International Journal for Quality Research 8(1) 23–38
ISSN 1800-6450

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A CONFIRMATORY STUDY OF SUPPLY CHAIN PERFORMANCE AND COMPETITIVENESS OF INDIAN MANUFACTURING ORGANIZATIONS

Article info:
Received 09.01.2014
Accepted 25.02.2014

UDC – 65.012.7

Abstract: *This paper presents finding of a study on Indian manufacturing organizations. A conceptual model is proposed based on a rigorous literature review. The model so developed undergoes through a confirmatory factor analysis (CFA) using Structural Equation Modeling (SEM) approach. The paper highlights various factors responsible for supply chain performance (SCP), subsequently leading to competitiveness. The survey involves 361 manufacturing organizations across India and the data is gathered using 5-point Likert scale. The study attempts to integrate various factors contributing to SCP in a single study. It is proposed to further test the model using exploratory factor analysis (EFA).*

Keywords: *Supply chain performance, Competitiveness, Structural Equation Modeling, Manufacturing*

1. Introduction

According to a report on global manufacturing sector, western companies have progressively downsized over the past decades, which has resulted in increase in manufacturing productivity. Also, lean manufacturing techniques are almost universally adopted. Emerging markets concentrate on mass manufacturing and competing on price. The top three countries in the Global Competitiveness Index are Asian, namely China, India & Korea (CIMA, 2010).

The manufacturing sector is growing rapidly in India and China and has shrunk in most advanced economies. This growth will require several changes, which include significant increase in productivity and quality at the plant levels, quest for worldwide competitive manufacturing strategies and operations and successful integration into the global supply chains (Deloitte, 2007).

The manufacturing sector is facing huge pressure because of environment and market forces. Indian manufacturers are facing competition from new foreign entrants on cost, quality, flexibility and innovation. International competitors are continuously working on improving manufacturing techniques, bringing new products and making manufacturing more proactive and responsive (Chandra and Sastry, 1998). This competitive environment compels Indian manufacturers to understand the forces of driving industry competition (Porter, 1980). In a manufacturing competence survey, a researcher has highlighted the need for Indian manufacturers to be competitive by making suppliers' association, having cluster initiative for joint raw material procurement which reduces cost, improving product

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quality, reducing delivery bottlenecks to reach to their customers, by process enhancement leading to flexibility, creating market innovation, adopting lean practices, enhancing productivity and promoting R&D (Chandra, 2009).

An annual survey is conducted by KPMG of global supply chain trends with 300 international participants and answers are sought related to areas of critical concern, which include designing the future arrangement of supply chain networks in the face of rapid globalization and outsourcing, maintaining product quality and safety (KPMG, 2013).

The paper is structured as follows. Section 2 presents the literature review on the six identified constructs contributing to supply chain performance. Section 3 describes the proposed model. Research methodology is explained in Section 4. Results are presented in Section 5. Conclusions and limitations of the study are given in Section 6.

2. Literature review

In this paper, the authors put forward a conceptual model by linking the relationships of supplier-buyer relations, external supply chain, human metrics, environmental factors, information sharing and supply chain approaches with SC performance in a single study in the context of Indian manufacturing organizations.

2.1. Supplier Buyer Relations (SBR)

In supply chain management (SCM) strategies, supplier activities play an important role by building good relationships (Wisner, 2003). Long-term relationships refer to intention that the agreement is not going to be temporary (Chen *et al.*, 2008). A successful strategic alliance and integrated relationship with suppliers and buyers is very much necessary in today's competitive environment (Li *et al.*, 2005).

To progress the flow of information and materials, many buyers work with a smaller number of suppliers and transfer them sufficient product design activities (Karthik, 2006). Buyers recognize how the operations of the upstream suppliers affect their downstream customers.

In particular, to any firm, a long-term buyer–supplier relationship provides fast and easy access to new technologies and markets; the capability to deliver a wider range of goods and services; economies of scale due to joint research and production; access to knowledge beyond a firm's boundaries; bridges to other firms; risk sharing capacity; and also access to various complementary skills (Chen *et al.*, 2008). A collaborative and long-term buyer–supplier relationship will develop as long as both the exchange partners get benefitted from the relationship. This type of collaboration helps both the firms in gaining competitive advantage which on acting alone could not be achieved (Hult *et al.*, 2007).

Researchers have identified different phases of development of buyer-supplier relationship. In the awareness phase, buyers unilaterally become aware of a group of potential suppliers with whom they may conduct business. In the exploration phase, buyers begin to test suppliers by negotiating contract terms, setting product specifications for them, and by placing small orders to ascertain if further relationship development is worthwhile or not. In the expansion phase, buying firms make multiple purchases from suppliers or negotiate long-term contracts, and decide to seek benefits from current exchange partners rather than from alternate suppliers. In the commitment phase, both buyers and sellers implicitly or explicitly pledge to establish stable relationships. They express a willingness to make sacrifices to maintain their relationships and a confidence in the continuity of the relationships (Li *et al.*, 2005; Claycomb and Frankwick, 2010).

Table 1. Supplier-buyer relations construct

Construct	Definitions	Literature
Supplier-Buyer Relations	"The long-term relationship between the organization and its suppliers. It is designed to leverage the strategic & operational capabilities of individual participating organizations to help them achieve significant ongoing benefits". (Li *et al.*, 2006)	Li *et al.*, 2005; Gunasekaran *et al.*, 2001

2.2. External supply chain (ESC)

One factor which is common to all the world class companies in India, whether in the textile/garment field, the automotive field or the pharmacy field, is the established and nurtured supply chain network. The existing supply chains have been strengthened through increased collaboration. Integration with external partners is now very much needed. Strategic partners throughout the global supply chain work together to identify joint business objectives and corresponding action plans (Fynes *et al.*, 2005).

Today, thinking has already moved from simple supply chains to complex networks of organizations working together to create competitive advantage and value, i.e. value networks. Consequently, there are developments of networks that criss-cross organizational boundaries shifting from inter- to trans-organizational networks (Bititci, 2006). Differences between 'traditional' and 'networked' organizations are well discussed in literatures (Gunasekaran *et al.*, 2004).

2.3. Human Metrics (HM)

While establishing and implementing the key Performance Measures (PMs), there is a heavy influence of behavioral issues. Organizations sharing values in terms of trust, commitment and collaboration, organizational capability and top management supports are crucial for an effective SCM (Mello and Stank, 2005). It is also suggested that human factor significantly affects the SCM effectiveness (Tony and Kevin, 2007) and SCM managers are a decisive factor in achieving strategic and operational objectives and changes in the supply chain.

It is found that firms lacking in the appropriate cultural elements tend to fail when implementing SCM initiatives (Mello and Stank, 2005). On top of that, the organizational commitment and governance for supply chain success are also being studied (Fawcett *et al.*, 2006). Few more research works (Robinson and Makhotra, 2005; Wouters, 2009) clearly support the need for a performance measurement system taking the holistic picture, including the human side and organizational issues.

The importance of human resource and supply chain management (SCM) has been recognized as a means of competitive advantage in manufacturing industries. Hence integration of HR and SCM functions enable organizations to craft a unique strategy, and will increase the performance of the organizations (Naveed *et al.*, 2013).

Various studies conducted have disclosed a strong correlation between human resource management (HRM) and supply chain management (SCM). Researchers have emphasized the necessity to create a desirable fit between supply chain and human resources strategies (Skinner *et al.*, 2009; Gosh and Fedorowicz, 2008). Bulk of literature has been produced on HRM and SCM separately. But very few of them investigate the relationship between human resource practices and supply chain

management processes which is the focus of this study.

2.4. Environmental Factors (EF)

The effects of globalization, technology and the growing need for environmental responsibility and sustainability is forcing organizations and individuals to make changes in the way they work. The ministry of corporate affairs and the industry chamber, Confederation of Indian Industry (CII) had recently come out with a study on the Corporate Social Responsibility (CSR) in which the role of private sector in fostering inclusive growth and globalization has been recognized. Almost all major companies in India have a CSR program.

The growing interest towards sustainability issues has initiated a series of new lines of research dealing with various supply chain activities that have important environmental implications. These activities suggest that sourcing operations must involve acquiring, storing, handling, and recovering virgin or recycled materials. In sourcing, for example, the failure to reduce the obsolescence and waste of maintenance, repair, and operating (MRO) supplies or scrap materials can significantly contribute to environmental problems (Sarkis, 1995).

In manufacturing, for example, the irresponsible disposal of defective products or unwanted manufacturing by-products can have adverse impact on the environment. Likewise, logistics dependency on transportation modes such as trucks and airplanes using fossil burning fuels and the subsequent emission of CO_2 can pollute the living environment such as air, water, and ground (Seuring and Muller, 2008; Srivastava, 2007).

As environmental issues spread across different functional areas of the supply chain and encompasses the different levels of decision-making hierarchy (from operational to strategic), there is a growing need for a more open research methodology tools that can effectively deal with ill-defined, less structured environmental issues facing practicing managers and policy makers (Carter and Easton, 2011).

The environmental factors construct is shown in table 2.

Table 2. Environmental factors construct

Constructs	Definitions
Environmental Factors	The source of events and changing trends and regulations which create opportunities and threats for an individual organization

However, today the rate of change of environmental factors is likely to be more frequent and larger than before and they also might come from unexpected directions.

2.5. Information Sharing (IS)

Information sharing is defined as the access to private data between business partners thus enabling them to keep an eye on the progress of products and orders as they pass through different processes in the supply chain (Simatupang and Sridharan, 2002). Information sharing pertaining to key performance metric and process data improves the supply chain visibility thus enabling effective decision making. Information that is shared in a supply chain is of use only if it is relevant, accurate, timely and reliable (Simatupang and Sridharan, 2002; Thatte, 2007).

Information sharing with business partners enables organizations making better decisions and making action on the basis of greater visibility (Thatte, 2007; Davenport *et al.*, 2001). In order to make the supply chain competitive, a necessary first step is to acquire a clear understanding of supply chain concepts and be willing to openly share

information with supply chain partners (Thatte, 2007; Lumus and Vokrurka, 1999). The information sharing construct is shown in table 3.

Information sharing has garnered greater research attention in recent years, but most of the research works have investigated the types of information shared and the gains from information sharing (Croson and Donohue, 2006). Further, these studies assume that the institutions sharing information are willing to do so, however, willingness to share information can be predetermined or spontaneous (Timon *et al.*, 2012).

Although flow of information is essential in SCM, many organizations are still not willing to share information freely with their supply chain partners. Information may be withheld from supply chain partners due to the lack of trust, as a part of company policy or for security reasons. Poor information quality attributed to lack of sufficient information, inaccurate information and information delay could also affect the information exchange both at operational and strategic level. Eventually, this could have an adverse impact on supply chain performance (Ramayah, 2010).

Table 3. Information sharing construct

Constructs	Definitions	Literature
Information Sharing	"The extent to which critical and proprietary information is communicated to one's supply chain partner" (Li *et al.*, 2006)	Li *et al.*, 2005

In the context of manufacturing organizations in India, many of them have recognized the importance of information sharing and information quality; however, the extent of these practices and its impact on supply chain performance has not been empirically established. Therefore, this study examines the impact of information sharing on supply chain performance.

2.6. Supply Performance Measurement Approaches (SPA)

Because of recent pressures due to technological and competitive changes facing the manufacturing sector, performance measures and measurement continue to be of critical concern for the management and improvement of the competitiveness of manufacturing organizations. In this context, understanding the scope, frequency and relevance of different performance measures available to executives is essential to the process of integrating the different dimensions of organizational performance (Carlos *et al.*, 2011).

The art of performance management is an evolving dynamic process. Such process is always in search of innovative approaches to the management of organizational resources in order to better track, monitor and improve the different aspects of organizational performance.

While several studies have attempted to empirically shed some light on the different aspects of performance measures and measurement in a manufacturing operational environments (Anvari *et al.*, 2011; Shepheard and Gunter, 2006), studies examining changes in the perspectives of manufacturing organizations with regard to practices related to the utilization of different performance measures have not been forthcoming. Since such organizations are considered dynamic systems, which are operating in an ever-changing operational

and competitive environment, it is important to assess their changing perspectives on performance measurement and measures practices.

Most of the organizations are following financial and non-financial performance measurement approaches; however they are not representing them in a balanced framework. The basic concern is to find the suitability of the financial and nonfinancial performance measures (PMs) to evaluate the performance of a SC system (Marwah *et al.*, 2012). For example, strategic level PMs are mostly based on financial metrics. PMs at tactical level can be evaluated using both financial and nonfinancial indicators. Operational level performance evaluation is mostly based on nonfinancial indicators. While some companies concentrate on financial performance measures, others are concentrating on operational measures (Gopal and Thakkar, 2012).

Researchers suggested that an appropriate performance measurement system (PMS) is critical for the effective management of a supply chain (Liang *et al.*, 2006). There are studies about the PMSs and metrics of supply chains by critically reviewing the contemporary literature (Cuthbertson and Piotrowicz, 2011). SCM needs to be evaluated for its performance in order to evolve an efficient and effective supply chain. These should represent a balanced approach and should be classified at strategic, tactical and operational, levels, and be financial and nonfinancial measures as well (Gunasekran and Tirtiroglu, 2001).

Recently, many research papers that deal with performance measurement in a SC context (Van Hoek, 1998) have appeared in the literature. However, most of them are prescriptive and not based on historical facts and their analysis and changing market and operations environments or well grounded empirical analysis. In addition, they lack a complete coverage of all the performance measures and metrics in new enterprise environments considering different levels of decision-making.

There are not many review articles on performance measures and metrics in logistics and supply chain. An outline and assessment of the performance measures used in SC models is presented and also a framework for the selection of PMSs for manufacturing SCs has been proposed (Beamon, 1999). Another study suggested that traditional models for PM should be separated from more innovative non cost measures such as the time, quality and flexibility (Toni and Tonchia, 2001).

2.7. Supply Chain Performance (SCP)

Different researchers have suggested different types of measurements to evaluate supply chain performance. For instance, few researchers have suggested eight measurements, namely, delivery time, customer satisfaction, cost reduction, on-time delivery, inventory turnover, system reliability, market share, and value- added activities, but only three measurements (delivery times, customer satisfaction, and cost reduction) are found to be commonly used to evaluate SCM. Timeliness, profitability, growth, availability, and product and service offering are used as measurements by (Min and Mentzer, 2004; Gunasekaran *et al.*, 2001) look at SCM performance from the strategic, tactical, and operational levels.

Additionally, they develop key performance metrics emphasizing performance dealing with suppliers, delivery, customer service, inventory, logistics costs in SCM, and most importantly customer satisfaction. Five major dimensions are also proposed to measure SCM performance: supply chain flexibility, supply chain integration, customer responsiveness, supplier performance, and partnership quality (Li *et al.*, 2006).

The method of accurately measuring SC performance is identified as an important field of research for both organizations and academics alike. However, the area of SC

performance measurement has not received satisfactory attention from researchers or practitioners (Gunasekaran *et al.*, 2004; Lummus and Vokurka, 1999; Shepherd and Gunter, 2006).

There are several metrics in the literature for measuring the performance of a supply chain yet an effective performance measurement method has always been under considerable debate, and requires further research exploration. The supply chain performance construct is shown in table 4.

Table 4. Supply chain performance construct

Construct	Definitions	Literature
Supply Chain Performance	The overall efficiency and effectiveness of a supply chain	Beamon, 1999; Gunasekaran et al., 2001; Van Hoek, 1998

2.8. Supply Chain Competitiveness (SCC)

Manufacturing organizations all over the world have some inherent advantages and some hard-wired disadvantages. Some of them have higher per unit labor costs (as in the US) while others face higher consumption of utilities to overcome natural challenges like extreme temperatures and some others face small labor force for the size of their economy (i.e., Singapore and Tiawan) or small domestic markets (as in Japan). However, successful firms in these environments focus their energies to develop other competitive advantages to overcome their inherent disadvantages. They design technological and managerial interventions to overcome their disadvantages. Same must become true for firms in India.

The biggest challenge for an Indian organization today is to be competitive, not only in the country but globally also. Competitiveness is a multi-dimensional concept and can be enhanced through various ways. An effective and proven way is through the quality way, which is a major source for creating sustainable competitive advantage for organizations (Dutta, 2007).

While Indian organizations do suffer from higher utility rates and its poor quality, uncertain policy regimes, high internal taxes, some labor rigidities, infrastructure glitches etc., they must ask themselves some tough questions: have they utilized existing resources effectively; have they developed new processes and practices that overcome the inherent disadvantages; have they resisted policy-related-competitiveness and sought competence-related-competitiveness for themselves, etc.

In the present work, authors are proposing a conceptual model which links all these constructs together.

3. Proposed model

Figure-1 shows a SEM model, which links all the six constructs measuring supply chain performance together. The various terms associated with each construct and variable are explained in Table 5.

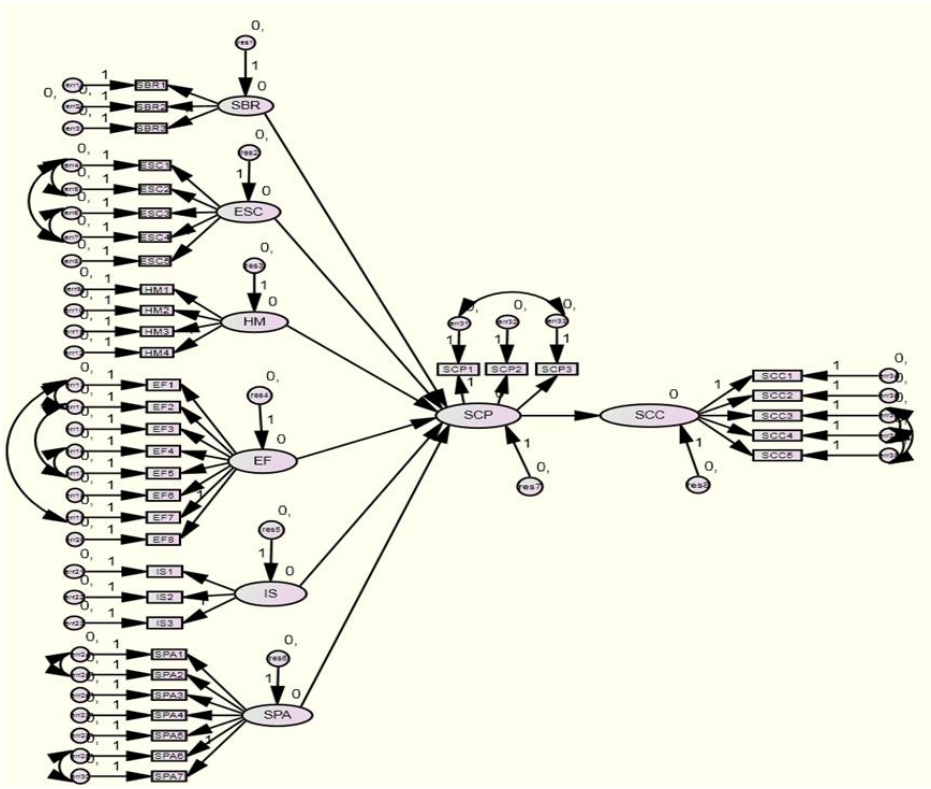

Figure 1. Proposed Conceptual Model

4. Research methodolgy

Literature review results in identification of six constructs viz. supplier-buyer relations (SBR), external supply chain (ESC), human metrics (HM), environmental factors (EF), information sharing (IS) and supply chain measurement approaches (SPA) which lead to supply chain performance (SCP). The model also incorporates supply chain competitiveness (SCC) as a dependent variable with SCP as independent variable. All the terms are as in table- 5 below.

Structural Equation Modeling (SEM) technique is used and confirmatory factor analysis (CFA) is performed. Data is collected from the questionnaire using Likert 5-point scale from the respondents occupying senior positions in manufacturing organizations all over the country. 361 responses are found suitable for testing the model, out which 5 responses are removed during the analysis as they have been identified as outliers.

Table 5. Variables Summary

S.No.	Item Name	Description
1	SBR1	We discuss quality related problems with our suppliers.
2	SBR2	We have continuous quality improvement programs for our suppliers.
3	SBR3	We actively involve our key suppliers in new product development processes.
4	ESC1	Our supply chain partner feels strongly attached to our supply chain relationship.
5	ESC2	Our supply chain partner is ready for sharing of investments and risks with us.

6	ESC3	Our supply chain partner believes in loyal relationships.
7	ESC4	Our supply chain partner believes in long term relationships.
8	ESC5	Our supply chain relations bring good reputation to our supply chain partner.
9	HM1	We are involved in strategic activities of our supply chain partner.
10	HM2	We are transparent in all our dealings with our supply chain partner.
11	HM3	We respect honesty and trust between us and our supply chain partner.
12	HM4	We have strong sense of commitment towards each other.
13	EF1	Improved technology has helped our competitors introduce more of new products.
14	EF2	Intensified competition has made competitor's actions unpredictable.
15	EF3	Changes in technological and infrastructure facilities are affecting us.
16	EF4	Our suppliers' product quality varies much.
17	EF5	There is uncertainty in suppliers' delivery time as well as customers' needs.
18	EF6	We are affected by mergers and acquisitions.
19	EF7	Globalization has helped in our performance.
20	EF8	Suppliers' engineering level is unpredictable.
21	IS1	We have an up-to-date information sharing system with our suppliers.
22	IS2	We share core business ideas with our suppliers.
23	IS3	We inform our suppliers in advance of the changing needs.
24	SPA1	Human related approach (like absentee rates, community involvement, etc).
25	SPA2	Finance related approach (like sales, profit/sales, cash flows, etc).
26	SPA3	Environment related approach (like environmental policies implementation, etc).
27	SPA4	Manufacturing related approach (like capacity utilization, cycle time, etc).
28	SPA5	Training related approach (like employee training, etc).
29	SPA6	Management reputation (like safety record, experience, etc).
30	SPA7	New product development (like number of new products, percent of sales due to new products, etc).
31	SCP1	Our firm meets customer orders on time.
32	SCP2	We are able to introduce new products faster by adjusting our capacity as per customers' preference.
33	SCP3	Our firm has a high level of integration of information systems.
34	SCC1	We provide customized high quality products on time.
35	SCC2	We are competitive enough by introducing new quality products as per customer needs.
36	SCC3	We offer new features at lower prices.
37	SCC4	We offer reliable and durable products to the customers on time before our competitors.
38	SCC5	We offer competitive prices with dependable delivery.

5. Results and discussions

AMOS 18.0 is used to test the model and the results are as tabulated in table 6.

Absolute fit indices determine how well an a-priori model fits the sample data (McDonald and Ho, 2002) and demonstrates which proposed model has the most superior fit. These measures provide the most primary indication of how well the proposed theory fits the data. Their calculation is a measure of how well the model fits in comparison to when there is no model at all (Joreskog and

Long, 1993). This category includes Chi-Squared test and RMSEA. The Chi-Square value (or CMIN) is the traditional measure for evaluating overall model fit and, assesses the magnitude of discrepancy between the sample and fitted covariance matrices (Hu and Bantler, 1999). Due to the restrictiveness of the Model Chi-Square, researchers have sought alternative indices to assess model fit. One example of a statistic that minimizes the impact of sample size on the Model Chi-Square (Wheaton *et al.*, 1977) relative/normed chi-square ($\chi 2$/df) also known as CMIN/DF. Although there is no consensus regarding an acceptable ratio for this statistic, recommendations range from as high as 5.0 to as low as 2.0 (Wheaton *et al.*, 1977; Tabachnick and Fidell, 2007). The present model gives a value of 8.825, which suggests that model is rejected.

The RMSEA tells us how well the model, with unknown but optimally chosen parameter estimates would fit the population's covariance matrix (Byrne, 1998). Recommendation for RMSEA cut-off points for a well-fitting model is taken as lower limit to be close to 0 while the upper limit to be less than 0.08. The present model gives a value of 0.148, which is also unacceptable.

Table 6. Results (Model Fit Summary)

A) CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	134	5692.31	645	.00	**8.825**
Saturated model	779	.000	0		
Independence model	76	9263.85	703	.00	13.178

B) Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	**.386**	.330	.414	.357	**.410**
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

C) RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	**.148**	.145	.152	.000
Independence model	.185	.182	.189	.000

Incremental fit indices, also known as comparative or relative fit indices, are a group of indices that do not use the chi-square in its raw form but compare the chi-square value to a baseline model. For these models the null hypothesis is that all variables are uncorrelated (McDonald and Ho, 2002). This category includes NFI, CFI, etc.

The NFI assesses the model by comparing the $\chi 2$ value of the model to the $\chi 2$ of the null model. Recommendations as low as

0.80 as a cut off have been preferred. However, (Wheaton *et al.*, 1977) have suggested NFI ≥ 0.95 as the threshold. Our model's NFI value of 0.386 indicates poor fit.

The Comparative Fit Index (is a revised form of the NFI which takes into account sample size (Byrne, 1998) that performs well even when sample size is small (Tabachnick and Fidell, 2007). A value of CFI ≥ 0.95 is presently recognized as indicative of good fit (Hu and Bentler, 1999). Our model's NFI value of 0.450 again indicates poor fit.

Although the model shows considerably poor fit, the regression weights (table 7) show good values, especially between SCP and SCC.

Table 7. Regression weights

			Estimate	S.E.	C.R.
SCP	<---	SBR	.105	.027	3.936
SCP	<---	ESC	.093	.038	2.434
SCP	<---	HM	-.027	.013	-2.089
SCP	<---	EF	.022	.010	2.264
SCP	<---	IS	.028	.020	1.370
SCP	<---	SPA	.107	.026	4.040
SCC	**<---**	**SCP**	**3.865**	.863	4.481

Also, there are 13 covariance relations between different error terms which are shown as double headed curve arrows in the model as shown in figure 1. These relations are developed during model fitting process as Standardized Residual Covariance ≥ 2.5.

6. Conclusions and limitations

To enhance the manufacturing competitiveness, Indian manufacturing organizations should focus on spending more on research and development, bringing innovation in manufacturing, developing more and more clusters, establishing a trust between government, industry and society, focusing on "green" manufacturing techniques and disciplining the Indian talent. This can be achieved by bringing stability in policies and tax regimes, focusing on long term planning, improving the supply chain etc (The Asia Competitivness Forum, 2012).

An important factor that is identified in the present study is the linking across the supply chain performance constructs to gain competitiveness. Different studies (Porter, 1985; Fearne, 2008) focus on improving the supply chain activities to gain competitive advantage. On the other hand, other studies (Lee, 2002; Ketchen and Hult, 2002) have argued that performance improvement in the supply chain gives competitive advantage.

The present model tries to confirm various relationships, firstly between the six constructs of SCP and then secondly, the dependence relationship between SCP leading to SCC.

The results suggest the need to redefine the model and to apply exploratory factor analysis (EFA). Furthermore, the responses from other industries and sectors can be included to generalize the outcomes. Also, secondary data can be used simultaneously for evaluating performance measurement and competitiveness.

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