# Studies on the improvement of the supply chain in the automotive industry: production of electrical wiring

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**Abstract.** Procurement is the beginning of the global supply chain and is driven by customer demand for goods. In the automotive industry and not only, the timely and qualitative delivery of finished products is an important goal, the customer being 100% satisfied. This paper addresses the issue of improving the supply process in case of urgent changes, especially in the automotive industry, in the processing of electrical wiring, for a number of companies producing vehicles. The Romani car industry grew quite a bit after the 1990s. The arrival of the world's major car companies has cemented the domestic sector in adopting best practices in the supply chain. This has led to improved competitiveness and increased quantum exports. However, the Romanian car industry must operate in a unique environment that still presents challenges for the supply chain. It is therefore necessary to continuously study supply chain practices in the automotive sector.

## 1. Introduction

The concept of SCM has gained over time an increased importance in the world economy due to its impact on the competitive advantages of companies [1-2].

Supply chain management is under pressure from companies that strive to maintain high levels of service for their customers, while being forced to reduce costs and maintain profit margins [3]. Decision support tools, strategic planning and cost reduction are extremely valuable. Each situation is unique and requires a customized model to suit the particular situation and purpose of the company in question [4].

Thus, over time in the automotive industry, standards related to product quality have been developed and implemented, one of which is the ISO/TS 16949 standard, which refers to the quality elements within the supply chain.

Joe Bransky, member of the International Automotive Task Force (IATF) comments: "In the current manufacturing environment, the huge intervention stocks in the inventory have been replaced by logistics and just-in-time delivery. Rooting safety as the ISO TS 16949: 2009 standard ensures major improvements in terms of quality, productivity, delivery is essential."

In essence, supply activity includes the purchase of material resources and inventory management. It is a very important activity, because it has a great financial impact on the company's turnover [4-5].

The organization of the circulation of material values from the supplier to the beneficiary, their reception from a quantitative and qualitative point of view, their proper storage and maintenance and their distribution to the consuming sections and jobs, represent some problems that compose the supply process [6].

## 2. Procurement and supply - basic logistics operation

The supply of material resources is defined as "the activity that ensures the elements necessary for the consumption of production, in volume and structure to ensure an activity, with a high profit, of economic units." [7]. The good functioning of the enterprises' activity is conditioned, to a large extent, by the timely and complete supply of raw materials that will become part of the finished product manufactured and delivered to the customer.

A competitive and reliable supply means a timely management and adequate quantity of components and raw materials needed in production. This requires a brief analysis / prospecting, a good forecast and optimal management of stocks, a good rotation of them and at the same time a low level of supply disruptions, but also to control, verify, systematically monitor the use of materials, negotiation, contracting.

Figure 1 presents the trends of the automotive industry that have an impact on the supply chain [8]. According to Fisher [9] the supply chain must be adapted to the specific requirements of the manufactured product. This is especially the case for the complex automotive industry, where a car manufacturer has to struggle with the management of a network that includes several supply chains. The macroeconomic cycles of growth, contraction and recovery create extraordinary efforts on the efficiency of the established supply chain, especially in the automotive sector, due to its widespread links with other industries [10].

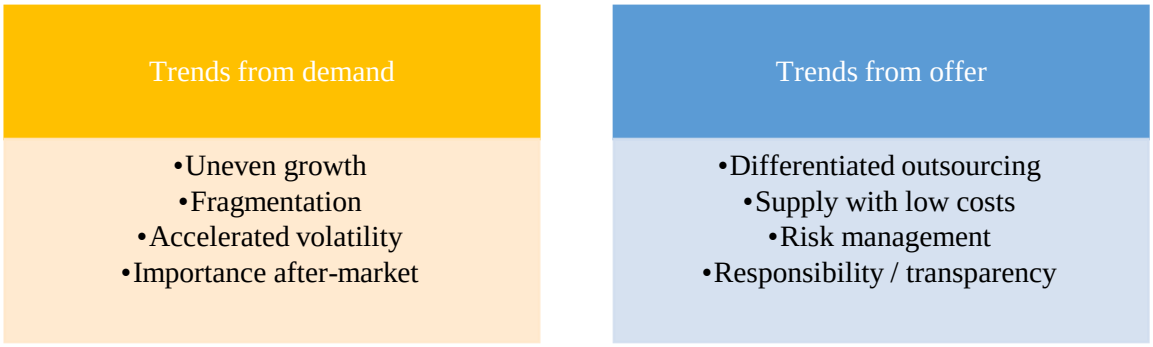


**Figure 1.** Trends affecting SCM [8]

The share of costs related to raw materials and materials is generally high, sometimes decisive, representing 70-80%, maybe even more. According to some authors, it is an exchange of a commercial nature, through which material values are traded following the elaboration of consumption needs, after the suppliers have been identified; the prices and other conditions of the transfer of ownership between the partners have been negotiated.

## 3. Evaluation of the efficiency of the supply process - Case study

The case study is carried out on a company producing electrical wiring in Romania that performs cutting operations - automatic and semi-automatic crimping, with and without Seal, tinning operations, printing of strips and automatic banding. The company produces electrical wiring mainly for the automotive industry (lighting systems, safety systems, dashboard, mirrors, handsfree telephony ...). The company has a number of 170 employees, currently having a mainly manual, semi-automatic and very little automatic production. Within the company there are 3 major departments: Automatic/Semi-automatic, Manual/electrical assembly and Final testing. The Automata/Semiautomata Department cuts/crimps the wires, which are then sent to the Manual/Electrical Assembly Department where they perform pressing operations / plug inserts, applying collars, spot bandages, hair dryer operation, etc ... and finally reach the Testing Department where it is checked electrically and visually if the products comply with the customer's requirements.

The main customers of the company are: Harting SCS Romania, Kuhnke Production Romania, Electromagnetica SA Bucharest, and among the final customers are the largest car manufacturers: Mercedes, Audi, Volkswagen, BMW, Aston Martin and Volvo (fig.2).


**Figure 2.** The company's customers

In the field of engineering and measurement technology, the company has all the necessary facilities for a supplier for the automotive industry, whose products are qualitatively appropriate.
Within the company, the supply department has a very important role, that of maintaining internally a permanent connection with the finance department and with the production department, and externally it relates to the suppliers but also to the company's customers. An essential condition is the synchronization of the production plan with the supply, only in this way it is possible to obtain the reduction of stocks, of the costs related to them, the increase of the quality, of the productivity and of the capacity to adapt to changes [10].

The supply department pays special attention to the way in which the movement of stocks takes place, the evolution of stocks, the conditions and the degree to which they ensured the productive consumption, the critical periods determined by the lack of stock, their speed of movement.
As in any other company, the issue of stock management and the quantity to be supplied is raised by establishing supply rules so that the items necessary for the production process are not missing from the stock.

To optimize the size of the stock, the Wilson-Within model is used, which takes into account two categories of variables:

- $C_l$ - the cost of launching supply orders
- $C_s$ - storage or inventory costs

As stocks of materials are depletable over time, they gradually pass into consumption, storage or inventory costs are calculated as an average of the expenses from the first day of the stock and the expenses from the last day of its existence => any storage costs is weighted (corrected) by 0.5.
Sometimes the company is faced with situations where there is no stock of raw materials, suppliers do not deliver the goods on time or it is delivered with defects.

**4. Improving the supply process within the company**

In order to be able to start a process of improvement in terms of supply, the main problems were identified. Thus, between 17 - 22.11.2019, the head of the supply department analyzed and identified the problems he faced in the last 6 months. These were grouped according to how often they occurred, importance, degree of occurrence and risk.

The problems identified are:

- Delays in the supply of special conditions (due to changes imposed by customers)
- Impossibility to predict long-term framework orders
- There is no feedback from suppliers to solve the problems identified in the evaluation of suppliers (lack of corrective action plan)
- The supplied products do not correspond to the technical specifications (lack of invoice, documents accompanying the goods)

The Pareto Diagram statistical quality tool was used to solve the problem and apply an improvement [11-12]. The 4 identified problems were given grades, as shown in the table 1.

**Table 1.** Alternative evaluation matrix

| Identifyed Problems | Cronicity 10 % | Importance 40 % | Degree of potential impact 2 % | Expedite 38 % | Risk 10 % | Total |
|---|---|---|---|---|---|---|
| Delays in the supply of special conditions | 5 | 5 | 5 | 5 | 1 | 21 |
| Impossibility to predict long-term framework orders | 2 | 5 | 0 | 5 | 1 | 13 |
| There is no feedback from suppliers to solve the problems identified in the evaluation of suppliers | 5 | 5 | 0 | 5 | 1 | 16 |
| The supplied products do not correspond to the technical specifications | 5 | 2 | 0 | 5 | 2 | 14 |

Following the evaluation, the issue with the highest weight and, also the highest priority was considered as "Delays in the supply of special conditions".

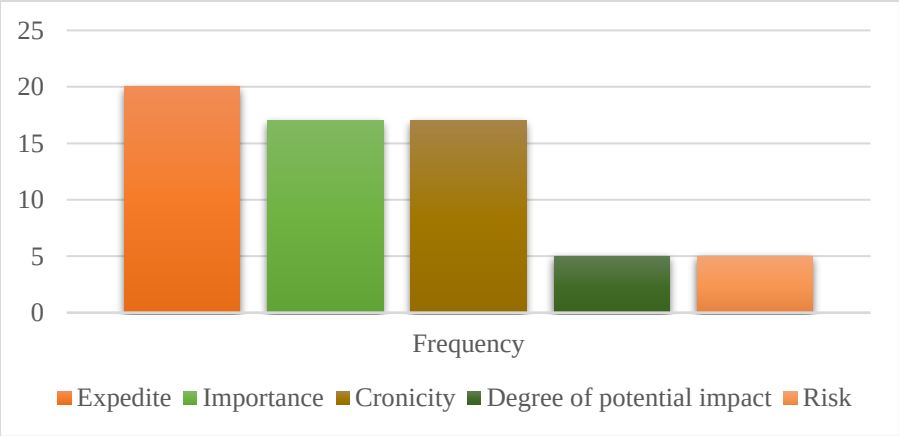


**Figure 3.** Frequency of the problem

In order to improve the supply process with the raw material necessary to make the car wiring according to the requirements imposed by the company's clients, the DMAIC method was applied, performing the steps [11-13]:

• Defining the problem

The main problem is the supply in special conditions (as a result of changes imposed by customers). Delays in raw materials for special orders are on average 2 weeks. The company's proposal is to reduce delays by 1 week within 6 months. In order to fulfill this mission, a team of project manager and 5 members was created.

• Measuring the main aspects of the current process and collecting the main relevant data

In order to reduce the delays related to the supply of raw materials, it was necessary to identify the main reasons that lead to their occurrence.

To identify the causes, a Fishbone & 5 Why diagram was drawn up, which is presented in figure 4 [12-13].

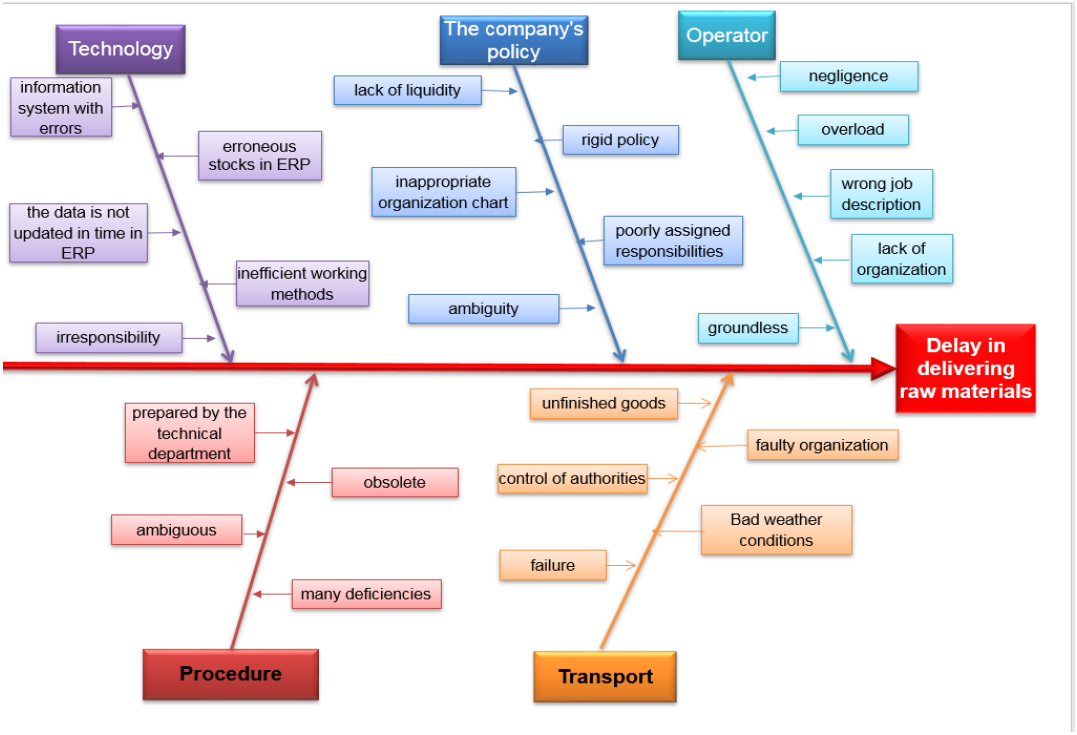


**Figure 4.** Fishbone diagram combined & 5 Why

• Data analysis and verification of relational causes and effects.

All 130 cases in which there were dysfunctions in the last 6 months were analyzed and the defects that initiated the respective dysfunctions were identified. Based on the frequency of these malfunctions, the Pareto Diagram was drawn up with the help of which the most important defects were identified, which produce 80% of the delays.

**Table 2.** Alternative evaluation matrix

| Defect description | Frequency | Relative frequence | Cumulate relative frequence | | **TOP defectcs "80%"** |
|---|---|---|---|---|---|
| **Incorrect stocks in the system** | **40** | **30.77%** | **30.77%** | | |
| **Ambiguous procedure** | **40** | **30.77%** | **61.54%** | I | **Incorrect stocks in the system** |
| **Overworked employees** | **23** | **17.69%** | **79.23%** | ÎI | **Ambiguous procedure** |
| Delayed transport | 13 | 10.00% | 89.23% | III | **Overworked employees** |
| Rigid company policy | 8 | 6.15% | 95.38% | | |
| Disorganization | 4 | 3.08% | 98.46% | | |
| Unclear responsibilities | 2 | 1.54% | 100.00% | | |

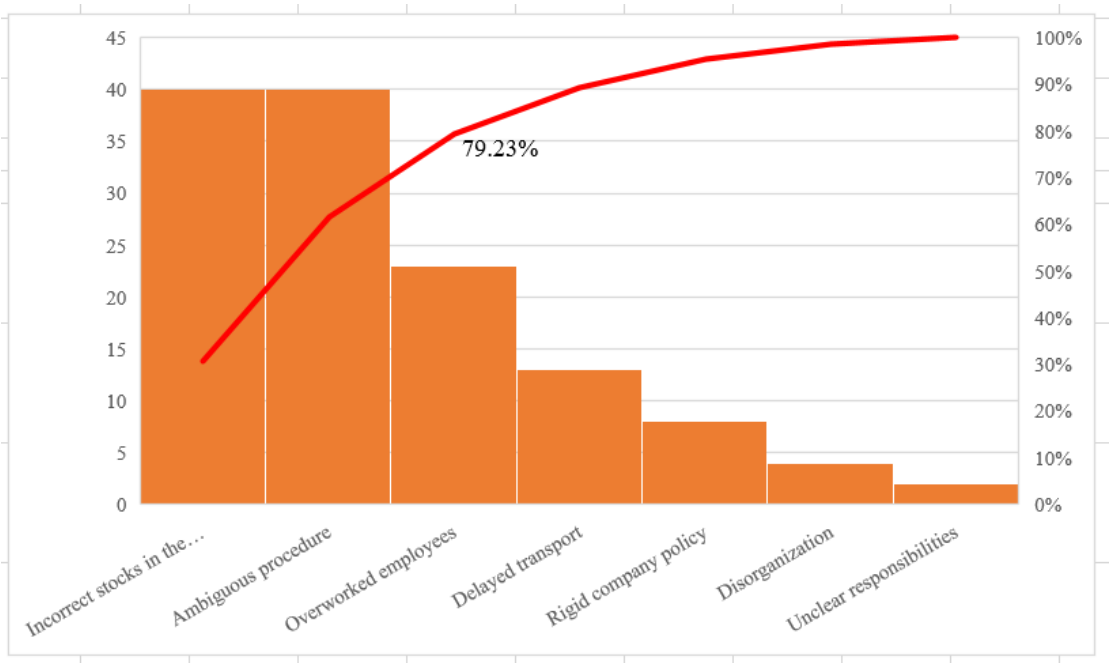


**Figure 5.** Pareto diagram

So, if the company focuses on eliminating or at least reducing the frequency of these defects, the delays will be reduced by 80%.

• Improving and optimizing the supply process based on the analyzed data

Once the improvement team identified the root causes of the problem, it was ready to identify solutions/improvements. As it emerged from the analysis of the data from the last 6 months, the main non-conformities were:

- Incorect stocks in the system
- Ambiguous procurement procedure
- Overloaded employees

In order to reduce the frequency of non-conformities, several measures have been proposed presented in figure 6.

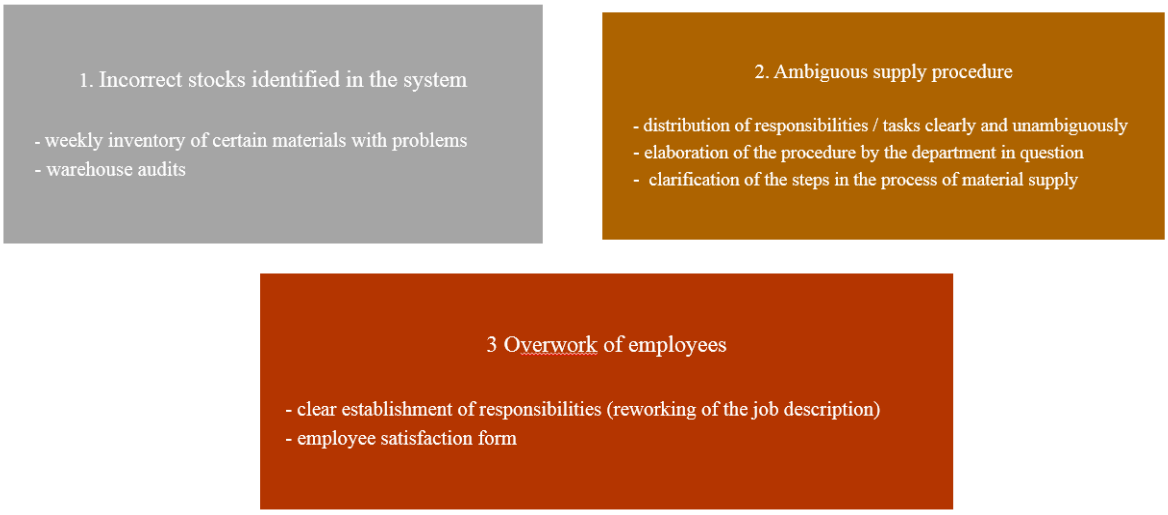


**Figure 6.** Measures to reduce non-conformities

As not all the improvements found are equally effective, the team had to consider other criteria for evaluating alternatives:

- (3) the impact on the main issue
- (2) implementation time
- (1) the total cost which must not exceed the available resources

The magnitude of the impact of the proposed solution on the current non-conformities was quantified by grades between 1 and 3, where:

- 3 - very favorable impact
- 2 - favorable average impact
- 1 - weak favorable impact

**Table 3.** Other criteria for evaluating alternatives

| Cause | The improvement alternative | Selection criteria 1 | 2 | 3 | TOTAL score |
|---|---|---|---|---|---|
| - Incorrect stocks in the system | **- weekly inventory. to certain materials with problems** | **3** | **3** | **1** | **7** |
| | - warehouse audits | 3 | 2 | 1 | 6 |
| - Ambiguous supply procedure | - redistribution of responsibilities / tasks | 2 | 3 | 1 | 6 |
| | - elaboration of the procedure by the department concerned | 2 | 3 | 1 | 6 |
| | **- clarification of material supply steps** | **3** | **3** | **1** | **7** |
| - overwork of employees | **- clear establishment of responsibilities (reworking of the job description)** | **3** | **3** | **1** | **7** |
| | - employee satisfaction form | **3** | **2** | **1** | **6** |

It is observed that in order to correct the first non-conformity, the incorrect stocks in the system, the biggest impact would have the performance of a weekly inventory for the materials identified as being with problems.

Regarding the ambiguity of the procurement procedure, the measure of clarifying the steps of the process seems to have the greatest impact. With regard to overworked employees, it is recommended to rework the job description in order to clearly establish the responsibilities of each employee.

At the end, we started to plan the improvement process, drawing up the following file.

**Table 4.** Plan the improvement process

| Main causes | Corrective action | Necessary resources | Responsible | Term | Achievement stage% |
|---|---|---|---|---|---|
| Incorrect stocks in the system | Weekly inventory. to certain materials with problems | Material resources: scales<br>Human resources: specialist<br>Information resources: ERP | warehouseman | weekly | |
| Procedure | Clarify material supply steps | Human resources: specialist | Manager supply | 2 weeks | |
| Overworked employees | Stabilirea clară a responsabilităţilor (reelaborarea fisei postului) | Material resources: office<br>Human resources: specialist | Manager Human resources | 2 weeks | |

Following the implementation of the control elements, the improvement team ensured that the improvements are put into practice and maintained, and at this moment, the delays in the supply of raw materials within the company were reduced by 15%.

## 5. Conclusions

The importance of supply is materialized by the responsibility assigned to it. It can be said that the procurement process includes both the purchase of material resources and the management of stocks.

The supply department is necessary and very important because it comes to the aid of organizations, so that they maintain internal control, to meet their own requirements and especially those of customers. It has a special importance because it achieves the establishment of the material needs of the production, the continuous reduction of the consumptions of raw materials and materials, the attraction in the economic circuit and in the consumption of the production of new material sources, the increase of the organization's profit.

Good supply of raw materials and materials is the optimal way to accomplish the of production tasks and manufacturing of products. Procurement management can provide the means necessary for improvement activities through a consistent development of its processes. It can generate "good or bad" performance, thus providing the basis for managing these processes.

If the organization does not have a well-defined supply management, it fails to achieve a necessary pace of improvement in order to be able to face the competition in the market, in a very short time. Procurement management that emphasizes continuous improvement can build capacity, lead to significant cost reductions, and create added value.

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