Supply Chain Risks Management in Manufacturing Industry. Case Study from a Developing Country

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Abstract
Supply chain risk management has raised companies' and researchers' focus on the supply chain environment. The definition and consequences of risk in a company's supply chain depend on its position and the depth of analysis it can conduct. Developing Countries' companies, such as those in Albania, perceive supply chain risk management as an expenditure that does not generate profit, so they do not allocate funds or personnel to it. The recent financial crisis caused by the consequences of Covid-19 worldwide suggested that countries urgently need to implement effective risk management processes in all sectors of the economy. Companies must understand which risks should be accepted, avoided, transferred, mitigated, or exploited. This article studies a company in the Albanian Textile industry using Hierarchical Holographic Modeling (HHM). The model implemented involved assigning risk management responsibilities to a specific employee over time limit intervals. Furthermore, the company's overall risk management capabilities and competencies are enhanced as an intangible outcome. This article aims to identify strategies the company uses to mitigate risks and improve the performance of the supply chain. From the results obtained from this article, managerial perceptivity can be deduced on how to manage supply chain risk in the future.

Keywords: Risk Management, Supply Chain, Hierarchical Holographic Modeling (HHM), Decision-making, Risk Matrix.

1. Introduction
The operational environment of a company is influenced by numerous uncertainties, which have both positive and negative effects. Risk and uncertainty are often used interchangeably, but they are different. Risk comes from uncertainty, which has a few possibilities. (Lavastre O. et al. 2013) define risk as the probability of a loss for the company/ the individual. Supply Chain Risk Management is a systematic and phased approach for recognizing, evaluating, ranking, mitigating, and monitoring potential disruptions in the supply chain (Aqlan F. and Lam S. 2016). Supply Chain Risk Management's primary objective is to safeguard the company from unfavorable events.

The past decade has seen the introduction of a vast array of tools and techniques for supply chain risk management. Hierarchical Holographic Modeling (HHM) is a structured and analytical model developed because capturing all the essential and vital aspects of a risk system in a single model is complex. One of the most essential and valuable aspects of HHM is the ability to facilitate the evaluation of risks regardless of whether an immense amount of data and their related contributions to the entire structure are attainable. Various models that represent what is essential to the numerous measurements, dreams or visions and viewpoints of infrastructure systems can be developed and coordinated using HHM. It is crucial to emphasize that Supply Chain Risk Management (SCRM) presents a framework incorporating the techniques and procedures companies use to manage risks directly associated with accomplishing their goals. Risk filtering, ranking, and management (RFRM) systematically evaluate all significant risks. HHM, SCRM, and RFRM could be incorporated into a risk management model that bridges the divide between industrial-level risk management and company-level risk management to create an integrated and systematic model of risk management.
1.1 Objectives
The objectives of the proposed risk management model are as follows:
(1) Establishing potential risk situations in an industry's company environment,
(2) Filtering potential risk situations in a company's business operations,
(3) Evaluating risk scenarios in a risk matrix,
(4) Setting up and identifying activities that could mitigate or avoid any negative impact from disruptive risks.
This article starts by providing an in-depth discussion of risk management models, including HHM and SCRM. A case study called “DBS Group”, a sportswear manufacturer which belongs to the Albanian Textile industry, is used to demonstrate the suggested risk management model. The results are presented, and conclusions are derived from implementing the proposed risk management model.

2. Literature Review
2.1 Risk management
Risk is defined as uncertain circumstances that could positively or negatively impact the assignment's goals. Risks include circumstances or situations that, with a reasonable prediction of the future, harm any aspect of implementing the project if they exist or appear. Risk can be defined as the likelihood that the outcome of a process will not meet expectations (Knechel W. R. 2002). As a company continually changes, stakeholders increasingly want companies to identify and manage their company risks (Rao Z. 2007). Risk Management is defined as an organized and comprehensive method tailored towards “organizing”, “identifying”, and “responding” to risk factors to achieve project goals. (Bahamid R.A. and Doh S.I. 2017). By considering alternative scenarios generated by a risk management process, a company can judge their respective merits, select solutions, and implement them (Zsidisin G. and Ritchie B. 2008). Improvement in technology expands the possible sources of risk in the company environment. Consequently, innumerable risk management models have existed over the last decades.

2.2 Hierarchical Holographic Modeling
HHM is a comprehensive methodology. The HHM has been used for identifying – underlying risks in numerous studies (Kaplan S. et al. 2001; Lambert J.H. et al. 2006). HHM develops the multi-view image of a system hierarchy of terrorist threats to generate many scenarios and then classifies these scenarios according to their probabilities and repercussions. HHM is introduced to address multiple dimensions and perspectives of risks of terrorism, cyber and interconnected physical infrastructures, information technology, information assurance, and survivable dependable systems (Haimes Y.Y and Longstaff T.A. 2002).

2.3 Supply Chain Risk Management
(Delesse C. 2010) sees the SCRM as a systematic approach to determining the best course of action in the event of uncertainty, which is by identifying, assessing, understanding, communicating, and addressing risk-related issues. SCRM is an integrated framework for managing supply chain risks, including credit, market, operation, and financial risks, to maximize company value. SCRM includes, in general, the steps of establishing objectives, determining, and evaluating significant risks, selecting a course of action for each risk event, and constantly monitoring both the internal and external environments for changes in conditions.

2.4 Risk Filtering, Ranking, and Management
It is essential to identify the two fundamental structural components of HHM. First, the most important topics are the fundamental visions, concepts, and viewpoints of success. Second, are the subsections, which provide a more detailed requirements categorization. Each requirement class relates to a class of risk scenarios, namely, those that affect that requirement. In this regard, each class of requirements is also recognized as a “source of risk”.
Then, it is necessary to classify these sources according to the probability and impact of their effects and to do so regularly based on reasonable criteria and solid premises. The recommended analytical framework for risk filtering and classification is founded on the following key considerations:
- It is often difficult (because of restrictions such as time and resources) to implement quantitative risk assessment for hundreds of sources of risk. In such circumstances, qualitative risk analysis could be sufficient for decision-making under specific conditions.
- For the process of risk management, the company should respond to three questions:
  1. What could potentially go wrong?
  2. What would be the probability that this will occur?
  3. What might be the repercussions?
3. Methods

Problem identification is more important than problem-solving. Risk managers consult line managers in designing and implementing risk management programs (Corbett M.F. 2004). Line managers can only identify risks at the front-line level and present concerns about enhancing risk management practices. Using the HHM, prospective risks can be identified at the industry level. It encompasses all industry-wide risks pertinent to the company's operations and objectives. However, not all the potential risks identified by the HHM methodology have the same impact on companies within the same industry.

Consequently, the SCRM is utilized to identify the company's risks. RFRM is presented to evaluate the risk evaluation regarding risk consequence and occurrence probability. As shown in Figure 1, the proposed risk management model integrates HHM, SCRM, and RFRM.

![Risk Management Model](image)

Figure 1. The Risk Management Model

In the suggested model, it is suggested to apply (Kaplan S. and Garrick J. 1981) quantitative definition of risk R, in terms of a "set of triples":

\[ R = \{<S_i; L_i; X_i >\} (I) \]

Where:
- \( S_i \) means the ith “risk scenario” identification,
- \( L_i \) means the probability of that scenario,
- \( X_i \) means the resulting repercussions of the scenario, i.e., damage measurement.

After identifying the risk scenarios, the probability of the risk scenario implies the probability that the risk scenario will occur. The consequence of its occurrence is then determined, and the risk rating is computed using equation (1). Based on the risk exposure-outcome, risks are categorized, and subsequent actions are determined.

4. Data Collection

This article presents a case study illustrating how the risk management model can be implemented in a company environment. This article was structured through semi-structured interviews with four essential employees in the chosen company. The research question of this article is, “How can the proposed risk management model be utilized to recognize, evaluate, and manage the potential risk scenarios in a textile company”?
Considering the industry and company environment, the objectives of the case study are as follows:
1. Analyze the applied technique and strategy of risk management in the company,
2. Identify the principal risks and difficulties throughout the entire industry,
3. Ensure that the management and staff in the company have a greater awareness of the risk and value of risk management,
4. Identify the potential risks and be mindful of where they might originate.

DBS Group, a Sportswear Manufacturer in the Textile industry, is used to demonstrate how the proposed risk management model is applied. Below, various common and risks will be identified, and reasonable solutions will be recommended.

4.1 Hierarchical Holographic Modeling
This article conducted interviews with four senior staff head departments in order to identify a set of potential risks which the Sportswear Manufacturing industry might have to face. By applying the HHM model for management and risk exposure, risk scenarios that result from the multiple overlapping hierarchies in real-life systems can be identified. This method provides a holographic view of a modeled system and considers different hierarchical structures together to identify significant sources of risk. A total of nine major model categories are identified by applying the HHM in the industry. They are economic, reputation, resources, operations, environmental, market, policy, managerial, and financial risk. These risks are shown in Figure 2.

![Figure 2. Identification of the Textile industry using HHM model](image)

Considering the information from the HHM and the background of the industry, some of the risks are more likely to occur and especially difficult to manage. These risks are resources, operations, market, and managerial risks. Most of them are high-level risks and are related to the company's daily operations. Among these risks, the operation (risk of system shutdown) and market risk are difficult to manage because of the company's difficulty controlling them.

4.2 Supply Chain Risk Management
Based on the model of the HHM, DBS Group can review the company's current operations and estimate which risks they may face in the Textile industry. The potential risks of DBS Group are identified and shown in Figure 3.

(A) ECONOMIC RISK
Global economic risk (A1)
Most Albanian Textile Manufacturers are exporting companies, including the DBS Group, and do not engage in any company related to the domestic market. Consequently, if a global economic crisis comes, DBS Group would suffer loss directly and immediately.
Oil Price Increase ($A_2$)
In the past few years, various factors have led to the fluctuation of the oil price and have increased the operating costs, material distribution, production, and shipment of DBS Group.

(B) RESOURCES RISK
Material delivery and unbalanced material supply ($B_1$)
Occasionally, materials are delivered late, especially during the peak seasons. Sometimes, delivery problems hinder the fulfillment of essential orders and lead to compensation claims.

Unbalance demand in labor ($B_2$)
During the peak season, there is a lack of labor and an oversupply of labor during off-seasonal periods. Also, human resources must be managed carefully to avoid high labor costs throughout the year.

(C) OPERATIONS RISK
System shutdown ($C_1$)
DBS Group uses a system to conduct all the daily operations such as transfer of orders, production planning, picking list establishment, and confirmation of shipments. If the system is shut down, the whole company's operations must stop immediately and wait until the system recovers. These are costs for DBS Group, and this risk may appear in winter as there are power constraints and disruption in many Albanian companies.

Improper operations ($C_2$)
Most employees are residents living in Tirana, and even if they have an excellent educational background, they need better qualifications and experience in the sector. Therefore, inappropriate operations such as applying wrong system controls or poor machine handling may sometimes affect the quality of the product.

The decrease in work efficiency ($C_3$)
Some members of staff have worked for DBS Group since the beginning. It has been noticed that their working efficiency is decreasing.

(D) MARKET RISK
Competitors ($D_1$)
Many companies would like to run textile export companies in Albania in these last years due to the low labor cost and the relatively high profits. The market share of DBS Group could decrease due to greater competition from new companies in the Albania Textile sector.

(E) POLICY RISK
Labor legislation ($E_1$)
The government now requires higher provisions in employee contracts, a higher quality standard of general facilities, and pollution constraints in compliance with the latest laws of labor legislation.

Policy fluctuation ($E_2$)
Any changes made by the Albanian Government would affect DBS Group’s daily operations or company strategy. In these past three years, Albanian Government has introduced different policies for which DBS Group had to amend its strategy.

(F) MANAGERIAL RISK
Conflict in the workflow ($F_1$)
As most of the staff in DBS Group has a low level of education, and all Department managers have a Bachelor’s or Master’s Degree, there are culture gaps in the management of company activities, i.e., conflicts are likely to occur between managers and other employees.

Insufficient monitoring (On workers and product quality) ($F_2$)
The company has to improve and become stronger in the qualifications of the staff engaged with the quality system.

(G) FINANCIAL RISK
Poor financial planning ($G_1$)
One of the essential components of risk can bring, mainly after the pandemic crisis of Covid-19 worldwide, a poor risk analysis which can lead to losing beneficial investments or taking up band investments.

Low Cash flow ($G_2$)
Investment in increasing apparel companies from 2020 to 2021 has generated cash flow problems for DBS.
4.3 Risk Filtering, Ranking, and Management

After the risk identification, the management of each risk using standard probability and consequence indicators has been carried out using RFRM. RFRM is a tool that provides a systematic risk score for either screening or prioritizing risks. The probability and consequence are divided and assessed qualitatively on scales of six levels, from level 0 to level 5. With the measurement methodologies for the two indicators, probability, and consequence, risk ratings for each identified risk are calculated with the formula, i.e., Risk = Risk Probability (P) x Risk Consequence (X)—the qualitative risk assessment matrix with the definition of the corresponding qualitative measures’ Figure 3. The probability and consequence of the DBS Groups’ risk, identified with SCRM, are also measured quantitatively, and the ratings are calculated.

In Table 1, all risks have been measured by probability calculation, and their risk ratings are then determined. Details of the measurement of each risk are shown in Table 1. Based on the risk rating and the classification standard; the above risks are divided into four main categories:

1. Acceptable/ moderate risk,
2. Significant risk,
3. Severe risk,
4. High risk.

Table 1. Qualitative measures of probability

<table>
<thead>
<tr>
<th>Level</th>
<th>Descriptor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Impossible</td>
<td>The event will not happen practically under any circumstances</td>
</tr>
<tr>
<td>1</td>
<td>Rare</td>
<td>The event may occur in exceptional circumstances</td>
</tr>
<tr>
<td>2</td>
<td>Unlikely</td>
<td>The event could occur at some time</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>The event should occur at some time</td>
</tr>
<tr>
<td>4</td>
<td>Likely</td>
<td>The event will probably occur in most circumstances</td>
</tr>
<tr>
<td>5</td>
<td>Almost certain</td>
<td>The event is expected to occur</td>
</tr>
</tbody>
</table>

The risk classification is shown in Table 2. Four actions are suggested for each category corresponding to the degree of the risk involved. They include:

1. Accept. Accept the level of risk and take no action to minimize it further.
2. Avoid. Take action to avoid the risk.
3. Transfer. Transfer the risk to someone else.
4. Mitigate. Take action to manage the risk, generally through internal control.

The risk classification clearly indicates which risk is more significant and which risk should be transferred or mitigated.
Table 2. Qualitative measures of consequence

<table>
<thead>
<tr>
<th>Level</th>
<th>Descriptor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Negligible</td>
<td>No financial loss</td>
</tr>
<tr>
<td>1</td>
<td>Minor</td>
<td>Low financial loss. Temporary loss of dignity. No loss of reputation.</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>Serious financial loss. Moderate loss of reputation. Moderate company interruption.</td>
</tr>
<tr>
<td>4</td>
<td>Catastrophic</td>
<td>The potential closure of the company.</td>
</tr>
</tbody>
</table>

The collaboration between Table 1 and Table 2 is given in the Matrix in Table 3.

Table 3. Consequence of impact realized

<table>
<thead>
<tr>
<th>Consequence/impact of risk being realized</th>
<th>Probability of risk being realized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impossible (0)</td>
</tr>
<tr>
<td>Negligible (0)</td>
<td>0</td>
</tr>
<tr>
<td>Minor (1)</td>
<td>0</td>
</tr>
<tr>
<td>Moderate (2)</td>
<td>0</td>
</tr>
<tr>
<td>Serious (3)</td>
<td>0</td>
</tr>
<tr>
<td>Severe (4)</td>
<td>0</td>
</tr>
<tr>
<td>Catastrophic (5)</td>
<td>0</td>
</tr>
</tbody>
</table>

No risk (0), Acceptable/ moderate risk (1-2) and (3-4), Significant risk (5-10), Severe risk (12-16), High risk (20-25)

5. Results and Discussion

5.1 Numerical Results
The processing of data related to the most potential risks of DBS Group is given in Table 4.

Table 4. Risk measurement results of DBS Group

<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk category</th>
<th>Probability</th>
<th>Consequence</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. Global economy crisis</td>
<td>Uncontrollable</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>A2. Oil price increase</td>
<td>Uncontrollable</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>B1. Negative media and news</td>
<td>Somewhat controllable</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>C1. Supplier constraints</td>
<td>Uncontrollable</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>C2. Bad reorder planning</td>
<td>Somewhat controllable</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>C3. Unbalance work force</td>
<td>Somewhat controllable</td>
<td>5</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>D1. System shut down</td>
<td>Uncontrollable</td>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>D2. Improper operation</td>
<td>Controllable</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>D3. Decrease in working efficiency</td>
<td>Controllable</td>
<td>4</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>E1. Global warming</td>
<td>Uncontrollable</td>
<td>5</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>E2. Environmental disaster</td>
<td>Uncontrollable</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>F1. Competitors</td>
<td>Uncontrollable</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>G1. Labor legislation</td>
<td>Uncontrollable</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>G2. Policy fluctuation</td>
<td>Uncontrollable</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>H1. Conflict in the workflow</td>
<td>Somewhat controllable</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>H2. Insufficient monitoring</td>
<td>Controllable</td>
<td>4</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>I1. Poor financial planning</td>
<td>Uncontrollable</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>I2. Low cash flow</td>
<td>Controllable</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
5.2 Graphical Results
The processing of data related to the most potential risks of DBS Group is given in Figure 4.

5.3 Proposed Improvements
The final and most important table is Table 5, which gives information about DBS Group's actions in response to the analysis and risk matrix.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Response</th>
<th>Action plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Transfer</td>
<td>Develop Albanian market</td>
</tr>
<tr>
<td>A2</td>
<td>Transfer</td>
<td>Transfer extra costs to customers</td>
</tr>
</tbody>
</table>
| B1   | Avoid    | 1. Prevent defective products from reaching the market  
2. Develop an emergency plan in case negative media news is reported |
| C1   | Avoid    | Perform supplier development program to help suppliers to improve their product quality |
| C2   | Transfer | Apply a software-managed inventory model for core components |
| C3   | Mitigate | Simplify the production process and hire part-time staff during peak season |
| D1   | Avoid    | 1. Set up a backup electricity generator  
2. Perform preventive system maintenance frequently |
| D2   | Avoid    | Provide sufficient training to workers |
| D3   | Avoid    | Develop employee relationship programs such as senior club to inspire those old members of the staff |
| E1   | Mitigate | DBS Group should diversify its product line and design products with various novel functions |
| E2   | Transfer | Buy disaster insurance |
6. Conclusion

The proposed risk management model provides a comprehensive risk analysis tool using a top-down approach which helps a company understand its risks better and have a better chance of success. Applying the HHM and SCRM, risks have been identified, and the company could prioritize risks so that options to mitigate the risk can be appropriately considered and addressed. Most of the uncertainties and risks that the Textile industry is facing have been identified by HHM. The most likely and high-level risks in the industry are identified. SCRM method was applied to identify the company’s risks, triggers, and current mitigation strategies. Furthermore, some additional outstanding risks are provided for the case company to avoid or transfer those risks. The proposed model provides theoretical merits to the literature and applies to different industries for risk management practices. Today, customer has higher expectations in terms of speed of delivery and service quality. It is challenging for a company to sustain efficient product flow and on-time delivery simultaneously. In order to ensure the flexibility of the supply chain, a company should have internal competencies to manage its external partners. Therefore, further research is required to combine the risk management model with the customer and supplier relationship management concept.

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Biographies

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