Analyzing pharmaceutical reverse logistics barriers an interpretive structural modeling approach

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Abstract

Purpose: *Reverse logistics can no longer be treated as an afterthought, especially for industries that are susceptible to product recall or for products whose existence in market after their sell-by date can cause severe problems. One such industry is pharmaceuticals where it is important to properly dispose of the recalled and expired drugs.*

In Egypt, the problem related to reselling expired pharmaceuticals is increasing and it has raised the need for a proper management and disposal of pharmaceutical returns. In light of the above-mentioned problem, the purpose of this paper is to explore the barriers affecting the application of reverse logistics at a leading pharmaceutical manufacturer in Egypt.

Design/methodology/approach: *The methodological approach of Interpretive Structural Modeling (ISM) is applied to study the 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.*

Findings: *This paper reveals that as many as 17 reverse logistics barriers are affecting the case company in implementing reverse logistics and these barriers have been ranked into 10 levels using the ISM method. The analysis also showed that eight dependent barriers are influenced by nine driving barriers. A key finding of the analysis is that lack of regulation enforcement and lack of public awareness regarding the importance of reverse logistics are the most driving barriers influencing the rest of the identified barriers.*

Practical implications: *The application of such an ISM-based model on reverse logistics barriers in the pharmaceutical industry would help the company managers and decision makers in better understanding of these barriers and to focus on the most driving barriers while implementing reverse logistics in their company.*

Originality/value: *The identification and the presentation of pharmaceutical reverse logistics barriers in the form of an ISM-based model and the exploration of the mutual influences among those barriers is a new effort in the area of pharmaceutical reverse logistics.*

1. Introduction

Reverse logistics is one of the most critical aspects for any business related to manufacturing, distribution, and service and support of any type of product (Donald F Blumberg, 2004, p. 1). It is also practiced in different industries, including those producing steel, commercial aircrafts, computers, automobiles, appliances, and chemicals and medical items (Dowlatshahi, 2000, p. 144). The importance of reverse logistics is underscored by its increasing popularity in both business and academic communities since the last decade (Nikolaou, Evangelinos, & Allan, 2013, p. 173).

Earlier, reverse logistics was often considered as a process that has little effect on enterprises as a whole. However, the evolving financial and competitive pressure, as well as the complexity in environmental regulations, have made it clear that reverse logistics is no longer an option for an organization to meet its goals and increase profitability (Partida, 2011, p. 62).

Deployment of reverse logistics is not free from barriers (Ravi & Shankar, 2005, p. 1012). Some of the most common barriers facing companies implementing reverse logistics in different industries are: Importance of reverse logistics relative to other issues, company policies, lack of systems, competitive issues, management inattention, financial and personnel resources, and legal issues (Dale S. Rogers & Tibben-Lembke, 1998, p. 32). In spite of these barriers, companies are becoming active in reverse logistics for different reasons, including economic reasons, legislative reasons, and corporate citizenship (de Brito & Dekker, 2003, p. 6). Growing concerns relating to environmental issues, coupled with legal regulations, have made organizations responsive to reverse logistics not only in developed countries but also in developing countries (Samir & Rajiv, 2006, p. 525).
Reverse logistics is very important in the pharmaceutical industry—not only from the economic point of view but also from the environmental and the regulatory points of view. In addition, the application of reverse logistics in this industry is more challenging than in any other industries, as most pharmaceuticals get destroyed when they are recalled or returned, they are seldom repaired or resold (Kabir, 2013, pp. 89, 97).

Proper disposal of recalled, unused, and expired pharmaceuticals is an important issue with legal implications, as some of these products contain hazardous chemicals. Also, the sensitive nature of medicines as well as the potential harm from use of expired or non-effective medicines means that pharmaceutical companies must effectively implement reverse logistics to promptly clear their supply chain channels of expired and non-conforming drugs (Shaurabh, Saurabh, & Moti, 2013, pp. 12, 18).

In Egypt, the head of the General Directorate of Pharmaceutical Inspection and the head of the Pharmacist Syndicate explained that "only slight amounts of expired medicines are accepted by pharmaceutical companies to be returned from distributors and pharmacies which, in turn, leads to the improper handling and disposal of expired pharmaceuticals" (Seif, Tharwat, Naser, & Madiha, 2010). Furthermore, The General Directorate of Pharmaceutical Inspection in Egypt discovered 48 cases where they found a large amount of expired pharmaceuticals in pharmacies and in distributors' warehouses, which have not been returned to manufacturers (General Directorate of Pharmaceutical Inspection, 2010). In addition, 150 pharmacists were arrested in a recent government crackdown on pharmacies; they have been charged with selling drugs past their sell-by date (BMI, 2014, p. 84).

2. Research problem

Reselling expired pharmaceuticals in Egypt is an increasing problem with severe consequences (Ramadan, 2014; RASSD, 2015). Recent studies by Kabir (2013); Kwateng, Debrah, Parker, Owusu, and Prempeh (2014)suggest extended focus on reverse logistics to potentially reduce this problem. There are however several barriers which hinder or prevent the application of reverse logistics in pharmaceutical industry. Accordingly, this research attempt to explore these barriers that hinder or prevent the application of reverse logistics practices 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 lead to other barriers, and "dependent" barriers influenced by the driving barriers. Ravi and Shankar (2005) indicate that "*we lack a holistic view in understanding the barriers that hinder reverse logistics*" (p. 1011) and highlight that the ISM approaches allows for a more in-depth understanding of the situation than observing individual barriers in isolation.

Structural modeling was defined by John N. Warfield (1974) as a methodology that employs graphics and words in carefully defined patterns to illustrate the structure of a complex issue or problem. The ISM method can be used to employ a systematic and logical thinking process while approaching a complex issue and then to communicate the results of that process to others (Malone, 1975).

3. Reverse logistics concept

The concept of reverse logistics is relatively old. Lambert and Stock (1982) provide one of the oldest descriptions of reverse logistics by saying that it is like *"going the wrong way on a one-way street because the great majority of products shipments flow in one direction"* (p. 19). In the 1980s the field of reverse logistics was only limited to the movement of materials in the opposite direction of the primary flow—i.e. from the customer toward the manufacturer (Rogers & Tibben-Lembke, 2001, p. 129).

Carter and Ellram (1998) provide a summary of the general literature, saying that the concept of reverse logistics came into being in 1970's. However, the focus shifted from recycling toward the effect of environmental issues on logistics management in the 1990's. Hence, Carter and Ellram (1998) defined reverse logistics as *"a process that enables companies to become environmentally efficient through recycling, reusing and reducing the amount of materials used"* (p. 85). During the late 1990s Dale S. Rogers and Tibben-Lembke (1998) defined reverse logistics as "[t]*he process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal"* (p. 2).

The above-mentioned definition by Dale S. Rogers and Tibben-Lembke (1998, p. 2) was criticized by de Brito and Dekker (2002, p. 3), as returns could be generated at any point in the supply chain before consumption and could be returned to any point of recovery other than the origin. Accordingly, de Brito and Dekker (2002, p. 3) adopted the following definition provided by The European Working Group on Reverse Logistics REVLOG (1998):

> *The process of planning, implementing and controlling flows of raw materials, in process inventory, and finished goods from a manufacturing, distribution or use point to a point of recovery or point of proper disposal. (p. 3)*

This definition clearly illustrates that the concept of reverse logistics focuses on activities with the goal of both value recovery and proper disposal. In this way, a clear distinction between reverse logistics and waste management concept is made, as the latter primarily focuses on waste collection and processing, and thus there is no reuse or recovery of economic value (de Brito & Dekker, 2003, p. 3).

3.1. Importance of reverse logistics

The evolvement of financial, competitive and customer pressures, as well as the increased complexity regarding the environmental policies and regulations, raised the need for organizations to engage in reverse logistics processes (Partida, 2011, p. 64). According to Dowlatshahi (2000, p. 144), reverse logistics enables companies to achieve the goal of sustainable development, as it focuses on environmental and economic goals. Hence, reverse logistics aims to maintain the environment and also to generate profits. In addition, effective implementation of reverse logistics can help companies to better compete in an industry characterized by intense competition and low profit margins.

Reverse logistics is also gaining interest in developing countries due to increased competition, market growth, and large numbers of products users. Therefore, the management of product returns in an effective as well as a cost-efficient way has become important as it leads to profitability and elevation of customer service levels, and ensure higher customer retention (Samir & Rajiv, 2006, p. 524).

3.2. Reverse logistics barriers

Although the application of reverse logistics practices can result in environmental and economic benefits, it is not free from barriers. The most common barriers in implementing good reverse logistics, according to Dale S. Rogers's and Tibben-Lembke's (1998, p. 32) examination of 300 companies in different industries, are as follows: Importance of reverse logistics relative to other

issues, company policies, lack of system, competitive issues, management inattention, financial and personnel resources, and legal issues.
In addition, different studies (Donald F. Blumberg, 1999; Chouinard, D'Amours, & Aït-Kadi, 2005; Cojocariu, 2013; Eric, Thomas, & Lauren, 2010; Gupta, 2013; Ismail et al., 2010; Lau & Wang, 2009; Ravi & Shankar, 2005; Richey, Chen, Genchev, & Daugherty, 2005; Ronald & Dale, 2002) have identified similar barriers as those identified by Dale S. Rogers and Tibben-Lembke (1998, p. 32) as well as other different barriers.

4. Company overview: Pharco pharmaceuticals

Pharco Corporation is a group of nine healthcare companies operating in the pharmaceutical field in Egypt since 1987. The corporation specializes in the development, manufacturing, marketing, distribution, and export of a wide range of branded, generic drugs and licensed pharmaceutical products (Pharco Corporation, 2014). Currently, the corporation consists of six manufacturing facilities in Alexandria, Egypt. In addition, there are two trading companies in Egypt while one marketing and distribution Branch in Bucharest, Romania, has been operating in the Romanian market since 1993. Through the nine companies, the corporation employs more than 5,700 employees.

In 2011, the corporation was ranked number one in the Egyptian pharmaceutical market with a market share of 13.2 percent in terms of sales units (345 million units). The corporation is focusing on increasing its product portfolio while improving efficiency and optimizing its processes to provide affordable medication in the Egyptian market. Pharco Pharmaceuticals is the founder of the corporation and is the second private Egyptian shareholding company. The company is located and headquartered in Alexandria, Egypt, producing and marketing for 237 brands, generics, branded generics and licensed products. Moreover, the company exports to 47 countries (Pharco Pharmaceuticals, 2014).

5. Ism methodology

In this research, the ISM methodology is applied to analyze the information gathered from the case study on the barriers hindering Pharco's application of reverse logistics. John N. Warfield (1974) defines structural modeling as a methodology which employs graphics and words in carefully defined patterns to illustrate the structure of a complex issue or problem. Thus, in this technique, the intention of the modeler is to embody the geometric rather than the algebraic and to describe form rather than calculating or measuring quantitative output (Lendaris, 1980, p. 807).

Ravi and Shankar (2005, p. 1017) explain ISM as an interactive learning process in which a set of different directly and indirectly related variables affecting the system under consideration are structured into a comprehensive systematic model. This methodology helps to identify order and direction on the complexity of relationships among the elements of a system.

The ISM methodology is *interpretive* as the judgment of the expert group decides whether and how the variables are related. It is *structural* on the basis of relationships, and an overall structure is extracted from the complex set of variables. In addition, it is a *modeling* technique because the specific relationships of the variables and the overall structure of the system under consideration are represented and illustrated in a diagraph model (Ravi & Shankar, 2005, p. 1018). In this regard, the value added by using the ISM methodology is structural and no information is added by the process (Farris & Sage, 1975).

Attri, Dev, and Sharma (2013, p. 5), Luthra, Kumar, Kumar, and Haleem (2011, p. 240), and Ravi and Shankar (2005, p. 1018) explain and summarize the various steps involved in the ISM methodology into **eight steps as follows:**

1st step: Identify the variables affecting the system under consideration and which are relevant to the problem. Those variables can be objectives, actions, and individuals etc.

2nd step: Based on the identified variables in the first step, establish a contextual relationship between the variables with respect to which pairs of elements would be examined.
3rd step: Develop a structural self-interaction matrix (SSIM) for variables, which would indicate a pairwise relationship among variables of the system under consideration.
4th step: Develop a reach ability matrix from the SSIM and check this matrix for transitivity. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if a variable "A" is related to another variable "B," and "B" is related to "C," then "A" is necessarily related to "C."
5th step: Partition the reach ability matrix obtained in step four into different levels.
6th step: Based on the relationships given in the reachability matrix, draw a directed graph and remove the transitive links.
7th step: Convert the resultant directed graph into an ISM-based model by replacing the element nodes with the statements.
8th step: Review the model to check for conceptual inconsistency and make the necessary modifications.

6. model development

A preliminary list of 17 barriers that hinder the company's implementation of reverse logistics practices have been generated by a literature review and semi-structured interviews with the company management. These are summarized in Table 1 below.

Barriers facing the company in implementing reverse logistics
1. Lack of strategic planning resulting in contradicting objectives.
2. The non-existence of a logistics department at the company.
3. Lack of advanced information system.
4. Insufficient performance metrics.
5. Lack of dedicated workers and facilities for handling returns.
6. Financial constraints.
7. Management did not consider reverse logistics as a priority.
8. Restrictive return policy.
9. Lack of workers' support and personnel training.
10. Lack of information sharing across the supply chain.
11. Lack of regulation enforcement.
12. Lack of economic support from the government.
13. Lack of public awareness regarding the importance of reverse logistics.
14. Difference in the supply chain partners' objectives.
15. Opportunistic behavior.
16. Long processing cycle time of returned products.
17. Unknown total cost of return process.

Table 1 Identified barriers of reverse logistics at Pharco Pharmaceuticals

6.1. Structural self-interaction matrix

To develop the Structural Self Interaction Matrix (SSIM) with contextual relationships of types "leads to" across the barriers, a set of closed-ended questions were answered by the company managers. The following four symbols are applied to denote the direction of the relationship between the factors (*i* and *j*):

- **V:** barrier *i* will lead to barrier *j*;
- **A:** barrier *j* will lead to barrier *i*;
- **X:** barriers *i* and *j* will lead to each other; and
- **O:** barriers *i* and *j* are unrelated.

Table 2 illustrates the SSIM matrix, with the contextual relationship between the 17 Barriers.

Table 2 Structural self-interaction matrix (SSIM)

6.2. Reachability matrix In this step, the SSIM is converted into a binary matrix (called the initial reachability matrix) by substituting V, A, X, and O by 1 or 0. The rules of substitution of 1s and

Barriers	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1. Lack of strategic planning resulting in contradicting objectives.	O	O	O	O	A	A	A	O	V	V	A	A	V	V	O	V
2. The non-existence of a logistics department in Pharco.	V	O	O	O	O	O	O	O	V	O	V	A	V	V	O	
3. Lack of advanced information system.	V	V	O	O	O	O	O	V	O	O	A	A	V	V		
4. Insufficient performance metrics.	A	V	O	O	O	A	O	A	V	O	A	O	O			
5. Lack of dedicated workers and facilities for handling returns.	O	V	O	O	O	O	A	O	O	A	A	A				
6. Financial constraints.	O	O	V	O	O	A	O	V	V	V	V					
7. Management did not consider reverse logistics as a priority.	O	O	V	O	A	A	A	V	V	V						
8. Restrictive return policy.	O	V	X	A	A	A	A	O	O							
9. Lack of workers' support and personnel training.	O	V	O	O	O	A	A	O								
10. Lack of information sharing across the supply chain.	V	V	X	A	O	O	O									
11. Lack of regulation enforcement.	O	O	V	V	A	O										
12. Lack of economic support from the government.	O	O	V	V	A											
13. Lack of public awareness regarding the importance of reverse logistics.	O	O	V	O												
14. Difference in the supply chain partners objectives.	O	V	V													
15. Opportunistic behavior.	O	V														
16. Long processing cycle time of returned products.	O															
17. Unknown total cost of return process.																

0s are as follows:

- → If the *(i, j)* entry in the SSIM is **V**, then the *(i, j)* entry in the reachability matrix becomes 1 and the *(j, i)* entry becomes 0.
- → If the *(i, j)* entry in the SSIM is **A**, then the *(i, j)* entry in the reachability matrix becomes 0 and the *(j, i)* entry becomes 1.
- → If the *(i, j)* entry in the SSIM is **X**, then the *(i, j)* entry in the reachability matrix becomes 1 and the *(j, i)* entry becomes 1.
- → If the *(i, j)* entry in the SSIM is **O**, then the *(i, j)* entry in the reachability matrix becomes 0 and the *(j, i)* entry becomes 0.

According to these rules, the final reachability matrix in Table 3 is obtained by adding transitivity, as explained in step four of the ISM methodology. The driving power and dependence of each barrier are also shown.

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**

Table 3 Final reachability matrix

The *Driving power* of a particular barrier is the total number of barriers, including itself, which it influences. The *dependence* of a particular barrier is the total number of barriers, including itself, which may influence it.

Those driving power and dependencies shown in Table 3 will be used later to classify barriers into four groups of autonomous, dependent, linkage and independent (driver) barriers in the Driver-Dependence diagram.

6.3. Level partitions

Based on the final reachability matrix, the reachability set and the antecedent set for each barrier is found. The *reachability set* for a barrier comprises the barrier itself and the other barriers influenced by it. The *antecedent set* consists of the barrier itself and other barriers that may influence it. The intersection between the reachability and antecedent sets for all barriers determines the *intersection set*.

The barrier for which the reachability and intersection sets overlap is assigned as a top-level barrier in the ISM hierarchy or Level 1, as shown in Table 4.

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

Table 4 iterations summary result 1–10

Level 1 is then, discarded from the other remaining barriers and the iterative procedure is continued until further levels are identified. The 10 identified levels in Table 4 helps to build the ISM model.

6.4. ISM-based model

The conical matrix helps to generate the structural model from the initial direct relation graph. Hence, after removing the transitive links, as described in the ISM methodology, the diagraph is finally converted into the ISM model by replacing nodes with statements, as shown in Figure 1 below.

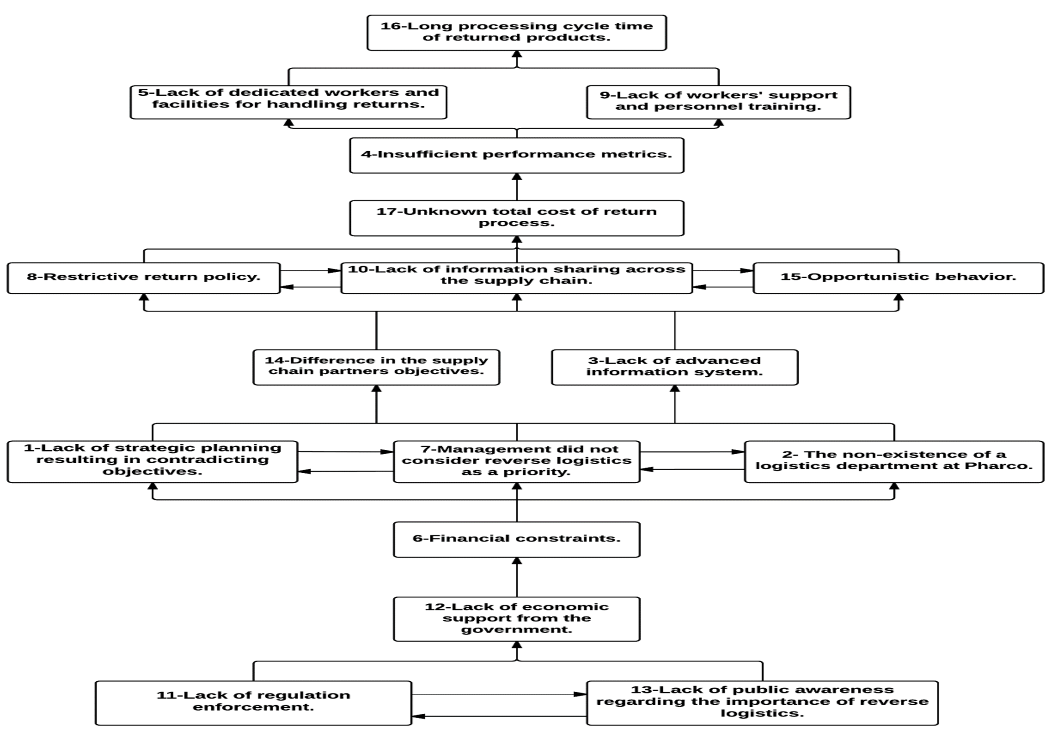

Figure 1 ISM-based model for barriers of reverse logistics at the case company.

The ISM-based model indicates that Barrier 16 – on **level 1** – *long processing cycle time of returned products* has the lowest driving power, and it is strongly dependent on the rest of barriers.
On the other hand, the lack of regulation enforcement from the government (Barrier 11) and the lack of public awareness regarding the importance of reverse logistics (Barrier 13) are very significant

barriers hindering the application of reverse logistics at the company. These two barriers form the bottom **Level 10** of the model, as they have the highest driving power and the lowest dependence on the rest of the barriers.

7. Model results

The final results of the ISM can be seen in Figure 1, which depicts the series of influences between the barriers affecting the application of reverse logistics at Pharco.

The lower side of the ISM model consists of driving barriers which have very strong driving power and significant influence over the other barriers. These barriers are located in the driver factors' quadrant in the drive-dependence diagram.

Based on the performed analysis, the lack of regulation enforcement and the lack of public awareness regarding the importance of reverse logistics are the most significant barriers hindering reverse logistics application at the company. Also, the ISM model shows that the lack of regulation enforcement and the lack of public awareness regarding the importance of reverse logistics are interrelated, which is similar to the research findings of Donald F. Blumberg (1999, p. 147) and Ismail et al. (2010, p. 51). Their findings indicate that the creation of public awareness is derived from the imposed legislation. In addition, Grabara, Man, and Kolcun (2014, p. 13) state that consumer awareness as well as the imposed legislation are key factors for a successfulimplementation of reverse logistics, and that the consumer awareness creates legislation which, in turn, leads to a change in consumer behavior.

Therefore, the absence of regulation enforcement negatively affects the application of reverse logistics since the company's main driver in adopting reverse logistics is the imposed regulations by Ministry of Health, as explained earlier. On the other hand, it becomes difficult for the company to make use of reverse logistics in creating a green image if their final consumers lack awareness regarding the importance of reverse logistics in protecting their health as well as the environment.

The absence of economic support from the governmentis one of the powerful barriers hindering the company implementation of reverse logistics practices, as shown in the power-dependence diagram. The economic support provided by the Egyptian government is essential for the company in order to alleviate the financial pressure resulting from the cost associated with reverse logistics activities. This is especially required when the company cannot capture direct economic value by recycling the expired products that represent a significant amount of returns. The financial constraint has a significant influence on the application of reverse logistics and derives the managers' inattention to the importance of reverse logistics relative to other issues such as sales, marketing, and production activities.

Also, the lack of strategic planning in reverse logistics practices is derived from the financial constraint and is also influenced by the non-existence of a logistics department. This is because the combination of sales and returns activities in the sales department creates a conflict of interest due to the contradicting objectives of each responsibility. Consequently, the company management gives less priority to returned products and reverse logistics activities compared with sales activities. Therefore, the existence of a logistics department for coordinating the multiple reverse logistics activities between the various responsible departments is important for a better application of reverse logistics.

The presence of the previously-mentioned barriers also result in the company's reliance on an outdated information system for handling returns. This is because the developed information system to support reverse logistics requires huge funds (Ravi & Shankar, 2005, p. 1016).

On the fifth level of the ISM model, where the lack of advanced information system is located, the differences in supply chain partners' objectives are located. The presence of the differences in supply chain partners' objectives as a barrier in this position in the ISM model implies that the internal strategic planning and the company's own objectives in handling returns influence the objectives of other chain partners. Thus, setting up of a good internal strategic plan and clear objectives for handling returns might help to align the chain partners' objectives.

The discussed driving barriers are considered key barriers as they have very strong driving power and significant influence over the other barriers. In this regard, the company's management should devote considerable efforts to address such barriers first, as they heavily affect the company's success in implementing reverse logistics. The upper side of the ISM model consists of barriers which are strongly dependent on the discussed driving barriers. These barriers are located in the dependent factors' quadrant in the drive-dependence diagram. The appearance of the *long processing cycle time of returned products* on the top of the ISM model implies that this barrier is derived from the rest of the model barriers. Despite the fact that the lack of dedicated workers and facilities for handling return and also the lack of workers' support and personnel training is a dependent barrier, they have an influence on the processing time of returned products.

Since the company's knowledge about the total cost of return process is limited, the unknown total cost of return process is one of the dependent barriers which limits the company from measuring their reverse logistics performance by establishing performance metrics. Therefore, information sharing between the company and its downstream partners is essential in order to acquire knowledge about the total cost of return process, and develop performance metrics and cost-related KPIs. This is similar to the research findings of Hazen, Overstreet, Hall, Huscroft, and Hanna (2015, p. 7), as they suggest that setting up of clear, specific goals for reverse logistics, combined with information system capabilities (i.e., the ability to receive information within and between organizations) are antecedents to establishing reverse logistics performance metrics.

Opportunistic behavior and restrictive return policy fall in the same sixth level with lack of information sharing in the ISM model. In addition, these three barriers have the same dependence and driving power on the drive-dependence diagram, and they influence each other. Therefore, addressing the three barriers together will be beneficial for the company. The lack of information sharing between the company's partners results in asymmetric information. Togar M Simatupang and Sridharan (2001, p. 4) explain that asymmetric information results from a situation where different supply chain partners have different information regarding resources, cost data, chain operations, performance status, and market condition. Therefore, information asymmetry results in a situation where one partner has private information that other partners in the chain do not possess to make a good decision.

As explained by Togar M. Simatupang and Sridharan (2002, p. 17), supply chain members do not prefer to share private information with each other due to the economic value of that information. Consequently, the supply chain suffers from opportunistic behavior as the existence of asymmetric information allows supply chain partners to hide their private information and increase their willingness to reduce the effort levels by offering incomplete or distorted information. Such behavior was defined by Oliver E. Williamson (1985, p. 47) as opportunism—"self-interest seeking with guile", which includes apparent behaviors such as lying, cheating, and stealing. It also refers to the offering of incomplete and distorted information for the purpose to mislead, confuse, or blind for one's own benefit.

The above clarification for the relationship between information sharing and opportunistic behavior helps to understand the interaction between those two barriers in the ISM model. Therefore, the company's supply chain is vulnerable to opportunism in a situation where each of the supply chain partners tries to maximize individual benefits and avoid reverse logistics costs. This is clearly illustrated in the ISM model as the differences in supply chain partners' objectives leads to the lack of information sharing between partners, thereby paving the way for opportunistic behavior. As a result, the company is adopting a restrictive return policy, known as "zero returns," for small distributors in order to safeguard itself from such opportunistic behavior, as well as a partial return policy (2 percent) of the purchased amount with full credit for the rest of distributors.

Finally, the dependent barriers are heavily influenced by the previously discussed driving barriers, and as the ISM model depicts the influence between barriers and does not provide a road map, the model remains useful even in case where a driving barrier cannot be totally alleviated or is difficult to overcome.

8. Conclusion

This research attempted to understand the interrelation between the different reverse logistics barriers facing Pharco in implementing its reverse logistics practices. The methodological approach of ISM was applied to study the mutual influences across barriers listed by a preliminary case analysis, and to identify the "driving" barriers which may lead to other barriers, and "dependent" barriers influenced by the driving barriers. Thus, the systematic analysis using ISM approach contributed to a more realistic representation of the complex problem in a visualized and simplified manner and also has provided a deeper understanding of the situation than observing individual barriers in isolation.

A key finding of the analysis is that the “lack of regulation enforcement,” “lack of public awareness regarding the importance of reverse logistics,” and “lack of economic support from government” form the bottom levels of the ISM model. Thus, those barriers imply high driving power and should be treated as the root cause of the remaining barriers. It was also observed that the “long processing cycle time of returned products,” “lack of dedicated workers and facilities for handling returns,” and “lack of worker support and personnel training” form the top levels of the model. Those barriers imply high dependence and represent the undesirable outcome of the driving barriers.

9. Limitations of the research

This research has been limited by the absence of Pharco’s key downstream partners’ perspectives. Their incorporation would have added more value to the research to understand the problem from a more holistic view. This research used only the ISM approach. However, since the relation among the identified reverse logistics barriers depends on the respondent’s knowledge and familiarity with the supply chain of Pharco Pharmaceuticals, its reverse logistics operations, and the pharmaceutical industry in Egypt, there might be a subjective bias affecting the final model due to their judgment. In this regard, the applied ISM methodology should be evaluated in connection with its utility in the research context.

Also, even though the application of ISM approach provides a much better visualization of the complex problem, with directed linkages between the identified reverse logistics barriers, the ISM output is not statistically valid.

10. Future research

This research was carried out within the context of a single case. Hence, further research could extend the investigation to a wider range of companies in the Egyptian pharmaceutical industry. Also, it would be interesting to incorporate the other downstream parties involved in application of reverse logistics in the pharmaceutical industry.

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