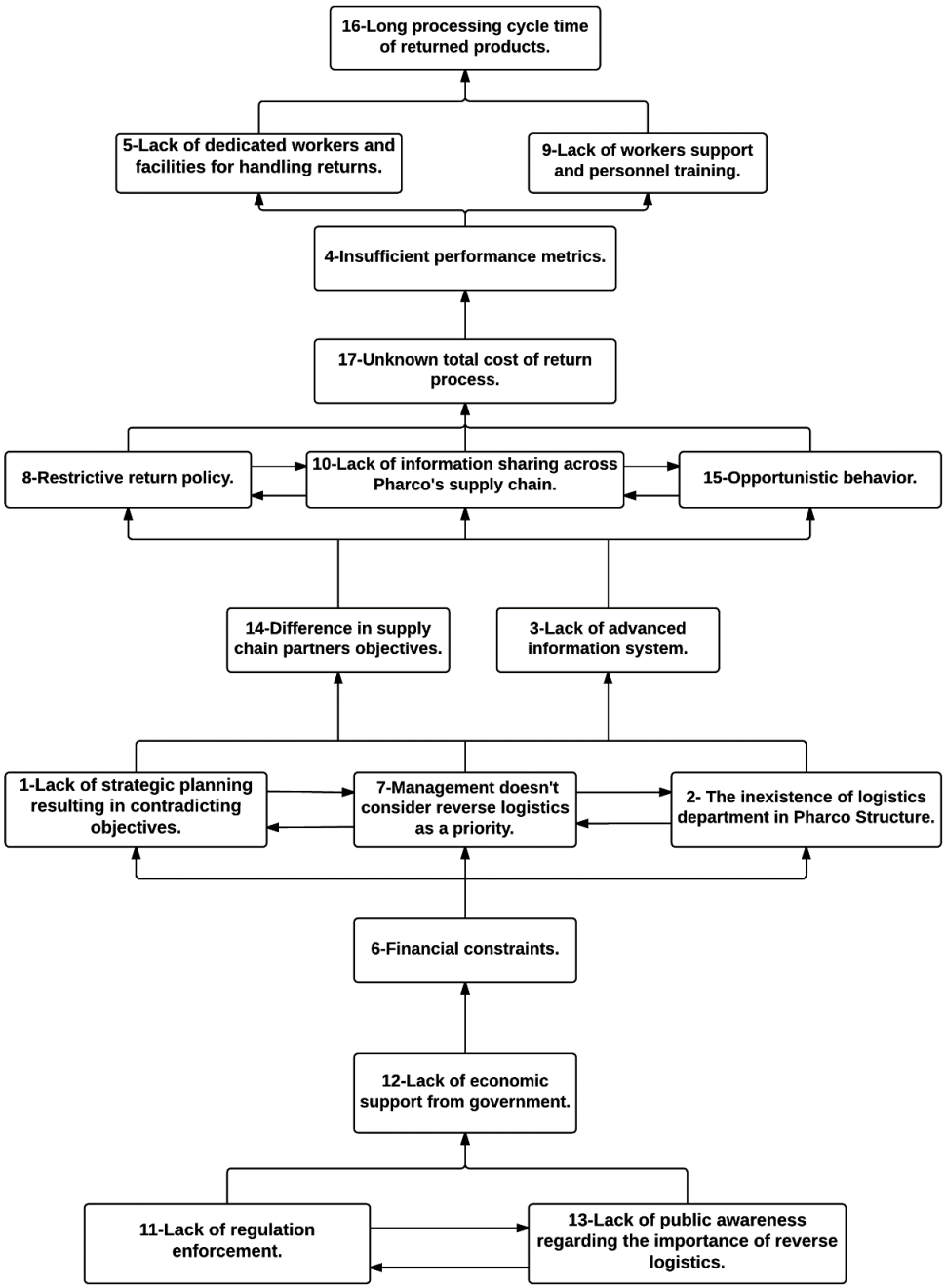

Figure 1.ISM-based model.

Practical Implications

The findings indicate the driving barriers "*lack of regulation enforcement*" and "*lack of public awareness on the importance of reverse logistics*" to be the root cause of the other barriers. Both barriers are company external; the first one is regulatory driven, the second one is related to consumer behaviour. It is, hence, less simple to reduce them by supply chain internal actions. The company may, however, use its leading role in the industry to raise consumer awareness, which in order may lead to regulations enforcement and change in customer behaviour. These findings are also supported by Grabara et al. (2014).

Limitation

The relationship across barriers depends on the respondents' contextual understanding of the problem. The bias of subjective interpretation may, hence, skew model output. Accordingly, the ISM model should not be treated as a roadmap for implementing reverse logistics strategies, but as a process to structure and visualise the interrelations across individual elements of a complex system, with the aim to assist human decision processes.

Originality/ Value

To the best of the authors' knowledge, the ISM modeling approach to reverse logistics barriers within the pharmaceutical industry is unique.

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