

An Empirical Study on Supply Chain Risk Management Strategies in Indian Automobile Industry

Satyendra Kr. Sharma*, Anil Bhat** and Srikant Routroy***

Supply chain disruptions, major or minor, have affected supply chains negatively. Literature shows that supply chain disruptions also lead to reduction in shareholder value. Supply Chain Risk Management (SCRM) has become a concern for boardrooms, and companies have started to think how they can better manage their supply chains to survive and continue operations. This paper provides insights into SCRM in Indian automobile sector. Strategies used to deal with supply chain risks are explored in this paper. First a taxonomy is suggested based on the review of the extant literature, i.e., proactive strategies, coping strategies, aligning strategies, early warning strategies and survival strategies. These strategies are then empirically tested in the context of Indian automobile industry. A total SCRM strategy index is calculated and the status of Indian automobile industry in SCRM is discussed.

Introduction

The 9/11 terrorist attack in the US and Tsunami in Japan in 2011 attracted the attention of research community and practitioners towards Supply Chain Risk Management (SCRM). While the literature on SCRM has been growing, it lacks an organized structure of SCRM strategies. The current paper bridges this gap. The purpose of this paper is to review the diverse literature on SCRM, specifically risk management strategies consisting of proactive strategies, coping strategies, alignment strategies, early warning strategies, and survival strategies, and explore the SCRM strategies in Indian automobile industry. This paper presents how Indian automobile companies manage supply chain risks and what are the practices being used by them, and determines the level of maturity in their SCRM practices. It is a pioneering effort, and to the best of our knowledge such a study has not been done earlier in any industry in India.

The paper is structured as follows: it presents a review of related literature, followed by description of the conceptual model and research methodology. Subsequently, the results of data analysis are presented. Finally, the conclusion is offered with limitations and future scope of the research.

* Assistant Professor, Department of Management, BITS Pilani, Rajasthan, India.
E-mail: Satyendra.sharma1979@gmail.com

** Professor, Department of Management, BITS Pilani, Rajasthan, India. E-mail: bhatanil@gmail.com

*** Associate Professor, Department of Mechanical Engineering, BITS Pilani, Rajasthan, India.
E-mail: srikantroutroy@gmail.com

Literature Review

Supply chains are complex, and processes involved in delivering physical goods to customers efficiently require the understanding and view of all supply chain members. In complex and globally dispersed supply chain, risky events may happen at any link and disrupt the whole supply chain. So continuous monitoring of risky events and mitigating them before they halt the supply chain is essential. SCRM is management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity (Christopher, 2000).

SCRM literature focuses on the supply chain risk mitigation strategies and enablers, which mitigate the effect of supply chain risks. SCRM is more proactive rather than reactive (Hoeing and Thun, 2009). It is an integrated part of supply chain strategy. At the time of supply chain design, managers have to keep in mind the factors and Supply Chain Management (SCM) practices that mitigate the negative effects of risky events (Juttner, 2003). Flexibility has been shown to enhance the ability to minimize risk exposure in the event of a supply chain disruption. In a study, Skipper and Hanna (2009) established the relationship between top management commitment, recourse alignment, information technology usage and external collaboration with supply chain flexibility.

SCRM implementation requires strategy formulation and, in final stage, performance evaluation (Varma *et al.*, 2006). In literature, no clarity exists on SCRM strategies. They have been classified differently by different authors. To mitigate the impact of supply chain risks, companies can use four approaches, which are: supply management, demand management, product management and information management. Tang (2006) suggested robust supply chain risk mitigation strategies, which enable a firm to be more resilient. These robust strategies are postponement, strategic stock, flexible supply base, flexible transportation, economic incentives, dynamic assortment planning, revenue management and silent product spillover. Manuj and Mentzer (2008) illustrated the use of strategies like postponement, speculation, hedging, share, transfer, control, security and avoidance. Chopra and Sodhi (2004) gave a framework of supply chain risk mitigation. They suggested certain strategies which have a positive and negative effect on various risks.

This paper first discusses all types of SCRM strategies. Then, using logic of supply chain risk assessment (estimating likelihood and detrimental impact of risky events), a framework for classifying SCRM strategies is presented.

Proactive Strategies

Proactive strategies are decisions and activities that are aimed towards reducing the probability of disruptions. Proactive strategies are implemented prior to occurrence of the risky event in supply chain. These strategies reduce the probability of risky events. Following are the types of proactive strategies:

Avoidance

Avoidance occurs when risks associated with operating in a given product market or geographical area are considered to be unacceptable (Miller, 1992). From a supply chain perspective, avoidance can be related to products/geographical markets, and supplier/customer organizations. A company could avoid specific products, suppliers or geographical markets if supply seems too unreliable. Similarly, terrorist attacks occur more in some countries than others. Therefore, risk of disruption can be considerably reduced by choosing locations that are less susceptible to catastrophes. US-owned companies face a higher risk of terrorist attacks outside the country. Therefore, it might be advantageous for companies to sell or lease their vulnerable overseas assets to local companies (Simchi-Levi *et al.*, 2001).

Investment in Developmental Activities

Enforced security can help prevent man-made catastrophes. Physical security can prevent pilferage, leaking of sensitive documents, and disruptions at a plant by unsocial elements and terrorists. Information security can prevent cyber attacks by hackers, computer viruses, accounting scandals, and unauthorized access to communication media. Technologies such as radio frequency identification tags on containers and global positioning systems can help in enforcing security. Firms should integrate security not only internal to the company, but it should be implemented across the supply chain (William *et al.*, 2008).

Given the impact suppliers have on company's performance, it is important to know about suppliers. Companies which invest in supplier development get improvement in supply performance. This consideration becomes critical if supplier is supplying mission-critical components (Smeltzer and Siferd, 1998). Resource dependency theory explains that when a firm becomes too much dependent on some firms, it causes risk to that company. Too much dependency on one supplier might cause disruptions, but close relationship with suppliers increases efficiencies. Supplier development leads to trust between supplier and buyer, which mitigates risks and suppliers have an incentive to remain committed in relationship.

Supply Chain Integration

Supply chain integration is easy to conceptualize and hard to accomplish. The silo approach cannot help in integrating supply chains. Integrated supply chains are better off in handling disruptions. Lee *et al.* (1997) investigate the distinct contribution of integration with customers and suppliers on supply chain performance like cost containment and reliability. Kim (2006) builds an aggregate construct of integration and demonstrates that integration positively relates to performance and customer satisfaction. Kannan and Tan (2010), in their study, not only classified the arch of integration but also showed the impact of broad span of integration on several dimensions of performance. In literature, it not clearly defined whether supply chain integration leads to supply chain risk management.

Coping Strategies

Coping strategies provide a capability to mitigate the effects of a disruption. These strategies are built on flexibility and redundancy in supply chain, which provide options that can allow a company to offset the losses in a part of a supply chain by gains from available alternatives (options).

Redundancy in the form of excess stocks and capacity provides options to companies that can be used in uncertain environment. Following are the various coping strategies:

Flexibility

Nordahl and Nilsson (1996) classified flexibility into external flexibility and internal flexibility. They further divided external flexibility into four different classes as product flexibility, mix flexibility, volume flexibility, and delivery flexibility, and internal flexibility into two levels, namely, flexibility characteristics of the production system and flexibility characteristics of the resource system. While disruptions and heightened risk levels can cause serious challenges, several studies, including Fawcett *et al.* (1996), Goldsby and Stank (2000), Fredericks (2005), and Swafford *et al.* (2006), found that organizations characterized by higher levels of flexibility are more capable in responding to unexpected events as compared to their non-flexible counterparts. Supply chain flexibility acts as a measure of risk management to organizations facing increased supply chain risks.

Toyota keeps in excess capacities in its Thailand and Indian plants. The company changes the capacity utilization based on the rate of respective country currency (Shah, 2009).

Redundant Resources Maintain Multiple Manufacturing Facilities with Flexible and/or Redundant Resources

Excess inventory can mitigate disruptions without affecting normal supply chain operations. Excess inventory in the form of safety stock is used to mitigate the effects of supply and demand uncertainty. A disruption at a supplier can result in a shortage of supplies at the organization down the line in a supply chain. Availability of excess inventory also provides the companies an ability to mitigate demand variations in volatile markets. And single sourcing considerably increases the risk of disruption.

For example, automobile products may have over 700 components. Even the best integrated supply chain suffers losses when they do not give due weightage to redundant resources (Lee, 2004).

Risk Pooling Strategies

If underlying supply mechanism is inflexible, specifically in service industry, where supply capacities are fixed, companies use different demand management strategies so that they can manipulate uncertain demand dynamically to match the demand with supply. Demand management strategies pool the uncertainty in demand and shape the uncertain demand so that a firm can use an inflexible supply to meet the modified demand.

Demand management strategies were examined by Carr and Lovejoy (2000) and Miegheem and Dada (2001). Demand management strategies are designed to generate one or more of the following effects:

- Shifting demand across time;
- Shifting demand across markets; and
- Shifting demand across products.

Supply Chain Alignment Strategies

The other important antecedent for SCRM is aligning the resources and interests of all supply chain partners. Here alignment means aligning the supply chain partner's interests to reduce the supply chain disruptions and increase the supply chain performance. The method for supply chain alignment is described in the following:

Aligning Performance Metric

All the supply chain members do not have a performance measure for the entire supply chain. Focus on local optima rather than global optima creates detrimental effect to overall system (Goldratt, 1994).

Aligning Incentives

Different companies in a supply chain should behave like one entity and incentives should be aligned across the supply chain. Alignment of chain removes the incentives from the system that creates distortions in order patterns. Misaligned incentives in supply chain lead to the opportunistic behavior of the supply chain members, and that causes stockouts and poor customer service.

Aligning Business Processes

Fragmented business processes often contribute to a lot of waste in supply chain and create demand-supply mismatch. Globally dispersed companies have different business processes like overlapping ordering processes and different inventory estimation methods. Managers can find the position of their supply chain on the fragmented business processes spectrum, looking at past data of how many times their company faced undesirable situations like high markdowns, excess levels of inventories, etc. Aligning the business processes among the supply chain partners increases supply chain resiliency (Olvera, 2008).

Early Warning Strategies

An advance warning or forecast of a catastrophe can provide a company valuable preparation time to align its capabilities to minimize disruption effects. It also requires constant monitoring of the geographical environment and supply chain visibility. Foresight can provide strategic advantages. Adoption of early warning system allowed Nokia to foresee the problem at one of its chip supplier and Nokia increased its market share by 4%. Nokia, anticipating the potential disruption, responded fast to contact

Phillips to use its alternate facilities to meet Nokia's demand. Ericsson was late. All available capacity of Phillips was taken by Nokia. Consequently, Ericsson reported a loss of \$1.8 from the shortage of chips (Norman and Jansson, 2004).

Enhanced Visibility and Coordination in a Supply Chain

Information visibility provides a clear picture of disruptions occurred in one part of the supply chain; thus, other companies can respond effectively. Information immediately enables them to take appropriate actions like rerouting, changing production plans, redeploying production resources or adjusting capacities.

Predictive Analysis

The second issue related to visibility is predictive analysis. Understanding the supply chain and tools is necessary to predict the supply chain risks. There is a need of intelligent search agents and dynamic risk indices at every node of the supply chain (Menczer, 2003). Prediction of capacity of bottlenecks in global transportation networks and production capacities has become critical. In today's global supply chains, enormous information is available and the key challenge is to gather relevant, timely and credible information. Intelligent web agents are a relatively new technology that may be useful to search the web for data/text mining and searching disruption-related information (Blakhurst, 2005). At present, there are no tracking and control systems that can affordably manage every shipment continuously from origin to destination. There is a need of advanced technologies which provide real-time visibility and monitoring capabilities to identify disruptions and also alert the right parties when problems occur.

Survival Strategies

In situations like disaster, where whole supply chain temporarily breaks down and becomes stagnant for a while, survival strategies can be used by companies. Survival options are difficult to devise because of uncertainty in its likelihood. However, past examples of survival can be used to identify possible strategies that might be suitable for a company. Helferich and Cook (2002) provide a detailed guideline for a disaster management process. Risk is retained by developing a contingency plan to implement, if risk materializes.

The aim during the response stage is to save life and property. Recovery refers to reorganizing resources to restart supply chain operations. Disasters have a timeline of pre-disaster, response and post-disaster.

Implementing Organizational Emergency Plans

These include emergency safety procedures for life and property. A response team should analyze the need for emergency assistance and community support.

This decision ensures the safety of the workers and avoids the potential security and transportation problems that Starbucks might have encountered. Pre-assigned roles and responsibilities can help in maintaining control and preventing chaos. Resources of the firm across the supply chain need to correctly align with disaster and recovery planning.

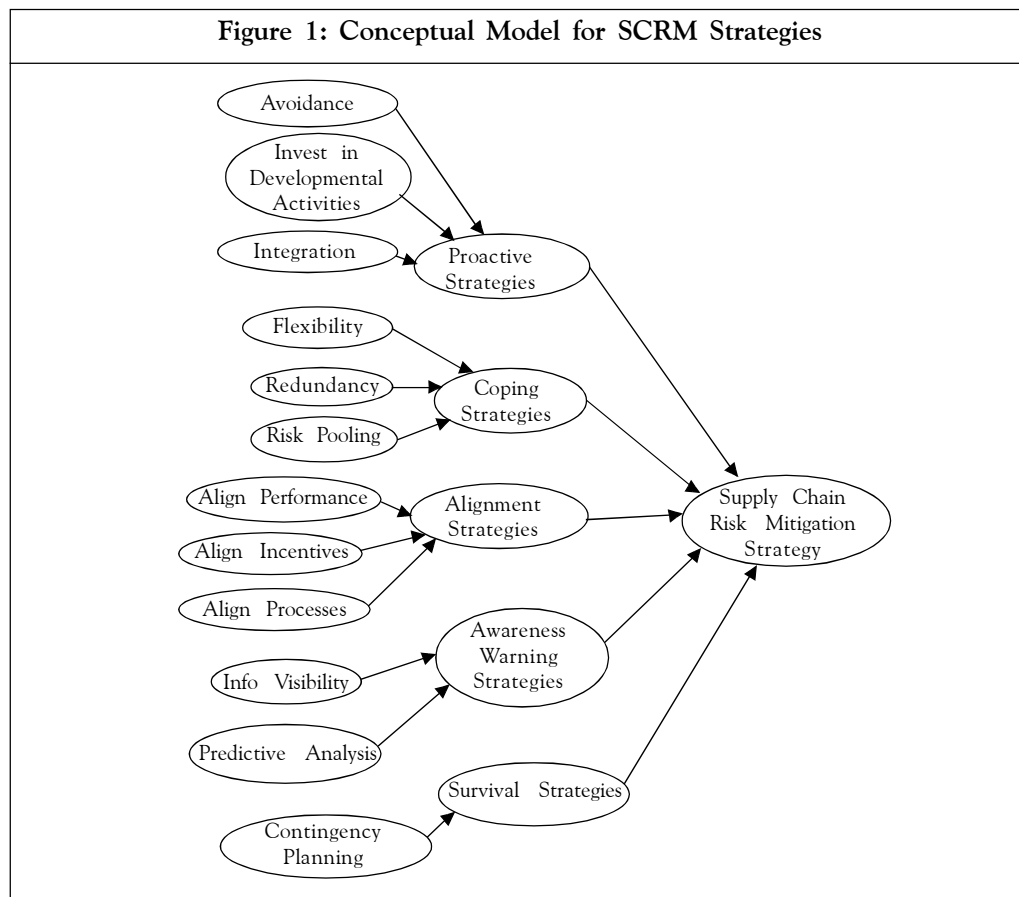
Right deployment of resources across the chain becomes aid, driving capabilities with matched organizational processes (Day, 1994).

Contingency Planning

Like all plans, contingency plan answers all other questions of what, when, where and how much action takes place. Important tasks at the recovery stage include assessment and identification of the human resources and physical infrastructure needed. Cooperation with law enforcement and government efforts is essential.

Conceptual Model

Based on the various types of SCRM strategies, we use the logic of supply chain risk assessment (estimating likelihood and detrimental impact of risky events) and present a conceptual model classifying SCRM strategies (Figure 1).



Data and Methodology

For examining the SCRM practices in Indian automobile companies, first, the practices were identified from literature and a taxonomy was developed. Then a questionnaire was

developed to measure SCRM practices on a 7-point Likert scale. The survey was conducted online. Once data was collected, analysis was done through SPSS 19.

Data Collection

Data was collected through a survey administered in India to a sample of 546 companies. This list was prepared from the data taken from Society of Automotive Manufacturers. The questionnaire was sent to purchase managers, logistics managers or supply chain managers (if any). First, mailing generated only 26 responses, then followups were planned and three followups generated 43 usable responses. In total, 69 usable responses were collected, of which 27 respondents were related to supply chain/logistics, 7 were related to production, and 35 were purchasing/procurement officers. The response rate of 12.7% was fairly good enough for online questionnaires. Given the length of the survey and the high level of managers targeted, the response rate is in line with those reported by other researchers in SCM (Basnet *et al.*, 2003). For all questionnaires responses of late respondents and early respondents were compared on two parameters, i.e., sales and number of employees. The comparisons indicate non-response bias.

The test showed no significant differences ($p = 0.10$) in the mean responses between early and late respondents for all the included variables. This shows no presence of non-response bias. The sample covers 45 auto components suppliers and 24 OEMs. The details of the surveyed companies and respondents are given in Tables 1 and 2 respectively.

Table 1: Details of Surveyed Companies			Table 2: Details of Surveyed Respondents		
Sale (in ₹)	No. of Companies	Percentage	No. of Employees	No. of Companies	Percentage
10 mn-under 50 mn	12	17.38	Less than 100	5	7.24
50 mn-under 100 mn	10	14.49	100-Under 500	12	17.38
100 mn-under 250 mn	10	14.49	500-Under 1,000	17	24.63
250 mn-under 500 mn	15	21.73	1,000-Under 5,000	17	24.63
500 mn and Above	21	30.43	5,000 Above	18	26.08

Questionnaire and Measure Development

We used a multi-step process to initially develop and validate our instrument (Churchill, 1979). From this process, 12 item statements for all dimensions were identified (Table 3). Furthermore, pretesting of the instrument involved the use of a panel of experts to identify ambiguous items, poorly worded questions, and poor instructions for answering the questionnaire. Several item statements were rewritten after evaluation by this panel. The panel found no major problems with the response format, directions, or other survey procedures.

Table 3: Scale Development		
Construct	Measured Item	References
Proactive Strategies	Avoiding unreliable suppliers, avoiding geopolitical severe locations (A)	Miller (1992)
	Developing suppliers (S)	Smeltzer and Siferd (1998)
	Supply chain integration (I)	Kannan and Tan (2010)
Coping Strategies	Flexibility in suppliers, manufacturing (F)	Fawcett <i>et al.</i> (1996); Swafford <i>et al.</i> (2006)
	Redundant resources (R)	Lee (2004)
	Risk pooling like insurance, aggregating demands across customers (RP)	Carr and Lovejoy (2000); and Mieghem and Dada (2001)
Alignment Strategies	Aligning performance metric of all supply chain partners (AP)	Bowersox (1990)
	Aligning incentives, risk and rewards among supply chain partners (AI)	Narayanan and Raman (2004)
	Aligning business processes of all supply chain partners (ABP)	Bowersox (1990)
Early Warning Strategies	Information visibility, sharing information across supply chain (IV)	
	Predictive analysis tools for predicting risk events (PA)	Menczer (2003)
Survival Strategies	Keeping contingency plans and making someone responsible for executing contingency plans at the time of disruption (CP)	Helferich and Cook (2002)

A preliminary questionnaire was designed and relevance of constructs and their measures, their wordings, directions and format of questionnaire was refined on the basis of comments of practitioners and academicians. To establish the content validity of the survey questionnaire, we first did a pilot study of some practitioners and academicians related to risk management and SCM.

Finally, the pre-tested questionnaire was administered to Indian automobile industry (see Appendix). Respondents were asked about their perceptions of the current SCRM practices with their upstream or downstream supply chain partners. A 5-point likert scale was used to operationalize all constructs.

Scale of the SCRM was generated by itemizing the strategies into practices or set of activities followed by companies. Statistical tests were performed to check the reliability and validity of the measurement instrument (Churchill, 1979). Consistent with the

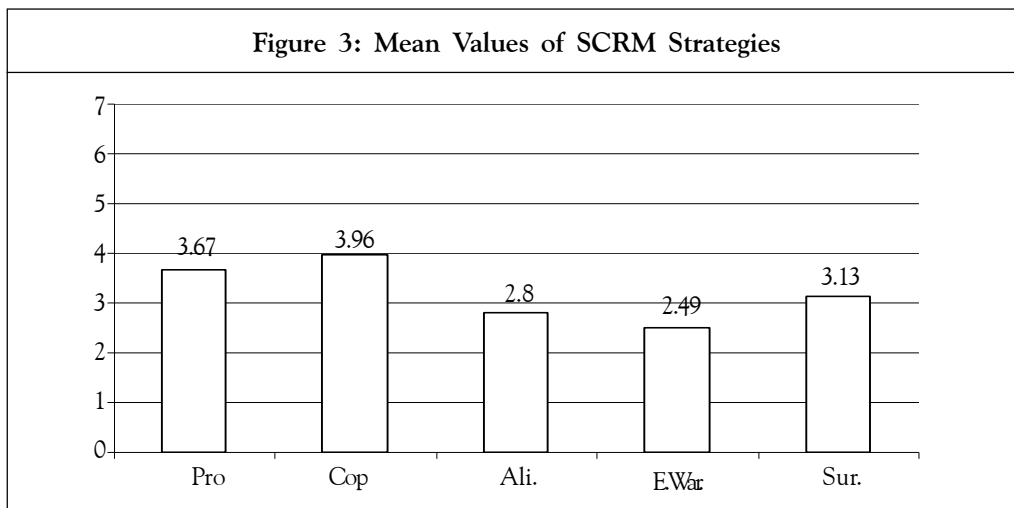
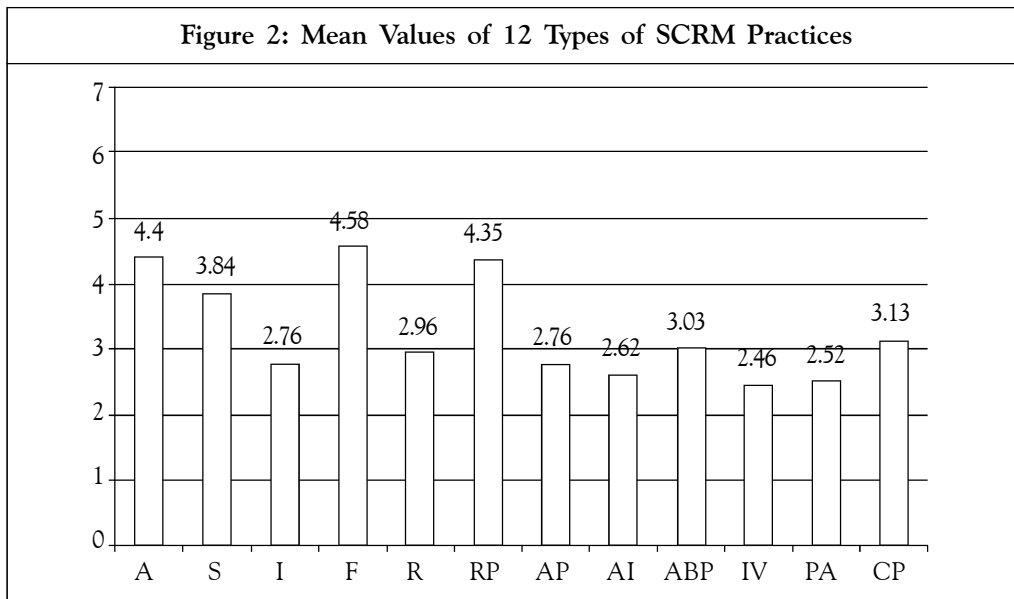
conceptualization and theory, proactive, coping, alignment, early warning and survival strategies were specified as five different factors. The measurement items were modified by corrected item-to-total correlation and factor analyses. The eigenvalues for each factor suggested that there was only one predominant factor. Cronbach's alpha (Cronbach, 1951) coefficient was used to check inter-item consistency reliability of the scale, the extent of measurement error in a measure.

Table 4 presents the means, standard deviation, alpha coefficients and factor loadings of the scale items.

Table 4: Measurement of Five SCRM Strategies					
Construct	Measured Variables	Mean	SD	Factor Loadings	Alpha
Proactive Strategies	Avoiding unreliable suppliers, avoiding geopolitical severe locations	4.4	0.871	0.552	0.698
	Developing suppliers	3.84	1.40	0.723	
	Supply chain integration	2.76	1.39	0.869	
Coping Strategies	Flexibility in suppliers, manufacturing	4.58	0.99	0.715	0.792
	Redundant resources	2.96	1.08	0.702	
	Risk pooling like insurance, aggregating demands across customers	4.35	0.96	0.684	
Alignment Strategies	Aligning performance metric of all supply chain partners	2.76	1.28	0.547	0.758
	Aligning incentives, risk and rewards among supply chain partners	2.62	1.02	0.749	
	Aligning business processes of all supply chain partners	3.03	1.24	0.785	
Early Warning Strategies	Information visibility, sharing information across supply chain	2.46	1.32	0.792	0.824
	Predictive analysis tools for predicting risk events	2.52	1.06	0.704	
Survival Strategies	Keeping contingency plans and making someone responsible for executing contingency plans at the time of disruption	3.13	1.27		

Results and Discussion

An SCRM index was developed as an average of the scores aggregated across the five dimensions of SCRM. The calculation of the SCRM index assumed equal weight for each dimension. Figures 2 and 3 show the unweighted mean scores of the five dimensions of SCRM.



Indian automotive industry is a globalized one and all foreign players have presence in the Indian market. Automotive industry uses flexibility as the most important practice for minimizing risk and this is followed by avoidance and risk pooling strategies as shown in Figure 2. The industry is still lacking supply chain visibility and alignment. Although SCM gained popularity in the 1990s and became a competitive weapon, automotive companies are still struggling with IT tools adoptions and alignment among supply chain partners.

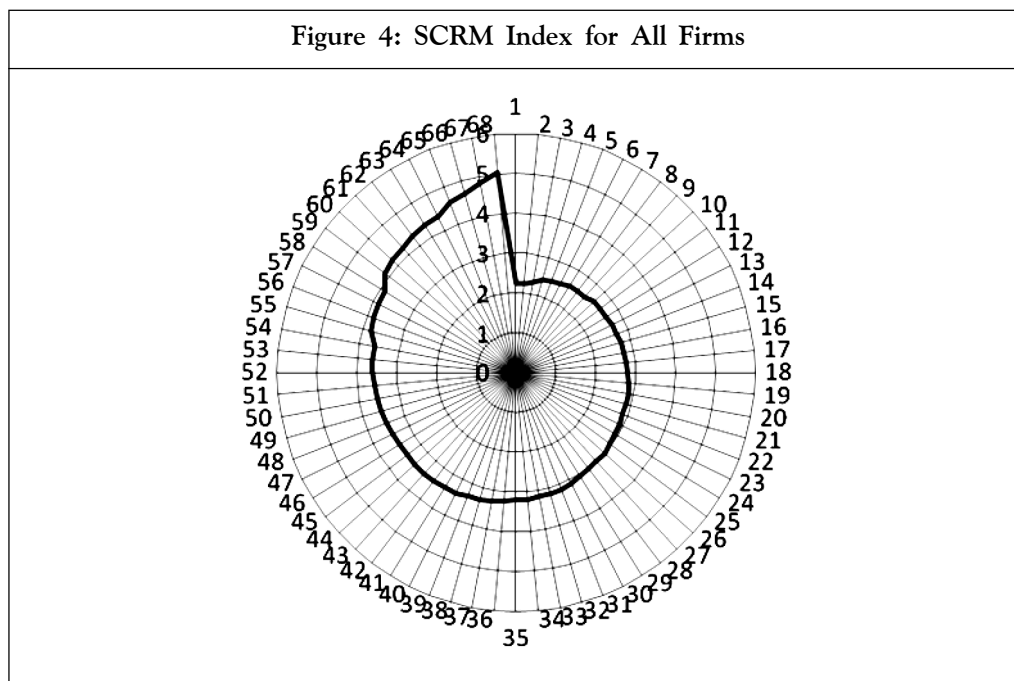
After averaging all the dimensions of SCRM strategies, mean values for five strategies were obtained. Automotive focuses more on coping strategies, followed by proactive

strategies (Figure 3). SCRM literature also focuses only on these two types of SCRM strategies. In this paper, five types of strategies have been highlighted to show the importance of all types of strategies. It is observed that Indian automotives (both Indian origin and MNCs) are lacking in use of alignment and early warning strategies. For reaching the highest level of SCRM maturity, they need to think of implementing these two important strategies.

In this paper, an SCRM index has been proposed to measure the SCRM maturity level based on the SCRM strategies, namely, proactive, coping, early warning, alignment and survival strategies. The index score for each individual case simply equals the mean scores of the five dimensions of SCRM $[(Pro + Cop + Ali + Ew + Sur)/5]$. The rationale is that responses to Likert scales can be treated as quasi-ratio data (Gaski and Etzel, 1986). A higher score on this SCRM index helps the chain members to discover the most important risk mitigation practices, as they would have a higher score on the SCRM index.

The mean of SCRM index was obtained as 3.50. The above-stated calculation of SCRM index assumes equal weight for each dimension of SCRM strategies.

Figure 4 shows the average score of all strategies used by respondent companies for risk mitigation. Process maturity models are relatively popular in software development projects (Ibbs and Kwaks, 2000). Based on BPO and SCM, process maturity models show five stages, which show continuous progression of processes and activities towards effective SCM. These five stages are: ad-hoc, defined, linked, integrated and extended (Lockamy and McCormack, 2004).



There is a lack of SCRM maturity models. We follow same maturity levels for business processes as suggested by Davenport (1996), and added one more level called least level, as organizations are not aware of supply chain risks. Not a single firm is at Level 1 and 2; all are above level 1 and 2. This means that all firms are aware of supply chain risks and they have structured processes in some parts of organizations. It is observed that 27 (39%) surveyed firms are at Level 3, and 19 (27.53) firms are at Level 4, implying that these firms have established formal and consistent processes across the organization. 22 firms are observed to be at Level 5, that is, have integrated systems across the organization. Only one organization is at the highest level of maturity, which has risk management capability with knowledge sharing and continuous improvement.

Conclusion

The survey findings show that Indian automobile companies do have proactive measures like manufacturing flexibility and adaptability (alternative supply chains). Managers expressed that industry is cost-competitive and lean management practices have been adopted by the OEMs, which have risk implications. To cope with the risk implication of cost pressures, the companies invest in supplier development and more involvement of supply chain members in planning. Though visibility is the key issue in supply chain, for that, willingness of supply chain members to share right information at the right time is critical. Managers expressed that to motivate supply chain members with regard to information sharing, aligning incentives should be addressed. Still companies lack in intelligent tools to forecast problem, and preparedness of supply chain members is also lacking.

Limitations and Future Scope: This research was carried out on automobile industry in India. Thus, the research findings are relevant only for the specific industry. SCRM maturity model needs to be developed and survey studies need to be carried out for other industries as well. Maturity models in different industries and other countries will help in identifying the best practices and other industries can benchmark their practices with other best practices. The sample size is another limitation of this research. Surveying industry executives is a real challenge. Collaboration with industry associations can help in survey and more data can be gathered.⌘

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Appendix

Questionnaire					
Q.1. Please indicate the extent of disagreement or agreement on the following key strategies/practices in relation to your organization's supply chain.					
SCRM Strategies	1	2	3	4	5
We do conduct defined hierarchical meetings to share Key Performance Indicators (KPI).					
Our customers priority on cost matches with our suppliers priority on cost.					
Our customers priority on delivery matches with our suppliers priority on delivery.					
We do have defined communication network protocol for our suppliers.					
Cost pressure is borne by our suppliers only.					
Our suppliers keep inventories, and risks and rewards are shared by us.					
If distributors perform on inventory turnover ratio, incentives are given to them.					
Early involvement of supplier in product design.					
Enforcing contracts with suppliers.					
We use cross-functional teams to solve problems.					
Internal management communicates frequently about goals and priorities.					
When problems or opportunities occur, face-to-face meetings occur with customers.					
Joint efforts to share risk-related information.					
Joint efforts to prepare supply chain continuity plans.					
Maintain multiple manufacturing facilities with flexible and redundant resources.					
We can operate efficiently at different output levels.					
We can produce a wide variety of products in our plants.					

Appendix (Cont.)

SCRM Strategies	1	2	3	4	5
We can produce different product types without major changeovers.					
We use multiple sourcing.					
We operate with excess capacity prod./storage to fulfill unforeseen demand.					
We use increased stockpiling/excess inventory.					
We do revenue management through dynamic pricing.					
We have product rollover strategies.					
We do have predictive analysis tools for SCRM.					
We use risk indices to check risks on a continuous basis.					
We have risk reporting and governance (risk enumeration, severity analysis and contingency planning) procedures in place.					
In our case, inventory levels are visible throughout the supply chain.					
In our case, demand levels are visible throughout the supply chain.					
In our case, there is transportation visibility.					
We have command groups to analyze end-to-end supply chain operations.					
We maintain organization's emergency plans.					
We keep control on the organization at all times.					
We have defined contingency plan responsibilities.					
Note: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; and 5=Strongly Agree.					

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