Quantitative analysis of model supply chain coordination risks

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Abstract. *Supply chain management has become an important factor for organizations supply chain coordination can be defined as an act of managing dependencies between entities working together towards mutually defined goals. There are variables which affect supply chain coordination and optimization in supply chain at different stages. Supply chain coordination provides risk reduction, access to resources, competitive advantages. The barriers in supply chain are generally depend on each other and have influence over effect of each other and also have adverse affect on supply chain. The main objectives of papers are to select one of the set of the crucial barriers and to find out the relationship between these barriers and then quantify that relationship. First to develop the relationship between these barriers we will use ISM (interpretive structural modeling) and Construct a model showing relationship between these barriers and then depending on the model we will construct a questionnaire to gather the data required for the quantification of relationship between the barriers. The quantification between the barriers will be done by the software of IBM the software will use are AMOS and SPSS.*

***Key words*: coordination, barriers, interpretive structural modeling, supply chain management, AMOS, SPSS, SEM**

1. Introduction

Today, in the world of globalization the role of supply chain for a business firm has become more important than ever to provide competitive advantage over other firms. The improved significance of SCM can be attributed to several forces driving global outsourcing and an emphasis on quality during a period of great competition and environmental uncertainty (Mentzer, 2001).Supply chain has become an important focus of competitive advantage for organization business.

Supply chain is a group of organizations working together towards achieving common goal and customer satisfaction. The Supply Chain is a concept designed to manage entire supply chains consisting of numerous participating organizations (Mentzer et al. 2001, p. 7).

A supply chain consists of a network of organizations that are involved in different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer (Christopher 1998). The Supply Chain is a metastructure (Grzybowska 2010b). A metastructure is an intermediate form between a single enterprise (microstructure) and global economy (macrostructure). A metastructure is characterized by a dynamic holarchy of cooperating holons. The supply chain includes manufacturer, suppliers, transporters, warehouses, retailers and even customers themselves. Within each organization, such as a manufacturer, the supply chain includes all function involved in receiving and filling a customer request. These functions includes new product development, marketing, operation, distribution, finance, customer service and other function that related to serving customer request (Chopra and Meindl, 2007).

Coordination between different organizations is very important in a supply chain. Coordination is defined as managing the dependencies or joint efforts of members towards common goals (Mal- one and Crowston, 1994 [45]).so supply chain management can be defined as "the act of managing dependencies between entities and the joint effort of entities working together towards mutually defined goals" (Malone and Crowston, 1994 [45]).

The main focus of SCM is to provide right product to the right customers at the right cost, right time, right quality and right quantity (Basher, 2010). Meanwhile, the short-term strategic goal of SCM is to reduce cycle time and inventory and thus increasing productivity, whereas the long-term goal is to enhance profits through market share and customer satisfaction (Tan, 2002).

Supply chain coordination provides risk reduction, access to resources, and competitive advantage. Uncoordinated decision-making creates inefficiency with the channel members' profits significantly lower for each channel member independently and collectively than what could be achieved with coordination, Jorgensen and Zaccour (2003) [33]. Quantified benefits of SCM include lower supply chain costs, overall productivity, inventory reduction, forecast accuracy.

The coordination between organizations is hindered due to different reasons these reasons are known as barriers. There are a number of barriers present in an organization. There are barriers which affect not only coordination in the supply chain, but also influence one another. It is, there- fore, important to understand their mutual relationship so that those barriers that are at the root (called driving barriers) and those which are most influenced by others (called driven barriers) are identified. Shukla et al (2013) has defined fourteen barriers which are the root barriers in a supply chain.

Generally ISM technique is being used for defining relationship between directly and indirectly related elements in a model. It is a well established methodology for identifying relationships among specific items, which define a problem or an issue (Warfield, 1974 [89]; Sage, 1977 [68]).But the restriction with ISM is that it is only able to define relationship but it does not quantify the relationship. So as to quantify the relationship we will use structural equation modeling (SEM). SEM is able to quantify the relationship but does not able to quantify them .It is a family of statistical methods designed to test a conceptual or theoretical model.

1.1 Selection of barriers

Kumar Shukla, Garg & Agarwal (2013) defined 14 major barriers in supply chain and defined them as follows

1. Different organizational Culture
2. Cross-functional Conflicts
3. Poor supply Chain Planning
4. Lack of Channel trust and commitment
5. Lack of Top management Commitment
6. IT deficiencies
7. Lack of coherent Contracts
8. Lack of meeting, cooperation and technical assistance
9. Resistance to Share Information
10. Inflexible organizational systems and processes
11. Resistance to change and adopt innovations
12. Lack of clear alliance guidelines

These barriers are classified in 4 categories

(1) Autonomous barriers: These are those barriers which have weak driver power and weak dependence. They seem to be disconnected from the system, with which they have few strong links.

(2) Linkage barriers: These are the barriers which have strong driver power as well as strong dependence. They are also unstable. Any action on them has an effect on other barriers and also a feedback effect on themselves.

(3) Dependent barriers: These are those barriers which have weak driver power but strong dependence power.

(4) Independent barriers: These barriers have strong driver power but weak dependence power. It has been generally observed that a barrier with a very strong driver power, called a 'key barrier' falls into the category of independent barriers.

Based on this classification we have selected the independent barriers as they can affect other are the cause for other barriers .And they themselves are independent of other barriers. So we have selected three barriers for further study. The barriers selected are

1 different organizational culture

2 inflexible organizational systems and processes

3 lack of clear alliance guidelines

1.2 An introduction to ISM (interpretive structural modeling)

ISM is one of the interactive management methods which assist research groups in dealing with complex issues (Warfield 1974, 1990). ISM transforms unclear, poorly articulated mental models of a system into visible well defined, hierarchal models. It is a well known methodology for identifying and summarizing relationships among specific elements, which define an issue or a problem, and provide a means by which order can be imposed on the complexity of such elements (Mandal and Deshmukh 1994).. ISM is an interpretive tool based on a group's judgment and the decision as to whether or how the system's elements are linked to each other. It is structurally constructed on the relationship's foundation as well as the final structure exploited from the complex set of the system's variables. It is also a modeling tool, as the final relationship is explained in a directed graphical model.

ISM can transform a group of directly and indirectly related elements into a well defined structure. a relationship between directly and indirectly related items tend to make a structure very complex but by using an ISM approach the structure can be given a direction and a well defined meaning.

Steps in ISM

(1) The first step is to identify the elements which are relevant to the problem or issue with the help of a questionnaire and enlist them.

(2) The identified elements will be used to establish contextual relationship among them. This represents the relationship indicating whether or not one element leads to another.

(3) The next step is to develop a pair wise relationship among the elements, for which a structural self-interaction matrix (SSIM) of sources will be developed.

(4) The next step is to develop a reachability matrix from the SSIM, and checking the matrix for transitivity. Transitivity of the contextual relation is basic assumption in ISM which states that if an element A is related to an element B, and element B is related to an element C, then A is necessarily related to C. The SSIM is transformed in the form of a reachability matrix by transforming the information in each entry of the SSIM into 1s and 0s in the reachability matrix.

 (5) The reachability matrix obtained is further partitioned into different levels.

(6) From the relationships obtained in the reachability matrix, we will remove any transitive links and draw a directed graph.

(7) Then we will replace element nodes with statements to construct the ISM model.

 (8) The ISM model developed will be reviewed to check for conceptual inconsistency, and to make the necessary modifications.

1.3 Introduction to structural equation modeling (SEM)

It can be defined as a group of statistical methods designed to test a hypothetical model. Some common SEM methods employ confirmatory factor analysis, path analysis, exploratory factor analysis and latent growth modeling. The term "structural equation model" mostly refers to a combination of two things a "measurement model" that defines unobserved variables using one or more observed variables, and a "structural regression model" that links unobserved variables together .Two parts in structural equation modeling are linked to each other by simultaneous mathematical regression equations

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Table 1 of literature study for ISM study and supply chain management

1)K. Grzybowska (&) Poznan University of Technology, Strzelecka 11, 60-965 Poznan, Poland	Sustainability in the Supply Chain: Analyzing the Enablers
2)Rajendra Kumar Shukla , Dixit Garg & Ashish Agarwal (2012)	Modeling barriers in supply chain coordination
3)T. Raj , R. Shankar & M. Suhaib (2008)	An ISM approach for modeling the enablers of flexible manufacturing system
4)P. Parthiban & H. Abdul Zubar (2013)	An integrated multi-objective decision making process for the performance evaluation of the vendors
5)Pratima Mishra & Rajiv kumar shukla(2014	investigate the impact Of perfect orders fulfillment on quality level and SCM performance
6) Thoo Ai China Abu Bakar Abdul Hamida,Amran Raslia, Rohaizat Baharuna (2012)	Adoption of supply chain management in SMEs
7)Inda Sukatia, Abu Bakar Hamida, Rohaizat Baharuna, Rosman Md Yusoffa	The Study of Supply Chain Management Strategy and Practices on Supply Chain Performance
8) Mohd. Nishat Faisal (2010)	Analyzing the barriers to corporate social responsibility in supply chains

1.4 Objectives of the paper

Most of the papers reviewed have discussed the work by considering single barrier such as different organizational culture, inflexible organizational system and processes, lack of clear alliance guidelines on SCM performance. However, none of the previous studies have analyzed the impact or association of different organizational culture, inflexible organizational system and processes and lack of clear alliance guidelines impact together. Moreover, previous authors have not tested empirical relationship between these barriers and SCM performance. Based upon the above gaps found in the literature, the following research questions arise such as:
• What are the different dimensions of different organizational culture that significantly affect the inflexible organizational system and processes, lack of clear alliance guidelines in SCM in knowledge outsourcing firms in India?
• What are the empirical relationships between three selected barriers them?

Based on these two research questions, the objectives of this paper are:
• To identify the dimensions of different organizational culture, inflexible organizational system and processes and lack of clear alliance guidelines that effect SCM.
 • To empirically examine whether different organizational culture metrics have significant impact on SCM performance
 • To empirically test whether inflexible organizational system have significant impact on lack of clear alliance guidelines
 • To empirically test whether there is direct effect of inflexible organizational system and processes and lack of clear alliance guidelines on SCM performance
• To test whether overall hypothesized model has good fit.
Based upon the review of literature on different organizational culture, inflexible organizational system and processes and lack of clear alliance guidelines, authors intend to empirically examine the relationship between three barriers. To this effect, authors propose a conceptual framework (shown in Figure 1) which integrates different organizational culture, inflexible organizational system and processes and lack of clear alliance guidelines. After proposing this framework, constructs were developed and tested empirically, using data collected through a well administered survey questionnaire. Further, SEM was used to test the hypothesized relationships.

2. Literature background

Conceptual model Figure 1 presents the conceptual framework developed in this study, which is based on three main constructs, i.e.

1 Different organizational culture
 2 Inflexible organizational systems and processes
 3 Lack of clear alliance guidelines
 The framework depicts that Different organizational culture have an impact on Inflexible organizational systems and processes directly and also indirectly with Lack of clear alliance guidelines. The details of each construct are presented below in following paragraphs.
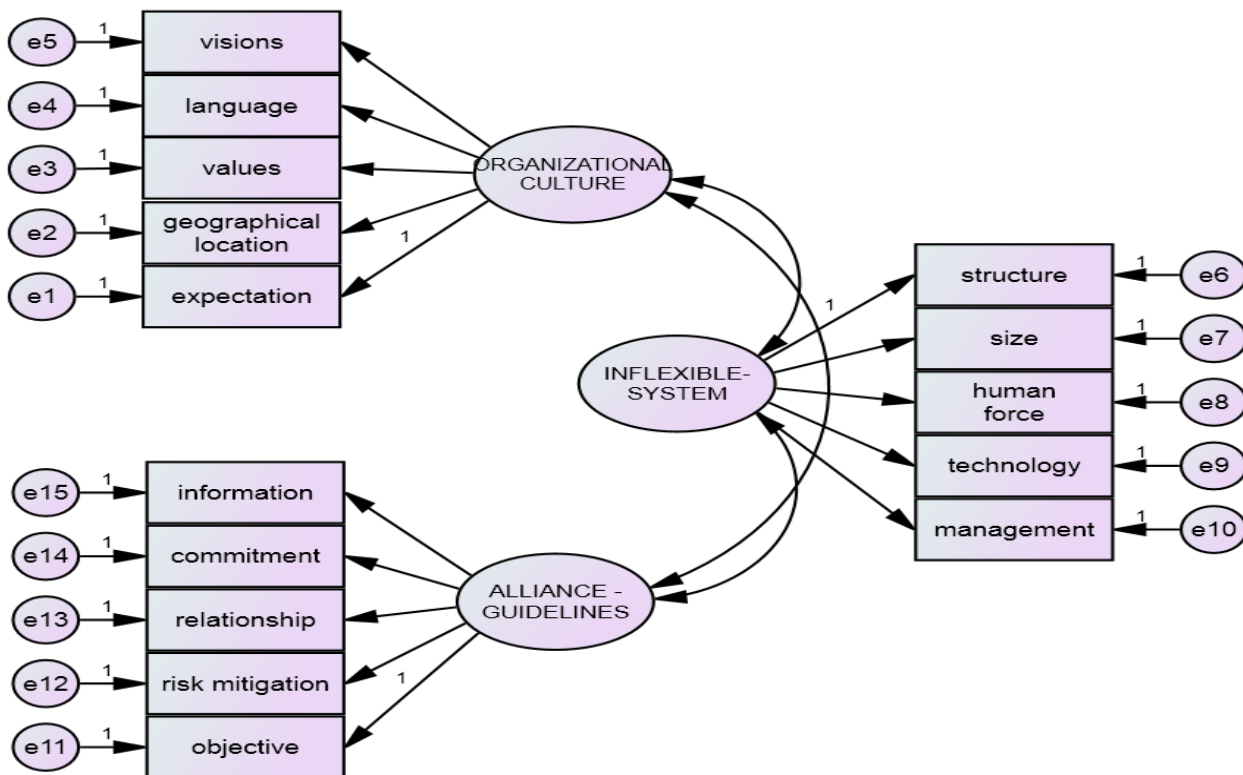

Figure1:research_framewor

2.1 Different organizational culture

1 Vision of an organization is very important in deciding the kind of partnership an organization wants with others
2 Language can be a problem as it causes hindrance in flow of information as asset of word can have different meaning for different people.
3 Beliefs and values of an organization differ with every organization. Some organizations have a very high sense of social responsibility while some don't.
4 Geographical location of an organization is an important factor in choosing the partnership with other organizations.
5 Expectations of an organization with other organizations is that the relationship with other organization will be economically beneficial for it.

2.2 Inflexible organizational systems and processes

1 Structure of the organization decide the flexibility of the processes as more complex the structure of the organization less flexible it tends to be
2 Size of the organization, large size of the organization result in less flexibility. While smaller organizations tend to be more flexible.
3 Human resources, skilled workers are required to impart the flexibility in the organization and obtain good quality product or service.
4 Willingness to accept new technology, the implementation of new technology is very important for the flexibility in an organization and to keep up with the competition in the market.
5 Management, a supportive management can be very crucial to impart flexibility in a supply chain.

2.3 Lack of clear alliance guidelines

1 Information, there should be availability of correct information at the correct time for forming alliance between organizations.
2 Commitments, every organization in a supply chain should be whole heartedly committed to other organization.
3 Undefined relationships, the extant of relationship between organizations should be well defined. So there will be no confusion at later stages.
4 Risk mitigation, the risk factor in an alliance should be calculated before taking the decision for forming an alliance risk calculation should consider every factor involved in forming an alliance.
5 Objective, it should be clear while taking the decision to create an alliance objective may differ for every organization while forming an alliance some form alliance to expand, others to get rid of competition.

Table 2 for literature study of variables that effect the barriers

1)Mohammad Alawamleh & Keith Popplewell (2011)	Interpretive structural modeling of risk sources in a virtual organization
2)P. Childerhouse, E. Deakins, A. Potter, R. Banomyong, P.McCullen, A. Thomas, T. Böhme, T. Hosoda, E.A. Yaseen and D.R. Towill	Pyynational cultural diversity and global supply chain management
3)John T. Mentzer ,William DeWitt ,James S. Keebler , Soonhong Min ,Nancy W. Nix ,Carlo D. Smith and Zach G. Zacharia (2001)	Defining supply chain management
4)Stanley E. Fawcett ,Gregory M. Magnan Matthew W. McCarter(2005)	Supply chain alliance : rhetoric and reality
5)Douglas M. Lamber t& Martha C. Cooper(2000)	Issues in Supply Chain Management

3. Research methodology

3.1 Survey design

To examine the degree of structural relationship among different organizational culture, inflexible organizational system and processes and lack of clear alliance guidelines, a structural equation modeling is developed and three hypotheses pertaining to different organizational culture, inflexible organizational system and processes and lack of clear alliance guidelines have been formulated. To test various research hypotheses a survey instrument was developed. The items and questions in the questionnaire were framed after review of literature. The different organizational metrics consisted of 5 items. Similar to different organizational culture, the measures of inflexible organizational system and processes and lack of clear alliance guidelines indicators was derived and adopted from previous studies on the topic. The instrument was first tested by considering experts academia to see the appropriateness of the questionnaire and to ensure that no important dimensions were missed out. After a few iterative reconsiderations and improvements in the questionnaire, authors have designed the final questionnaire. On the basis of feedback received from the expert, the statements of the questionnaire have been modified and the final questionnaire has been prepared for survey. In order to ensure the validity of the survey, the Cronbach's α coefficient was calculated. The data and scale was reliable as Cronbach's α > 0.70 and is acceptable in literature (Martinez, 2008). The questionnaire was developed on a five-point Likert scale ranging from 1 'strongly disagree' to 5 'strongly agree'. The respondents were from various B.P.O situated in northern part of India. The respondents were asked to indicate the level of importance of the factors affecting the SCM performance. Data was collected using self administered questionnaire through online, mailed and personal contacts.

3.2 Descriptive statistics and reliability

Mean and standard deviation (SD) are two basic descriptive statistics these are the statistics which are used to derive advanced statistics. SD is a measure dispersion. Dispersion refers to the variation in value of the variable. SD is a measurement of dispersion from the central tendency of the value. A factor analysis is performed on the data obtained through questionnaire on IBM software SPSS statistics 20. A principal axis factoring was performed using varimax factor rotation to group the factors and then to determine the category of the factors. Further, Cronbach's α coefficient analysis is used to find out the reliability of the data collected and their scale. Each of the constructs has the Cronbach's alpha >0.70, thus, showing that the constructs are reliable (Koh et al., 2007; Martinez, 2008).The TABLE 3 shows the mean and standard deviation value for each dimension and the reliability value for each construct.

Table 3 mean SD and reliability

Dimensions	Mean	SD	Reliability
Different organizational culture			
1 vision of organization	3.49	1.006	
2 language barrier in organization	3.44	.992	
3value of organization	3.75	.666	.744
4geographical location	3.71	.814	
5expectations	3.58	.808	
Inflexibility in system and processes			
1structure of organization	3.60	.780	
2sizeof organization	3.53	1.031	
3 human resource	3.72	.842	
4willingness to accept new technology	3.51	.842	.773
5management cooperation	3.45	.840	
Clear alliance guidelines			
1avalibility of correct information	3.60	.866	
2commitement between organization	3.66	.810	
3undefined relationship	3.71	.814	
4risk mitigation	3.81	.731	.802
5objective of organization	3.50	.981	

3.3 Exploratory factor analysis

EFA (Exploratory Factor Analysis) involved the calculation of K.M.O. (Kaiser Meyer Olkin) measure of central tendency K.M.O helpful in determining suitability of data for structure detection K.M.O value should be greater than 0.6 (Byrne 2001), Eigen values to decide the number of factors to be extracted the factors to be extracted must have Eigen value greater then 1.And percentage of variance explained, higher the variance explained by a model more accurate the model is. Table 4 shows the value of K.M.O. Eigen values and percentage of variance explained which are obtained in SPSS statistics 20.

Table 4 K.M.O, Eigen values and percentage of variance explained

Construct	KMO	Eigen value	Percentage of variance explained
Different organizational culture			
1 vision of organization		2.558	51.157
2 language barrier in organization		1.942	18.841
3value of organization	.768	1.585	11.691
4geographical location		1.524	10.483
5expectations		1.391	7.829
Inflexibility in system and processes			
1structure of organization		2.212	44.223
2sizeof organization		1.002	20.038
3 human resource		1.894	17.871
4willingness to accept new technology	.642	1.482	9.648
5management cooperation		1.411	8.212
Clear alliance guidelines			
1avalibility of correct information		2.843	56.854
2commitement between organization		1.812	16.232
3undefined relationship		1.569	11.390
4risk mitigation	.791	1.453	9.060
5objective of organization		1.323	6.453

Notes: Extraction method: principal component analysis; rotation method: varimax with Kaiser Normalization.

3.4 Correlation analysis

Pearson correlation analysis was conducted to examine relationship among the different organizational culture dimensions, inflexibility in system and processes and lack of clear alliance guidelines themselves (Table 5). Table 5 shows significant and strong relationship (r = 0.606) among vision of organization and geographical location of organization. On the other hand in inflexible organizational system and processes, human resources and acceptance of new technology (0.559) has strong and significant association with suppler satisfaction index. Similarly, objective of organization and commitment between organization have(r=.645).

Table 5 Pearson's correlation between variables

Dimensions	1	2	3	4	5
Different organizational culture					
1 vision of organization	1				
2 language barrier in organization	.266**	1			
3value of organization	.468**	.168**	1		
4geographical location	.606**	.220**	.450**	1	
5expectations	.455**	.409**	.341**	.428**	1
Inflexibility in system and processes					
1structure of organization	1				
2sizeof organization	.433**	1			
3 human resource	.309**	.402**	1		
4willingness to accept new technology	.217**	.299**	.559**	1	
5management cooperation	.246**	.338**	.123**	.153**	1
Clear alliance guidelines					
1avalibility of correct information	1				
2commitement between organization	.383**	1			
3undefined relationship	.356**	.580**	1		
4risk mitigation	.480**	.490**	.504**	1	
5objective of organization	.298**	.645**	.452**	.380**	1

Note: **Correlation is significant at the 0.01 level (two-tailed).

3.5 Structural equation modeling results

 The theoretical framework demonstrated in Figure 1 has 3 hypothesized relationships between the different organizational culture dimensions, inflexibility in system and processes and lack of clear alliance guidelines. Goodness fit test for SEM is performed to establish whether the particular variable provides an acceptable fit or not which require us to accept that overall hypothesized model has good fit (H0). The SEM structure diagram is shown in Figure 2 resulting from the SEM analysis using AMOS. The model was evaluated using various common goodness of fit measures, i.e., the ratio of chi-square ($\chi2$) statistics to the degree of freedom (df), normed fit index (NFI), CFI, goodness of fit index (GFI), adjusted goodness-of-fit index (AGFI), and root mean square error of approximation (RMSEA). The observed normed ($\chi2$ / df) for this model was established to be (2.871) with p-value = (0.071 > 0.05) which meet the terms with the requirement of < 3 (Hair et al., 2010) as shown in Table 6. The overall indicators shows that the model is good fit with NFI = 0.979, CFI = 0.980, GFI = 0.936, AGFI = 0.904, and RMSEA = 0.029 by previous research (Li et al., 2006; Chong et al., 2011).

Table 6 statistical indices of SEM

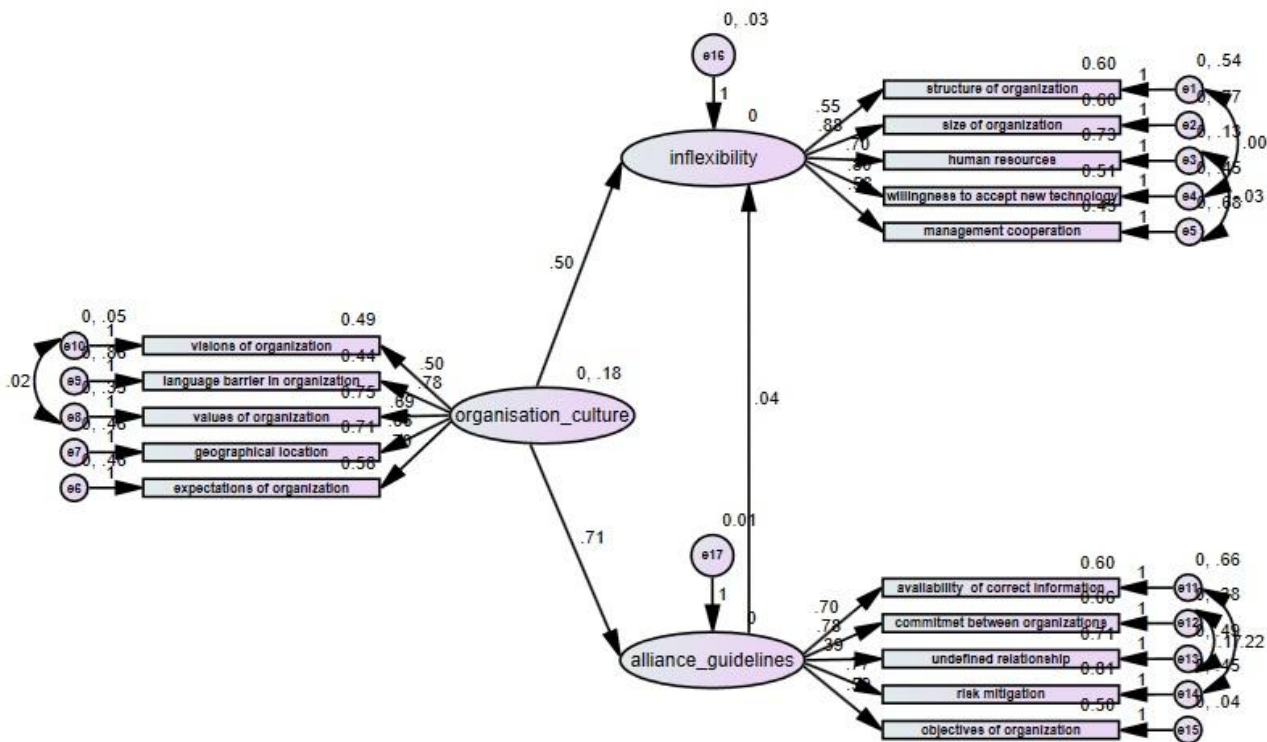| Statistics	structural model	Recommended value for good fit
χ2	235.422	--
Probability level	.071	≥ 0.05
Df	82	--
χ 2/df	2.871	≤3.00
NFI	.979	≥ 0.90
Root mean square residual	.045	≤ 0.05
CFI	.980	≥ 0.90
GFI	.936	≥ 0.90
AGFI	.904	≥ 0.90
RMSEA	.029	< 0.05

Figure 2 Structural equation model Different organizational cultures, inflexibility in organizational system and processes and lack of clear alliance guidelines

4 Results and discussion

The proposed framework shows the relationship between the barriers and the variable that drives them .From the framework it can be seen that barrier different organizational culture depend upon the geographical location of the organization as well as on the background of the people who are employed as different people have different understanding of the same words or different people have different level of command over a language similarly belief of an organization are also important as well as their vision and expectations from other organization. While inflexible organizational system depends upon the size and structure of the organization. It also depends upon the willingness of management to provide new technology and on skills of the workers. Lack of clear alliance guidelines depend on flow of information which if wrong or incorrect can be responsible for insatiability of the supply chain. The structure shows the empirical relationship between unobserved and observed variable. Depending on the situation and by giving considerable amount of effort the effect of these variables can be reduced which in turn will bring the sustainability in supply chain.

This conceptualized framework has been used to quantify the relationship between the barriers and the variables by using structural equation modeling by using the IBM software like AMOS and SPSS

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