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Abstract: The purpose of this paper is to identify the risk factors involved in the process of supply chain management by small medium enterprises (SMEs) especially the companies engaged in the production of auto components as well as assessing those risks by 'probability-impact analysis'. Researchers conducted a survey of about 72 auto component manufacturing companies in the Manchester of South (Coimbatore District) by using a well-structured questionnaire. Based on the survey of literature as well as discussion with the domain experts, we identified the 17 risk factors in the context of SMEs' supply chain. The identified risk factors are further categorised into four dimensions viz. supply-side risks, operation side risks, demand side risks and external side risks. The major findings of this study point out towards the crucial supply chain risk factors such as lack of financial support, breakdown of machineries, demand fluctuations, up gradation of technology and unable to reduce the raw material cost by the key suppliers. It is expected that the outcome of this study will assist SCM professionals in decision making for better mitigating of risks and to excel in the supply chain performance.

Keywords: supply chain; supply chain risk; P-I matrix; risk assessment; COVID-19.

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1 Introduction

In general, risk is used in the negative connotation. It is the probability of loss, damage or other negative consequences which are caused by internal or external disruption. In other words, risk is equivalent to uncertainty. Supply chain risk is an emerging research area in dynamic business environment. In recent times, Organisations' higher authorities have been showing a serious concern over the risk in the supply chain and how it impacts their business performance (Ganeshan and Suresh, 2017). This makes supply chain risk management (SCRM) more interesting research area and attracts noble researchers. Gaonkar and Viswanadham (2007) states that supply chain risk is the losses occurred in the entire supply chain operation resulting from the discrepancy in possible outcomes. Chen et al. (2013) defined that supply chain risk is the divergence from the expected value of supply chain performance.

SMEs of auto component manufacturing companies seem to be the most relevant industry to conduct research. Indian Auto components industry marked their aggressive growth by 8.8% and recorded the turnover from these sectors as $49.3 billion US dollar during 2019–20. The Indian automotive industry has already proved its capability and has given global recognition to the Indian economy. This recognition gives the place of India on the global map as a manufacturing hub (Frost & Sullivan, 2017). Managing risks in these industries are critical because of their supply chain complexity. Therefore to start with auto components manufacturing sector of small medium enterprises (SMEs) appears to be the most relevant industry to conduct a research for the development of comprehensive framework of SCRM. Christopher and Holweg (2011) addressed that many organisations have not set up a structured and systematic SCRM methods. In addition, firms have very low supply chain performance due to poor knowledge in SCRM (Johnson and Nagarur, 2012). Lavastre et al. (2012) defined SMEs as an inadequately organised, having less number of people and less structured as well as informal risk management practices.

There is a lack of knowledge in SCRM, unhidden risks in supply side, operations side, demand side and external side risks in supply chain, unknown consequences of these risks, poor risk assessment methods, and poor application in mitigation strategies and implementation of SCRM in the context of SMEs. SMEs have shown in lack of SCM knowledge in terms of SCM benefits (Rahman et al., 2011). Sunjka and Emwanu (2013) stated SCRM should be studied more comprehensively in SMEs due to limited studies in this area. Most of the research papers addressed the large scale enterprises' SCM related risks. Only few literatures highlighted the examining of SCRM in SMEs. Ho et al. (2015) noted that manufacturing or process or internal risks are not paid much attention. This gap is identified and addressed as the risk factor in manufacturing or processes of supply chain through wide collection of literature survey. New categories of supply chain risks are identified and are novel to risk categorisation in the main stream SCRM literature. In addition, a statistical report stated that more than 60% of the companies revealed that

their key performance indicators had decreased by more than 3% due to risks in supply chain (PWC and MIT, 2013). Another research report mentioned that supply chain risks caused the decline of the value of shareholders by 11% and 40% decline in their share price (Zsidisin et al., 2015). Supply chain risks are not assessed by probability-impact (PI) analysis with respect to small scale industries. On the basis of these statements, considering them as of paramount importance, this paper ventures to assess the SMEs risks in supply chain by PI analysis.

This paper is categorised into sections ranging from 2 to 7 which enumerates literature review on supply chain risks and risk assessment, research objectives and methodology, analysis and main findings, managerial implications, limitations, future research direction and conclusion of the paper respectively.

2 Review of literature

2.1 Supply chain risk

SCRM is united with risk management practices. It is in upstream and downstream of supply chain. SCRM includes the supply chain members in risk identification, planning, assessing and mitigating of risks in supply chain. Researchers propose that a common method to mitigating supply chain risks needs to follow a systematic and structured method to identifying, assessing and mitigating risks (Yates and Stone, 1992; Steele and Court, 1996; Khan, 2017). Takashi et al., (2020), conducted a comparative study on SCRM analysis between USA and Japan. Their study was related to product risk management and how does it affect firm's performance. Manuj and Mentzer (2008) also proposed that identifying risks is the first and foremost step in SCRM process. Kouvelis et al. (2006) have noticed that very limited literature addresses the issues of risk identification in supply chains. In turbulent business environment, it is becoming increasingly difficult to assess the supply chain risks (Sheffi and Rice, 2005). Rao and Goldsby (2009) mentioned organisational risks occur from one or more of the following sources which includes environmental factors, industry factors, organisational factors, problem specific factors and decision maker factors.

Chopra and Sodhi (2004) classified supply chain risks into system failure, delays, forecast errors, intellectual property issues, procurement, disruptions, inventory and capacity constraint. Sinha et al. (2004) categorised the supply chain risks into four major areas which include suppliers, standards, technology and practices. Finch (2004) sort out the supply chain risks into three broad categories which includes application level, organisational level and inter-organisational level. In the application-level risks include earth quake, Tsunami, accidents, data and information security risks. At the organisational level risk includes legal and compliance issues, while at the inter-organisational level risks occurred from the external side of the organisation. Researchers categorised supply chain risks into strategic risks, operational risks and external risks (Tapiero, 2007; Shimizu et al., 2020).

Risks in the supply chain is broadly identified and categorised into supply chain functional aspects such as upstream risks, operational or process supply chain risks, downstream risks and external risks. In addition, various authors identified and classified the supply chain risks which are environmental risks, organisational risks, network related risks, industry risks, problem specific risks, decision makers risks, disruption

risks, operational related risks, market characteristics risks, product characteristics risks, business or strategic characteristics risks natural and man-made disaster risks and other miscellaneous risks (Miller, 1992; Goldberg et al., 1999; Christopher and Peck, 2004; Manuj and Mentzer, 2008; Tang, 2006; Rao and Goldsby, 2009; Singhal et al. 2011; Ghadge et al., 2012; Hariharan et al., 2019; Wang and Yu, 2020).

Moreover, Christopher and Peck (2004) classified supply chain risks into two categories which includes External risks such as environmental risks, demand and supply risks, internal to the firm: process and control risks. Bogataj and Bogataj (2007) categorised supply chain risk into functional aspects such as supply side, processing/production side, demand side, control and external side risks. Samvedi et al. (2013) categorised supply risks such as supply, demand, process and environmental risks. Each supply chain is exposed to different types of risks based on functional aspects. In the context of SCRM, identifying the potential sources of supply chain risks is the first key step. For the purpose of the present research, we prefer the risk classified by the functional aspect of supply chain which includes supply side risks (upstream), operation side risks, demand side risks (downstream) and external risks.

2.1.1 COVID-19 pandemic in supply chain

Highly dynamic coronavirus (COVID-19) has posted huge challenges for supply chain across different industries irrespective of sizes. Unexpected lockdown urged the industries to redesign their supply chain strategies. Supply chain is the crucial phase for all industries starting from procurement of raw materials, production and distribution of finished goods to final customers. The global economy is witnessing a huge decline in the growth due to the spread of coronavirus at lightning speed in Europe, USA, Asia and Australia. Statistical data revealed that more than 75% of Chinese' production, wholesale, retail and services sectors were impacted by COVID-19 pandemic. In the International market more than 50,000 companies have a direct source of tier 1 suppliers from China and five million companies have a tier 2 supplier there with 940 of those in Fortune 1000 companies. The whole business operation in global market is shaken up by these COVID-19 (Anderson, 2020).

Indian Economy is the fastest growing economy in the world. The unprecedented long period of lockdown and the resultant disruption in production and distribution slow down the growth of Indian economy. The coronavirus outbreak in India had seriously disrupted supply chain across the industries. Few industries like electronics and pharmaceutical sectors' supply chain are already been impacted by coronavirus.

2.2 Supply side risks

Organisations are exposed to numerous risks associated with supply side or upstream side of their supply chain. Supply side risk arises mainly due to the procurement and relationship with suppliers. Supplier risk includes inbound raw material quality, shipment time variability and bankruptcy of suppliers (Manuj and Mentzer, 2008; Wang and Yu, 2020). Sharma and Bhat (2012) mentioned that suppliers' raw material quality problems, delay in delivery, financial failure of suppliers, shortage in production capacity, key suppliers fail to reduce raw materials cost, illegal practices of suppliers, increase in the purchase prices and leakages of knowhow. Moreover, researcher noticed that upstream side of risks include supplier bankruptcy, supply restriction, sharing sensitive

information, fluctuation prices of raw materials and unavailability of raw materials (Kodithuwakku and Wickramarachchi, 2015).

2.3 Operation side risks

The operation side or process side risk is generally perceived as operational disruption and tactical disruption (Kleindorfer and Van Wassenhove, 2003; Paulsson, 2004). The operation side risk takes place in production aspects. It includes equipment malfunction, disruption of supply utilities like poor electricity, labour strikes, industrial actions, breakdown of machineries and tools, failure of IT infrastructure and poor inventory control (Chopra and Sodhi, 2004; Spekman and Davis, 2004; Sharma and Bhart, 2012; Paul et al., 2019; Bao et al., 2020). Operation side risks include, not to achieve required product quality, limited finance capability, absence of adequate labour force, careless accidents, theft, unable to increase production and distorted information (Kodithuwakku and Wickramarachchi, 2015). Ho et al., (2015) mentioned that operation side risks include rate of product obsolescence, capacity flexibility, warehouse and production disruption, production flexibility, technical/knowledge resources, wage rate fluctuations, job dissatisfaction, poor maintenance, lack of motivation, lack of training, product/process design changes, high inventory and production cost.

2.4 Demand side risks

Disruptions occurred in downstream of the supply chain is known as demand side risks. Demand side risks include short product life cycle, customers' dependency, inaccurate forecast, information distortion, demand uncertainty, credit risks and logistics failures (Sharma and Bhat, 2012; Dolgui et al., 2020; Das et al., 2019). Researcher analysed the demand fluctuations which results in bullwhip effect in upstream of supply chain. Nagurney et al. (2005) stated mismatch between the supply and demand due to the changing consumer's purchasing behaviour. This leads to firms making a mistake in forecast.

2.5 External side risks

External side risks are external to the supply chain. These risks may not be controlled by firms. External side risks include natural disaster, war, terrorism, economic downturn, pandemic situation like COVID- 19, competitor risks, change in global market and fluctuations in oil prices and currency rates (Sharma and Bhat, 2012). Hajoary (2015) mentioned change in economic policies such as tax, export and import, trade procedure and unstable international politics cause a major disruption in supply chain. The chance of external side risks is very rare but on its happening it will made a drastic impact on supply chain disruptions. For instance COVID-19 (Salman et al., 2020), Table 1 presents sub classification of supply chain risk factors those identified from comprehensive literature survey and discussion with SCM professionals of auto component manufacturing companies in Manchester of South. The supply chain risks are classified based on the supply chain functions (Bogataj and Bogataj, 2007).

Table 1 Sub classification of supply chain risk factors

S.N.	*Supply chain risks*	*Supply chain risk sub classifications*	
1	Supply side risks	S1	Suppliers quality problem
		S2	Supplier delay risks
		S3	Capacity shortage of supply
		S4	Key suppliers fail to reduce the cost
		S5	Supplier bankruptcy
2	Operation side risks	O1	Breakdown of machineries
		O2	Low production capacity
		O3	Lead time variation
		O4	Lack of financial support
		O5	Job dissatisfaction
3	Demand side risks	D1	Demand fluctuations
		D2	Forecast error
		D3	Credit risks
		D4	Poor logistics performance
4	External side risks	E1	Frequent change in government policy with respect to SMEs
		E2	Up gradation of technology
		E3	Competitors risk

2.6 Risk identification

The first and foremost step of risk management process is identification of risks (Kleindorfer and Saad, 2005). The primary goal of risk identification is to discover the possible potential risks which adversely affect the supply chain. Brindley (2004) stated that its main aim is to recognise and identify the potential risks and uncertainties in order to prevent the adverse effects in advance. Muhammad Saeed et al., (2020) developed a theoretical framework for supply chain risk identification and assessment of their effects on SC performance for Malaysian manufacturing sectors. Buhman et al., (2005) noted that the step of risk identification should make a complete form of understanding regarding the supply chain continuously till find a weak link of the supply chain. Venkatesan and Kumanan (2012) prioritised the supply chain risk by a hybrid AHP model. They opted plastics industry for their study. Tummala et al. (1994) discussed the following methods to identify the potential risks in the supply chain viz.

1 checklists or check sheets

2 event tree analysis or fault tree analysis

3 failure mode and effect analysis method

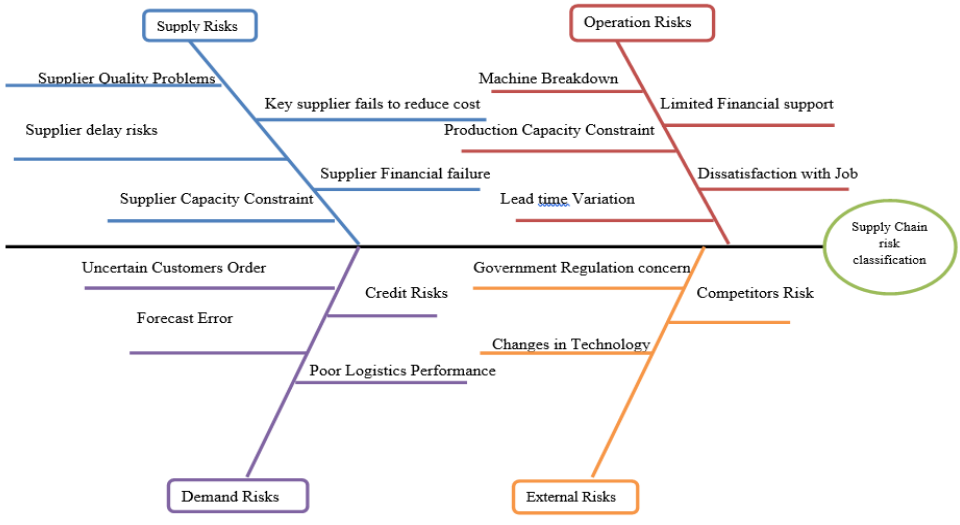
4 cause and effect analysis (CEA) or Ishikawa diagram.

Chase et al. (2006) presented a CEA method or fish bone diagram. It involves the brainstorming of all possible potential causes and effect of risks. The prime motive of fish bone diagram is to identify the root cause of the failure.

The purpose of this paper is to classify supply chain risk factors based on the supply chain functions such as supply-side risks, operation side risks, demand side risks and

external side risks. Further we sub categorised into 17 supply chain risks. Here we depicted the supply chain risks in fish bone diagram (Figure 1).

Figure 1 Cause and effect or fish bone diagram of supply chain risk factors of auto component manufacturing companies in Manchester of South (see online version for colours)



2.7 *Supply chain risk assessment*

After identifying the potential supply chain risk, the next stage is the assessment of risk. It is one of structured process in the risk management system. For every risk there should be a likelihood (probability) as well as consequences (impact). The probability can be defined as the likelihood or chances of occurrence of a particular risk event in future and consequences can be defined as significant impact on the risk event. Impact typically affects the firm's supply chain in terms of cost, quality, and delivery performance. Cox and Townsend (1998) stated that likelihood and impact are the two factors through which the risks are assessed. A standard formula for a quantitative definition of risk:

$$Risk = P(Loss) * I(loss)$$

where

P – Probability

I – Impact.

Researchers used the method of PI risk matrix for the assessment of supply chain risks. It is a semi quantitative method and used two variables of risks, the severity of undesirable event's consequences and the likelihood of occurrence of undesirable event. Zsidisin and Ellram (1999) developed a ten-step systematic approach for risk assessment process. Cigolini and Rossi (2010) proposed fault tree approach to analyse and assess the manufacturing related risk in a supply chain of the particular oil industry. Dietrich and Cudney (2011) adopted a Pugh matrix method to assess the risk in three levels (green, yellow and red) for the selected aerospace industry's supply chain. Sharma and Bhat

(2012) employed the method of analytic hierarchy process (AHP) to rank the risks in supply chain. This method is used to evaluate supply chain risk factors for achieving the supply chain goals. In this paper researchers used PI matrix for assessing the supply chain risk factors.

3 Research objectives and methodology

3.1 Research objectives

The objective of this study is to identify the potential risk factors involved in the process of supply chain by the companies engaged in the production of auto components of SMEs and to assess those risks factors by the method of PI analysis.

3.2 Types of research

Based on the research objectives, descriptive study was used in this paper. SME of auto components manufacturing companies were the target respondents of this study.

3.3 Sampling techniques and sample size

Purposive sampling was used to select the respondents. The study focused on Auto component manufacturers in Coimbatore district. There are two divisions of auto component manufacturers in Coimbatore, registered and unregistered. The auto component companies registered with CODISSIA and Southern Indian Engineering Manufacturers Association (SIEMA) was taken for this study. According to CODISSIA-SIEMA members' lsit-2018, the number of registered small and medium of auto component manufacturers are 103 in Coimbatore. The registered SMEs with Codissia-SIEMA are the population of study. The population consists of SMEs with experience of five years and above from October 2015 to October 2020. SMEs with sufficient experiences can contribute more for this study. Hence, the units which have lesser experiences of below five years are not considered because they have teething problem. In other words, the study focused only on those units which have five years and more experiences in their field of activities. Purposive sampling was used to select 72 units out of 103. The sample works out to 69.90%. The researcher considered that this sample size was adequate for conducting the present research. The data was analysed quantitatively and then inferences drawn from statistical data.

3.4 Research instrument

Researchers used structured questionnaire as a research instrument for conducting survey from 72 auto component manufacturing companies in Coimbatore District. The respondents were the owners, directors or managers of SMEs who have experienced in company operations.

3.5 Data analysis procedure

The primary data were entered into Microsoft Excel software. Microsoft excel was used to calculate the probability – impact matrix for supply chain risk assessment. The probability and impact analysis was calculated for each supply chain risk variables. Standard deviation was used to find out the most critical risks in supply chain. Conclusions were drawn based on the findings of the research.

4 Analysis, inference and discussion

4.1 Descriptive statistics profile SMEs' of auto components manufacturing companies

Most of the studies addressed that impact of education facilitates the development of human capital and in turn contributes for SME performance. It is obvious that individuals with higher level of education can cope up with their business situation than others (Cooper et al., 1994). Today in the competitive business world, the SMEs are under a great pressure. They are competing with Local, National and International players. One of the major challenges faced by Indian SME is lack of talent management. Most of the talented individuals are attracted towards the multinational companies for higher pay prospects. Table 2 shows that educational qualification of the respondents. 45.8% of the respondents were graduates with a bachelor degree, whereas 27.8% of the respondents were post graduates and 26.4% of the respondents were diploma holders. From this it could be inferred that educational qualifications of employees help them to improve their skills and ultimately better performance. They could manage effectively and meet challenges confidently. Table 2 shows that 38.9% of SMEs were providing employment from 6 to 10 employees, whereas 31.9% of SMEs employs from 11 to 15 employees, whereas 15.3% of SMEs were possessing above 15 employees and 13.9% of SMEs below five employees. 51.4% of SMEs were more than seven years of experience in their business and 48.6% of SMEs were five to seven years of experiences in the business. Table 2 shows that amount of money invested by SMEs. It was found that 66.7% of SMEs invested more than 5 Cr; whereas 33.3% of SMEs has invested between 25 lakhs to 5 Cr in their businesses. 30.6% of SMEs marked an annual turnover of 21 lakhs to 30 lakhs, 19.4% above 30 lakhs as an annual turnover and 15.3% has registered less than10 lakhs rupees of their annual turnover.

Table 3 indicated that, high level risk in supply side was the key suppliers' inability to reduce the raw materials cost (70.8%), followed by supplier bankruptcy (51.4%) and suppliers' raw material quality problem (26.4%). On the other hand the respondents rated the poor quality of raw materials (59.7 %) followed by suppliers delay in delivery of raw materials (54.2%). Table 3 also mentioned that the mean and standard deviation of supply side risk factors. If the standard deviation increases, the risk will also increase and vice versa. It is clearly revealed that SMEs face a great deal of risk in upstream of supply chain as the key suppliers refuse to reduce the raw materials cost, the standard deviation value was 0.795 (m = 1.34). The Price of raw materials was directly connected with the production cost. The cost of raw materials was unstable. Thus, SMEs find the ways to mitigate the risk of raw materials price volatility. A research report addressed that irregular change in cost of raw materials and improper pricing structure can negatively

affect the company's performance (Leybovich, 2012). Another survey report indicated that 51% SME owners showing their concern towards the cost of raw materials (McDonald and Wiltjer, 2012). The unprecedented price volatility of raw materials creates a considerable influence on the SMEs operations. The statement also mentioned that 20% of total costs of original equipment manufacturers' are obtained from raw materials (McDonald and Wiltjer, 2012). The major reasons behind volatile price of raw materials are changes in global economy, rising demand and rate of consumption in emerging markets. The second major risk faced by SME was suppliers' quality problem. The standard deviation value was 0.692 (m = 2.33). Most of the respondents felt that the risk was moderate in the quality of raw materials procured from suppliers. Zsidisin et al. (2015) noticed that quality risk is a considerable threat to the firm operations. It is observed that most of the SME is taking steps to address the quality issues with their suppliers at an initial stage. The third major risk faced by SME was supplier bankruptcy (standard deviation was 0.686; m = 1.58). A study revealed that due to the financial crisis of suppliers 84% of SMEs suffered (Brady, 2017). Sharma and Bhat (2012) their study revealed that the financial failure of suppliers impacted the supply chain performance.

Table 2 Profile of SMEs' of auto component manufacturing companies

Characteristics	*Frequency*	*Percentage*
Educational qualification		
Diploma	19	26.4
UG	33	45.8
PG	20	27.8
Total	*72*	*100*
Number of employees working in respondents' firm		
Up to 5	10	13.9
06–10	28	38.9
11–15	23	31.9
Above 15	11	15.3
Total	*72*	*100*
Number of years experiences in business		
05–07 years	35	48.6
Above 7 years	37	51.4
Total	*72*	*100*
Total Investment		
25 lakhs – 5 Cr	24	33.3
Above 5 Cr	48	66.7
Total	*72*	*100*
Annual turnover		
Up to 10 lakhs	11	15.3
11 lakhs–20 lakhs	25	34.7
21 lakhs–30 lakhs	22	30.6
Above 30 lakhs	14	19.4
Total	*72*	*100*

Table 3 Descriptive statistics profile SMEs' of auto components manufacturing companies

S.N.	*Risks*		*Variables*	*Percentage*			*Mean*	*Standard deviation*	*Cumulative standard deviation*
				High	*Moderate*	*Low*			
I	Supply side risks	S1	Suppliers quality Problem	26.4	13.9	59.7	2.33	0.692	0.72
		S2	Supplier delay risks	19.4	26.4	54.2	2.34	0.680	
		S3	Capacity shortage of supply	22.2	57.0	20.8	1.98	0.661	
		S4	Key suppliers fail to reduce the cost	70.8	23.6	5.6	1.34	0.795	
		S5	Supplier bankruptcy	51.4	38.9	9.7	1.58	0.686	
II	Operation side risks	O1	Machine breakdown	15.3	22.2	62.5	2.47	0.707	0.711
		O2	Low production capacity	12.5	38.9	48.6	2.36	0.698	
		O3	Lead time variation	19.4	63.9	16.7	1.97	0.727	
		O4	Lack of financial support	30.6	47.2	22.2	1.91	0.750	
		O5	Job dissatisfaction	20.8	20.8	58.3	2.37	0.513	
III	Demand side risks	D1	Demand fluctuations	76.4	20.8	2.8	1.27	0.813	0.683
		D2	Forecast error	29.2	58.3	12.5	1.83	0.675	
		D3	Credit risks	75	23.6	1.4	1.26	0.678	
		D4	Poor logistics performance	18.1	66.7	15.3	1.97	0.581	
IV	External side risks	E1	Frequent change in government policy with respect to SMEs	23.6	47.2	29.2	2.05	0.629	0.612
		E2	Speed in changes technology	27.8	45.8	26.4	1.98	0.641	
		E3	Competitors risk	75	20.8	4.2	1.29	0.542	

Source: Primary data

4.1.1 Operation risks

From Table 3, it is observed that one of the biggest risks in operation side of supply chain was lack of financial support. The value of standard deviation was 0.750; (m = 1.91). SME faces burdensome availing financial assistance from both private and public financial institution and it urges those SMEs to deal with major current asset to procure raw materials. While applying for a loan by SMEs for their capital expansion, bankers considers the aforesaid issues and refused to. In addition, they aren't familiar with any kind of electronic transactions and also fail to maintain prime financial documents. According to bankers' perspectives, lending to SMEs is a tough task and one third of SMEs operate in informal economy and withstanding on unreliable data (Khan, 2017). Lack of experience cum knowledge in business, failure to submit collateral, higher risk assessment and poor return on investment are considered as the major reasons for the refusal to offer loans to SMEs by financial institutions (AnkitSatsangi, 2017). Kodithuwakku and Wickramarachchi (2015) also found that the reimbursement of financial bills, negatively affect the SMEs' growth. The second major operation risk faced by SMEs was the variation in lead time. The value of standard deviation was 0.727; m = 1.97. The major issues in SMEs' lead time variation are particularly, due to excess inventory, stock out situation or both. Cao et al., (2005) mentioned that longer lead time results in uncertain process of internal supply chain. Firms can withstand in any demand uncertainty promptly with the shorter lead time. Heydari et al., (2009) mentioned that however, lead time is a core parameter in the supply chain and it would affect every elements of the supply chain. Bigliardi and Bottani (2014) also found that the lead time variation have hands in the Supply chain performance. The other operation risks faced by SMEs are machine breakdown (SD = 0.707; m = 2.47), followed by low production capacity (SD = 0.698; m = 2.36) and employees' job dissatisfaction (SD = 0.513; m = 2.37). Sharma and Bhat (2012), Sunjka and Emwanu (2013), Hajoary (2015) and Ganeshan and Suresh (2015) also emphasised in their studies about the impact of breakdown of machines and equipment in the supply chain activities.

4.1.2 Demand risks

It is observed that the foremost downstream supply chain risk is demand fluctuations. The standard deviation value is 0.813; (m = 1.27). The main cause for this risk is imbalances of supply and demand. Demand fluctuations are probabilistic; customers may abruptly increase, reduce, or withheld or withdraw their orders. Sharma and Bhat (2012) found the demand fluctuations affect the supply chain performance. He stated, uncertainty of customer order was the major problem faced by SMEs (4.01) in their supply chain. Ouabouch and Amri (2013) noticed that the unexpected demand fluctuation adversely affect the supply chain activities. In the present day context, volatile demand and changing customer preferences are the biggest challenges faced by SME and in turn urges to maintain a well responsive supply chain. Mentzer et al. (2001) addressed that supply chain practices should be well-organised for products in such a way that effectively respond to the market demand. Krishnadevarajan et al. (2015) stated that Indian manufacturing SMEs face major challenge while tracking the demand i.e. uncertainty in customer orders. Bhattacharya et al. (2014) also stated that demand side trends even impact the supply chain in auto industry. Manufacturers face a tough challenge while determining what to produce, how much units to be produced and when to be produced.

If the firm fails to address that question, they will be out of date for their business. The reasons for uneven demand and supply are that SMEs may not get right quantity of raw materials to meet the production requirements, increased production cost due to setup cost, slow moving goods stored in a surplus manner, inventory shortage and stock out situations. Secondly, the major demand risk faced by SMEs is credit risk. The standard deviation value is 0.678 (m = 1.26). Most of the SMEs are borrowing money from banks and financial institution for operating their businesses. Customers place bulk orders and are requesting credit from the SMEs. SMEs are in a position to give the credit to the trustworthy customers. However, they fix the credit limit and time period. Sharma and Bhat (2012) also highlighted the credit risk as the major supply chain risk for SMEs. It is followed by forecast error (0.675; m = 1.83) and poor logistics performance (SD = 0.581; m = 1.97). Sunjka and Emwanu (2013) found that the failure of logistics services has a considerable impact on the supply chain activities.

4.1.3 External risks

From Table 3, it is observed that the prime external risks variable faced by SMEs was rapid technology advancement. The standard deviation is 0.641 (m = 1.98). Due to the insufficient fund SMEs couldn't invest in any kind of modern technology and thus they could not avail the same. Kusmantini et al. (2015) found the same issue in his studies. Sharma and Bhat (2012) also found that SMEs lacks competency while using the modern technologies. The second most external risk is frequent change in government policy. The standard deviation is 0.629 (m = 2.05). It is observed that SMEs are struggling with the change in the government policy. The policy includes demonetisation, goods and services tax for SMEs, frequent changes in oil prices, rate of interest, trade regulations, minimum wages and the requirements for permits or licenses of safety, environment have effects on business. Government policies reflect on the political culture prevailing in the country. A government should design business friendly policy and regulations in such a way that promotes local businesses. In this connection, Indian government is offering cheap loans and free accidental insurance coverage to millions of small businesses. Small scale companies have been facing problematic situation because of the recent government policies like demonetisation and hasty implementation of nationwide good and services tax. Government announced the GST concessions for SMEs. For instance, the Indian government is working on offering a discount of two percentage points on loans for businesses with annual sales turnover of Rs. 5 cr [Reuters, (2019), p.04]. Lastly, competitor risk (SD = 0.542; m = 1.29). SMEs are facing a stiff competition with local and global players. SMEs normally don't compete on price factor. On the other hand they compete on other factors like quality, flexibility, value and services. Sharma and Bhat (2012) found competitors risk of SMEs as a paramount risk in supply chain. Table 3 also noticed the standard deviation of entire supply chain risk. The foremost risk in entire supply chain is operation side risk and the standard deviation value is 0.711, followed by supply side risk (0.702), demand side risk (0.683) and external side risk (0.612). From the various types of analysis (PI, graphical method and standard deviation), it could be safely concluded that similarity could be seen in these analysis. The high risk factors are operation side risks, supply side risks, demand side risks and external side risks.

4.2 Supply chain risk assessment probability-impact analysis

Formula for calculating the risk probability score

$$Probability\ Score = \left(\sum n_i * P_j\right) \Big/ N$$

whereas

n_i – Number of respondents selecting the rating scale *i*

pi – Probability rating scale (high – 1, moderate – 2, low – 3)

N – Total number of respondents (Lee and Chung, 2008).

Formula for calculating the risk impact score

$$Impact\ Score = \left(\sum n_i * I_j\right) \Big/ N$$

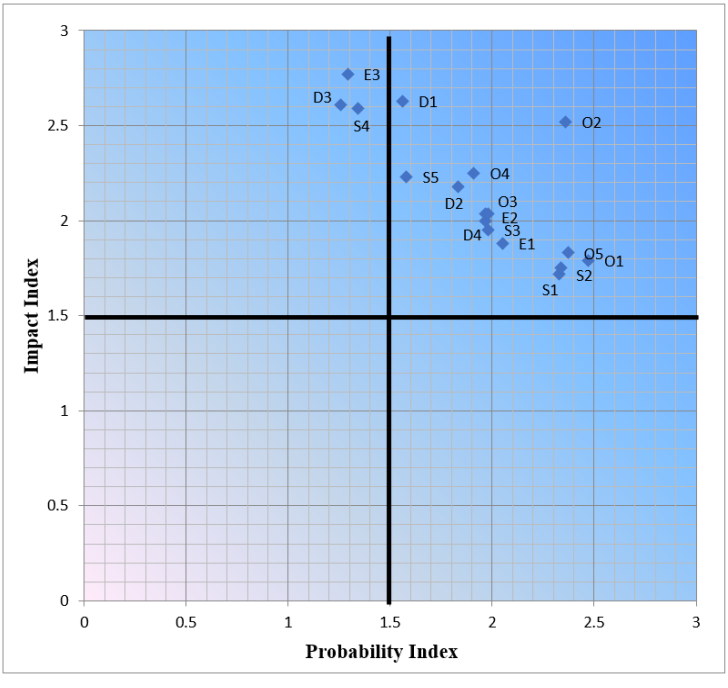
whereas

n_i – Number of respondents selecting the rating scale *i*

Ii – Impact rating scale (minor – 1, significant – 2, serious – 3)

N – Total number of respondents.

Graph 1 Level of criticality value of supply chain risks with average value p-i matrix (see online version for colours)



Notes: LP – low probability, LI – low impact, HP – high probability, HI – high impact

Source: Primary Data

Table 4 Supply chain risk assessment – probability-impact analysis

S. no.	*Supply chain risks*	*Scale*		*Risk probability* High 1	Moderate 2	Low 3	*Probability score*	*Risk impact* Scale	Minor1	Significant2	Serious3	*Impact score*
		Probability		*0.1 to ≤ 0.25*	*0.25 ≤ to <0.75*	*0.75 ≥ to 1*		*Probability*	*0.1 to ≤ 0.25*	*0.25 ≤ to <0.75*	*0.75 ≥ to 1*	
I	Supply risks	S1	Suppliers quality problem	19	10	43	2.33		38	16	18	1.72
		S2	Supplier delay risks	14	19	39	2.34		31	28	13	1.75
		S3	Capacity shortage of supply	16	41	15	1.98		21	33	18	1.95
		S4	Key suppliers fail to reduce the cost	51	17	4	1.34		5	19	48	2.59
		S5	Supplier bankruptcy	37	28	7	1.69		17	21	34	2.23
II	Operation risks	O1	Machine breakdown	11	16	45	2.47		32	23	17	1.79
		O2	Low production capacity	9	28	35	2.36		32	27	32	2.52
		O3	Lead time variation	14	46	12	1.97		16	37	19	2.07
		O4	Lack of financial support	22	34	16	1.91		11	32	29	2.25
		O5	Job dissatisfaction	15	15	42	2.37		33	18	21	1.83
III	Demand risks	D1	Demand fluctuations	55	15	2	1.56		7	12	53	2.63
		D2	Forecast error	21	42	9	1.83		10	39	23	2.18
		D3	Credit risks	54	17	1	1.26		7	14	51	2.61
		D4	Poor logistics performance	13	48	11	1.97		16	40	16	2
IV	External risks	E1	Frequent change in government policy with respect to SMEs	17	34	21	2.05		21	38	13	1.88
		E2	Up gradation of technology	20	33	19	1.98		16	37	19	2.04
		E3	Competitors risk	54	15	3	1.29		2	12	58	2.77

Source: Primary Data

Table 5 Probability and impact averages in supply chain risks

S.N.	*Category of risks*	*Probability score*	*Impact score*
I	Supply risks	1.93	2.048
II	Operation risks	2.216	2.09
III	Demand risks	1.58	2.355
IV	External risks	1.77	2.23

Source: Primary Data

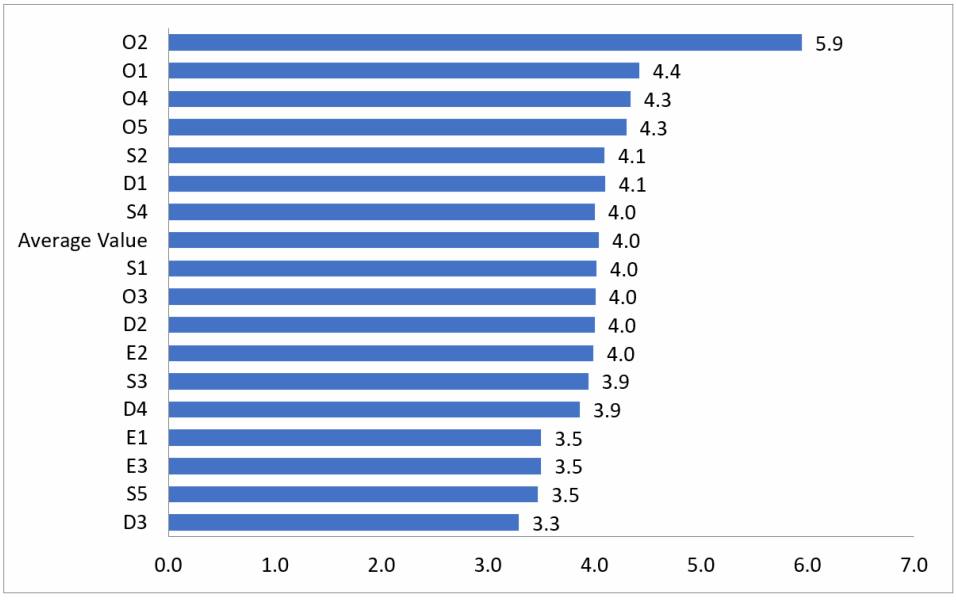
Table 4 shows supply chain risk assessment by using the PI analysis. It is semi quantitative analysis. The table addressed that the PI analysis is calculated for each supply chain risk variables. In response to the risk of supplier quality problem, for instance, 19 respondents (26%) said that raw materials quality issues with suppliers occurred with a probability of less than 25%, 10 respondents (14%) said that probability was between 25% and 75%, 43 respondents (60%) cited a probability more than 75%. The probability score of 2.33 was computed by averaging the risk of the number of respondents and the scale corresponding to each risk. When assessing the impact of suppliers' quality risk, 38 respondents (53%) said that suppliers' quality risk would not result in any impact on operations, 16 (22%) respondents said quality risk has significant impact on supply chain and the probability was between 25% and 75% and 18 respondents (25%) mentioned the probability was more than 75% which indicated quality risk with suppliers a serious impact on operations. The impact score of 1.72 was computed by averaging the product of the number of respondents and the scale corresponding to each risk.

Firstly, based on the upstream side of supply chain risks the major risk variables are key suppliers' failure to reduce the cost of raw materials (2.59), followed by supplier bankruptcy (2.23) and capacity shortage of suppliers (1.95) have gained high impact values. Secondly, in the operation side risks, the low production capacity (2.52), financial constraint of SMEs (2.25) and lead time variations (2.07) have notable values of probability and impact. Thirdly, demand risks noticed that the demand fluctuations (2.63), credit risk of SMEs to buyers (2.61) have gained a high impact value. Lastly, competitors' risk (2.77) and up gradation of technology (2.04) have high level impact values.

To identify the most critical risks PI matrix was employed. Graph 1 shows the probability and impact matrix of supply chain risks, the X axis represents the probability, which increases from left to right and Y axis represents the impact, which moves from lower to higher in upward direction. The matrix depicts that unable to reduce the raw material cost by the key suppliers, demand fluctuations, credit risks and competitors' risk has fallen in least probability and high impact side and other risks factors have fallen in high probability and high impact. It was observed that risk factors (S1, S2, S3, S5, O1, O2, O3, O4, O5, D2, D4, E1 and E2) have the greater supply chain criticality.

In order to verify previous results, researcher calculated the level of criticality for each risk factors using the below formula. Graph 2 indicated criticality levels for supply chain risk factor studies.

Graph 2 Level of criticality value of supply chain risks with average value (see online version for colours)



Source: Primary Data

The supply chain risk criticality is calculated based on the formula:

$$C = P * I$$

whereas

C – Criticality

P – Probability

I – Impact (Dani, 2009).

Graph 2 indicated the criticality intensity of supply chain risk factors with average values. The average value of supply chain risk was 4.00. The seven supply chain risk factors were considered as critical with the average value of above 4.00. As it can be seen from Graph 2, low production capacity (5.9), breakdown of machineries (4.4), lack of financial support (4.3), job dissatisfaction (4.3), supplier delay risks (4.1), demand fluctuations (4.1) and unable to reduce the raw material cost by the key suppliers (4.0) have the highest criticality levels. This study also found that supplier quality problem (4.00), lead time variation (4.0), forecast error (4.00), speed in changes in technology (3.9), capacity shortage of suppliers (3.9) and low or poor logistics performance (3.9) are in medium criticality level. In addition, frequent changes in government policy with respect to SMEs (3.5), supplier bankruptcy (3.5), competitors' risks (3.5) and credit risks to buyers (3.3) have the lowest criticality. Apparently, these findings are convergent with previous results (Table 4) about supply chain risk assessment of probability-impact analysis.

5 Managerial implications

There are multiple benefits that SMEs would get out of the present research. These benefits will have a lot of implications in the management of SME. Firstly, the management of SME would realise details about different types of supply chain risks starting from supply side to demand side and external risks. Secondly, SME managers would get knowledge on risk assessment methods by using PI matrix. This study gives awareness regarding the risks around the SME of auto component manufacturing companies in the process of supply chain. SME owners' should be aware of risk mitigation strategies for each supply chain risk and it would depend on specific situation. The method used in this paper may be useful for practitioners and academicians those who are engaged in exploring the design of supply chain risk analysis models, as well by pointing out vital risk factors which should retain main attention in the SME of auto components manufacturing sectors. The results of this study advocate managers to turn their attention on supply side and demand side risk sources and on excelling in the supply chain management activities such as supplier relationship management, flexibility in operations, forecasting the demand as well as cooperative information sharing with customers and suppliers.

6 Limitations and future research

There are few limitations in this study, firstly, the identification of risks in supply chain, which was used as a wide collection of literature survey to identify the potential risks in supply chain. Further, the identification of supply chain risks can be explored by check list or check sheet method. This method can be used to collect the reliable data and also to know that frequency of failures occurred in a specific event. Secondly, this paper recommends the supply chain risk assessment by semi quantitative method. Further, research can be done by quantitative methods like simulation methods and AHP. Thirdly, this paper only focused on SME of auto components manufacturing companies; it can be further explored across multiple SMEs' industrial sectors like motor pumps, textiles and plastics. Fourthly, primary data generally have limitations on supply chain risk factors consideration and other risk factors such as natural and political risks are beyond the purview of the present study. Fifthly and lastly, Supply chain in services sectors are attracted many researchers. The research must be enriched in SCRM of service sectors for instance banking, insurance, healthcare, IT, ITES and telecommunication.

7 Conclusions

Supply chain risks management analysis paves more attention on industry and academics. Often SME classify supply chain risks into supply side, operation side, demand side and external side risks. On the basis of extensive literature survey and discussion with SCM professionals of auto component manufacturing companies in Manchester of South, 17 supply chain risks were identified. Author represented these risks into fish bone diagram. Supply chain risks were assessed by PI matrix. The major potential risk factors identified were operation side risks followed by supply side, demand side and external side risks. The supply chain risk identification method proposed in this paper can be useful for

managers and academicians involved in investigating the design of supply chain risk analysis models, as well by pointing out critical risk factors which should retain main attention in the auto components industry. The findings of this study can also paves the way to the professionals to achieve effective risk management practices in the whole supply chain. The results of this study encourages managers to primarily pay their attention on operation side, demand side and supply side risks and on excelling in the field of supply chain management such as planning and scheduling the work, emphasise JIT principles, maintain strategic relationship with suppliers, improve forecast accuracy as well as information sharing with customers and suppliers.

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