# Using the ANP Approach for Assessing Supply Risks in a Manufacturing Logistics Chain

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## Abstract

Concerning the standards of Quality certification and Audits, the risk management appears more and more like a fundamental component. For example, in the ISO 9001 V2015, risk management is one of the major changes compared to the ISO 9001 V2008. In this article, we focus on risk management for the supply component of a logistics chain in the automotive sector; we are interested in the cases of international ALPHA companies that manufacture equipment for companies in the automotive industry. At first, we use the classic risk management approach and we show its limits. In a second step, we suggest an approach based on the AHP (Analytic Hiearchy Process) or the Analytic Network Process (ANP) methods to overcome the limits of the classical approach.

## Keywords

Supply Chain, Risk Management, ANP Approach, Risk Classification

## 1. Introduction

The supply chain is the set of components or interrelated links that coordinate with the realization of the procurement, production and distribution activities see Figure 1.
In particular, it is also about "Coordination and collaboration with partners along the chain" [4]. And according to Donald J et al., 2002 "The SC or the supply chain is not a chain! It is a network of companies in interaction "[1]. However, the term chain is the one most commonly used in logistics literature and terminology. It is indeed the "management of material, informational and financial flows through a network of organizations such as suppliers, manufacturers, logistics providers, wholesalers / distributors, retailers, etc., aimed at the production and distribution of delivery of goods or services to consumers "[2] and [3].

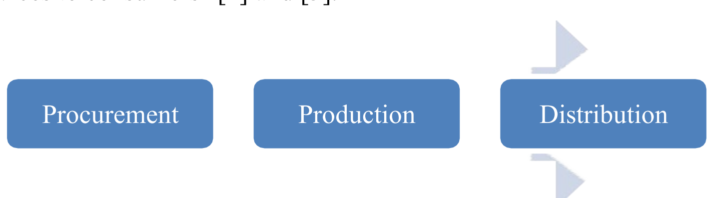


Figure 1: Overview of links in the supply chain

The concept o f risks, other than those related to occupational health and safety, ISO 45001: 2018 [1], where the person is exposed to properties that are likely to cause harm, is an inherent and dominant concept are facing the organisms.
It is primarily a business strategy that aims to achieve goals and make informed decisions.
Most research consider the risk as purely negative and lead to undesirable results or consequences (Harland et al., 2003, Manuj and Mentzer, 2008) [6], however the ISO 31000 standard applies to any type of risk, whatever its nature, whether its consequences are positive or negative.
Risk is "an effect of uncertainty on objectives, in other words, it is measured against an expected. It can be positive, negative or both, and treat, create or lead to opportunities and threats "[5].

Risk management can help avoid, transfer, mitigate or minimize the risks associated with a critical area. To lead and succeed in a risk management process, it is important to define it well. Sometimes this single step allows for some perceptions and a good deal of difference.
The main steps are common in most of the risk approaches addressed by Kasap and Kaymak (2007) [7] as well as ISO 31000 V 2018 [5], and focus on identifying, assessing and prioritizing risks like in Figure 2 below:

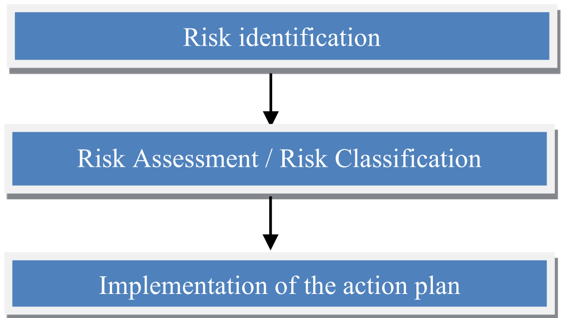


Figure 2: Overview of Risk Management Steps

In this article, we are interested in the procurement chain supply component. This component is an important part of the supply chain, as it allows covering the production component with the needs of raw materials. Moreover, it is an external component to the company that presents risks and hazards that can be high and often difficult to control. This component is therefore inherently risky and it is in no way possible to completely annihilate all sources of risks such as climate hazards. At the level of the company studied, we consider the case of a manufacturing company operating in the automotive sector. This article is divided into three major parts. The first part is specific to risks in a supply chain. The second concerns the traditional approach of risk management, its application to a manufacturing logistics chain as well as the limits associated with this form of risk management.
Finally the last part concerns the suggestion of using a risk management approach based on the ANP method.

## 2. Risks related to a supply chain

A risk actually associated with a logistics chain can be defined as an uncertain event that can lead to an undesirable result, mainly supply chain disruption, which could disrupt normal and planned activities (Waters, 2007) [8], negatively affecting supply chain operations and subsequently the desired performance (Rao & Schoenherr, 2011) [9].
Above all, it is a "probability of occurrence of an incident related to a supply failure, generated by a single supplier or by the procurement market, and the results of which result in the incapacity of the enterprise buyer to meet the demands of their customers or endanger their lives and safety "(Zsidisin, 2003) [10]. Indeed, the risk in SC is centered around the disruption of information flows, material, product or financial flows between organizations.
These flows may not be independent of each other but are clearly often connected (Uta, 2005) [11].
The analysis and risk management of a supply chain is an element that contributes to the performance of this chain. In this respect, mention can be made of ISO 9001 V 2015 [13] and VDA [14], in which risk analysis and control of associated failure modes are cited in several places. For ISO 9001, this is one of the major novelties of this standard. Its main benefits are to increase performance by focusing on desirable effects and to prevent or reduce adverse effects.
At the level of analysis and identification of risks, it can be said in a general way that the specifications and the plans, the synopsis of the manufacturing process and the flow diagram etc ..., are elements of output of the design of the manufacturing process and which will subsequently be verified and validated against the input requirements of the manufacturing process design according to IATF 16949: 2016 [12].
Our study is focused on the risks related to the supply process, defined as a key component of the supply chain. In addition, we considered as case of study sector, that of the automobile and more precisely the car wiring. For confidentiality purposes, this company will be named ALPHA. It is a company that has large domestic and international customers and suppliers. Moreover, it is a company that needs to open up on its suppliers to stock up. and knowing that More than 85% of its suppliers are at the international level (Coil, Contact, Connector, Kaufteil ...) using multi-mode transport dominated by a transport by sea way for the routing of the raw materials and

components towards the ALPHA company. Often this transport is not direct but contains several junction points such as grouping / unbundling platforms, ports, warehouses, ... Figure 3 represents a part of these junctions. The risks associated with ALPHA's supply chain are numerous and varied. For example, between the moment when a new supply of components is ordered and the moment when it is received and ready for production, several major hazards in the professional life can occur and call into question the availability of these components.


Figure 3: Supply flow

Procurement risks include the following examples of risks:

- Maritime Hazard: Delays in delivery due to the means of transport
- Environmental Risk: Climatic hazards, non-respect of the environment and condition of delivery
- Handling Hazard: Damage to delivery due to handling equipment
- Production Risk: Failure to meet delivery deadlines; nonconformity of the delivered product / change in product or process characteristic level when it comes to raw material delivered product defective.

We have adopted two approaches to risk assessment.

## 3. Use of classic approaches for risk assessment

### 1.3 Presentation and application of the classical approach

The associated risks can be many and varied. But the resources of the company are often limited and do not allow to treat all risks. The conventional approach allows prioritizing risks based on their degree of criticality. For a x risk, criticality C is often defined as the product of its frequency or probability of occurrence P and its severity G. Therefore, a risk that is very frequent and has certain gravity must be given more importance. when it occurs. Conversely, a risk that is not frequent and does not have significant gravity will not be favored. This approach allows the company to focus its means of treatment on significant risks. In addition, the traditional approach is based on four main steps: the identification of risks, the risk assessment, the prioritization and the implementation of a plan of action as presented in figure 2. For our case study, the identification of the risks allowed to list the 8 risks R1 to R8 summarized in Table 2. At the level of the risk assessment [5] and [7], we chose a simple quotation by assigning to each risk a value between 1 and 3 related to the probability of occurrence and the severity, as shown in the tables below. The values of probabilities and gravities were obtained by consulting a sample of ALPHA companies operating in the field of procurement.

Tableau 1: Rating matrix

| P | Estimated Probability | Quote |
|---|---|---|
| Always | Almost every delivery | 3 |
| Hardly ever | Once or twice a month | 2 |
| Almost never | One, twice a year | 1 |
| S | Effect of Severity | Quote |
| Disaster | Dangerous without warning, loss of reputation | 3 |
| Not bad | Low | 2 |
| It does not matter | No | 1 |

Tableau 2: Classical approach to risk assessment

| | Risks | P | S | P*S |
|---|---|---|---|---|
| R1 | Delivery delays due to the means of transport (generally maritime) | 2 | 3 | 6 |
| R2 | Delays in delivery due to weather conditions | 1 | 3 | 3 |
| R3 | Failure to meet delivery deadlines | 1 | 2 | 2 |
| R4 | Non-compliance of the delivered product | 1 | 3 | 3 |
| R5 | Change in product or process characteristic level when it comes to the raw material | 1 | 3 | 3 |
| R6 | Product delivered defective | 1 | 3 | 3 |
| R7 | Non-respect of the environment and condition of delivery | 2 | 2 | 4 |
| R8 | Damage to delivery due to handling | 2 | 2 | 4 |

The total of all individual assessments defines the priority. Table 2 shows the R1 risk related to delivery delays as the most critical risk, followed by R7 and R8. A Pareto analysis can be done to determine the risk classification A,B and C. From this a plan of action can be derived.
Another possibility of classification into risk classes can be achieved by an individually determined tabular classification, with which non-linearities and different weights of damage can also be taken into account. We can also deduce the risk matrix, represented by Figure 4

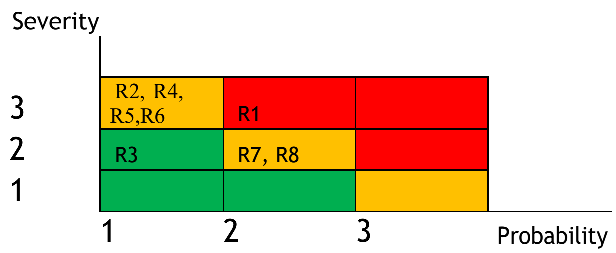


Figure 4: Risk Matrix

In this matrix, evaluations are staggered for a clear graphic risk classification:
• The risk does not apply
• The risk applies to the minimum degree.
• The risk applies and to a large extent.

### 2.3 The limits and disadvantages of the classical approach

Although it is often used for risk assessment in several areas, the conventional approach has several disadvantages, among which are:

**a-** The difficulty of assessing in absolute terms the probability and severity ofa risk. Indeed, this evaluation requires a very experienced sample of stakeholders. Stakeholder judgments may be for some very different risks from one stakeholder to another. This difficulty increases if we adopt a finer rating scale, for example ranging from 1 to 10 instead of 1 to 3.

**b-** the classical method does not take into account the dependencies that can exist between the different risks. In some cases, there maybe dependencies between these risks, which calls into question the absolute judgment attributed to each risk.

To avoid these flaws and limitations, we propose a relative risk assessment approach based on the Analytical Network Process (ANP) approach.

## 4. Suggestion an evaluation approach based on the ANP method

AHP (Analytic hiearchy Process) is a multi-career method applied in the field of decision-making. In this method we use a hierarchical decomposition of the elements studied. In this approach, a hierarchical analysis comparing the elements studied is carried out which allows to deduce a classification of these different elements. In our case, the elements studied will be the risks identified in the identification phase. The main advantage of this approach lies in the relative comparison of one element with respect to another, for a given criterion. A relative comparison is often easier to perform than an absolute evaluation of a criterion.
An overall comparison of the relative importance of the eight risks identified in paragraph 1 is given in Table 3. In this table, risk R1 is twice as high as risk R2, R4, R5 and R6.

Tableau 3: AHP judgment matrix

| | **R1** | **R2** | **R3** | **R4** | **R5** | **R6** | **R7** | **R8** |
|---|---|---|---|---|---|---|---|---|
| **R1** | 1 | 2 | 3 | 2 | 2 | 2 | 3/2 | 3/2 |
| **R2** | 1/2 | 1 | 3/2 | 1 | 1 | 1 | 3/4 | 3/4 |
| **R3** | 1/3 | 2/3 | 1 | 2/3 | 2/3 | 2/3 | 1/2 | 1/2 |
| **R4** | 1/2 | 1 | 3/2 | 1 | 1 | 1 | 3/4 | 3/4 |
| **R5** | 1/2 | 1 | 3/2 | 1 | 1 | 1 | 3/4 | 3/4 |
| **R6** | 1/2 | 1 | 3/2 | 1 | 1 | 1 | 3/4 | 3/4 |
| **R7** | 2/3 | 4/3 | 2 | 4/3 | 4/3 | 4/3 | 1 | 1 |
| **R8** | 2/3 | 4/3 | 2 | 4/3 | 4/3 | 4/3 | 1 | 1 |

Using the AHP method, we were able to make a relative comparison of one risk versus another. This relative comparison is easier to make than an absolute evaluation used in the classical approach. However, the AHP method does not make it possible to take into account any dependencies between the different risks. In order to integrate this dependence, we suggest using the Analytic Network Process (ANP) method. We are currently finalizing an in-depth study of the use of ANP in a supply chain risk assessment process.

## 5. Conclusion

In this article, we presented a study on the limits of the classical risk assessment approach. In particular, we looked at the supply component of a supply chain and considered the case of a manufacturing company operating in the automotive sector. We have shown the limits of the traditional approach to risk management, especially at the stage of assessing these risks. The first limitation is due to the difficulty of the absolute evaluation of the criteria (Probability and severity) of a risk. We have suggested the use of the AHP method for easier assessment based on a relative comparison of risk criteria. The second limitation of the classical method concerns the fact that this method does not take into account the dependence between the risks. We suggest using the ANP method to integrate this dependency

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## Biographies

**Dr K. Benhida** is the author and co-author of several articles, communications and patents. He has also contributed to the establishment of a research team and laboratory and to the supervision of several doctoral students.

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