

## Warehousing Risk Management in Different Industrial

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Sahar Elbarky<sup>1</sup>, Maha Morssi<sup>2</sup>

<sup>1</sup> College of International Transport & Logistics, Arab Academy for Science, Technology and Maritime Transport, Alexandria – Egypt.

<sup>2</sup> College of International Transport & Logistics, Arab Academy for Science, Technology and Maritime Transport, Alexandria – Egypt.

{ selbarky@aast.edu, maha.morsy@aast.edu }

**Abstract.** Organizations seek to improve their supply chain performance to be more effective and efficient even in risky environment that lead to supply chain vulnerability. Therefore, managing risks across supply chain activities and entities became significant requirement. One of those entities is the warehouse that provide the chain with value-added through availability of goods at right time and right place. This study attempts to assess the risks associated with warehousing in different industrial sectors. Also, to propose a response for significant risks to eliminate and mitigation their impact on the chain performance. Eight case studies were used to assess the risks associated with warehouse in real-life context. The findings show that damage of goods and accidents are common significant risks, missing of goods, and fire across the industrial sectors. The study opens new opportunities for researchers for further investigation in risk management in the warehouse as a significant entity in the supply chain.

**Keywords:** Supply Chain Vulnerability, Risk Management, Warehousing.

### 1 Introduction

Supply chain management (SCM) has traditionally been viewed as a process in which raw materials are converted into final products, and then delivered to the end-consumer [2]. The main objective of SCM is creating net value, building a competitive infrastructure, synchronizing the goods supply, measuring the performance globally and leveraging worldwide logistics. Supply Chain does not only include the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves. Supply chain includes many activities and not limited to new product development, marketing, operations, distribution, finance, and customer service [9]. It includes warehousing, transportation and purchasing. The way to manage these activities will influence the efficiency and overall success of the business [6]. A warehouse provides a central location for receiving, storing and distributing products. As each inbound shipment arrives, responsibility for the goods transfers to warehouse personnel. Warehouses can be classified according to the type of goods stored and such a method would involve classification as follows: dry, refrigerated or frozen foods, clothes and textiles in general, construction equipment and materials, machinery and spares, and so on [10]. The warehouse provides the chain with value-added through availability of right goods at right time and right place. Warehouses can be a source of competitive advantage, as for example when Wal-Mart introduced cross-docking techniques in their warehouses [30]. Therefore, if there is any risk inside the warehouse, this risk has impact on the personal and activities performance which can be lead to the supply chain vulnerability.

Over the last decade, the globalization of business and the manufacturing industry in particular have made it imperative for executives and risk managers to reassess how they manage the growing number of risks facing their organizations, especially those affecting supply chains [25]. Supply chain risk is about any threat of interruption to the workings of the supply chain. Risk may be generated as a result of risk 'drivers' that are either internal or external to the company [11]. The Supply Chain Risk Leadership Council (SCRLC) defines "Supply-Chain Risk" as the likelihood and consequence of events at any point in the end-to-end supply chain, from sources of raw materials to end use of customers, and "supply-chain risk management" as the coordination of activities to direct and control an enterprise's end-to-end supply chain with regard to supply-chain risks. Supply chain professionals among whatever the companies' size face a wide range of risks that never make the headlines. Indeed, the Japanese tsunami and earthquake riveted the world a few years ago, but in the meantime, supply chain professionals have to deal with the

unexpected day-to-day challenges that have just as much impact when taken as a whole on an organization [14]. Effective supply chain risk management in the manufacturing organization goes beyond traditionally insured risks such as tangible assets and related liabilities; rather, it focuses on the assets as part of a process. With rapid change in today's international business environment contributing to increased risk exposure across all operational functions. Top management must consider a more comprehensive risk management program that emphasizes efficiencies and addresses a wide variety of traditional (or insurable) and nontraditional (or no insurable) risks.

## 2 Research Problem

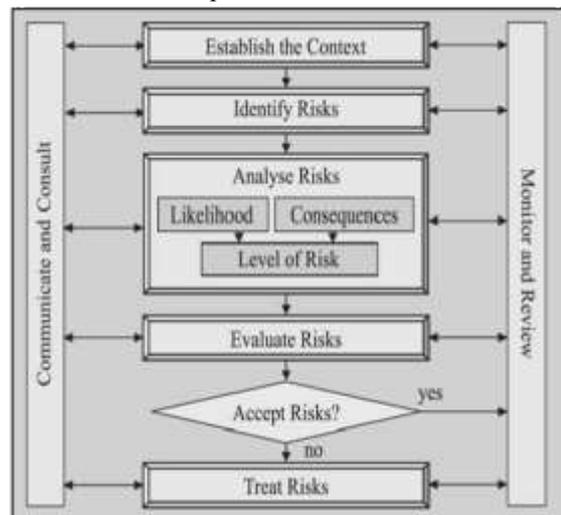
Many Egyptian companies in different industrial sectors are seeking to increase their supply chain effectiveness and efficiency through minimizing the potential risks that could happen and lead to decline in performance and supply chain vulnerability. Some of those risks face the warehousing. Therefore, research problem can be summarized in the following question:

***"What are the common significant risks across the different industrial sector in the warehouses that lead to supply chain vulnerability?"***

## 3 Risk Management Process

According to [36], Risk Management is the act or practice of dealing with risk. It includes planning for risk, identifying risks, analysis risks, developing risks response strategies, and monitoring and controlling risks to determine how they have changed. Furthermore, Stanleigh (2010) defined risk Management as the process of identifying, analyzing and responding to risk factors throughout the life of a project and in the best interests of its objectives. Proper risk management implies control of possible future events and is proactive rather than reactive. Risk is the main cause of uncertainty in any organization. Thus, companies increasingly focus more on identifying risks and managing them before they even affect the business. The ability to manage risk will help companies act more confidently on future business decisions. Their knowledge of the risks they are facing will give them various options on how to deal with potential problems [4].

Risk management is the process for systematically identifying, assessing and responding to risks. According to Standards Australia and Standards New Zealand (2004)[14], the risk management process includes three phases are necessary: risk recognition; risk prioritization; and risk management. The three phases and the steps in the process are presented in Figure 1. The risk recognition phase has two parts: context establishment, which defines what is at risk; and risk identification, which covers the identification within the established context of uncertain events that could cause harm or benefits, their associated causes and their potential consequences. The outcome of this phase is a list of the risks that are likely to affect the supply chain, logistics hence the broader organization. Once the risks have been identified, the next stage is risk prioritization phase which has two parts. This first is risk analysis based on quantitative approach, which is based on likelihood and consequence. Likelihood depends on the probability of occurrence and the frequency of activity. The consequence or severity of risk can be measured in many ways, such as effects on specific process or on the organization. To analyze or assess the risk quantitatively, the likelihood of a risky event occurring and the severity of risks can be estimated using Likert scale 1-5. 1 is for the lowest probability and severity and 5 is for highest probability and severity. Then multiplying these two values together gives a score that reflects the impact of the risk as follows [36]: Risk = the likelihood of a risky event occurring X the consequences or the severity of risks.



**Figure 1:** Risk Assessment Process (Standards Australia and Standards New Zealand, 2004a, b)

#### 4 Literature Review

To review the previous literature on supply chain and warehousing risk management, several web sites and journals such as Elsevier, Science Direct, SSRN, and Emerald have been used. The reviewed papers were mostly published between 1990 since 2015. The keywords used in searching and reviewing were “supply chain risk management”, “risk management framework”, “warehousing”, “assessing risks in warehouse”. The subject of supply chain risks has become a growing topic of management research [20]. [17] stated that disruptions in supply chains caused by fuel protests, disease outbreaks, terrorist attacks, and the threat of weapons of mass destruction have been appeared at the beginning of the twenty-first century. In the same year, [28] reported risk management at Samsung Electronics and describing the risk-mitigation steps used to deal with risks in all categories of risk appropriate to that firm’s operations. [24] also reported risk analysis in a supply chain involving agricultural equipment, as well as a second case involving construction. Moreover, [36] declared the following types of supply chain risks as follow:

- Physical risks are associated with the movement and storage of materials – and include risk to transport, storage, delivery, material movement, inventory systems, etc. These risks typically appear as late deliveries, interrupted transport, damage to goods, shortage of stock, missing products, Accidents and so on.
- Financial risks are associated with the flows of money – and include risks to payments, cash flows, debt, investments, accounting systems, etc. These risks appear as poor returns on investment, excessive costs, unpaid bills, shortage of cash and missing accounts.
- Information Risks are associated with the systems and flows of information – And include data capture and transfer, integrity, information processing, market intelligence, system failure, etc. These risks appear as missing data, errors in information, and breaches of data security, systems failure, and incorrect transactions and so on.
- Organizational Risks arise from the links between members of the supply chain – and include relationships between suppliers and customers, alliances, shared benefits.

[37] used Monte Carlo simulation to evaluate risks associated with vendor selection, following up on similar modeling from many sources. System dynamics models have been widely used, especially with respect to the bullwhip-effect [34] and to model environmental, organizational, and network-related risk issues [16]. The authors clarified the environmental risk associated with warehouses is limited to the presence of materials which are potentially toxic for the general environment or the workplace environment. [32] mentioned that existing literature on SCRM includes mainly descriptive and conceptual models rather than quantitative models. The researchers summarized the risks that mentioned in the previous studies [8]; [38]; [12]; [15]; [3]; [19];[35]; [26]; [21]; and [36] in table 1. The table shows supply chain risks and their causes/hazards.

**Table 1: Supply Chain Risk Categories and Their Triggers/causes**

Risk category	Risk triggers/causes		References
Demand risks	-Order fulfillment errors -Inaccurate forecasts due to longer lead times -product variety -swing demands -seasonality	- short life cycles - small customer base - Information distortion due to sales promotions and incentives - lack of SC visibility exaggeration of demand during product shortage	[26] : [28]
Delay risks	-Excessive handling due to border crossings or change in transportation mode -Port capacity and congestion	-Custom clearances at ports -Transportation breakdown	
Disruption risks	-Natural disasters -Terrorism and wars -Labor disputes	-Single source of supply -Capacity and responsiveness of alternate supplier	
Inventory risk	-Costs of holding inventories -Demand and supply uncertainty	- Rate of product obsolescence - Supplier fulfillment	

Manufacturing breakdown risks	<ul style="list-style-type: none"> <li>- Poor quality</li> <li>- Lower process yields</li> </ul>	<ul style="list-style-type: none"> <li>- Higher product cost</li> <li>- Design changes</li> </ul>	
Physical plant (capacity) risks	<ul style="list-style-type: none"> <li>- Lack of capacity flexibility</li> </ul>	<ul style="list-style-type: none"> <li>- Cost of capacity</li> </ul>	
Supply (procurement) risks	<ul style="list-style-type: none"> <li>-Quality of service, including responsiveness and delivery performance</li> <li>-Supplier fulfillment errors</li> <li>-Selection of wrong partners</li> <li>-High capacity utilization supply source</li> <li>-Inflexibility of supply source</li> </ul>	<ul style="list-style-type: none"> <li>- Poor quality or process yield at supply source</li> <li>- Supplier bankruptcy</li> <li>- Rate of exchange</li> <li>- Percentage of a key component or raw material procured from a single source</li> </ul>	
System risks	<ul style="list-style-type: none"> <li>-Information infrastructure breakdowns</li> <li>-Lack of effective system integration or extensive system networking</li> </ul>	<ul style="list-style-type: none"> <li>-Lack of compatibility in IT platforms among SC partners</li> </ul>	
Sovereign risks	<ul style="list-style-type: none"> <li>-Regional instability</li> <li>-Communication difficulties</li> <li>-Government regulations</li> </ul>	<ul style="list-style-type: none"> <li>- Loss of control</li> <li>- Intellectual property breaches</li> </ul>	
Transportation risks	<ul style="list-style-type: none"> <li>-Paperwork and scheduling risks</li> <li>-Port strikes</li> <li>-Delay at ports due to port capacity</li> </ul>	<ul style="list-style-type: none"> <li>- Late deliveries</li> <li>- Higher costs of transportation</li> <li>- Depends on transportation mode chosen</li> </ul>	
Natural disaster	<ul style="list-style-type: none"> <li>-Flood</li> <li>-Earthquake</li> </ul>	<ul style="list-style-type: none"> <li>-Plant fire</li> <li>-Diseases</li> <li>-epidemics</li> </ul>	
Political system	<ul style="list-style-type: none"> <li>-War</li> <li>-Customs and regulations</li> </ul>	<ul style="list-style-type: none"> <li>-Terrorism</li> <li>-Labor disputes</li> </ul>	
Competitor and market	<ul style="list-style-type: none"> <li>-Price fluctuation</li> <li>-Economic downturn</li> <li>-Exchange rate risk</li> <li>-Consumer demand volatility</li> </ul>	<ul style="list-style-type: none"> <li>-Customer payment</li> <li>-New technology</li> <li>-Changes in competitive advantage</li> <li>-Obsolescence</li> <li>-Substitution alternatives</li> </ul>	[7];[37];[12];
Available capacity	<ul style="list-style-type: none"> <li>-Capacity cost</li> <li>-Financial capacity/insurance</li> <li>-Ability to increase production</li> </ul>	<ul style="list-style-type: none"> <li>-Structural capacity</li> <li>-Supplier bankruptcy</li> </ul>	[3];[19];[35]
Internal operation	<ul style="list-style-type: none"> <li>-Forecast inaccuracy</li> <li>-Safety (worker accidents)</li> <li>-Bullwhip effect</li> <li>-Agility/flexibility</li> </ul>	<ul style="list-style-type: none"> <li>-Holding cost/order fulfillment tradeoff</li> <li>-On-time delivery</li> <li>-Quality</li> </ul>	
Information system	<ul style="list-style-type: none"> <li>-IS breakdown</li> <li>-Distorted information</li> </ul>	<ul style="list-style-type: none"> <li>-Integration</li> <li>-Viruses/bugs/hackers</li> </ul>	
Environmental risk	<ul style="list-style-type: none"> <li>-Political</li> <li>-Policy</li> </ul>	<ul style="list-style-type: none"> <li>-Macroeconomic</li> <li>-Social</li> </ul>	
Industry risk	<ul style="list-style-type: none"> <li>-Input market</li> </ul>	<ul style="list-style-type: none"> <li>-Product market</li> </ul>	
Organizational risk	<ul style="list-style-type: none"> <li>-Agency Credit</li> </ul>	<ul style="list-style-type: none"> <li>-Liability Operating</li> </ul>	[21]
Problem specific risk	<ul style="list-style-type: none"> <li>-Risk interrelationship</li> <li>-Objectives and constraints</li> </ul>	<ul style="list-style-type: none"> <li>-Task complexity</li> </ul>	
Decision maker risk	<ul style="list-style-type: none"> <li>-Knowledge / Skill / Biases</li> <li>-Rules and procedures</li> </ul>	<ul style="list-style-type: none"> <li>-Information seeking</li> <li>-Bounded rationality</li> </ul>	
Operational risk	Risk of loss resulting from inadequate or failed internal processes, people or systems. Quality, delivery, and service problems are examples of operational risks.		
Network risk	Risk resulting from the structure of the supplier network, such as ownership, individual supplier strategies, and supply network agreements.		[15]

In addition to, the risk in table 1, table 2 illustrates the categories of risks that may occur in the warehouses in any firm that mentioned in the previous studies and stated by Ackerman Company in its Warehouse Forum [1].

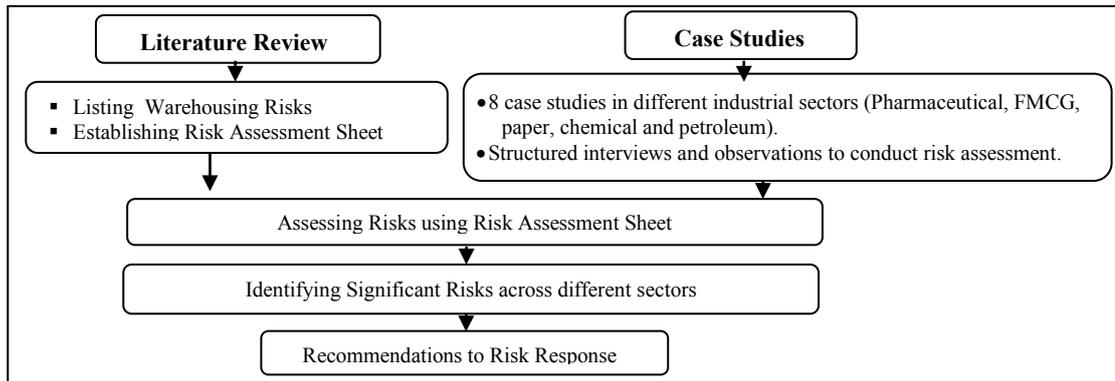
**Table 2: The categories of risks that may occur in the warehouses in any firm**

Risk category	Risk triggers
Natural Disasters	Flood, Earthquake, Windstorm, and Epidemic.
Chemical Disasters	Fire, Contamination, and Infestation of Rodents /Insects.
Operational Errors	Product damage, Mis-shipments, and Inventory discrepancies.
Human Disasters	Employee malfeasance, Theft, Pilferage, Collusion, Work stoppage (Strike at the warehouse or Strike at supplier or major customer), and Death or disability of key executives.
Customer Failures	Bankruptcy, Management change, Market change, and Litigation
Utility Failures	Power outage, Disruption of water supply, Disruption of natural gas supply, IT/telecoms failure, Mechanical breakdown – conveyors, Disruption of road access, and Disruption of rail service.
Government Disasters	Civil disobedience or riots, War or insurrection, Sanctions by OSHA, Sanctions for SOX violations.

Although, warehouses are playing an important component of modern supply chains, both in terms of cost and service. It is clear, most of studies focused on the supply chain risks and there are few studies that discussed the warehousing risks and its impact on the whole supply chain performance.

#### 4 Research Methodology

This research is a combination between exploratory, descriptive, and analytical research according to the research objectives and questions. The researchers conducted multiple case studies in different industrial sectors to explore and describe the different types of risk in warehousing. Then, based on the finding from the case studies the researchers analyzed the risks to identify the common significant risks across the sectors. The research methodology is demonstrated in figure 2.



**Figure 2: Research Methodology Framework**

The methods of collecting the data are divided into:

- 1. Reviewing the literature** to identify the previous studies that declared the type of risk in warehousing. The authors identified the list of warehousing risks in the risk assessment sheet based on the mentioned risks in the previous studies in table (1).
- 2. Structured interviews** with the warehouse managers in eight case studies that belong to different industries such as chemicals product, papers and FMCG. Table 3 shows the case studies that are conducted and their sectors. The interviews are conducted to:
  - Identify the risks that could happened in their warehouse using the risks list in the risk assessment sheet.
  - Add more risks that could happened in their case studies and are not available in the list.
  - Assess the risks in terms of probability of occurrence and severity of risk using the risk assessment sheet.
- 3. The observation** that conducted by the researchers through tours in the warehouses in the case studies.

**Table 3 Case Studies and their related industrial sector**

Case Study	Industrial Sector	Case Study	Industrial Sector
CS1	Chemical Jotun	CS5	Paper
CS2	Chemical Agility	CS6	FMCG

CS3	Pharmaceutical	CS7	FMCG
CS4	Pharmaceutical	CS8	Petroleum

The Risk assessment sheet was established by researchers to include risks, risk sources, probability of occurrence and severity of risk and score of risk. The sheet included the risks which were adopted from previous studies such as [36]; [16];[1]; [26]; [7].The Risk assessment sheet was validated according to the expert purposive sampling technique[39]; from experts in the academic field. The academic staff members were chosen to have a minimum of ten years’ experience in the logistic and risk management field. The risk assessment sheet includes two parts. First part, sought general information about respondents and their organizations. Part two asked respondents to tally check the risks that face the organization, probability of occurrence using a five-point Likert scale of 1 (impossible to occur) to 5 (certainly occurs) and severity of the risks using a five-point Likert scale of 1 (negligible risk) to 5 (critical risk). Researchers identified and list the risk associated with warehousing through reviewing the previous studies and interviews that conducted with the executives of warehousing and supply chain management in the case studies. The researchers identified 27 risks that categorized into 5 categories: physical risks, financial risks, information risks and organizational risks. Physical risks include 6 risks. These risks could harm the goods/services during warehousing. Financial risks include 1 risks. These risks could cause losses in Monetary or increasing costs. Information risks include 4 risks. These risks could lead to loss confidentiality of information. Organizational risks include 4 risks. These risks could lead to poor performance of organization associated with warehousing. Health and safety risk includes 3 risks. During the interviews conduction, the researchers were asked the executives to put tally mark in the front of the risk which they face, source of risk. Also, the interviewees have to identify the likelihood and severity of risk using Likert scale (1-5). Then, the researcher asked the executives to declare if there are other risks.

## 5 Results and Discussion

After collecting the data from the case studies, the score of each risk is calculated by multiplying the likelihood value by the consequences. After an analysis has been undertaken, risks are evaluated and level is identified against an appropriate risk-acceptance criterion to give a ranking, for example “low” (tolerable), “moderate” (which should be as low as reasonably practicable), and “high or significant” (intolerable). According to [36], a probability–impact matrix is another common diagram for describing classes/level of risk as shown in figure 3 the vertical axis shows probability categories and the horizontal axis shows categories of consequences. The result becomes a table with descriptions of the risks put in the appropriate boxes in the body of the table. The researcher summarized the findings of risk assessment process that conducted in the case studies in table 3. Table 3 shows the risks that have score above 16 and their sources. According to the level of risks in figure 3. Those risks are significant risks and need high attention and effective response from the case studies.

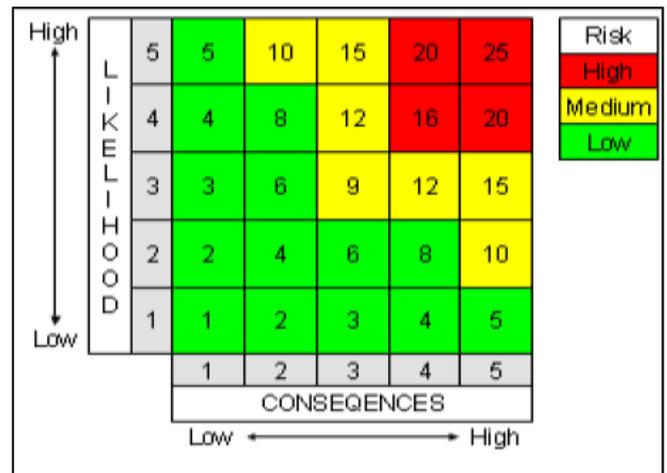


Figure 3: Probability–impact matrix for describing level of risk

Table 3: The significant risks across the case studies

Company/ Sector	Risk	Source of risk	Probability	Severity	Risk Value	
Chemical Industry	CS1	Damage of goods	Poor handling	5	4	20
		Missing of goods	Handling of goods	5	4	20
		Fire	Flammable material	4	5	20
	CS2	accidents	Failure in handling equipment's	4	5	20
		Information system failure	Power shut down	4	5	20

		Quality of supplies	Damage during transportation	4	5	20
Pharmaceutical	CS3	Data missing from warehouse	Hackers and thefts	4	5	20
		Fire	Electrical shot	4	5	20
		Missing of Goods	Theft accidents	5	5	25
		Damage of goods	Poor environmental condition	4	4	16
		Damage to goods	Accidents during movements of goods	4	4	16
	CS4	Decline of warehouse performance	Poor performance of equipment	4	5	20
Paper	CS5	Damage to goods	Insects and rates	4	4	16
		Fire	Electrical short	4	5	20
		Poor communication between warehouse and other parties	Wrong orders	4	4	16
Petroleum	CS8	Fire	Flammable material or Electrical short	4	5	20
FMCG	CS6	Accidents	Failure of handling equipment's	4	5	20
		Information system failure	Power shut down	4	5	20
		Quality of supplies	Damage during transportation	4	5	20
	CS7	Damage of goods	Poor handling of goods	5	5	25
		Damage of goods	Insect and Rats	5	5	25
		Errors in data	Human errors	4	5	20
		Injuries worker	Heavy load	4	5	20
		Fire	Electrical spark	4	5	20

Based on the results from case studies in different industrial sectors using the risk assessment sheet, the researchers found the following common significant risks across different industrial sectors as shown in the table below:

- Damage of goods risk due to poor handling, poor environmental conditions, insects and rates are common in Chemicals, Pharmaceutical, Paper and FMCG sectors.
- Missing of goods risk due to handling of goods and theft accidents are common in Chemicals and Pharmaceutical sectors.
- Accidents risks due to failure in handling equipment are common in Chemicals and FMCG sectors.
- Fire due to electrical spark or flammable material is common across sectors.

## 6 Conclusion, Recommendations and Future Work

Managing risks across supply chain activities and entities became significant requirement for the organizations to compete regionally and globally. One of those entities is the warehouse that provide the chain with value-added through availability of goods at right time and right place. This study reveals the risks associated with warehousing in different industrial sectors in order to propose an efficient and effective response to eliminate and mitigation their impact on the chain performance. In addition to, the study provide the practitioners with proactive actions to eliminate the probability of risks and mitigates their impacts. Eight case studies were used to assess the risks associated with warehouse in real-life context. The findings shows risks vary from one product to another according to the nature of the product itself. Whereas, it is clear that damage of goods, accidents and fire are common significant across the industrial sectors. Therefore, the researchers recommended the following proactive actions in order to eliminate and mitigate the impact of those risks:

- The warehouse manager shall establish, implement and maintain a procedure to handle the goods inside the warehouses effectively and efficiently to eliminate the probability of risks.
- The warehouse manager shall periodically review and audit the environmental conditions of the warehouses to eliminate the probability of fire and goods damage.
- The warehouse manager and workers shall follow instructions in the material safety data sheet of hazardous materials in case of storing and handling.
- The warehouse manager shall equip the warehouse with security devices.
- The warehouse manager shall equip the warehouse with effective firefighting system and team in addition to creating insurance contract.

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