

Proposal of a Preliminary Audit Approach for the Modeling and Digitization of a Green Supply Distribution Chain

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Abstract

The modeling and digitization of a supply chain are important assets for optimizing the functioning of this chain. However, these modeling and digitization operations are not always easy, especially if they take into consideration, in addition to economic aspects, other aspects such as environmental aspects. In order to facilitate the implementation of these modeling and digitization operations, we propose a preliminary audit of the supply chain before starting the modeling and digitization processes. This preliminary step ensures that a set of criteria has been respected before starting to develop a model or project to digitize the chain. In this paper, we will focus on the case of a distribution supply chain for a company operating in the production of equipment for the automotive industry. We consider the case of an international company with several production plants, implemented in several countries, and with several distribution warehouses and several car manufacturing customers.

Keywords

Preliminary Audit, Supply Chain, Modelization, Digitalization, Automotive Industry

1. Introduction

As part of this study, we are interested in the cases of international Alpha companies that manufacture equipment for Beta companies in the automotive industry. For reasons most often related to the reduction of production costs, these Alpha companies most often relocate their production plants to countries offering advantages allowing these costs to be reduced (labor, tax advantages, offshore area, etc..). However, these offshoring operations are most often accompanied by an increase in logistics costs, particularly in terms of transport. In addition, and due to the remoteness of the production sites of Alpha companies compared to Beta customer companies, the environmental impacts, mainly related to transport, are expected to be higher. Optimizing the supply chain then becomes a major imperative in order to control the costs, deadlines and environmental impacts of the chain.

2. Companies's interrelation Alpha and Beta

In this paper, we will focus more specifically on the logistics distribution component of Alpha companies. In this component and for this type of international car equipment manufacturing company, the production plants are generally implemented in different countries. Alpha's warehouses are often located in areas close to customers, who are the car manufacturers. We consider the specific cases where Beta customers are located in European countries and Alpha production sites located in countries of Eastern Europe, Africa or Asia. In order to facilitate the provision of products for their customers, Alpha companies often set up warehouses or distribution platforms in Europe in order to reduce the time taken to make products available to Beta customer companies.

For an Alpha company, we can associate the production plants with the term M_i (i varying from 1 to i_{max}), with warehouses the term E_j (j varying from 1 to j_{max}) and with Beta customer companies the term C_k (k varying from 1

at k_{max}). We consider that the transport between the sites and the warehouses is mainly by sea and that the transport between the warehouses and the Beta companies is mainly by land. We also consider that Alpha companies manufacture two types of products: standard products G_g (g varying from 1 to g_{max}), which can be used by several Beta companies and specific products $S_{s,k}$ (s varying from 1 to s_{max}) for a customer C_k . The order $d_{k,t}$ of a customer C_k at an instant t can be composed of standard products G_g and specific products $S_{s,k}$. This order must be followed by an availability check at the levels of the different E_j warehouses. Several situations are then possible, depending on the availability or not of these products at the various warehouses. Obviously, we must retain the case which optimizes a given objective function. This objective function can be related to the reduction of either costs or delays or environmental impacts. It can also be related to all of these aspects at the same time by adopting weighting parameters specific to each aspect. Evaluating the optimal case can be greatly facilitated by implementing a model and digitizing the supply chain. We offer a preliminary audit of the distribution logistics component of this type of Alpha business in order to facilitate the modeling and digitization of this chain. The preliminary audit is based on a frame of reference which makes it possible to assess whether the company Alpha has mastered a set of related parameters:

- The location of the various M_i production plants, E_j warehouses and C_k customers;
- The different transport times between M_i production plants and E_j warehouses on one side and E_j warehouses and C_k customers on the other side;
- Transport costs between M_i production plants and E_j warehouses on one side and E_j warehouses and C_k customers on the other side;
- Means of transport between M_i production plants and E_j warehouses on one side and E_j warehouses and customers on the other side and the capacities corresponding to these means;
- The environmental impacts related to means of transport between M_i production plants and E_j warehouses on one side and E_j warehouses and C_k customers on the other side;
- Information management systems exchanged between M_i production plants, E_j warehouses and C_k customers.

3. Material distribution flow:

Remembering that our scope of application is the distribution chain in the automotive sector which is characterized by just-in-time or the quantity produced by the company Alpha corresponds as closely as possible to the request of the Beta customer.

After receiving the order from the customer C_k , this order must be followed by an availability check at the various warehouses E_j and then send to the Just In Time service of production plant M_i , which in turn triggers its processing by developing the production schedule and setting delivery dates. This order is then sent to the Production Control department which will dissect it into elements of raw material re-entering its composition and will launch after the production schedule.

This order depends on two types of product, General G_g product and Specific $S_{s,k}$ product. Each product type is characterized by a different material distribution flow.

Let's start with a case of an order triggering a specific product.

- A Specific product is a complete product including the engine part and the interior part of the car, so it is a special product at the request of the end customer, who is the final consumer of the car.

The distribution center E , deals with all the products from different production plants. This center is still under the responsibility of the company or the Alpha group. It is a Customers / Industry interface and of which it is part of a strategy aimed at supervising the weekly needs of all production plants and prioritizing that in emergency.

We define $d_{k,t}$ the order of Customer C therefore the flow below:

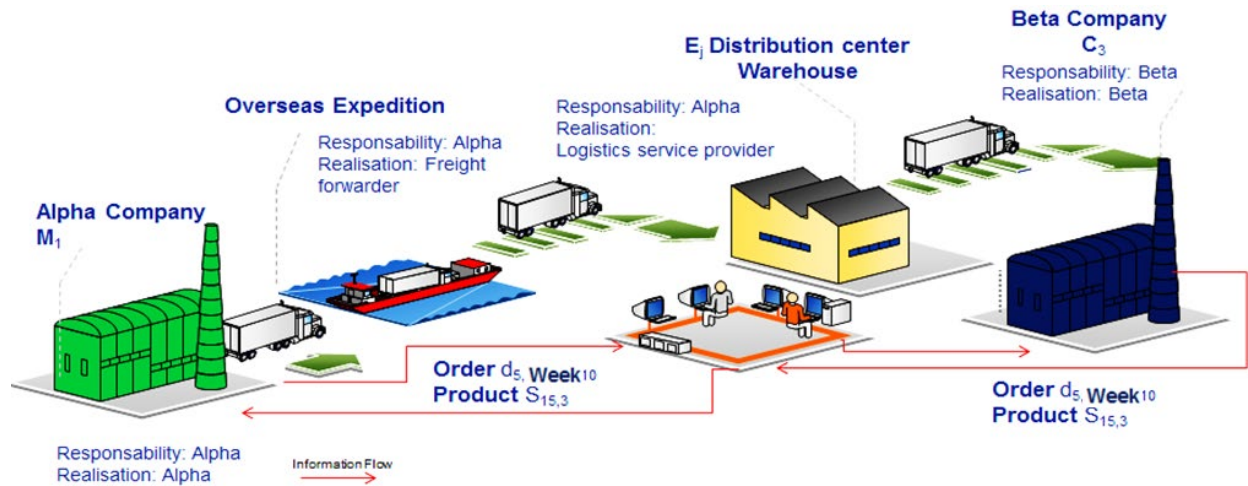


Figure 1: Case of a specific product

Going to the second case, where the G_g product is Alpha's outcome.

- A General product is characterized either by a part of the engine or by an interior part of the car such as glass wipers, airbag...

Let F_f (f varying from 1 to f_{max}) be the direct customer of the company Alpha and the supplier of the company Beta. F_f is an automotive supplier, G_g products from Alpha must be combined with other automotive accessories, therefore the need for a second assembly plant.

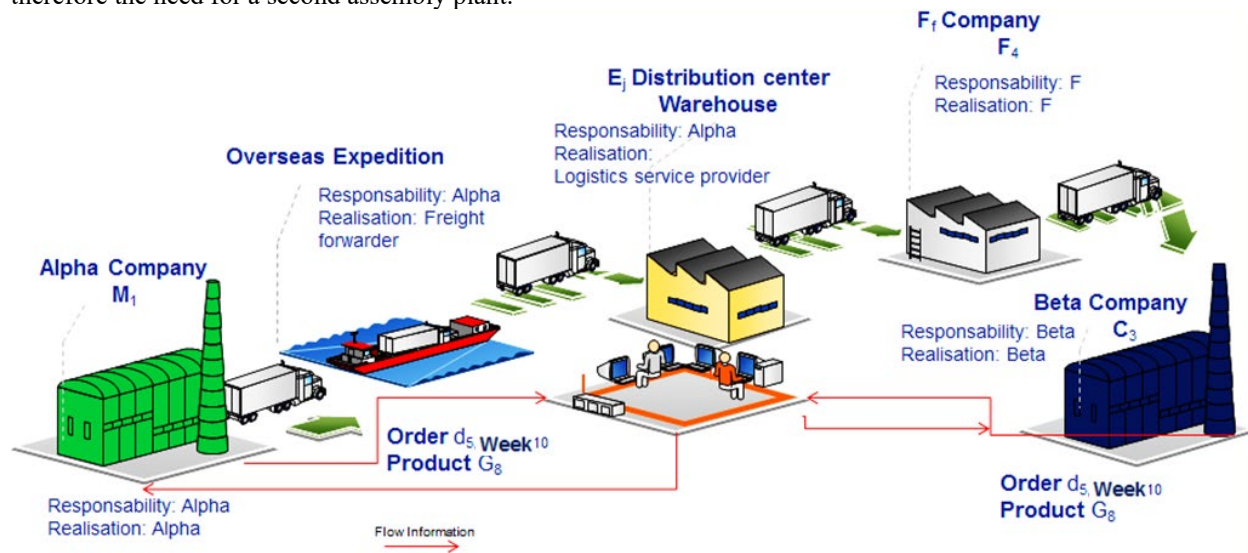


Figure 2: General product case

Essentially, a distribution network is a series of nodes and transport relations. It can differ from direct delivery from the source to the point of consumption to a complex multi-site network. The creation of a distribution network is dependent on certain factors such as the type of product, the variety and volume of products, the geographic extent of the service area, the level of service required as well as the number and type of customers. Below in Figure 3, it further explains the location of different stakeholders of the production company M_i .

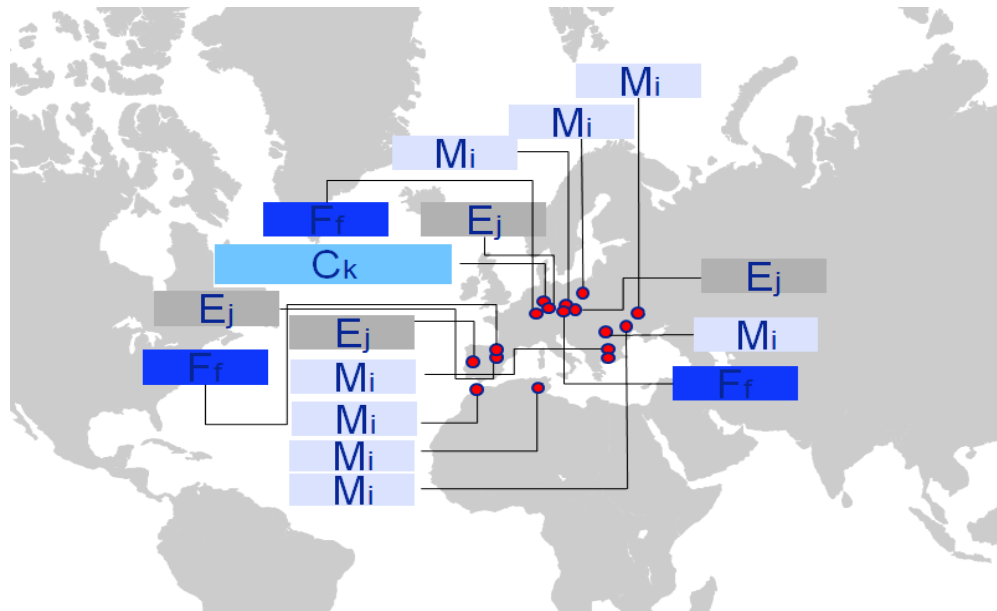


Figure 3: Distribution network

4. Criteria for the Audit of the distribution chain

A specialist in the automotive industry, Alpha is one of the world's leading suppliers of components for the international automotive industry. To reach such a position, it faces constant competition. It is in this perspective that Alpha has decided to ask for an additional Audit in its distribution chain. Customer requirements oblige this industry to adopt a more efficient and rigorous quality policy in terms of product quality supplied to its C_k customers. As we pointed out at the beginning of this writing, a prior audit makes it possible to ensure that a set of criteria have been met before starting to develop a model or a digitalization project for the chain in other words, it allows for an objective assessment to determine the extent to which the audit criteria are met.

We can mention 5 key components in order to ensure compliance with delivery times and produce a compliant product:

- Packaging and storage, between the company Alpha and the Warehouse, in trucks:

By respecting the storage method (Maximum limit of superimposition of centenarians) and by respecting specific packaging criteria (Reference of the authorized centenary, size of the centenary, quantity of the piece per centenary, method of packaging products and parts, identification of centenarians with labels, etc.)

- Delivery delay:

Respect for the distribution providers who are defined in advance and the deadlines for receiving the product from the Alpha company.

- Handling means:

Ensure that the handling means used are authorized for unloading, loading and then storage. And the arrangement of the locations of centenarians waiting for control and releasing before storage.

- Product quality:

Verification of the presence of the list of orders produced and declared to be sent to the customer and comparison between the actual quantity and that declared and then with that requested by the customer via the system. Control by sampling of a part per order for each delivery, which undergoes a destructive audit.

-Claim:

The last complaints which can be the subject of a check list, During the distribution phase in the Warehouses E_j or at the level of the suppliers of the Automobile suppliers F_f , all quality points must be audited to be able to act before non-compliance is detected at the customer rank 2 or even at the consumer and lock the failure system as much as possible. Product audit cells under the responsibility of the Alpha company are set up in Warehouses and at first-tier Suppliers.

5. Conclusion

In this article, we presented a study on a real case of an Alpha company. In particular, we examined the distribution component of a supply chain and examined the case of a manufacturing company operating in the automotive sector. We have shown its distribution network, in particular the Criteria for the Audit of the distribution chain. This preliminary step makes sure that a set of criteria has been met before starting to develop a model or a digitalization project for the chain.

Biographies

C. Abouessour is an Industrial Engineering and a PHD student at Cadi Ayyad University.

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.