Research

IDENTIFYING AND MODELING BARRIERS TO COLLABORATION AMONG AUTO-PARTS MANUFACTURING SMEs

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Abstract

This research aims to identify major barriers impacting collaboration and enhancing the understanding of these barriers among small and medium sized enterprises (SMEs) operating in the auto parts manufacturing sector of Pakistan. A mathematical based qualitative methodology known as interpretive structural modeling (ISM) approach is applied to diagnose foremost barriers and to develop a hierarchical model showing mutual relationships among them. Seven barriers have been identified with the help of literature and experts' opinion. Classification of barriers has also been carried out according to their driving and dependence powers.

Keywords: Barriers to collaboration, Interpretive structural modeling, SMEs.

JEL Classification: Z 000

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Introduction

Small and medium sized enterprises (SMEs) due to their small size and limited resources face many constraints to compete in the market and remain unsuccessful in achieving their desired goals. Smaller firms try to satisfy their potential customers through low-cost, high quality and innovative products. One of the best ways to achieve these goals is to collaborate with other small firms. Collaboration among SMEs can provide huge benefits than working in isolation. But due to limited awareness about the presence of collaboration barriers hinders to realize the benefits of collaboration. Therefore the main objective of this study is to diagnose those barriers of collaboration in auto-parts manufacturing SMEs of Pakistan and to realize the interaction of these barriers with each other. Successful SMEs of future will be those that overcome the barriers to collaboration to realize and enjoy its benefits. Thus essential objectives of the study are to:

- Discover foremost barriers to collaboration;
- Rank and classify these barriers as per their dependence and driving power;
- Build mutual and circumstantial relationships among these analyzed barriers;
- Represent these barriers in a hierarchical model according to their classification;
- Discuss managerial implications of identified barriers;

The next segment will discuss the review of literature which will be followed by explanation of the methodology of Interpretive Structural Modeling (ISM). It will be followed by discussions, managerial implications, limitations and directions for future research.

Review of Literature

The automotive sector is considered as the basic infrastructure that shapes the industry of any country. It is, in fact, the manufacturing sector that influences the structure of the industry. So every economy, that is on the way to development critically focuses on the growth of this sector (Ahmad, Pirzada, & Khan, 2013). It is observed that in Pakistan around 90% of auto parts manufacturing sector consists of SMEs out of which approximately 95% are self financed (Junejo & Kanasro, 2009). Many of the SMEs are newly emergent in this sector, since all the SMEs lie in the same industry, they have similar barriers as the businesses are dependent upon the Original Equipment Manufacturers (OEMs), scarce resources, lack of technology, lack of technical expertise and its usage (Ahmad et al., 2013), meager or limited working capital, less availability of professional, experienced and skilled labor, poor information about market and improper government incentives and support (Punyasavatsut, 2007). Frequently dynamic environment needs mutual cooperation and collaboration to cope with competition, whereas in Pakistan there is very little exercise of collaboration and mutual sharing and even at the fundamental level such activities and arrangements are lacking in formal business practices (Ameen, 2008). In Pakistan, any study addressing this issue could not be found which provide a motivation to conduct a research to identify major barriers hindering collaboration among SMEs. This study will be useful in filling this gap in literature addressing issues of collaboration among SMEs.

The inter firm collaboration refers to the cooperation among the businesses for the achievement of goals which are mutually established over certain predefined time and economic phase (Glaister & Buckley, 1996). Firms get involved in this activity to utilize the combined knowledge for satisfying their potential customers more effectively (Peters, Johnston, Pressey, & Kendrick, 2010). To attain new skills and expertise or the advantages of economies of large

scale as a competitive entity in the cluster of firms in a market, collaboration among smaller firms is very much favorable (Adobor, 2006). Collaboration is somewhat helpful to nurture economic development among the firms of any territory (Brunetto & Farr-Wharton, 2007). Collaboration tends towards unified goals attaining by sharing knowledge, information, ideas and risks as well as rewards mutually (Cohen & Roussel, 2005). This relationship causes new value creation through sharing of resources, enhances market access and efficiency of the firms (Peters et al., 2010). Organizations collaborate with other firms to attain competitive advantage (Ritter, Wilkinson, & Johnston, 2002).

In many cases the advantages of collaboration that the firms gain, are not recognized because of lack of understanding regarding the barriers to collaboration which, in fact, impede efficiency of collaboration (Ramesh, Banwet, & Shankar, 2010). The collaboration of SMEs is beneficial in all matters either industrial competitiveness (Rosenfeld, 1996), technological improvements, innovations, economies of scale, approach to the sound markets, and skilled human capital (Akdoðan & Cingšz, 2012), higher earnings, reduction of cost, lessening lead times, or sharing of technology and higher trade volumes (Bishop, 2003; Bengtsson & Kock, 2000; Ryssel, Ritter, & Gemünden, 2004). Firms having limited means or capital enjoy more benefits of the collaborative strategy (Akdoðan & Cingšz, 2012). Many smaller organizations are unable to survive and even cannot face and deal with the problems on their own. Collaborative strategy helps firms to indulge in the joint relationship to entertain advantages like market strength, lower costs, scale economies and above all competitive edge by performing in mutual practices like co-production, co-marketing, combined development and shared means or capital (Rosenfeld, 1996). Hanna & Walsh (2008) argued that through mutual practices the SMEs can overcome several disadvantages of their ‘smallness’.

ISM Methodology for Model Development

ISM is used for qualitative studies based on mathematical approach which facilitates to improve the direction of complex and critical relationships among variables or factors in any system (Sage, 1977). It is an interactive studying process used for presenting the complex relationships of different factors into a sophisticated and systematic model and hierarchy by employing words and graphics (Ravi & Shankar, 2005). ISM is a modeling technique used for developing specific relationships among factors of interest into a graphical model or digraph. This tool has been used by different researchers for more than twenty years. Some researchers applied this tool for publication in journals having impact factor of more than 4.50, for evidence the study of Vivek, Banwet, & Shankar (2008) can be reviewed. Govindan, Palaniappan, Zhu, & Kannan (2012) applied ISM for identifying third party reverse logistics service providers. Ansari, Kharb, Luthra, Shimmi, & Chatterji (2013) explored various barriers hindering the implementation of solar power in India through ISM, and made publication in a journal having a 5.51 impact factor.

Expert opinion is an essential keystone to ISM approach. Warfield, (1974) recommended that at least eight experts are needed to participate in an ISM technique, groupings have both industrial and academic experts in the domain under study. From the research presented and reviewed in this study, ISM models have been constructed with as few as two participating experts (Ravi & Shankar, 2005). Recently, Panahifar, Byrne, & Heavey (2014) utilized ISM methodology in their research with involvement of nine experts only, and made publication in an impact factor journal.

The present study dealing with the auto parts SMEs of Pakistan has used opinion of 20 experts for formulating ISM model. The large number of experts was chosen due to limited information available on the subject in the context of auto industry. These experts were selected from academia (6) and the auto-parts industry (14). The criteria for selection of industry experts, was based on their involvement in the auto parts manufacturing business and their rich experience of minimum 12 years to maximum 30 years. The inclusion of industry experts was made to gain benefit from their practical experience of Pakistani auto parts industry. The experts from academia were selected due to their qualification background (PhD from foreign universities) in the field of industrial engineering and research work. The experts from academia were helpful to prioritize and scrutinize the barriers enlisted from literature review. In the first stage of brain storming session consensus was developed for identification of major barriers impacting collaboration from a list of large barriers consolidated after extensive literature review. In the second stage, the mutual relationships among the identified barriers were developed by experts using a questionnaire (Appendix). Through the questionnaire the consensus of experts was obtained, although some discrepancies were faced initially but those were resolved after communication with the group of experts. Seven barriers were selected with the consensus and consent of experts (Table 1). In the last phase a diagram showing the relationships among barriers hindering collaboration was distributed to all experts for making any modifications if necessary. The following steps are involved in ISM methodology for developing a model:

1. Identifying factors, elements, barriers or variables which are related to any issue or problem;
2. Establishing pair wise relationships among barriers or variables;
3. Developing structural self interactional matrix (SSIM) representing pair wise relationships among all barriers or variables;

Table 1:

Summary of major barriers to collaboration as reported in the literature.

S. no.	Collaboration Barriers	Brief Description of Barriers	References
1	Absence of trust in SME owners-managers (ATSO)	Lack of trust is the biggest hurdle for development of successful collaboration.	(Vangen & Huxham, 2003; Sahay, 2003; Karlsson, Booth, & Odenrick, 2007; Hanna & Walsh, 2008; Ramesh et al., 2010; Darabi & Clark, 2012; Akdoğan & Cingšz, 2012)
2	Low literacy rate (LLR)	Researchers think that the literacy level of small businesses' owners and collaborative practice both has strong relationship, and the more the literate business owners, the more will be involvement in collaboration.	(Richbell, Watts, & Wardle, 2006; Coy, Shipley, Omer, & Khan, 2007; Blackburn, Hart, & Wainwright, 2013)
3	Lack of collaborative strategies and planning (LCSP)	There is low trend of strategic and collaborative planning in SMEs.	(Woods & Joyce, 2003; Richbell et al., 2006; Bridge, O'Neill, Martin, & Cromie, 2009; Ramesh et al., 2010)
4	No collaborative awareness and vision (NCAV)	Due to lack of vision and collaborative awareness such practices are discouraged.	(Mentzer, Foggin, & Golicic, 2000; Darabi & Clark, 2012)
5	Threat of elimination of competitive edge (TECE)	The threat of losing competitive advantage is high.	(Mohr & Spekman, 1994; Sun & Scott, 2005; Fiaz & Naiding, 2012)
6	Lack of R&D practices in SMEs (LRPS)	Research and development activities are limited in SMEs.	(Shane & Venkataraman, 2000; Waalkens, Jorna, & Postma, 2004; Muscio, 2007; Ansari et al., 2013)
7	Selfish and narrow mentality of SME owners-managers (SNMSO)	Selfish, possessive and narrow mindset of SME owners-managers stops them to collaborate with others.	(Hansen & Nohria, 2004; Ramesh et al., 2010; Blackburn et al., 2013)

4. Developing reachability matrix from SSIM by converting relationship symbols into binary values 1 and 0;
5. Level portioning of reachability matrix into various levels;
6. Drawing a relationship graph or digraph based on relationships in SSIM and reachability matrices;
7. Transforming the digraph into ISM based hierarchical model;
8. Reviewing the ISM based model for making necessary modifications to remove any conceptual inconsistency, if required.

Structural Self Interaction Matrix (SSIM)

Groups of experts were counseled for classifying the nature of relationships among barriers by using a questionnaire and a structural self interaction matrix was developed (Table 2). Various

researchers including Alawamleh & Popplewell (2011); Pfohl, Gallus, & Thomas (2011) and Azevedo, Carvalho, & Cruz-Machado (2013) recommended that the assessment based on questionnaire can be utilized effectively for obtaining the consensus of experts and their opinion for classification of mutual relationships among barriers, moderated by the researcher. For developing SSIM and analyzing the barriers the following four symbols have been utilized to denote the relationship between barrier *i* and barrier *j*:

V= Barrier *i* will alleviate barrier *j*;

A= Barrier *j* will alleviate barrier *i*;

X= Barriers *i* and *j* will alleviate each other;

O= Barriers *i* and *j* are not related;

Table 2:

Structural self interaction matrix

Barrier *j* → / **Barrier *i*↓**		**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	ATSO	X	A	X	A	A	A	-
2	LLR	V	V	V	V	V	-	
3	LCSP	V	V	V	V	-		
4	NCAV	V	X	V	-			
5	TECE	X	A	-				
6	LRPS	V	-					
7	SNMSO	-						

In case of ATSO, this barrier has been declared to have profound effect on the 7th (SNMSO) and 5th (TECE) barriers in such a way that they affect each other mutually. Thus the relationships are marked as X. On the other hand 6th (LRPS), 4th (NCAV), 3rd (LCSP) and

2nd (LLR) are declared to be responsible for reinforcing 1st barrier (ATSO). Thus these relationships are marked with A.

Reachability Matrix

The SSIM is converted into reachability matrix by replacing the symbols V, A, X and O into binary values 1 and 0. This replacement into 1s and 0s is as per following criteria:

- If "V" is allotted in the cell (i,j) of SSIM, then cell entry of (i,j) in reachability matrix converts into "1" and the entry (j,i) turns into "0".
- If "A" is allotted in the cell (i,j) of SSIM, then cell entry of (i,j) in reachability matrix converts into "0" and the entry (j,i) turns into "1".
- If "X" is allotted in the cell (i,j) of SSIM, then cell entry of (i,j) in reachability matrix converts into "1" and the entry (j, i) also turns into "1".
- If "O" is allotted in the cell (i,j) of SSIM, then cell entry of (i,j) in reachability matrix converts into "0" and the entry (j,i) also turns into "0".

Table 3:
Reachability matrix

Barriers *j* → / **Barriers *i*↓**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Driving power**	**Rank**
1	ATSO	1	0	0	0	1	0	1	**3**	**IV**
2	LLR	1	1	1	1	1	1	1	**7**	**I**
3	LCSP	1	0	1	1	1	1	1	**6**	**II**
4	NCAV	1	0	0	1	1	1	1	**5**	**III**
5	TECE	1	0	0	0	1	0	1	**3**	**IV**
6	LRPS	1	0	0	1	1	1	1	**5**	**III**
7	SNMSO	1	0	0	0	1	0	1	**3**	**IV**
Dependence power		**7**	**1**	**2**	**4**	**7**	**4**	**7**		
Rank		**I**	**IV**	**III**	**II**	**I**	**II**	**I**		

Thus a reachability matrix is developed by adopting this rule which is represented in Table 3, which also reveals the driving and dependence powers of the barriers. The driving power of a particular barrier is aggregate number of all barriers (counting it) which it may impact. The dependence power is aggregate number of barriers (counting it) which may help in influencing it (Table 3).

Level Partitions

The reachability set and antecedent set for each barrier is found from reachability matrix as recommended by Warfield (1974) and Farris & Sage (1975). The reachability set is composed of the barrier itself for a specific barrier and for all those barriers which it may help achieve, whereas antecedent set for a particular barrier comprises the barrier itself and those barriers which may alleviate them. Then an intersection set for all the barriers is derived. That barrier is considered as top level barrier in ISM hierarchy for which the reachability set and intersection set are alike. This top level barrier would not impact or influence any other barrier above its level. The top level barrier when identified is omitted from the reachability and the antecedent sets. The same process is repeated to dig out the next level barrier and repeated till the level of last barrier is identified. This iteration process of level partitioning helps in building the ISM model. The level partitioning process is completed in four iterations which are presented in Tables 4 – 7.

Formation of ISM Based Model

The ISM based model is constructed on the basis of reachability matrix (Table 3). The relationship between two barriers *i* and *j* is denoted by an arrow which directs from *i* to *j*. This graph is known as ISM based hierarchical model (Figure 1). The first and topmost level barriers are positioned at the top of the hierarchy, second

Table 4:

Barrier level iteration i

Barriers	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,5,7	1,2,3,4,5,6,7	1,5,7	I
2	1,2,3,4,5,6,7	2	2	
3	1,3,4,5,6,7	2,3	3	
4	1,4,5,6,7	2,3,4,6	4,6	
5	1,5,7	1,2,3,4,5,6,7	1,5,7	I
6	1,4,5,6,7	2,3,4,6	4,6	
7	1,5,7	1,2,3,4,5,6,7	1,5,7	I

level barriers are positioned at second level, this is continued till the last and fourth level barrier is placed at the bottom position of the hierarchy.

Table 5:

Barrier level iteration ii

Barriers	Reachability Set	Antecedent Set	Intersection Set	Level
2	2,3,4,6	2	2	
3	3,4,6	2,3	3	
4	4,6	2,3,4,6	4,6	II
6	4,6	2,3,4,6	4,6	II

Table 6:

Barrier level iteration iii

Barriers	Reachability Set	Antecedent Set	Intersection Set	Level
2	2,3	2	2	
3	3	2,3	3	III

Table 7:

Barrier level iteration iv

Barriers	Reachability Set	Antecedent Set	Intersection Set	Level
2	2	2	2	IV

Classification of Barriers

All barriers identified in this study are categorized into four different segments as autonomous barriers, independent barriers, linkage barriers and dependent barriers on the basis of their dependence and driving powers. This process of classification is developed by Duperrin & Godet (1973) and is similar to the method used by Ansari et al. (2013). The driving and dependence diagram is presented in Figure 2. For instance, it is observed from the figure that "LLR" has the driving power of 7 and dependence power of 1, hence it is placed at the position corresponding to driving power of 7 and dependence power of 1 as shown in Figure 2. The first segment (I) belongs to autonomous barriers which have weak driving power as well as weak dependence. In this study, there is no autonomous barrier. The second segment (II) relates to independent barriers which have strong driving power with weak dependence upon other barriers. In the present study barriers 2 and 3 are independent barriers. The third segment (III) consists of linkage barriers which have strong driving and dependence powers. Barriers 4 and 6 are in the category of linkage barriers. The fourth segment (IV) includes dependent barriers having weak driving and strong dependence powers. Barriers 1, 5 and 7 fall in this category and play the role of dependent barriers.

Discussion and Managerial Implications

It is essential to understand levels of barriers for successful initiation of collaboration. "LLR" is the most important barrier among

all diagnosed barriers having high driving and low dependence power, and positioned at the bottom level of the ISM model. The barriers "ATSO", "TECE" and "SNMSO" are placed at the top of the hierarchy as they possess high dependence and low driving power. The barriers with having high driving and low dependence powers like "NCAV" and "LRPS" are strategic barriers and play a key role in development of collaboration and hence require greater attention. The driving and dependence diagram is helpful in providing useful insights about the nature of barriers. There is no autonomous barrier in the system which indicates that policy makers and decision makers as well as SME owners-managers should pay special attention to all barriers for forming successful collaboration. We can conclude that all seven barriers, although varying in their degree, are important in the formation of collaboration among SMEs. This study is also helpful in classifying the nature of barriers through the driving and dependence diagram (Figure 2).

The ISM model proposed in this study will help SME owners/managers and decision makers to have a clear understanding about the barriers obstructing collaboration and their mutual interaction with each other. As SMEs generally operate under sole proprietorship, thus understanding of identified barriers by owners/managers can have considerable impact on the productivity and output of firms. This model could also help owners/managers and decision makers to utilize their resources in better way to minimize and overcome these barriers. The present research emphasize that there is dire need to understand, overcome and control these barriers for successful collaboration. The model proposed in present research could serve as guiding instrument which would help SME owners/managers to identify which pitfalls to be avoided.

Limitations and Scope for Future Research

The present study has some significant limitations. First, the ISM model constructed in this research, is based on the opinion and inputs of experts, therefore it may contain some sort of bias but inclusion of more experts has been made to reduce the bias to the minimum. Second, seven barriers are incorporated in this study, although extensive literature survey was conducted, there is a chance that some barriers might have been overlooked. Third, the model developed in this study is not yet validated and tested statistically. Thus it gives researchers a direction for future research. Future study can be conducted to test and validate the model presented in this study by using "Structural Equation Modeling (SEM)", and to provide some recommendations to overcome the identified barriers.

Figure 1:

ISM based model of collaboration barriers among auto parts manufacturing SMEs

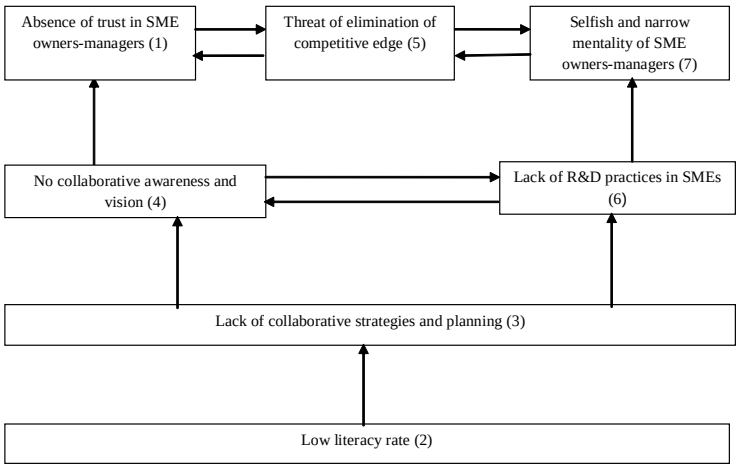
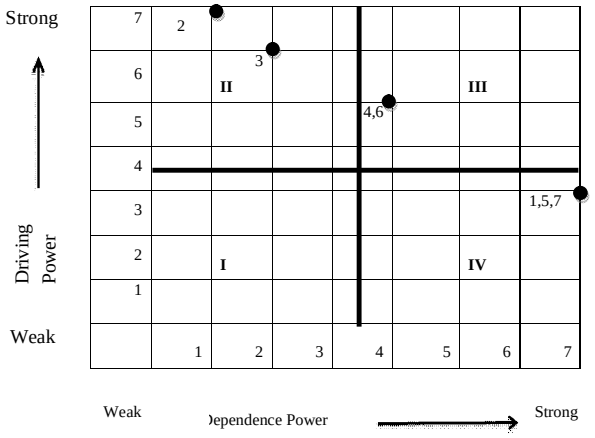


Figure 2:

Driving power and dependence diagram



References

Adobor, H. (2006). Inter-firm collaboration: configuration and dynamics. *Competitiveness Review: An International Business Journal Incorporating Journal of Global Competitiveness*, *16*(2), 122–134.

Ahmad, Y., Pirzada, M. D. S., & Khan, M. T. (2013). Strategic Orientation of Small to Medium Scale Manufacturing Firms in Developing Country: A Case of Auto Parts Manufacturing Small to Medium Enterprises (SMEs) in Pakistan. *Life Science Journal*, *10*(3), 517-527.

Akdoðan, A. A., & Cingšz, A. (2012). An empirical study on determining the attitudes of small and medium sized businesses (SMEs) related to coopetition. *Procedia-Social and Behavioral Sciences*, *58*, 252–258.

Alawamleh, M., & Popplewell, K. (2011). Interpretive structural modelling of risk sources in a virtual organisation. *International Journal of Production Research*, *49*(20), 6041–6063.

Ameen, K. (2008). Barriers in Collection Sharing among Libraries of Pakistan: University Library Managers' Viewpoint. *LIBRES: Library & Information Science Research Electronic Journal*, *18*(1), 1-11.

Ansari, M. F., Kharb, R. K., Luthra, S., Shimmi, S. L., & Chatterji, S. (2013). Analysis of barriers to implement solar power installations in India using interpretive structural modeling technique. *Renewable and Sustainable Energy Reviews*, *27*, 163–174.

Azevedo, S., Carvalho, H., & Cruz-Machado, V. (2013). Using interpretive structural modelling to identify and rank performance measures: An application in the automotive supply chain. *Baltic Journal of Management*, *8*(2), 208–230.

Bengtsson, M., & Kock, S. (2000). " Coopetition" in business Networks—to cooperate and compete simultaneously. *Industrial Marketing Management*, *29*(5), 411–426.

Bishop, P. (2003). Collaboration and firm size: some evidence from the UK defence industry. *Applied Economics*, *35*(18), 1965–1969.

Blackburn, R. A., Hart, M., & Wainwright, T. (2013). Small business performance: business, strategy and owner-manager characteristics. *Journal of Small Business and Enterprise Development*, *20*(1), 8–27.

Bridge, S., O'Neill, K., Martin, F., & Cromie, S. (2009). *Understanding Enterprise: Entrepreneurship and Small Business*. Palgrave Macmillan.

Brunetto, Y., & Farr-Wharton, R. (2007). The Moderating Role of Trust in SME Owner/Managers' Decision-Making about Collaboration. *Journal of Small Business Management*, *45*(3), 362–387.

Cohen, S., & Roussel, J. (2005). *Strategic supply chain management: the five disciplines for top performance*. McGraw-Hill Companies.

Coy, S. P., Shipley, M. F., Omer, K., & Khan, R. N. A. (2007). Factors contributory to success: a study of Pakistan's small business owners. *Journal of Developmental Entrepreneurship*, *12*(02), 181–198.

Darabi, F., & Clark, M. (2012). Developing business school/SMEs collaboration: the role of trust. *International Journal of Entrepreneurial Behaviour & Research*, *18*(4), 477–493.

Duperrin, J. C., & Godet, M. (1973). *Methode de hierarchisation des elements d'un systeme, Rapport economique du CEA*. R-45-41, Paris.

Farris, D. R., & Sage, A. P. (1975). On the use of interpretive structural modeling for worth assessment. *Computers & Electrical Engineering*, *2*(2), 149–174.

Fiaz, M., & Naiding, Y. (2012). Exploring the Barriers to R&D Collaborations: A Challenge for Industry and Faculty for

Sustainable UI Collaboration Growth. *International Journal of U-& E-Service, Science & Technology*, *5*(2), 1-16.

Glaister, K. W., & Buckley, P. J. (1996). Strategic Motives For International Alliance Formation*. *Journal of Management Studies*, *33*(3), 301–332.

Govindan, K., Palaniappan, M., Zhu, Q., & Kannan, D. (2012). Analysis of third party reverse logistics provider using interpretive structural modeling. *International Journal of Production Economics*, *140*(1), 204–211.

Hanna, V., & Walsh, K. (2008). Interfirm cooperation among small manufacturing firms. *International Small Business Journal*, *26*(3), 299–321.

Hansen, M. T., & Nohria, N. (2004). How to build collaborative advantage. *MIT Sloan Management Review*, *46*(1), 22–30.

Junejo, M. A., & Kanasro, H. A. (2009). Analyzing the Stylized facts for Developing SME's Business Opportunities in Pakistan. *Australian Journal of Basic & Applied Sciences*, *3*(3), 2315-2321.

Karlsson, J., Booth, S., & Odenrick, P. (2007). Academics' strategies and obstacles in achieving collaboration between universities and SMEs. *Tertiary Education and Management*, *13*(3), 187–201.

Mentzer, J. T., Foggin, J. H., & Golicic, S. L. (2000). Collaboration: the enablers, impediments, and benefits. *Supply Chain Management Review*, *4*(4), 52–58.

Mohr, J., & Spekman, R. (1994). Characteristics of partnership success: partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal*, *15*(2), 135–152.

Muscio, A. (2007). The impact of absorptive capacity on SMEs' collaboration. *Economics of Innovation and New Technology*, *16*(8), 653–668.

Panahifar, F., Byrne, P., & Heavey, C. (2014). ISM analysis of CPFR implementation barriers. *International Journal of Production Research* , 1-18.

Peters, L. D., Johnston, W. J., Pressey, A. D., & Kendrick, T. (2010). Collaboration and collective learning: networks as learning organisations. *Journal of Business & Industrial Marketing*, *25*(6), 478–484.

Pfohl, H.-C., Gallus, P., & Thomas, D. (2011). Interpretive structural modeling of supply chain risks. *International Journal of Physical Distribution & Logistics Management*, *41*(9), 839–859.

Punyasavatsut, C. (2007). SMEs in the Thai manufacturing industry: Linking with MNEs. *SMEs in Asia and Globalization, ERIA Research Project*, (5), 288–321.

Ramesh, A., Banwet, D. K., & Shankar, R. (2010). Modeling the barriers of supply chain collaboration. *Journal of Modelling in Management*, *5*(2), 176–193.

Ravi, V., & Shankar, R. (2005). Analysis of interactions among the barriers of reverse logistics. *Technological Forecasting and Social Change*, *72*(8), 1011–1029.

Richbell, S. M., Watts, H. D., & Wardle, P. (2006). Owner-managers and business planning in the small firm. *International Small Business Journal*, *24*(5), 496–514.

Ritter, T., Wilkinson, I. F., & Johnston, W. J. (2002). Measuring network competence: some international evidence. *Journal of Business & Industrial Marketing*, *17*(2/3), 119–138.

Rosenfeld, S. A. (1996). Does cooperation enhance competitiveness? Assessing the impacts of inter-firm collaboration. *Research Policy*, *25*(2), 247–263.

Ryssel, R., Ritter, T., & Gemünden, H. G. (2004). The impact of information technology deployment on trust, commitment and value creation in business relationships. *Journal of Business & Industrial Marketing*, *19*(3), 197–207.

Sage, A. (1977). *Interpretive structural modeling: methodology for large-scale systems, 91–164*. McGraw-Hill, New York.

Sahay, B. S. (2003). Understanding trust in supply chain relationships. *Industrial Management & Data Systems*, *103*(8), 553–563.

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review*, *25*(1), 217–226.

Sun, P. Y.-T., & Scott, J. L. (2005). An investigation of barriers to knowledge transfer. *Journal of Knowledge Management*, *9*(2), 75–90.

Vangen, S., & Huxham, C. (2003). Nurturing collaborative relations Building trust in interorganizational collaboration. *The Journal of Applied Behavioral Science*, *39*(1), 5–31.

Vivek, S. D., Banwet, D., & Shankar, R. (2008). Analysis of interactions among core, transaction and relationship-specific investments: The case of offshoring. *Journal of Operations Management , 26*, 180-197.

Waalkens, J., Jorna, R., & Postma, T. (2004). *Learning of SMEs in networks: the role of absorptive capacity*. University of Groningen.

Warfield, J. N. (1974). Developing subsystem matrices in structural modeling. *Systems, Man and Cybernetics, IEEE Transactions on*, (1), 74–80.

Woods, A., & Joyce, P. (2003). Owner-managers and the practice of strategic management. *International Small Business Journal*, *21*(2), 181–195.

Appendix:
Questionnaire/Protocol for experts

The following table is intended to register the perception of professionals from the automotive industry and academics to develop pair wise contextual relationships between barriers to collaboration among auto-parts manufacturing SMEs:

Please fill in the white boxes of the Table using one of the following symbols:

V= barrier *i* will help to achieve/alleviate barrier *j*

A= barrier *j* will help to achieve/alleviate barrier *i*

X= barriers *i* and *j* will help to achieve/alleviate each other

O = barriers *i* and *j* are unrelated

Barriers *j* → / Barriers i ↓		7	6	5	4	3	2	1
1	Absence of trust in SME owners-managers							
2	Low literacy rate							
3	Lack of collaborative strategies and planning							
4	No collaborative awareness and vision							
5	Threat of elimination of competitive edge							
6	Lack of R&D practices in SMEs							
7	Selfish and narrow mentality of SME owners-managers							