Identification and Assessment of Supply Chain Risks Associated with Dairy Products Sector

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Abstract: Risks cannot be entirely removed or eliminated from Human's life and from lives of Organizations but may be mitigated and their effects may be reduced. The principal objective of this research is to identify and assess supply chain risks in dairy products sector. A set of supply chain risks is identified through extensive literature survey and is divided into five major categories and 28 components through Risk Breakdown Structure approach. A questionnaire is developed based upon these 28 components and data collected from 170 respondents. Risks are assessed through Probability and Impact scores obtained from responses and then slotted into 2x2 Risk Matrix. A risk matrix comprising of 04 quadrants is formulated through low and high scores of probability and impact of all 28 risks. It is found that 16 risks fall in high risk quadrant, 08 in moderate and 04 in low risk quadrant. Risks of competition, deceases, terrorism, quality of raw materials, natural disasters along with those falling high risk quadrants are required to be promptly responded by dairy sector operators for effective risk mitigation. Similarly risk responses have been suggested for moderate and low gravity risks as well.

Keywords: Supply Chain Risk Sources, Risk Assessment, Risk Grid, Dairy Sector, Supply Chain Management.

1. INTRODUCTION

Most of the organizations rely on a strong supply chain management in order to support the process starting from purchase of raw material and ending on product delivery with consumers. Risks are also associated in each part of this process. The devastations caused by Supply chain disruption are evident by the example of 09/11 attacks which prompted Toyota in India to halt the production because raw material could not be arrived [1]. Risk Identification, prioritization and mitigation plays a critical role in ensuring success of supply chains. Effective risk management can only be made possible if risks are properly identified [2, 3]. Demand variability and supplier delivery risks have been presented as two major supply chain risk categories by Zhao, Huo, Sun, & Zhao, (2013) [4]. They also presented external factors risks during identification of relationship between supply chain risk and company's performance. Another example of effective supply chain risk mitigation can be given by famous Nokia and Eriksson example where Nokia preemptively acted and averted huge disruption in Supply chain due to fire in a Supplier's facility, but Eriksson could not and had to suffer. Researchers have mainly concentrated on five types of supply chains risks i.e. supply side, demand side, informational, logistics and external factors risks. According to IFCN, (2013) [5]; Pakistan is placed at Number 04 in Milk Production. Similarly Pakistan also enjoys the status of one of the highest dairy consuming countries in Asia [6]. Current research focuses on supply chain risks associated with Dairy Products Sector in Pakistan.

2. LITERATURE REVIEW

The terms risk and uncertainty are a bit perplexing and sometimes it is impossible to distinguish between them [7]. Risk has been defined as function of Probability and Impact by [8]. Christopher, (2011) [9] has elaborated Supply Chain Management as network of the organizations; which add value at each stage until the product reaches at end user. Supply chain risks have been classified in terms of internal and external by Olson and Wu, (2010) [10] and they further classified external risks into competition, political issues and naturals issues, whereas internal risks were classified into organizational operational activities, information systems and available capacity issues.

Demand fluctuation has been described as a major disruption on demand side risks by Tang and Tomlin, (2008) [11]. Similarly forecasting errors have been raised as demand side disruption by Manuj and Mentzer, (2008) [12]. The problems in distribution can be so devastating that it can force organizations to entirely change their distribution channel; which causes huge cost and efficiency issues [13]. The research has also shown that demand side of supply chain is affected by the issues of substitute availability as well [10].

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Quality problems of raw materials have been observed as risk component on supply side by various researchers [12, 14, 15]. Milk quality has been elaborated as critical supply side risk by Umm e Zia, Mahmood, and Ali, (2011) [16]. Incorrect ordering mechanism also affects supply side quite badly [17]. Abrupt changes in design and technology pose a lot of issues on Supply side of the organizations [18]. The supply side is also disrupted when suppliers create monopolies and different organizations have to rely on same supplier [3]. This phenomenon is also known as backward integration by competitors as it may create situation where competitor will be controlling supplies. Tang and Tomlin, (2008) [11] also listed risks like Supply risk, demand risk, intellectual property risk and political risk among supply chain risks; however they have subcategorized supply side risks into supply cost risks and supply commitment risks. Though presence of supply cost and commitment risks is not observed so frequently however lack of commitment has been presented in the shape of provision of inferior quality raw materials which has also been used in this research as well. Supply cost can also increase if manufacturers are to rely on same supplier.

Financial health of goods carrier plays a very important role for smooth operations of supply chain on logistic side [19]. Storage and Transportation have also been raised as risk components on logistic side of the supply chain [19,20]. Delay in product delivery has been observed many times due to improper packaging [21]. Timely delivery of milk due to its perishable nature leads to the nation that delivery is subcomponent of logistic side risks [22].

External factors in the shape of government, political situations, import laws, bureaucratic hurdles, competitors and fluctuations in pricing halted smooth operations of supply chain on many occasions; hence pose themselves as major risk components in supply chain management in the form of external factors risks. Natural disasters, terrorism and diseases do also create hurdles in smooth operations of supply chains [23, 24]. Another research has shown that political unrest, war, deceases, natural disasters and terrorism play major role in disrupting supply chains management [25]. Obsolescence, economic situation, competition and regulatory issues have been presented as major external factor risks by Olson and Wu, (2010) [26].

Smooth flow of information is considered as an important factor in supply chains [27, 28]. Sharing of information has also been presented as factors which separate successful and unsuccessful supply chains [29]. Pujawan and Geraldin, (2009) [17] have described Information System Breakdown as disruption component in informational risks. Incorrect market intelligence, access to key information and lack of smooth data movement have also been presented as major risk components in informational risks [29]. The distorted information also plays its part in halting smooth supply chain on information side [30]. Dairy Sector in particular is being affected by the Risks of quality of raw material due to lack of clean drinking water for animals [31]. Deceases, draughts and abrupt changes in regulations affect dairy supply chain negatively [32].

The negative impact of supply chain risks on supply chain performance has been evidenced by Wagner and Bode, (2008) [25]. The risks of product quality, cost, competition and transportation appear among top 05 risks calculated by Schoenherr, Rao Tummala, and Harrison, (2008) [33] and it will be interesting to observe in this research study that how much gravity these risk subcomponents possess in supply chain of Pakistan's dairy sector. The Managers in different organizations do mitigate supply chain risks by relying on safety stocks, flexible transport and utilization of multiple sources; however in absence of effective supply chain risk management; the organizations may have to face untoward situations if some unforeseen events happen [34].

Although supply chain management and supply chain risk management is the subject of choice for many researches in recent times however identification and assessment of risks in dairy sector still requires investigation. This is also pertinent to mention that empirical utilization of risk grid for risk assessment in dairy sector of developing country like Pakistan is still in its infancy stage. This is the gap in subject which this research study had endeavored to address.

3. RESEARCH METHODOLOGY

A thorough review of literature resulted in exploration of 28 risk components which stem from 05 major risk drivers i.e. demand side, supply side, external factors, logistics and informational risks. The risks elaborated in risk breakdown structure (Figure **1**) have been assessed through questionnaire responses. A 2x2 Matrix has been used for risk prioritization.

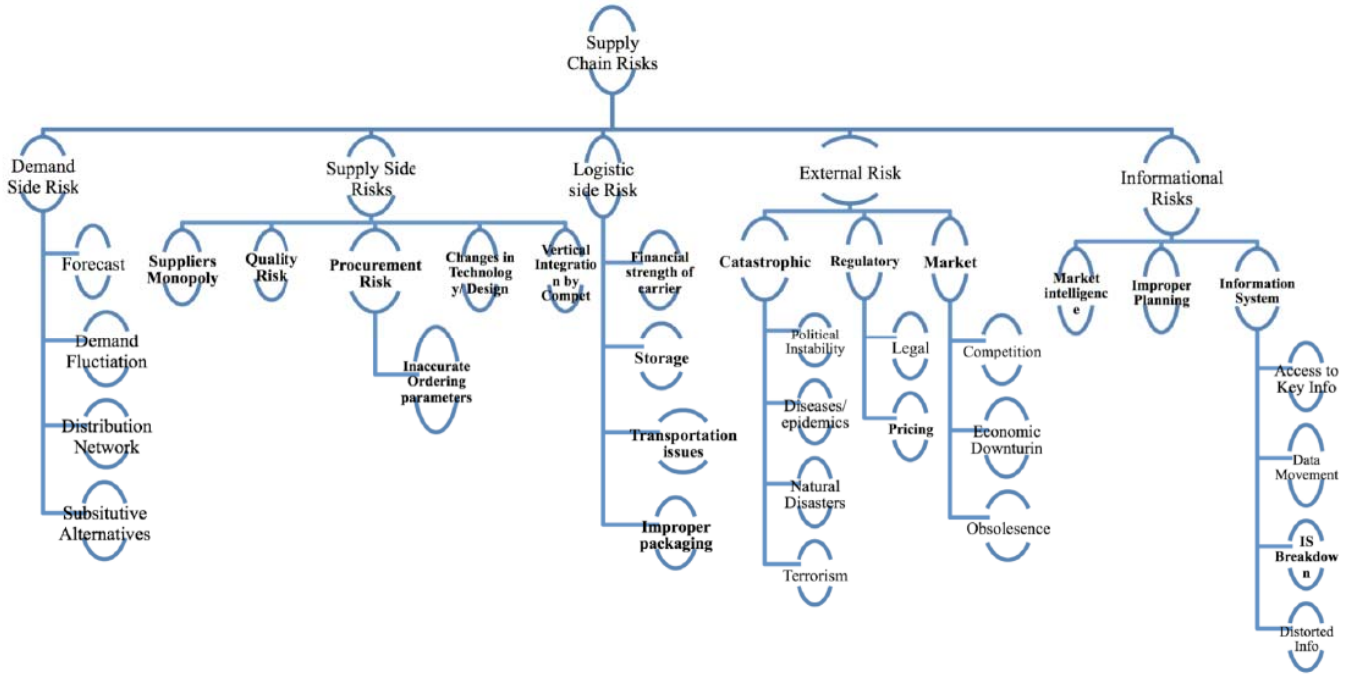

Figure 1: Risk Breakdown Structure.

3.1. Data Collection

A questionnaire containing 28 items has been developed and used to collect data from dairy sector. The sample for this study consists of 170 respondents who belong to 05 Organizations. 130 questionnaires out of 170 were received and 116 were used for the purpose of risk analysis. The breakup of Sample in terms of Demographics has been given at the end of this paper through Tables **4** to **7** in Appendix section.

3.2. Risk Matrix

Risk Matrix Approach has been used for the purpose of Risk prioritization. Risk matrix which is also known as Risk Grid; was explained by Vose, (2008) [35] in his research work of Quantitative Guide of Risk Analysis. Risk matrix has also been elaborated by Waters, (2007) [36]. Risks are distributed into 03 categories i.e. High, Medium and Low Severity. The severity of Risks is determined by Probability and Impact. Wieland, (2013) [37] categorized supply chains into Rigid and Agile Supply Chain by using risk grid formed through probability and impact scores. The questionnaire described in earlier section measures probability and impact of each component of risk through respondents feedback provided on Likert scale.

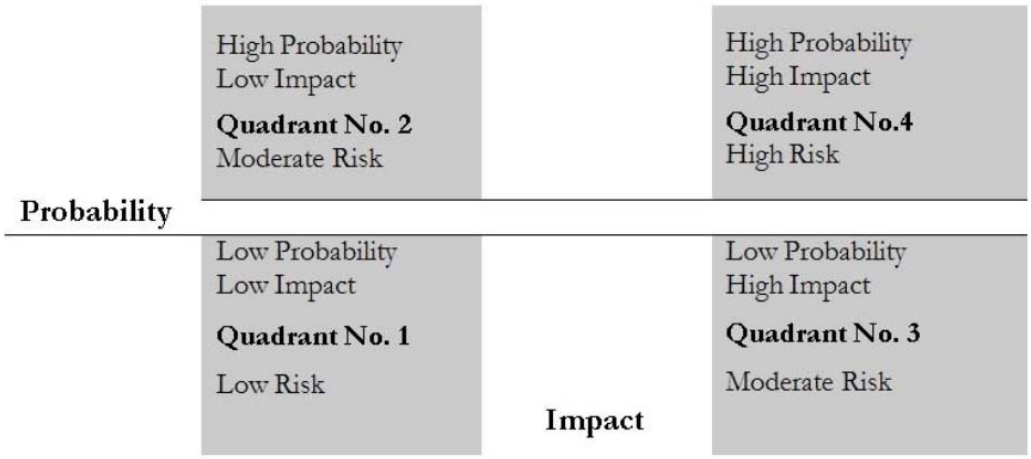

Figure 2: Risk Matrix.

The Risk matrix has been formed in this study by using following four quadrants with respect to Probability and Impact.

3.3. Questionnaire

Extensive literature review elaborated in the previous section has been utilized to develop instrument and each of supply chain risks i.e. demand side risk, logistic risk, supply side risk, external factors risk and information risk have been broken down into their components. Instrument comprising of 28 Items measured on five point Likert scale has been used to collect data. Separate questions have been used for probability and impact of each Risk component. Each item assesses the each risk described in Risk breakdown structure. The Risk as a function of Probability and Impact was explained by [38, 40]. It is pertinent to mention that Mitchell, (1995) [41] derived formula for calculation of risk through probability and impact as follows:

$$Risk = P(Loss_n) * L(Loss_n)$$

P denotes probability of certain loss and L shows the impact of that loss. Thun & Hoenig, (2011) [42] in their research on supply chain risks associated with German Automotive Industry also used this technique for calculation of Risk through probability and impact items in the questionnaire. Similarly Risk scores have also been calculated by Vilko & Hallikas, (2012) [43] during their Research on Multimodal Supply Chains.

3.4. Assessment of Scale

According to [44], an instrument is considered acceptable and reliable if Cronbach Alpha is more than 0.70. Table **1** shows value of Cronbach Alpha calculated for the scale used for this study. The score of 0.849 shows that instrument is reliable enough as it meets the criteria. This is also pertinent to mention that KMO measure of Sampling Adequacy is greater than benchmark of 0.70 and Bartlett's test is significant as well. Results are shown in Table **2**.

Table 1: Value of Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	**No. of Items**
.849	28

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.762
Bartlett's Test of Sphericity	Approx. Chi-Square	1808.171
	Df	378
	Sig.	.000

4. RESULTS

Table **3** shows risk scores of all 28 risks; earlier elaborated in Risk Breakdown Structure. The Risk Scores have been calculated through multiplication of probability and impact scores and presented in descending order for better visualization.

Competition is viewed as highest scored risk component among all risks associated with Dairy Products Sector of Pakistan. At present major market players i.e. Nestle, Haleeb and Engro Foods are striving to ensure their maximum presence in market; hence this situation is prompting competition asmaximum scored Risk. Substitutes is positioned at No. 02 as this research has been conducted in such a developing country where dairy sector is dominated by 90% unbranded and open milk; hence it is posing huge challenge for UHT milk processors. External factors are dominant in top ten scored Risks; mainly due to prevailing security, law and order and economic situation of the country. Deceases i.e. Animal deceases product drastic impact on supply chain of dairy sector as it poses serious issues on supply side i.e. supply of raw material in the form of milk. Quality is also present among top scored risk as milk is perishable product and even minor compromises on quality can affect supply chain badly.

5. DISCUSSION

Risk Matrix has been used for assessment of the Risks. This 2x2 Risk Matrix has been formed by using 2.5 as Midpoint. The cutoff point of 2.5 is used because items in the questionnaire comprise of 5 point Likert scale. Further this cutoff point also splits scores into High Probability/ High Impact Risks and Low Probability/ Low Impact respectively. The midpoint of Likert Scale has also been used in earlier Researches for assessment of Supply Chain Risks by [42, 45,46].

The Risks has been slotted according to the following mean values. The scores depicted geographically in Figure **4** have been used in the formulation of Risk matrix.

Table 3: Risk Scores

Rank	Risk Component	Risk Score	Rank	Risk Component	Risk Score
1	Competition Issues	54.24	15	Distorted Information for MIS	35.28
2	Substitutes	50.52	16	Inaccurate Ordering Mechanism	34.66
3	Terrorism	50.48	17	Obsolescence	32.59
4	Political Instability	42.34	18	Poor MIS	31.93
5	Backward Integration	42.17	19	Inaccurate Market Intelligence	31.48
6	Transportation Issues	40.62	20	Information System Breakdown	31.28
7	Storage Issues	40.03	21	Improper Packaging	31.21
8	Diseases	40.07	22	Same Supplier as Competitor	30.31
9	Substandard Quality	38.62	23	Economic Downturn	29.97
10	Price Fluctuation	38.41	24	Demand Fluctuation	29.90
11	Natural Disasters	38.28	25	Issues with Goods Carrier	26.55
12	Demand Forecast	37.76	26	Legal Issues	25.52
13	Access to Critical Info	37.10	27	Abrupt Technological Changes	24.59
14	Distributor's Issues	35.72	28	Hurdles in Data Movement	24.34

- Quadrant#01: Risk with the score of Low Impact (means≤2.50) and Low Probability (means≤2.50)
- Quadrant#02:Risk with the score of Low Impact (means≤2.50) and High Probability (means>2.50)
- Quadrant#03:Risk with the score of High Impact (means≤2.50) and Low Probability (means≤2.50)
- Quadrant#04:Risk with the score of High Impact (means>2.50) and High Probability (means>2.50)

Figure **3** summarizes all the Supply Chain Risks under study into four quadrants according to above mentioned treatment of mean values of their Probability and Impact Scores. The quadrants basically suggest relevant action to be taken. The figure shows that 16

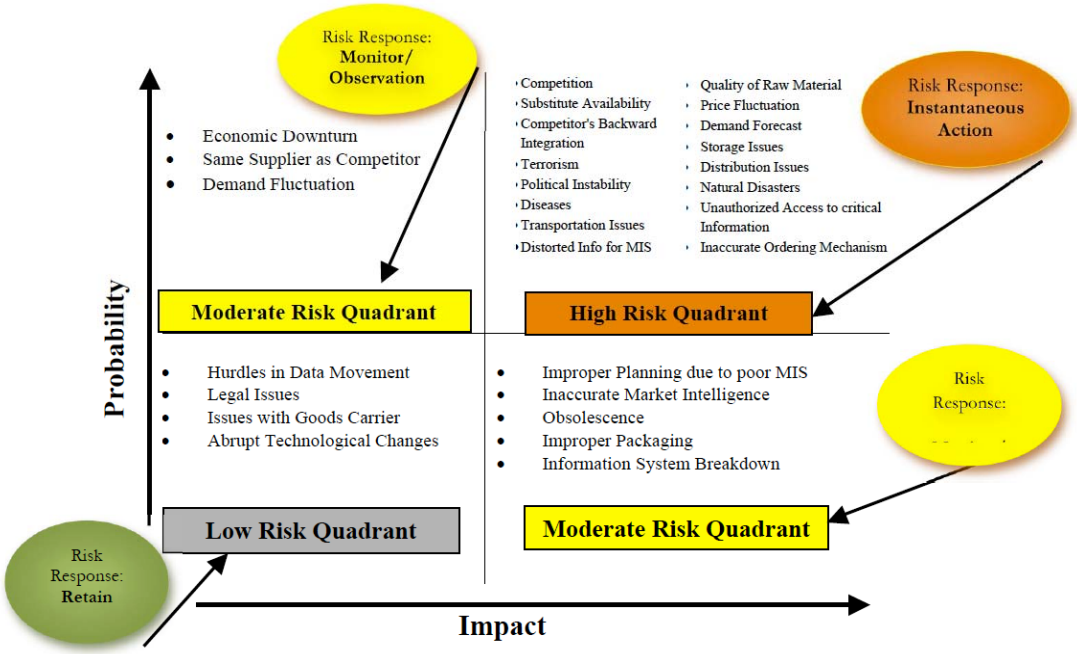

Figure 3: Risk Matrix and Risk Responses according to Severity.

risks fall in High Risk quadrant as their probability and impact both have been perceived as high. Similarly 08 risks have been assessed as Moderate and 04 Risks have been assessed as Low severity risks.

After slotting Risks into their relevant quadrant; next step is to decide type of strategic action to be taken for the mitigation of these Risks. Three types of Actions i.e. Immediate Action, Monitor and Retain have been suggested in line with Researches by [36, 42, 45, 46]. The mitigation strategies can be designed for each of the risk where immediate action needs to be taken. Few of the Risks can also be transferred through Insurance and by transferring the risk towards suppliers or distributors. Risks can be monitored through adoption of Risk response register and recording each potentially risky incident.

6. CONCLUSION AND PRACTICAL IMPLICATIONS

Pakistan is rated among one of the highest milk producing and consuming countries, which makes this sector as relevant and impactful sector to conduct a research study. Certain supply chain disruptions associated with dairy sector do cause hurdles in smooth operations of dairy sector operators. This study initially identified risk associated with supply chain through literature survey and slotted them into Risk breakdown structure. Then using questionnaire survey those risks have been rated high, medium and low on the basis of their probability and impact scores placed Risk grid.

High risk quadrant comprises of 06 external risks, 03 demand side, 03 supply side, 02 logistic side and 02 informational risks. Moderate risk quadrant comprises of 03 Informational, 02 External, 1 demand side, 1 supply side and 1 logistic side risk. Low risk quadrant comprises of 1 risk pertaining to Logistic side, Informational side, external factors and supply side risks. The risks falling in high risk quadrant needs immediate mitigating measures as if we have a glance on few of them then we come across the conclusion that their impact can be devastating. Deceases can be so impactful that it can disrupt whole supply chains and effective vaccination systems along with community based veterinary can be useful in the mitigation of deceases. Similarly reducing the role of middle man can be helpful in minimizing the impact caused by price fluctuation. The quality of raw material becomes even more critical if we consider dairy products as milk is highly perishable product and any deficiency in its quality can cause huge supply chain disruptions. Better quality can be obtained through adoption of supplier selection criteria and through introduction of supplier's rating mechanism. These are few of measures which can be adopted for the mitigation of some supply chain risks associated with dairy products sector. However detailed study on adoption of mitigation technique can unearth few more workable strategies.

7. RESEARCH LIMITATIONS

This Research has been conducted in a developing country and risk dynamics can vary in other countries due to variations in influencing factors. This study focuses on dairy product sector only and results may vary in other sectors and may require different treatment.

8. FUTURE RESEARCH

Precise mitigation strategies for each type of risk can be worked out through further research. Factor analysis can be performed to identify risks groups more precisely. Largerrisk matrices can also be used for further assessment of risks associated with supply chain management of dairy sector.

APPENDIX

Table 4: Education Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Inter	1	.9	.9	.9
	Bachelors	42	36.2	36.2	37.1
	Masters	66	56.9	56.9	94.0
	M.S and Above	7	6.0	6.0	100.0
	Total	116	100.0	100.0	

Table 5: Department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Planning	8	6.9	6.9	6.9
	Purchase	18	15.5	15.5	22.4
	Production	14	12.1	12.1	34.5
	Supply Chain	39	33.6	33.6	68.1
	Logistics	8	6.9	6.9	75.0
	Sales	18	15.5	15.5	90.5
	Any other	11	9.5	9.5	100.0
	Total	116	100.0	100.0	

Table 6: Locality of Workplace

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lahore	67	57.8	57.8	57.8
	Sahiwal	26	22.4	22.4	80.2
	Sheikhupura	6	5.2	5.2	85.3
	Kabiwala	17	14.7	14.7	100.0
	Total	116	100.0	100.0	

Table 7: Organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Engro Foods	57	49.1	49.1	49.1
	Nestle Pakistan	23	19.8	19.8	69.0
	Anhaar Dairy	13	11.2	11.2	80.2
	Haleeb Foods	18	15.5	15.5	95.7
	Others	5	4.3	4.3	100.0
	Total	116	100.0	100.0	

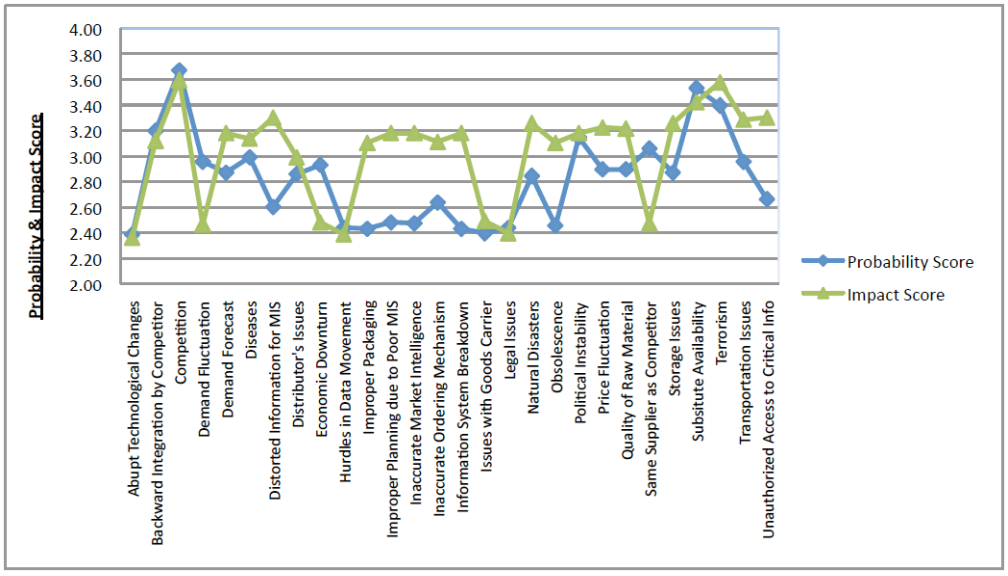

Figure 4: Graphical Description of Probability & Impact Scores of Supply Chain Risk Components.

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