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Analyzing the Barriers to Transparent Food Supply Chains

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1. Introduction

Non-vegetarians living in GCC countries have a particular advantage when it comes to purchasing red meat. In addition to the local meat, they have the choice of buying fresh red meat coming from Australia, USA, New-Zealand, Egypt, Syria, Sudan, India, and Pakistan. The presence of so many varieties is due to the large number of expatriates particularly from India, Pakistan, Arab nationalities, and western countries. But the red meat that is being sold as fresh in hypermarkets, supermarkets or small retailers, the only option the consumer has, is to believe the retailer that the meat is good for consumption. There is no information regarding various aspects of the supply chain like-the origin of the animal, the place where it was raised, vital information regarding vaccination, age, and also the logistics. It is highly likely that the cattle might have been be produced on one unit, grown on at another, finished on another and, between each stage, transported and sold through open markets, sometimes several times, before being purchased either in the open market or direct, deadweight, for slaughter (Calder and Marr, 1998). Further, in recent times, food poisoning outbreaks from E. coli, contamination of animal feedstuffs with dioxins, and epidemic of foot and mouth disease have intensified consumer concerns (Harper and Henson, 2001).

In global food supply chains the level of complexity increases due to a greater number of parties, with each party potentially handling product, as well as various geographic, administrative, cultural, and economic factors that must be considered (Ghemawat, 2001). Increased supply chain centralization and globalization has led to an increased risk of the spread of pathogenic bacteria and zoonoses present in meat (Sanders, 1999). A safe

and secure food supply is a primary tenet underlying social stability (Whipple et al., 2009).

The level of food hygiene practices and the development of food regulatory agencies differ between countries (Roth et al., 2008). In GCC countries a large quantity of meat is imported from Asian or African countries where food safety and sanitation laws are lax. This laxity could easily lead to unsafe meat reaching to the consumers in GCC countries. The economic impact on international, national, and individual organizations' in the event of an outbreak of a notifiable disease is potentially devastating (Manning *et al.*, 2005). Disease related interruptions of trade flow affect not only the exporting country but also the importing country especially when the meat affected by the trade ban cannot be fully replaced either by domestic producers or by other exporting countries (Manning et al., 2007).

Transparency in a supply chain can be defined as "the extent of information available to the final consumer to trace the information regarding the transformation of the raw materials into the final product". In case of red meat supply chain this would imply various type of information like the origin and the place of growth of the animal, information regarding vaccination, age, processing, and finally the logistics. But, in GCC the buyer of fresh red meat is devoid of this information. The primary reason for this being that there are certain barriers that needs to be addressed to make the supply chain transparent. Literature on supply chain do recognizes certain variables that may have an impact on the transparency in a supply chain but the influence of interrelationships among the variables on the supply chain transparency has been hardly taken into account in the literature. Therefore, there is a need to identify variables influencing transparency

in a supply chain and to develop generally applicable framework, which establishes interrelationships.

2. Objectives of research

In the GCC countries, red meat supply chain have some very unique characteristics like:

- Procurement from various countries as consumers' comes from various nationalities.
- Very little contribution from the local production in mutton and beef sector.
- Importing only from firms who comply with the Islamic requirement of halal meat.

The major supermarket groups have greatest power in the chain because they hold significant market share. This is because retailers are prepared to switch between suppliers as any upstream supplier is not recognizable in the supply chain. The purpose of this paper is to contribute and provide an understanding of factors that can be classified as barriers to transparency in a supply chain. It seeks to identify those factors in a supply chain so as to delineate areas that needs immediate attention. For the purpose of this research the following questions are framed:

- What are the various factors that could be barriers to transparency in red meat supply chain?
- What kind of the mutual relationships exists among these variables?
- Can we classify these variables in groups based on their importance?

3. Identification of the barriers to transparent supply chain

Transformation of supply chain which is transparent is not an easy task. Many researchers have observed that there are some barriers that inhibit the process of

transparency in a supply chain. Therefore, it is important to identify these barriers and develop strategies to mitigate them. Based on the literature review and discussions with the experts from industry and the academia, 13 barriers were identified and used for modeling . These are discussed below.

3.1 Lack of accountability and responsibility

Borders TAG Initiative has demonstrated that primary producers are aware of their responsibilities to the consumer. They are aware that there must be accountability throughout the chain from food producer to final consumer, and want proven credibility with consumers (Calder and Marr, 1998). The same is not true for the meat supply chains' operating in GCC countries. This is because the upstream companies' are not recognizable by the consumers' and this in turn work as an advantage to these suppliers who are least bothered about food safety. Also they are aware that the meat for which they are supplying the raw material is for the consumption in some other country and so why to care much about the issues related to the transparency in a supply chain.

3.2 Lack of regulatory environment

Though there exists regulations regarding the quality of meat products, many of the necessary requirements of a transparent supply chain are absent. Thus, it is required that individual governments and retailers with substantial power do undertake formal risk analysis and implement policies to ensure the health and safety of the human population, protect animal health and welfare and also minimize the potential for trade disruption and/or economic loss (Manning and Baines, 2004).

3.3 Lack of consumer concern

In a study in Belgium it was revealed that between 75 per cent and 80 per cent of daily meat consumers in Belgium have serious concerns about hormones, antibiotics, BSE and Salmonella in fresh meat (Viaene and Verbeke, 1998). But consumers' willingness to pay extra for quality is low in return for a guarantee that the meat they purchase comes from a healthy animal (Sans et al., 2005).

3.4 Lack of long term relationships

It has become widely recognized that the pro-active management of collaborative relationships can present a critical source of competitive advantage (Power, 2005). But even in a developed economy like the UK, meat industry remains highly fragmented. One causal factor is the adversarial relationships, which exist throughout the meat supply chain, in particular the balance of power between producer and retailer (Collins and Burt, 1999).

3.5 Lack of ethical framework

Legislation defines governmental policy but it does not define what is "good" or "right" and this is the role of ethics (Manning et al., 2006). Early (2002), suggested that the moral and ethical standing of the food industry is a reflection of the moral and ethical values of the executives who lead the organizations that constitute the industry. By ethical standards the consumer has the right to know what a transparent supply chain recommends. But it seems that the organizations operating in GCC countries dealing in meat lacks adherence to ethical standards and thus completely disregard what an ethical framework would have suggested regarding consumer rights.

3.6 Lack of incentives to upstream partners

The concept of sharing rewards and penalties within the chain is a mechanism for driving supply chain efficiency and unity (Peterson et al., 2000). This might be regarded as particularly important within meat supply chains where the margins of upstream suppliers are under pressure. This is partly due to the existence of several middlemen and also due to the frequent change of suppliers by the processing organization.

3.7 Financial constraints

The increasing costs of implementing additional food safety, welfare and environmental legislation and market requirements as well as the direct, or indeed indirect, costs of a disease outbreak also influence the extent of transparency in a supply chain. This is particularly true for the upstream side of the supply chain as most of the suppliers are in the category of small business.

3.8 Lack of strategy/planning across SC

Fearne (1998) in examining the evolution of supply chain partnerships in the British beef sector, concludes that partners need to share a common vision of how to work together and to meet their volume and quality requirements. The importance of planning activities in the meat industry is also reported by Sadler and Hines (2002), who conclude that "it is necessary to work with all partners in a number of supply chains to complete the design and practical steps required to enable the whole supply chain to plan its operations and logistics in one process".

3.9 Lack of benchmarking practices

Implementing benchmarking in the livestock sector requires integrated supply chains to specify clearly the intentions, scope, and type of benchmarking exercise (Manning et al., 2008). It requires a detailed understanding of the processes undertaken in order to

determine the ideas and information that needs to be shared both vertically and horizontally in the chain which in turn will deliver compliance with stakeholder requirements and drive continuous improvement. In case of GCC meat supply chains' there is absolutely no benchmarking among various supply chains' regarding their practices for transparency in the supply chain.

3.10 Fragmented supplier base

In case of red meat supply chain which is either mutton or beef, the supplier base is highly fragmented. This is in sharp contrast with chicken supply where the supply can be dedicated to specific farms. Red meat suppliers depend on the 'aggregate approach'- one they buy animals from varies sources and secondly they buy selected parts of the animal from local butcheries. They do this by paying a higher price for those parts of the animal which are required in the export market. As the Indian market is huge the left over parts of the animal are still readily sold in the domestic market albeit at a lower price. One of the typical characteristics of the meat supply chain in GCC which sources from Asian or African countries is that on the upstream side, in general, there don't exists big farms to provide animals. Typically, there are agents and brokers that collect the animals using their contacts and through weekly markets in towns and villages and transport them to the processing plants. This procurement strategy makes the task of transparency very difficult.

3.11 Lack of trust among SC partners

On the upstream side, farmers and processors are uneasy about the market power of supermarkets thereby resulting in mistrust (Palmer, 1996; Taylor, 2006). Fritz and Fischer (2007) observed that trust is positively affected by quality communication and

positive collaboration experience in the past. Lu et al. (2007) observed that trusted buyer-seller relationship enhanced farmers' participation in modern market outlet (export and supermarket) as well as increased the contracts application.

3.12 Lack of IT tools to support transparency

The ability to collect information regarding various aspects that are linked to transparency and use it to ensure product quality in "real time" provides tangible benefits to the food industry. To solve the problems of data collection, transmission and analysis within the industry, there must be a common and standard means of communication, available to all (Wilson and Clarke, 1998). But the real problem lies in the adoption of IT tools by the upstream suppliers. The major reason being that many of the suppliers are small businesses that could not afford the IT based systems (Aghazadeh, 2004)

3.13 Lack of senior management commitment and support

There is a lack of a steering group of mangers from the partnering companies to develop and deploy an appropriate strategic framework for improving the transparency in the supply chain. The steering group would provide the necessary context and support for cross-functional and inter-company decision making and the development of supply chain wide strategy, followed by communication of the strategy to all levels of the firms involved, so that all departments and individuals engaged in supply activity have a clear understanding of their role and requirements in terms of improving supply chain transparency.

4. Methodology

To model the barriers to the transparency in red meat supply chain's the research utilizes the Interpretive Structural Modeling (ISM) approach. ISM methodology helps to impose

order and direction on the complex relationships among elements of a system (Warfield 1974; Sage, 1977). The ISM methodology is interpretive from the fact that the judgment of the group decides whether and how the variables are related. It is structural too, as on the basis of relationship; an overall structure is extracted from the complex set of variables. The model so formed portrays the structure of a complex issue, a system of a field of study, in a carefully designed pattern employing graphics as well as words. The process of structural modeling consists of several elements: an object system, which is typically poorly defied system to be described by the model; a representation system, which is a well-defined set of relations; and an embedding of perceptions of some relevant features of the object system into the representation system. Interpretation of the embedded object or representation system in terms of the object system results in an interpretive structural model (Sage, 1977).

ISM model also portrays the hierarchy of the variables. The need of hierarchy is pressing as often the barriers considered together may seem equally important and sometimes overriding each other. Such a situation makes it difficult to have a clear mental model. The development of a hierarchy helps in the classification and categorization of the barriers, and thereby formulates their respective strategies and policies while providing clarity of thought. Further, when resources are scarce, this hierarchy is expected to facilitate the allocation of resources in a rational manner and to achieve the maximum leverage out of the resources employed. The hierarchy identified can also help control the situation in times of crisis. In other words, the hierarchy ascertained will help to achieve effective planning, scheduling, monitoring and control, thus helping top management (Faisal, 2010). In context of supply chains, ISM has been found to be used to model

various issues like risk, IT enablement, agility, reverse logistics, integration among others. ISM is primarily intended as a group learning process, but it can also be used individually. The various steps involved in the ISM methodology are illustrated in Figure 1.

4.1 Structural Self-Interaction Matrix

For developing an ISM, participant response reflect judgment as to the existence of a relation between any two elements and the associated direction of the relation. If the relation holds from element *i* to element *j* and not in both directions, the modeler or group responds with a V as symbolic of the direction from the upper element to the lower element. If the group perceives that the relation holds from element *j* to element *i* but not in both directions, the entry A is made as symbolic of the direction from the lower displayed element up to the upper displayed element. If the relation is perceived by the group as valid in both directions, it is represented by symbol X and lastly if the relation between elements does not appear valid, the response symbol is O (Sage, 1977).

In this paper, a contextual relationship of "aggravate" type is chosen to exist among the barriers of transparency in a supply chain. This means that one variable tends to aggravate another variable. Based on this, contextual relationship between the variables is developed. Keeping in mind the contextual relationship for each variable, the existence of a relation between any two barriers (*i* and *j*) and the associated direction of the relation is questioned. Four symbols are used to denote the direction of relationship between the barriers (*i* and *j*):

V: Barrier *i* will aggravate Barrier *j*;

A: Barrier *j* will aggravate Barrier *i*;

X: Barrier *i* and *j* will aggravate each other; and

O: Barriers *i* and *j* are unrelated.

Based on the discussion with experts, the relationships among the identified barriers to transparency in a supply chain are represented in Table I.

4.2 Reachability matrix

The SSIM is transformed into a binary matrix, called the initial reachability matrix by substituting V, A, X, O by 1 and 0 as per the case. The rules for the substitution of 1's and 0's are the following:

1. 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.
2. 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.
3. 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 also becomes 1.
4. 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 also becomes 0.

Following these rules and after incorporating the transitivities (employing the transitivity principle that if variable A is related to B and B is related to C, then A is necessarily related to C) the final reachability matrix is shown in Table II. In Table II, the driving power and the dependence of each barrier are also shown. The driving power for each barrier is the total number of barriers (including itself), which it may impact. Dependence is the total number of barriers (including itself), which may be impacting it. These driving power and dependencies will be used in the MICMAC analysis, where the

barriers will be classified into four groups of autonomous, dependent, linkage, and independent (driver) barriers.

4.3 Level partitions

From the final reachability matrix, the reachability and antecedent set for each barrier are found (Sage, 1977). For every element p_i, we define the reachability set $R(p_i)$ as the set of elements reachable from p_i. $R(p_i)$ may be determined by inspecting the row corresponding to p_i, the element that column represents is contained in $R(p_i)$. Similarly for every element p_j, an antecedent set $A(p_j)$ is defined which is the set of elements which reach p_j. $A(p_j)$ may be determined by inspecting the column corresponding to p_j. For every row which contains a 1 in column p_j, the element that row represents is contained in $A(p_i)$.

The elements in the top level of the hierarchy will not reach any elements above their own level. As a result, the reachability set for a top-level element p_i will consist of the element itself and any other elements within the same level which the element may reach, such as components of a strongly connected subset. The antecedent set for a top-level element will consist of the element itself, elements which reach it from lower levels, and any elements of a strongly connected subset involving p_i in the top level. As a result, the intersection of the reachability set and the antecedent set will be the same as the reachability set if p_i is in the top level. Note that if the element in question were not a top-level element, the reachability set would include elements from higher levels, and the intersection of the reachability and antecedent sets would differ from the reachability set. Therefore an element p_i is top-level element if

$$R(p_i) = R(p_i) \cap A(p_i)$$

Once the top-level element is identified, it is separated out from the other elements. Then, the same process is repeated to find out the elements in the next level. This process is continued until the level of each element is found (see Tables III-IV). These levels help in building the digraph and the final model.

4.4 Building the ISM-based model

From the final reachability matrix (Table II), the structural model is generated by means of vertices or nodes and lines of edges. If there is a relationship between the barriers *j* and *i* this is shown by an arrow which points from *i* to *j*. This graph is called a directed graph or digraph. After removing the transitivities, the digraph is finally converted into ISM as shown in Figure 2. From the model it is clear that the most important barrier that impedes the transparency are lack of consumer concern, lack of regulatory environment, and lack of ethical framework.

Further, due to lack of trust and lack of long term relationships there are no clear supply chain wide policies to implement transparency systems and which is further aggravated by the lack of senior management commitment. This also leads to lack of availability of funds and thus which results in non-availability of IT tools to facilitate transparency systems in the supply chain. This lack of supply chain wide strategy strategy also impacts the incentives available to the partners in the upstream side to adopt transparency systems.

Lack of consumer concern, lack of regulatory environment leads to lack to accountability and responsibility. Lack of accountability and responsibility is also aggravated due to lack of ethical framework. lack of long term relationships and lack of trust are major reasons that leads to fragmented supplier base. Because of lack of supply chain wide

strategy and lack of senior management commitment there are no efforts to improve transparency in the supply chain ultimately leading to lack of benchmarking as no one is concerned about transparency in a supply chain.

4.4 MIC-MAC analysis

The objective of MIC-MAC analysis is to analyze the driver power and the dependence of the variables (Mandal and Deshmukh, 1994; Faisal and Rahman, 2008). The variables are classified into four clusters (Figure 3). The first cluster consists of the 'autonomous barriers' that have weak driver power and weak dependence. These barriers are relatively disconnected from the system, with which they have only few links, although these may be strong. The second cluster consists of the 'dependent barriers' that have weak driver power but strong dependence. The third cluster contains the 'linkage barriers' that have strong driving power and also strong dependence. These barriers are unstable in the sense that any action on these barriers will have an effect on others and also a feedback on themselves. The fourth cluster includes the 'independent barriers' having strong driving power but weak dependence. It is observed that a variable with a very strong driving power (called a key variable) falls into either the 'independent' or 'linkage' categories. The driving power and the dependence of each of these barriers are shown in Table II. In this table, an entry of '1' along the columns and rows indicates the dependence and driving power, respectively. From this, the driver power–dependence diagram is constructed which is shown in Figure 3. As an illustration, it is observed from Table II that barrier 8 has a driver power of 7 and a dependence of 8. Therefore, in Figure 2 it is positioned in the square corresponding to driver power of 7 and dependence of 8 and subsequently it falls in the category of linkage variable.

Discussion

The driver power-dependence diagram shown in Figure 3 helps to classify various barriers of risk management in supply chains. There are no barriers in the autonomous cluster, which indicates that no variable can be considered as disconnected from the whole system and the management has to pay attention to all the identified barriers of risk mitigation. In the next cluster we have variables such lack of ethical framework, lack of consumer concern, lack of regulatory framework, lack of accountability and responsibility, lack of long-term relationships and lack of trust. These variables have high driving power and low dependence and among them lack of consumer concern, lack of regulatory framework and lack of ethical framework have the highest driving power and lowest dependence which indicates that these variable may be treated as the root cause of the problem. Large-scale retailers are required to play an active role in the definition of products' intrinsic and extrinsic attributes in particular their promotion of fresh meat. These initiatives, which engage the group's name, can only give them a competitive advantage if they contribute, with time, to enhancing the reputation of the products concerned (Sans et al., 2005).

Lack of supply chain wide strategy and lack of commitment by top management fall into the category of linkage variables. These variables are the ones which are influenced by lower level variables and in turn impact on other variables in the model. Thus for the supply chain's transformation into a transparent entity, there should be commitment from top management with the incorporation of transparency issues at the strategic level. Also a variety of management measures need to be taken and supported by top management,

not only the establishment of management systems, but also the introduction of incentives.

The last cluster consists of variables such as financial constraints, lack of benchmarking standards, lack of incentives to partners, lack of IT tools and fragmented supplier base. These variables have little driving power but high dependence and this is particularly true for the lack of benchmarking to understand the benefits of transparency. It has been demonstrated in other industries how effective benchmarking can be in delivering a lean, efficient supply chain and it is suggested that the poultry meat supply chain can also benefit from such benchmarking techniques (Manning et al., 2008).

The model developed shows that lack of trust and lack of long term relationships are important barriers to transparent supply chains. Collaborative efforts aimed at improvement of quality, cost and delivery implies a long term commitment from all the partners in a supply chain. For many companies in the red meat sector such a change will require the abandonment of many long held business norms and a significant change in attitude to overcome the traditional lack of trust and hostility towards other chain members (Taylor, 2006). Previous research (Hornibrook and Fearne, 2002; Katz and Boland, 2000) has also highlighted the importance of greater vertical coordination within red meat supply chains in order to reduce risk and uncertainty and foster an environment of innovation and value creation.

Information technology has developed over the last decade to a point where it can quickly and efficiently move, store and analyze vast volumes of data. As the use of personal computers continues to rise, access to appropriate technology and software systems is increasing amongst all members of the fresh meat supply chain.

The main contributions of this research include the following:

- In this paper, an attempt has been made to identify the important barriers impacting on the transformation of a supply chain into a transparent entity. This research assumes importance because it discusses transparency in context of meat supply chain which huge impact on the health and well-being of end consumers.
- A key finding of this research is that lack of consumer concern, lack of regulations and standards and lack of ethical framework are the primary inhibitors of transparency in a supply chain. These are strong drivers and may be treated as the root causes of all the other barriers.
- The variables with higher driving powers have more of a strategic orientation and there are other dependent variables being affected by them. Thus, management should accord prime importance to these variables.
- The ISM model presented in this paper for analyzing and representing relationships among the barriers to transparency in supply chains is simple and easy to understand by various partners in a supply chain.
- Though the context of the ISM model in this paper is red meat supply chains, the variables identified are quite generic and with marginal adjustments can be used for other food supply chains.

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Table I: Structural Self Interaction Matrix (SSIM)

Barriers	13	12	11	10	9	8	7	6	5	4	3	2
1. Lack of accountability & responsibility	V	O	X	V	V	V	O	O	A	X	A	A
2. Lack of regulatory environment	V	O	O	V	O	V	O	O	X	V	A	
3. Lack of consumer concern	V	O	O	V	O	V	O	O	V	V		
4. Lack of long-term relationships	V	O	X	V	V	V	V	V	O			
5. Lack of ethical framework	V	O	O	O	V	V	V	V				
6. Lack of incentives to upstream partners	A	O	A	X	V	A	A					
7. Financial constraints	A	V	O	O	V	A						
8. Lack of strategy	X	V	A	V	V							
9. Lack of benchmarking practices	A	A	O	A								
10. Fragmented supplier base	A	O	A									
11. Lack of trust	V	O										
12. Lack of IT tools	A											
13. Lack of senior management commitment												

Table II: Final Reachability Matrix

Barriers	1	2	3	4	5	6	7	8	9	10	11	12	13	**Driver**
1. Lack of accountability & responsibility	1	0	0	1	0	1	1	1	1	1	1	1	1	10
2. Lack of regulatory environment	1	1	1	1	1	1	1	1	1	1	1	1	1	13
3. Lack of consumer concern	1	1	1	1	1	1	1	1	1	1	1	1	1	13
4. Lack of long-term relationships	1	0	0	1	0	1	1	1	1	1	1	1	1	10
5. Lack of ethical framework	1	1	1	1	1	1	1	1	1	1	1	0	1	13
6. Lack of incentives to upstream partners	0	0	0	0	0	1	0	0	1	1	0	1	0	4
7. Financial constraints	0	0	0	0	0	1	1	0	1	1	0	1	0	5
8. Lack of strategy	0	0	0	0	0	1	1	1	1	1	0	1	1	7
9. Lack of benchmarking practices	0	0	0	0	0	0	0	0	1	1	0	0	0	2
10. Fragmented supplier base	0	0	0	0	0	0	0	0	1	1	0	0	0	2
11. Lack of trust	1	0	0	1	0	1	1	1	1	1	1	1	1	10
12. Lack of IT tools	0	0	0	0	0	1	0	0	1	1	0	1	0	4
13. Lack of senior management commitment	0	0	0	0	0	1	1	1	1	1	0	1	1	7
Dependence	6	3	3	6	3	11	9	8	13	13	6	11	8	

Table III-Iteration i

Barrier p_i	Reachability set $R(p_i)$	Antecedent set $A(p_i)$	Intersection set $R(p_i) \cap A(p_i)$	Level
1	1,4,6,7,8,9,10,11,12,13	1,2,3,4,5,11	1,4,11	
2	1,2,3,4,5,6,7,8,9,10,11,12,13	2,3,5	2,3,5	
3	1,2,3,4,5,6,7,8,9,10,11,12,13	2,3,5	2,3,5	
4	1,4,6,7,8,9,10,11,12,13	3,4,6	3,4,6	
5	1,2,3,4,5,6,7,8,9,10,11,12,13	2,3,5	2,3,5	
6	6,9,10,12	1,2,3,4,5,6,7,8,11,12,13	6,12	
7	6,7,9,10,12	1,2,3,4,5,7,8,11,13	7	
8	6,7,8,9,10,12,13	1,2,3,4,5,6,8,11,13	8,13	
9	9,10	1,2,3,4,5,6,7,8,9,10,11,12,13	9,10	I
10	9,10	1,2,3,4,5,6,7,8,9,10,11,12,13	9,10	I
11	1,4,6,7,8,9,10,11,12,13	1,2,3,4,5,11	1,4,11	
12	6,9,10,12	1,2,3,4,5,6,7,8,11,12,13	6,12	
13	6,7,8,9,10,12,13	1,2,3,4,5,6,8,11,13	8,13	

Table IV-Iteration ii-vi

Barrier p_i	Reachability set $R(p_i)$	Antecedent set $A(p_i)$	Intersection set $R(p_i) \cap A(p_i)$	Level
1	1,4,6,7,8,11,12,13	1,2,3,4,5,11	1,4,11	V
2	1,2,3,4,5,6,7,8,11,12,13	2,3,5	2,3,5	VI
3	1,2,3,4,5,6,7,8,11,12,13	2,3,5	2,3,5	VI
4	1,4,6,7,8,11,12,13	3,4,6	3,4,6	V
5	1,2,3,4,5,6,7,8,11,12,13	2,3,5	2,3,5	VI
6	6,12	1,2,3,4,5,6,7,8,11,12,13	6,12	II
7	6,7,12	1,2,3,4,5,7,8,11,13	7	III
8	6,7,8,12,13	1,2,3,4,5,6,8,11,13	8,13	IV
11	1,4,6,7,8,11,12,13	1,2,3,4,5,11	1,4,11	V
12	6,12	1,2,3,4,5,6,7,8,11,12,13	6,12	II
13	6,7,8,12,13	1,2,3,4,5,6,8,11,13	8,13	IV

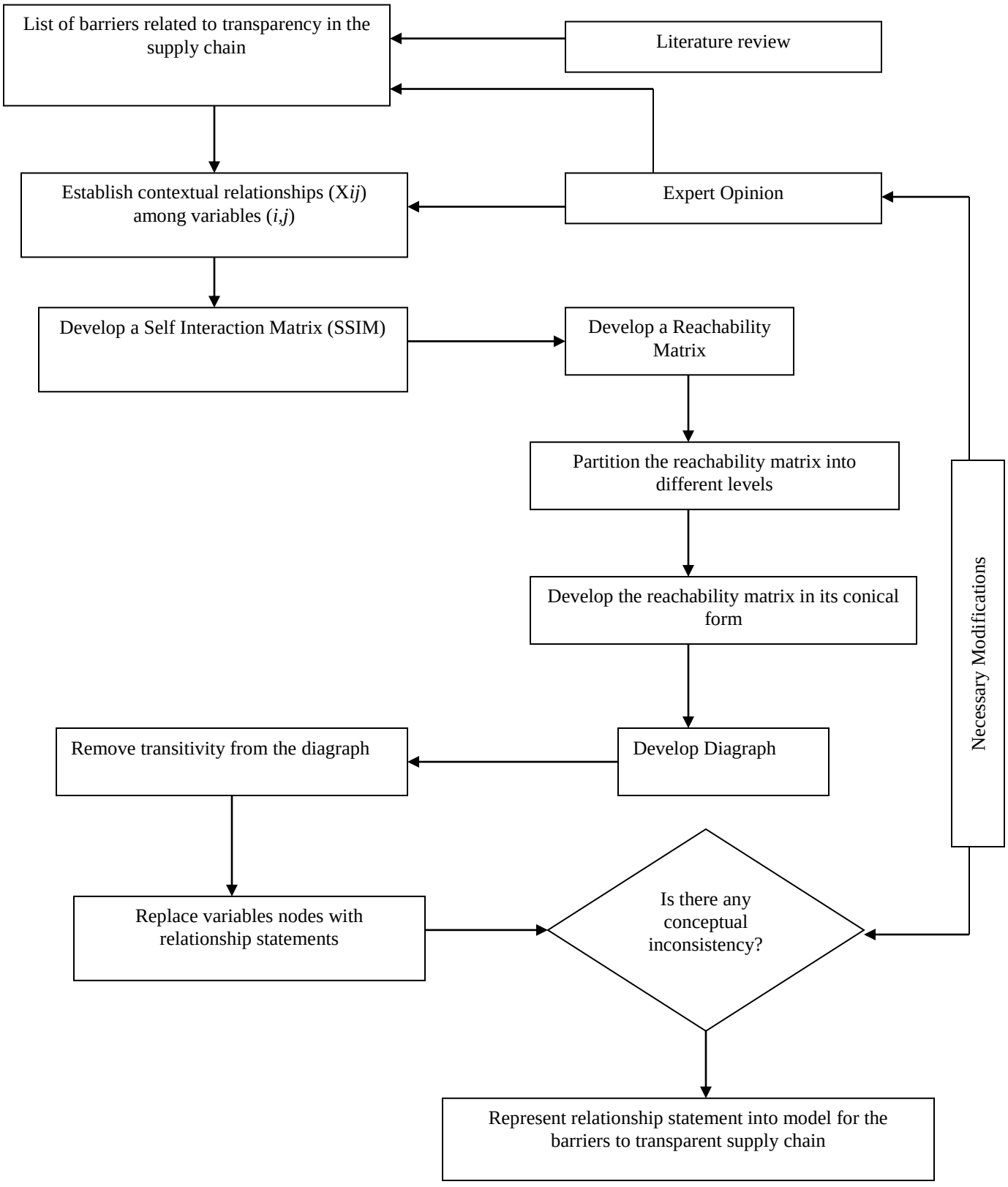

Figure 1: Flow diagram for developing an ISM based model

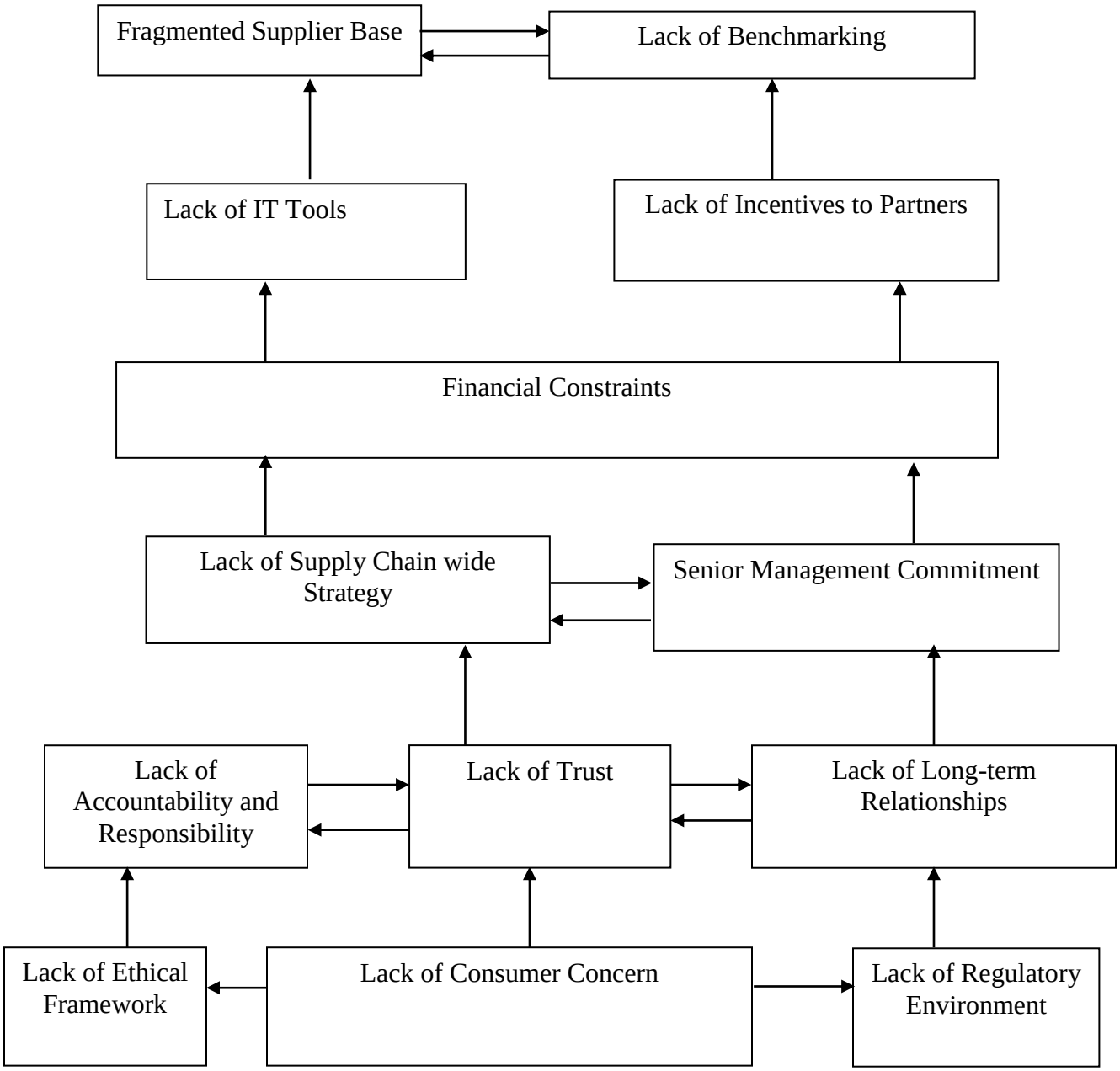

Figure 2: ISM based model for the barriers to transparent supply chain

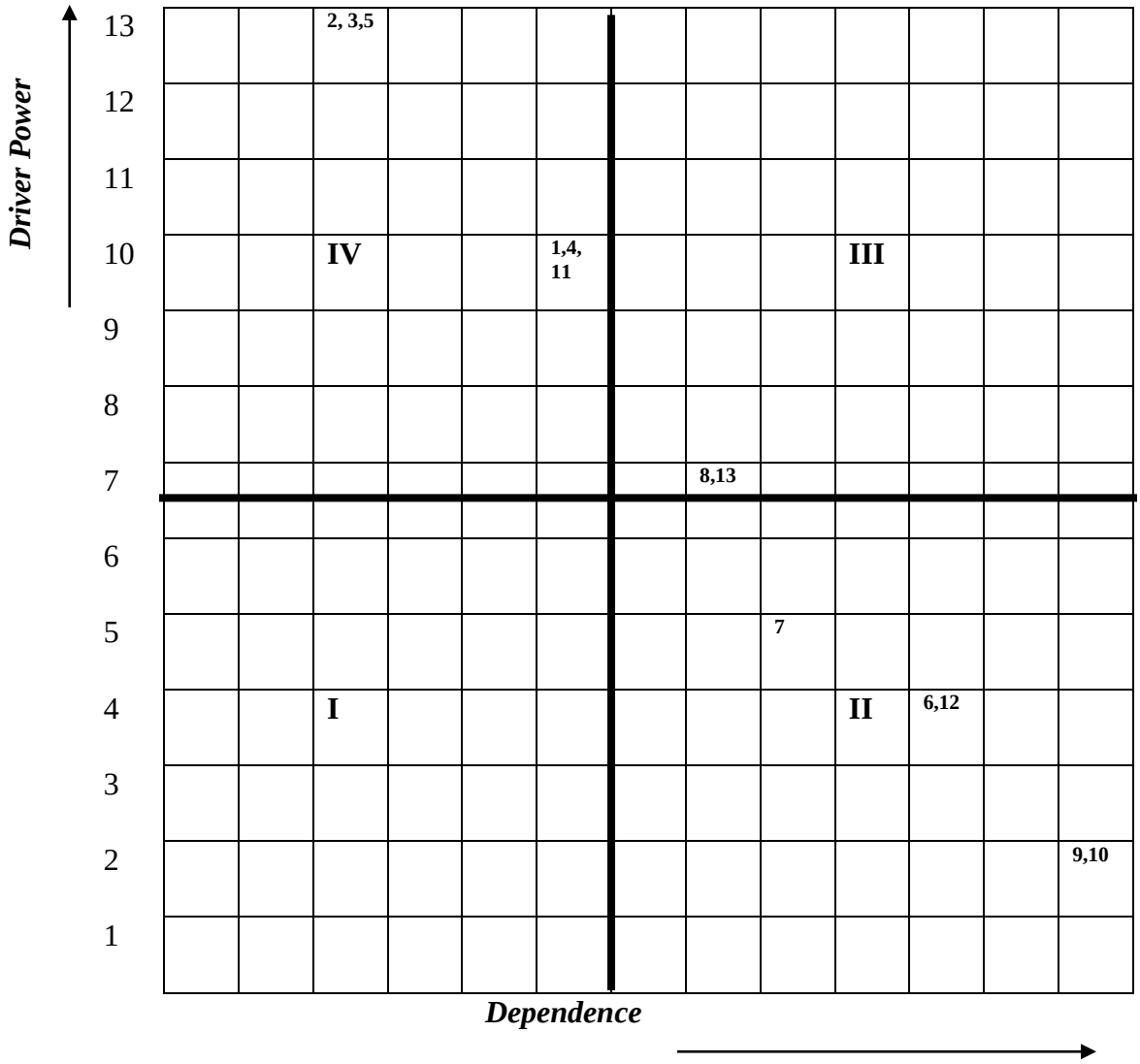

Figure 3: Driver power and Dependence diagram