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Research Paper

COMPARATIVE ANALYSIS TO MINIMIZE THE VARIOUS RISK FACTORS IN SCM

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The challenge to business organizations today is to mitigate that risk through creating more resilient supply chains. The motives behind organizations turning towards risk management approaches being the global competition, change in technology, and the continuous contention for competitive advantage. A simple approach for viewing supply chain risk management focuses on two fundamental aspects are probability of event actually occurring, impact of the event on supply chain and subsequently overall business. In this research the AHP concepts in manufacturing supply chain should be studied with perfection which is the need of the hour as manufacturing supply chain is becoming less vertically integrated and the manufacturer is focusing on its core competency. Therefore, a structured, simple and efficient proposed decision framework is proposed and has the ability to show the direction to determine the degree of impact level of each CRF. The degree of impact level of each CRF of the firm will give idea for optimally allocating the efforts to gain maximum benefit. This Research thus attempts to identify risk factors pertaining to supply chain management in context to Indian manufacturing organizations. A case situation is elucidated in order to reinforce the salient features of the proposed framework. The results indicate that the industrial risk and then product risk have got the highest impact on successful implementation of SC. In this, we present and explain concepts, insights, practical tools, and decision support systems important for the effective management of the supply chain

Keywords: Management, Risk, Certainty, Decision, Organization

INTRODUCTION

Supply Chain Management (SCM) is defined as managing chain of events that strives to balance activities such as promotion, sales, distribution and production. It can also be defined as profit maximization (Hise, 1995; Nelson and Toledano, 1979). In today's competitive and uncertain market supply chain vulnerability hasbecome an issue of significance for many organizations. As of

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today supply chain is becoming more and morecomplex due to global sourcing and continuous trend of leaning down and as a result supply chain risk increases. Risk management is emerging as important contributor to most fields of management and decisioncontrol. The challenge to business organizations today is to mitigate that risk through creating more resilientsupply chains. The motives behind organizations turning towards risk management approaches being the global competition, change in technology, and the continuous contention for competitive advantage (Brindley, 2004).

There are wide instances in the literature regarding the risks and vulnerabilities, and complex supply chains. The advancement of globalization in industries of any magnitude has increased uncertainties in both demand and supply and the likelihood of supply chain disruption. Surprisingly there is a lack of conceptual framework and empirical findings to provide clear meaning and guidance to visualize the global supply chain management. Global supply chains require highly coordinated flows of goods, services, information, and cash within and across national boundaries (Mentzer et al, 2001).

LITERATURE REVIEW

Supply Chain Management (SCM) is defined as managing chain of events that strives to balance activities such as promotion, sales, distribution and product ion. It can also be defined as profit maximization (Hise, 1995; Nelson and Toledano, 1979). In today's competitive and uncertain market supply chain vulnerability hasbecome an issue of significance for many organizations. As of

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A simple approach for viewing supply chain risk management focuses on two fundamental aspects are probability of event actually occurring, impact of the event on supply chain and subsequently overall business. MIT Research group on "Supply Chain Response to Global Terrorism" shows that organizations generally concentrate on the type of disruption and not its source in order to know how to get it prepared against risk. Once the risk events are being identified effective methods for managing the risks must be developed. Effective risk management requires quantifying risk in order to place them in their proper context and to weigh the costs of risk and benefits of making particular decisions. Supply chain risk management offers improved focus on risk and therefore, more effective risk mitigation.

Risk pervades every dimension of our lives; both personal and professional. In every element of our daily routine, we encounter and manage risks. It is not surprising then that the notion of risk and risk management is not a modern contrivance. Old Testament talks of the pharaoh who had a dream that seven healthy cattle were devoured by seven sickly cattle.

To protect against the risk,the pharaoh then bought and stored large quantities of corn in order to tide over the coming bad time. Indeed, when famine struck, Egypt prospered and Joseph became one of the most powerful men in Egypt (Froot et al., 1994).

FACTORS DESCRIPTION

The typology developed herein isbased on a synthesis of the extant literature in several research areas such as riskmanagement (Ritchie and Marshall, 1993), strategy (Miller, 1991), internationalbusiness (Oxelheim and Wihlborg, 1987), operations management (Wu et al., 2006), andSCM (Zsidsin et al., 2004; Manuj and Mentzer, 2008a, b; Harland et al., 2003).Towards the supply chain risksRitchie and Marshall (1993) argue that business and organizational risks emerge fromone or more of the following sources:

- Environmental factors;
- Industry factors;
- Organizational factors;
- Problem-specific factors;
- Decision-maker related factors.

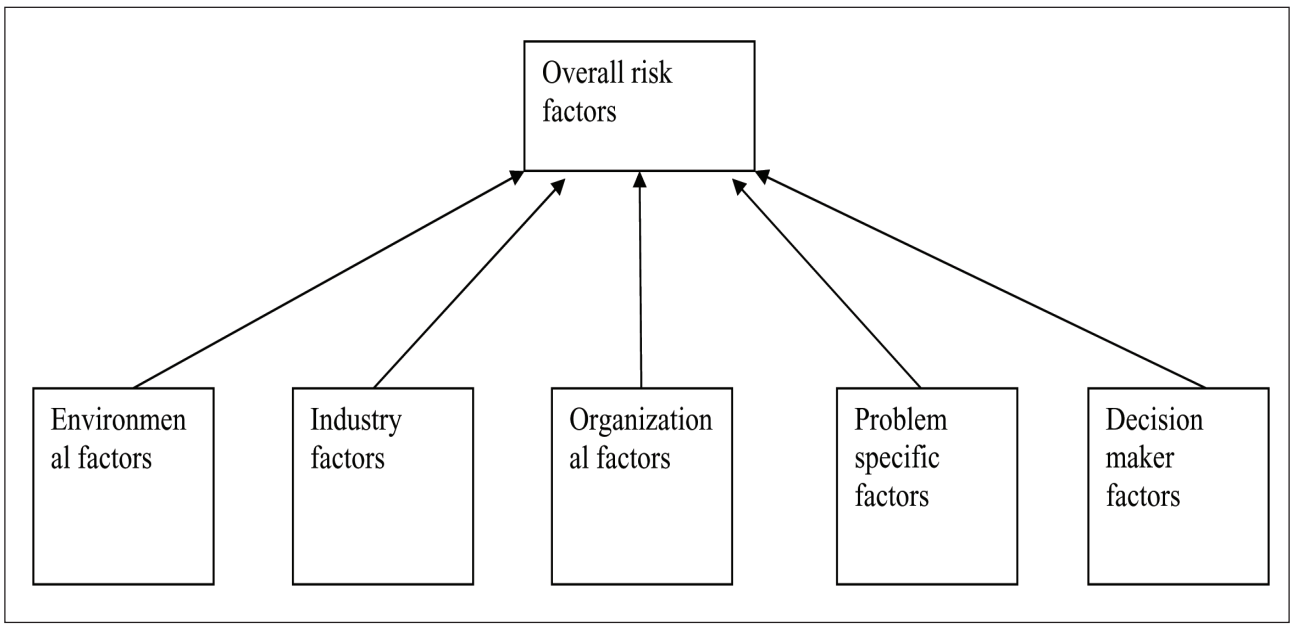
OVERALL RISK FACTORS

Environmental Risk

Environmental risk variables are those thataffect the overall business context across industries (Ritchie and Marshall, 1993). Whilethe magnitude of this impact across different industry sectors may be different, theunderlying premise is recognizable; everyone will be affected to some extent or anotherby way of general environmental uncertainties (Kouvelis et al., 2006). According toMiller (1991), general environmental risk variables could include political instability,shifts in government policy, macroeconomic uncertainties, social uncertainties, andnatural uncertainties. Short descriptions of each follow.

Political Uncertainty

While political uncertainty and instability are normallyreferred to in the context of major changes in political regimes (Shubik, 1983), theycould also refer to other factors. For



example, a weak government could impact firmsWithin the country and, consequently, their trading partners in other countries as well.Political uncertainty could also include potential or actual changes in the politicalsystem as a result of war, revolutions, other political disturbances.In one of the first articles studying the impact of political uncertainty on the supplychain, Cooke (2002) argued against the practice of extreme supplier-base reduction.Indeed, managers seem to be recognizing the importance of studying political risksinvolved in conducting business with overseas supply chain partners.

The need forstudying the political climate in a country before developing supplier relationships hasbeen stressed repeatedly. Underscoring the importance of political climates in offshorevendor relations, Willis Pugh, Executive Director of Honeywell has argued that fully understand such things as political uncertainty along with [theusual] things like tax policy, employment laws, regulations, tariffs, and the availability of rawmaterial and supplier development opportunities in their respective regions .According to Saha (2007), pol unrest in Bangladesh was one of the primaryreasons that large firms such as Wal-Mart and Hanesbrands began to find it unviableto conduct business there. It thus becomes apparent that political instability could be akey component of supply chain risk.

Policy Uncertainty

Policy uncertainty refers to changes in government policy thatimpact the business community (Ting, 1988). A prime example of a policy issue thathad strong global consequences was the 1973 oil crisis, where Arab OPEC membersdecreed that they would no longer sell oil to those nations that supported Israel in itswar with Egypt. However, as Miller (1991) argues, the basis fordifferentiating between the two lies with the understanding that changes ingovernment may not necessarily result in changes in government policy affectingbusiness involvement. Some of the most relevant types of government policyuncertainties could then include fiscal and monetary reforms, price controls, minimum-wage agreements, or nationalization/ privatization. Moreover, Miller (1991) argues that even when policies do not actually change, firms may be apprehensiveabout the government's commitment to keep existing trade policies in place for longtime periods. Harris et al. (1998), for example, argue about how behavior andrelationships with suppliers change when nationalized firms are privatized.

MACROECONOMIC UNCERTAINTY

Macroeconomic uncertainty is a broad termincorporating fluctuations in the level of economic activity and prices (Oxelheim andWihlborg, 1987). Price fluctuations may take the form of general price change in thecost of goods (inflation) or movements in the relative prices of inputs such as rawmaterial or labor, exchange rates, and interest rates (Miller, 1991). Kogut (1985) arguedthat a global supply chain will be most beneficial only if it is designed in a way such asto incorporate operational flexibility. It has also been seen recently that several global supply chain relationships that hadbegun on the premise of cost savings have not lived up to their promise. For example,with many firms outsourcing low-

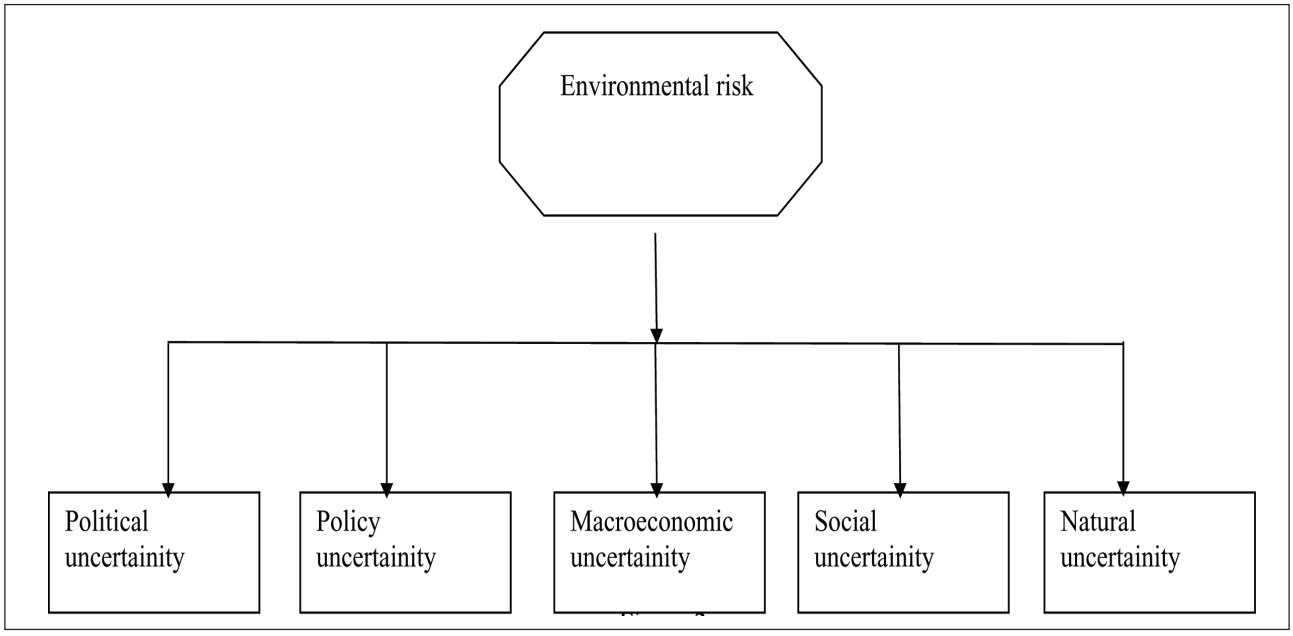
end jobs to low wage countries, the overall wage ratesof these “low-wage” countries are not as low as they are claimed to be (Jiang et al., 2008).This seems to have caused several firms to rethink their outsourcing decisions (Richter,2005).

Social Uncertainty

Social uncertainty follows from the beliefs, values, and attitudesof the population that are not reflected in the current government policy or business (Dunn, 1983). While firms are generally very adept at technical and financialrisk management, as it is an integral element of the delivery of services, social risk issometimes not given due consideration. According to Freeman (1984), the rationale forclassifying political and social uncertainty in two separate categories is that they dealwith two different (but connected) stakeholders – government and society at large.Societies may thus bypass existing government policy and appeal directly to businessfor reforms (Miller, 1991).

Natural Uncertainty

Natural uncertainty would include various phenomena such asearthquakes, floods, and fires, which could impair business functions and decrease theproductive capacity of firms operating in the affected region (Miller, 1991). Norrman andJansson (2004) tell of Ericsson’s loss of *e*400 million in revenue as a result of a fire at itssupplier’s plant. Increasingly, researchers stress that managers must consider naturalrisks in designing a global supply chain. According to Dimiturk (2005), but from Wal-Mart, because of the expertise Wal-Mart had gained indeveloping a supply chain that would be resilient to natural disasters. Zsidsin et al.(2004), However, themagnitude of these relationships does indeed vary across parameters. Marando andWanamaker (1972) argue that policy outcomes seem to be more strongly related tosocial variables than they are to political ones. Figure 3 provides a schematicrepresentation of the various environmental risk sources that we have discussed.



CASE STUDY

The factors enlisted above are tabulated in a questionnaire which is forwarded to the company to find out the most influencing risk in that organization so that the loss to the company can be enhanced.

Company Profile

The company ABC Limited Accreditation by JAS-ANZ, a Public Limited Company having its registered office at DLF Industrial Estate-1, Faridabad , Haryana. Basically the company is in the field of design, manufacture and supply of Centralised Lubrication System for various Machines, Plants and Equipments.

It is a listed company at Mumbai Stock Exchange incorporated under the Companies Act, 1956 by Registrar of Companies, Delhi & Haryana in the year 1992.

The company has been promoted mainly by Managing Director – a Mechanical Engineer with M.Sc. (Physics), M.Sc. Mech. Engg. Specialization in Machine Tools from Moscow. He has worked at senior position in TELCO for more than a decade. He started working on the import-substitution of the lubrication systems of machine tools in 1977 and had been instrumental in making the company a profitable concern in this field.

The company is having 2 manufacturing units in Faridabad and Bangalore.

The total numbers of employees are around 170.

The company has its own proprietary items of Lubrication Pump and Accessories and most of them are existing for the last 27 years.The company has the capability to take turn-key project from concept to commissioning. These projects are basically related to Plant Lubrication like Steel, Sponge Iron, Sugar etc. which are normally approved on blue print stage before taking up for manufacturing.

Customers

Machine Tools

Practically all the machine tool manufacturers, particularly CNC machine tool manufacturers have adopted our system as Original Equipment, some of them are

- ACE Designers
- ACE System
- Alex,
- Batliboi
- BFW
- Emco
- Galaxy
- GedeeWeiler
- Impact
- LMW
- Lokesh
- Mac Power
- Marshall
- Micromatic
- Nugen
- PARI
- Parishudh

Steel Plants

The company is supplying Centralized Lubrication System to various steel plants and have proven record for the same. Some of our major customers are

- Alloy Steel Plant, Durgapur

- Bhilai Steel Plant, Bhilai
- Bhushan Steel Ltd., Kolkata
- Bhuwalka Steel, Bangalore
- Bhuvee Profiles (BRG Group), Kolkata
- Bokaro Steel Plant, Bokaro
- Durgapur Steel Plant, Durgapur
- Lloyds Steel, Wardha
- LOI WesmanThermprocess, Kolkata
- Maharashtra Seamless, Thane
- MahindraUgine, Khapoli
- Malvika Steel, Sultanpur
- Mukand, Belapur, Maharashtra
- Multiform Machinery, Mumbai
- Reymonds Steel, Nashik
- Rollcon International, Chandigarh
- Rourkela Steel, Rourkela
- Visheswaraya Iron & Steel Co.

Investor Relations (Shares)

Analysis of Critical Risks of the Company

CALCULATIONS AND RESULTS

The Critical risk factors (CRF) are identified through literature review and in consultation with expert opinions from managers, senior engineers and engineers from Indian Manufacturing Industries. Therefore, AHP is used for prioritization of CRFs as it has the ability to capture both quantitative and qualitative decision criteria. Analytic Hierarchy Process (AHP) was developed in 1972 as a practical approach in solving relatively complex problems. The step by step algorithm used in this paper is shown below.

Step 1: The pair-wise comparisons among the CRFs are developed on the basis of expert judgments. A scale of 1 to 5 as shown below Table 2 is used for pair-wise comparisons. The

Table 1: Showing Shareholding Pattern of the Company

Category code	Category of Shareholder	Number of Shareholders	Total number of shares	Number of shares held in dematerialized form	Total shareholding as a percentage of total number of shares
	Total Shareholding of Promoter and Promoter Group	10	1658083	1491383	40.25
SHARE 1	Public shareholding	5353	2461917	1707951	59.75
SHARE 2	Public shareholding	5435	4120000	3307034	100
SHARE 3	Public shareholding	5415	4120000	3383534	100
SHARE 4	Public shareholding	5408	4120000	3196434	100

Questionnaire

S.NO.	PARAMETERS	intensity of importance				
1	**PRODUCT PLANNING AND DESIGN RISKS**	**1**	**2**	**3**	**4**	**5**
1.1	Master planning & scheduling mistakes			■		
1.2	Non feasibility of new techniques			■		
1.3	manpower shortage		■			
1.4	Manufacturing risks	■				
1.5	quality tools unavailability	■				
1.6	Quality control mistakes		■			
1.7	Change in quantity of products required		■			
1.8	process planning faults		■			
	AVERAGE	**2.0**				
2	**PRODUCT RISK**					
2.1	Inaccuracy in machining			■		
2.2	Machine fault		■			
2.3	process time increase	■				
2.4	Change in cost of product			■		
2.5	quality of raw materials					■
2.6	Faulty Design of product			■		
2.7	frequent maintenance required					■
2.8	scarcity of raw materials					■
2.9	tools and techniques required					■
	AVERAGE	**3.6**				

Questionnaire (Cont.)

3	**PRODUCTIVITY RISKS**					
3.1	Materialnon availability					
3.2	Manpowernon availability					
3.3	Machines malfunctioning					
3.4	Lack of team work					
3.5	Lack of training					
3.6	communication gap					
3.7	quality mistakes					
3.8	testing mistakes					
	AVERAGE			**2.6**		

4	**ENVIRONMENTAL RISK**					
4.1	Political uncertainty					
4.2	Policy uncertainty					
4.3	Social uncertainty					
4.4	Economic uncertainty					
4.5	Natural threats					
4.6	Legal procedures					
4.7	Ecological prospects					
4.8	Environment laws					
	AVERAGE	**1.4**				

Questionnaire (Cont.)

5	**INDUSTRY RISK**					
5.1	Input market uncertainty					
5.2	Product market uncertainty					
5.3	Competitive uncertainty					
5.4	New norms of industry					
5.5	Direct competition from existing firms					
	AVERAGE	**4.6**				

6	**ORGANIZATIONAL RISK**					
6.1	Operating uncertainty					
6.2	Credit uncertainty					
6.3	Liability uncertainty					
6.4	Agency uncertainty					
6.5	HR policy					
	AVERAGE	**1.0**				
7	**DECISION MAKING RISK**					
7.1	Knowledge/ skills					
7.2	Information seeking					
7.3	Rules and procedures					
7.4	Non feasibility of the decision					
7.5	Sudden change in the actual practice					
	AVERAGE	**3.0**				

Questionnaire (Cont.)

8	**PURCHASE RELATED RISKS**					
8.1	cost of purchase					
8.2	Change of price					
8.3	Irregularity in placing order					
8.4	discontinuity in purchase of each item					
8.5	Non availability of items in the market					
8.6	Purchasing person's mistakes					
	AVERAGE	**1.6**				

9	**SUPPLIER RELATED RISKS**					
9.1	Discontinuity in supply					
9.2	Supply mistakes					
9.3	Poor quality of materials					
9.4	Response to frequent demand					
9.5	Change of cost of materials					
9.6	High mixing of good and poor quality					
9.7	Fidelity lacking					
9.8	Delivery delay					
	AVERAGE	**3.5**				

Questionnaire (Cont.)

10	**OTHER RISK FACTORS**					
10.1	safety uncertainty					
10.2	obsolete safety equipments					
10.3	Employees attitude change					
10.4	Drain of skilled personnel					
10.5	High level of inventory					
10.6	Delivery mistakes					
10.7	information technology					
10.8	advanced software					
	AVERAGE			**1.2**		

pair-wise comparisons are done in terms of which a CRF dominates another. These judgments are then expressed as integers. If CRF A dominates over CRF B, then the whole number integer is entered in row A, column B and reciprocal is entered in row B, column A. If the CRFs being compared are equal, a one is assigned to both positions.

Step 2: Construct a set of pair-wise comparison matrices for CRFs on the basis of the opinions of all pre decided number of experts.

Step 3: Check consistency the pair-wise comparison matrix using the eigen value. To do so, normalize the column of numbers by dividing each entry by the sum of all entries. Then sum each row of the normalized values and take the average. This provides Principal Vector (PV). The check of the consistency of judgments is as follows:

Table 2: Pair-wise Comparisons

Intensity of importance	Definition
1	not at all
2	somewhat important
3	Important
4	quite important
5	very important

Let the pair-wise comparison matrix be denoted M1 and principal vector be denoted M2.Then define

M3 = M1*M2 and M4 = M3/M2.

Step 4: Step 2-3 are performed to have relative importance of each CRF. These weights form the basis for ranking the CRF and also the weights are normalized to determine the priority of each CRF.

Table 3: Pair Wise Comparison Matrix										
	PPR	**PR**	**PDR**	**ENR**	**INR**	**ORR**	**DMR**	**PRR**	**SRR**	**OTHR**
PPR	1.00	0.33	0.50	2.00	0.25	2.00	0.50	1.00	0.33	2.00
PR	3.00	1.00	2.00	4.00	0.50	4.00	2.00	3.00	1.00	4.00
PDR	2.00	0.50	1.00	3.00	0.33	3.00	1.00	2.00	0.50	3.00
ENR	0.50	0.25	0.33	1.00	0.20	1.00	0.33	0.50	0.25	1.00
INR	4.00	2.00	3.00	5.00	1.00	5.00	3.00	4.00	2.00	5.00
ORR	0.50	0.25	0.33	1.00	0.20	1.00	0.33	0.50	0.25	1.00
DMR	2.00	0.50	1.00	3.00	0.33	3.00	1.00	2.00	0.50	3.00
PRR	1.00	0.33	0.50	2.00	0.25	2.00	0.50	1.00	0.33	2.00
SRR	3.00	1.00	2.00	4.00	0.50	4.00	2.00	3.00	1.00	4.00
OTHR	0.50	0.25	0.33	1.00	0.20	1.00	0.33	0.50	0.25	1.00

Table 4: Normalized Weight Matrix										
	PPR	**PR**	**PDR**	**ENR**	**INR**	**ORR**	**DMR**	**PRR**	**SRR**	**OTHR**
PPR	0.06	0.05	0.05	0.08	0.07	0.08	0.05	0.06	0.05	0.08
PR	0.17	0.16	0.18	0.16	0.13	0.15	0.18	0.17	0.16	0.15
PDR	0.11	0.08	0.09	0.12	0.09	0.12	0.09	0.11	0.08	0.12
ENR	0.03	0.04	0.03	0.04	0.05	0.04	0.03	0.03	0.04	0.04
INR	0.23	0.31	0.27	0.20	0.26	0.19	0.27	0.23	0.31	0.19
ORR	0.03	0.04	0.03	0.04	0.05	0.04	0.03	0.03	0.04	0.04
DMR	0.11	0.08	0.09	0.12	0.09	0.12	0.09	0.11	0.08	0.12
PRR	0.06	0.05	0.05	0.08	0.07	0.08	0.05	0.06	0.05	0.08
SRR	0.17	0.16	0.18	0.16	0.13	0.15	0.18	0.17	0.16	0.15
OTHR	0.03	0.04	0.03	0.04	0.05	0.04	0.03	0.03	0.04	0.04

Consistency Index (CI) = $(\lambda_{max} - N) / N - 1$

Consistency Ratio (CR) = CI/RI corresponding to N

λ_{max} = average of the CRFs of M4

Where RI: Random Consistency Index (see Table 8) and N: Number of CRFs

Factors	PV	NW	Ranking
PPR	0.61	0.06	IV
PR	1.62	0.16	II
PDR	1.00	0.09	III
ENR	0.36	0.04	V
INR	2.47	0.26	I
ORR	0.36	0.04	V
DMR	1.00	0.09	III
PRR	0.61	0.06	IV
SRR	1.62	0.16	II
OTHR	0.36	0.04	V

M3	M4
6.11	10.04
16.51	10.22
10.17	10.12
3.68	10.07
25.30	10.24
3.68	10.07
10.17	10.12
6.11	10.04
16.51	10.22
3.68	10.07

λ_{MAX}	N
10.12	10
$CI = \frac{\lambda_{MAX} - N}{N - 1}$	CI = 0.0133
$CR = \frac{CI}{RI}$	CI = 0.0067

RESULT

If CR is less than 10%, judgments are considered consistent. And if CR is greater than 10%, the quality ofjudgments should be improved to have CR less than or equal to 10%.

In this study, the CR is less than 0.01. Thus the firm has consistent risk by the use of AHP method. Here the most critical risks are industrial risk and then product related risk. The industrial risk must be dealt with to reduce the losses to the supply chain management. The sub factors associated with the industrial risk should be solved according to their ranking.

Therefore it is advised to the company to deal with reducing the most ranked risks so that the supply chain of the firm can function without loss.

CONCLUSION

The AHP concepts in manufacturing supply chain should be studied with perfection which is the need of the houras manufacturing supply chain is becoming less vertically integrated and the manufacturer is focusing on its corecompetency. Therefore, a structured, simple and efficient proposed decision framework is proposed and has theability to show the direction to determine the degree of impact level of each CRF. The degree ofimpact level of each CRF of the firm will give idea for optimally allocating the efforts to gain maximum benefit. A case situation is elucidated in order to reinforce the salient features of the proposed framework. The results indicate that the industrial risk and then product risk have got the highest impact on successful implementation of SC. Further

research is suggested to develop a decision framework that can able tofind out optimal number of solutions for identifying and mitigating the most influencing factors of the supply chain in aspecific environment.

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