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INBOUND LOGISTICS OPTIMIZATION

A case study of an Original Equipment Manufacturer and its deviation handling process

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ABSTRACT

Globalization has its impact on almost everything and the automotive industry being one of the key contributors to the world's economy faces the challenges of maintaining the complex supply chain dealing with significant uncertainty pertaining to extensive supplier base with inbound logistics handling extensive transport networks and related transport deviations including time, quality, product, quantity, packaging or documentation. These deviations reflect on the performance of IBL operations making the process of handling deviations as extremely critical to ensure smooth operations in the supply chain. The purpose of this study is to evaluate the deviations handling process currently being employed at the Inbound logistics of an Original Equipment Manufacturer (OEM) by mapping and evaluating the existing process. Furthermore, root causes are identified for the inefficient deviations handling process and possible improvements are suggested for process optimization at Inbound logistics. Lean Six Sigma is the selected methodology for this research and DMAIC framework has been adopted to improve the process. Following a case study approach, qualitative data has been obtained through semi structured interviews and observations from company personnel and industry experts. Quantitative data is analysed using deviations log through descriptive data analysis. The results of this research show that the main causes leading to inefficiencies in the deviations handling process at Inbound Logistics of OEM are the IT tools, procedures and the information. These causes are obtained through value-added flow analysis and deviations reports affecting the Transport Operations and are presented through cause and effect analysis. The improvements suggested are related to implementation of real time visibility and data analytics tools, standardization of the deviations handling procedure and centralized information by implementing IT tools.

Key words: Inbound Logistics, Original Equipment Manufacturer, Deviations Handling Process, Lean Six Sigma, DMAIC Framework

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1 Introduction

This research thesis is carried out in an Original Equipment Manufacturer in Sweden in Cooperation with the University of Gothenburg as the final Masters of Science thesis project. The name of the company and teams under review are kept anonymous as requested by the management of OEM.

This chapter provides an overview to the research study along with a detailed description of the problem for the research study. The purpose of the project is also explained along with the research objectives formulated by the authors to converge towards the problem. Finally, delimitations of the study and overview of the report are stated in this chapter.

1.1 Background

Nowadays, industries operate in a globalized environment that not only generates business opportunities, but also higher competition in more complex supply chains; therefore, companies are constantly trying to optimize these supply chains that increase the profitability at lower costs (Delipinar and Kocaoglu, 2016). One of the most important challenges in supply chain optimization is to match the demand and supply (Jonsson, 2008), which with sophisticated forecasting tools lead companies to opt for "Just in Time" inventory management.

The automotive industry deals with similar complex supply chain challenges; being one of the core sectors contributing to world's revenue and employment. The large number of parts assembled demand an extensive supplier network, materials coordination, financial and information flow across the entire supply chain. Globalization in the automotive industry has led to more complexity in the supply chain operations making firms adopt practices like lean manufacturing, supplier consolidation and JIT (Nakashima and Sornmanapong, 2013).

The supply chain members concentrate efforts to make the process efficient and effective, there may be deviations affecting lead times, resulting in higher costs due to lack of timely stock (Zimmer, 2002). An important aspect within the supply chain is transport, is to manage it in an integrated way with the inventory instead of being treated separately. In this sense, the fact that supply chains are increasingly sophisticated, has made companies focus only on their core businesses, establishing partnerships with specialist companies for the outsourcing of certain activities, in this case transport operations (Fadile et al., 2018). Transportation responsible for timely delivery of materials and products are core to automotive logistics.

1.1.1 Scenario of Swedish Automotive Industry

The automotive industry holds a critical position for Sweden. It is the largest of the export sector contributing to the Swedish economy. Swedish automotive manufacturers and suppliers with the transformation in the global automotive industry face rising challenges(Automotive trend report, 2019) . There are 193,000 people employed globally by the Swedish automotive industry including the suppliers, among them 67,000 are Sweden based. The industry has a turnover of SEK 336 billion in 2017 and a value added of SEK 82 billion in 2019 (GDP contribution) (Bil Sweden, 2019). Top car manufacturers with highest number of cars sold in Sweden in 2019 (Statista, 2019) (Figure 1-1).

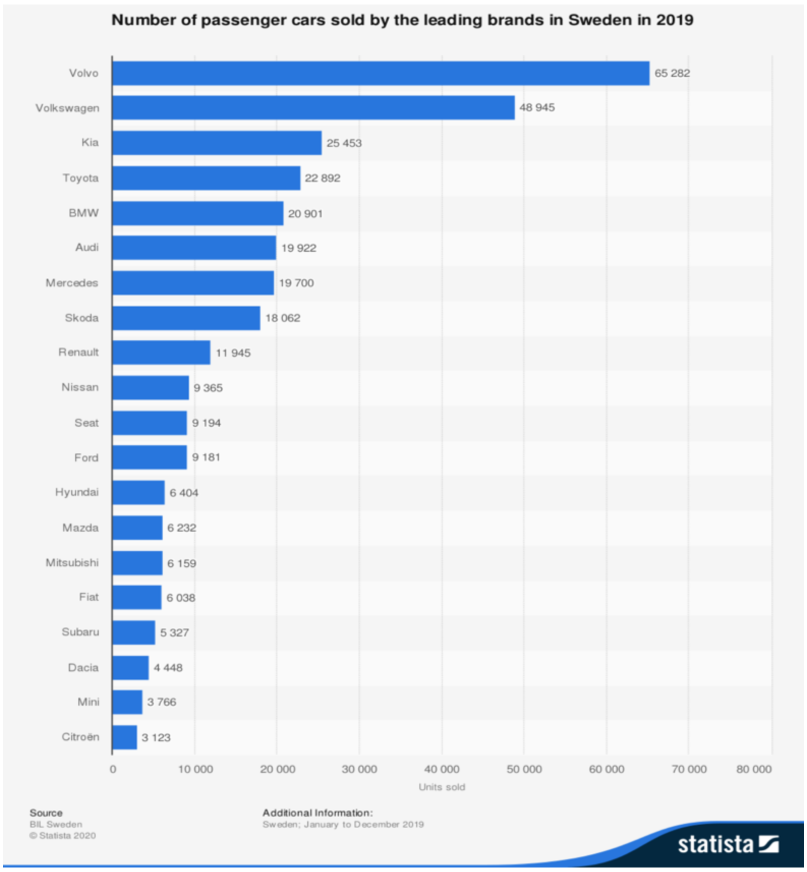

Figure 1-1 Sweden automotive cars in 2019 by brands

Source : Statista (2019)

The automotive eco system in Sweden comprises more than 1000 entities including the OEMs and the tier 3 suppliers (Automobile Industry Pocket Guide 2019-2020). This region has employed almost 40,000 people and is known to contributing almost 58% of the exports (figure 1-2) in the automotive industry.

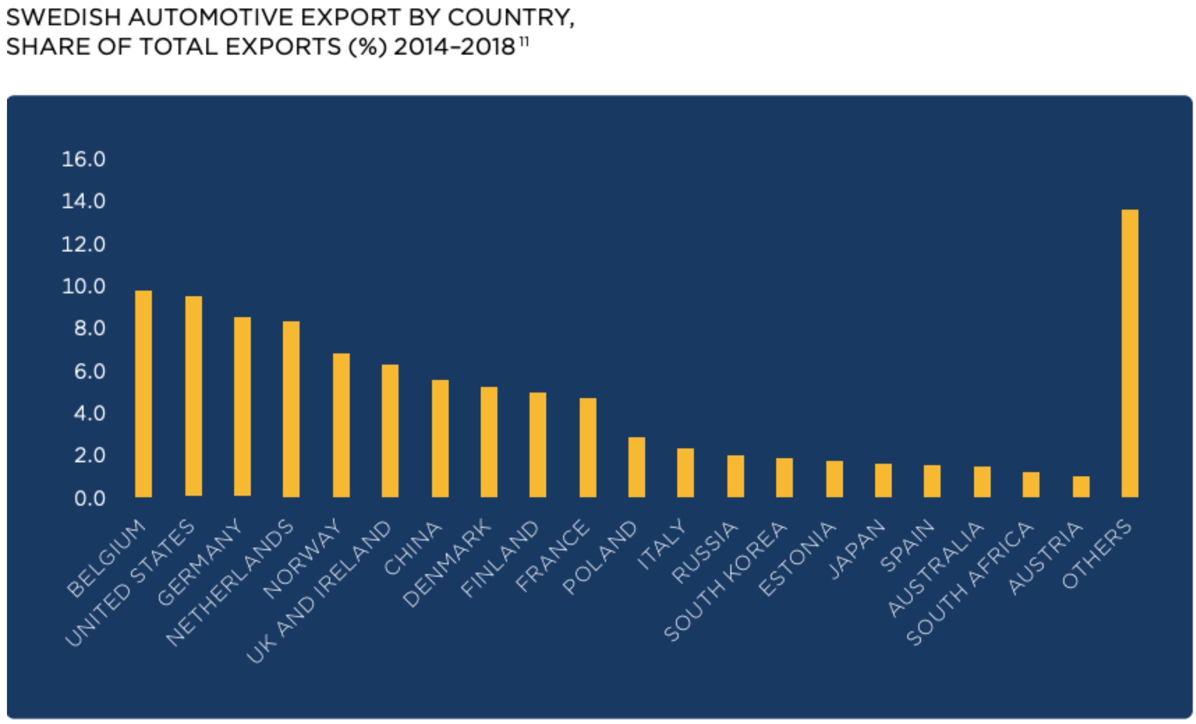

Figure 1-2 Swedish Automotive Export by Country

Source: Automobile Industry Pocket Guide (2019-2020)

1.2 Problem Description

Considering 44% of the deliveries in an organization have some kind of deviations namely lead time, quality, quantity, packaging, product or documentation deviation (Darvik and Larson, 2010), the automotive logistics face the challenge to handle these deviations for the Original Equipment Manufacturers (OEM). The existing challenges in the automotive logistics demand the automotive industry to study the existing systems and build logistics solutions that are customer oriented based on e business platforms namely Lean logistics (Yebiao, Huang and Zhang, 2010).

OEM analysed in this research has a very well-structured Inbound Logistics department. Since not all parts are manufactured in assembly plants, there are a large number of suppliers around the world, thus creating an extensive procurement network. Within this supply chain, transportation is one of the most crucial logistics processes, which according to the operations complexity may be exposed to endless uncertainties and deviations in each of the processes that comprise it (Sanchez Rodrigues et al., 2008).

The Inbound Logistics department of the focal company divides their logistics operations into teams that handle the different modes of transport: road, air and sea; which hereafter, due to confidentiality agreements, are referred to as operational team 1 (road) and operational team 2 (air and sea). Both teams aim to ensure the transport of the different parts according to the established lead times and for this purpose they have set a target of 90% in the On-Time delivery indicator, stating that 90% of orders must not arrive at assembly plants outside lead times.

However, logistic operations are subject to different unforeseen events that lead to deviations in lead times affecting delivery precision performance; therefore, it is very important for the company to identify these deviations opportunely and to act on them to avoid inventory fluctuations that generate additional costs, since the company works under the "Just in Time" inventory management methodology (Sanchez Rodrigues et al., 2008). For this purpose, the deviations handling process plays a vital role, since it not only helps to identify the incidents within the logistics transport operations, but it can also be used as a tool to take preventive and corrective actions to minimize deviations and improve the on-time delivery performance.

The deviation handling process is observed to be time bound involving different actors corresponding to the information obtained through different channels including email, the TMS and Excel sheets. The managers IBL consider the process demands identification of key areas that can improve the process and thereby allow the OEM to handle deviations effectively. Considering this, the company, in its constant search for the processes' optimization, has identified the need to evaluate and optimize the current deviations handling process in order to identify, report, measure and act on them opportunely to reduce the impact on its performance and on the production processes.

1.3 Purpose

The purpose of this research is summarized as follows:

To assess the deviations handling process currently being employed at the Inbound logistics of an Original Equipment Manufacturer (OEM) in a case study and suggest improvements for process optimization.

1.4 Research Objectives

Three research objectives are formulated to meet the purpose of the study, stated as follows:

- To map and evaluate the current deviations handling procedure
- To identify the root causes leading to the inefficient deviations handling process
- To investigate and propose improvements to optimize the deviations handling process

1.5 Delimitations

The focus of this research is on deviations handling process at inbound logistics at an OEM. This study is carried out in the areas of inbound logistics department of the automotive company responsible for managing the logistics operations of Europe, Middle East and Africa and some transport operations with Asia and America.

The research carried out is limited to the case study of the specific company and the information obtained involves all the operations carried out by the stakeholders.

1.6 Disposition

This section presents the disposition of the thesis report (figure 1-3).

Chapter 1 Introduction The research purpose is presented in this chapter. An introductory background to the research and a problem description of the study are presented in this chapter followed by research purpose and research objectives. Lastly, delimitations are presented for the research work.

Chapter 2 Theoretical Framework Relevant literature pertaining to deviations including the source of deviations are analysed in the first section. Followed by literature findings about lean six sigma implemented in logistics are presented to be analysed for empirical findings.

Chapter 3 Research Methodology The adopted research methodology is presented in this chapter. A detailed explanation about the selected research approach, data collection methods and analysis are provided in the chapter. Research validity and reliability are also presented.

Chapter 4 Measure Measure phase is presented based on the data gathered in the research project. This chapter aims to identify the improvement opportunities in the deviations handling process.

Chapter 5 Analyze In this chapter, data analysis is conducted for the data obtained in the measure phase. The key opportunities are discussed and analysed to optimize the deviations process.

Chapter 6 Improve Certain solutions to improve the process are presented in the chapter based on literature and primary research findings from measure and analyze.

*Chapter 7 Conclusion T*he key findings of the research study are presented in this chapter. The key improvements for the existing process employed by the inbound logistics department of the focal company and future research work recommendations are suggested.

Figure 1-3 Research disposition

Source: Authors

2 Theoretical Framework

This chapter covers the theoretical framework for this research study. The literature presents the theories and research with the aim to provide the researcher with an overview of the main concepts that the thesis is built upon. This chapter is subdivided into two main sections.

The first section explains the role of inbound logistics within supply chain management, transportation as a key component of inbound logistics and sources of transport deviations. The second section explains the literature findings about Lean Six Sigma and t six sigma which is further used for the structure of this thesis.

2.1 Inbound Logistics

Inbound logistics is a primary activity of the supply chain that is observed to be rooted in the value chain of the organization. Michael porter presented the concept of value chain by illustrating the different functions of the company and explained the connection between activities adding value to the products and the services for the customers (Porter, 1985). The value adding activities are divided into two main categories namely primary activities and support activities. Primary activities are inbound logistics, outbound logistics, operations, service and marketing and sales tend to create value exceeding the related costs. Procurement, Human Resource management, technology development and infrastructure are the four main support activities as can be seen in figure 2-1.

These activities coordinate providing the opportunity to the company to gain a competitive advantage. Optimizing one or more of either primary or secondary activities in the value chain also allows the company to gain competitive advantage. However, one main consideration is that the optimization in one activity should not be by sub optimizing the other activities (Van Weele, 2018).

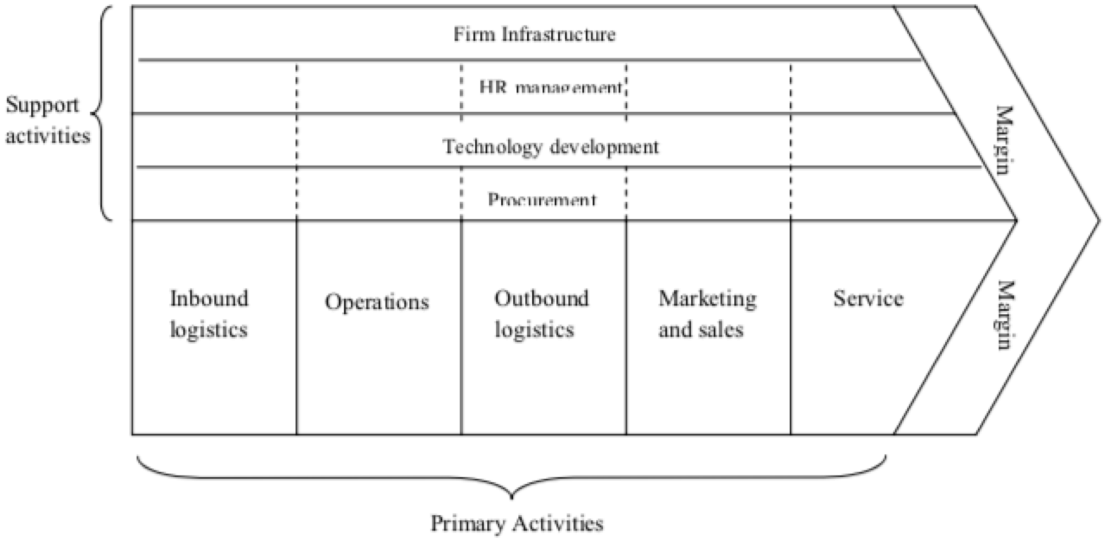

Figure 2-1 The value chain

Source: Porter 1985, in Van Weele (2018)

The research in this thesis is conducted in one of the primary activities of the Porter's value chain i.e. ‘‘inbound logistics”.

Lambert and Stock (1993) defined the inbound logistics (IBL) as the process to move components as well as parts from the suppliers using different modes of transport to the manufacturer. Alan and Baker (2008) work presents no standard definition explaining inbound logistics as three main practices are identified by them; namely transportation, warehousing and inventory. These three activities are significant practices of inbound logistics. Inbound logistics mainly enables the material flow to the manufacturing plant. The transportation functions hold a critical place when it is concerned with material flow and the movement of goods from one point to the manufacturing site (Stock and Lambert, 2001). Figure 2-2 presents the overview of supply chain with emphasis on inbound and outbound logistics. Harrington (2008) presented his views by explaining that the logistics and the planning in the inbound logistics allows the firm to create substantial savings and reliability in the supply chain (SC).

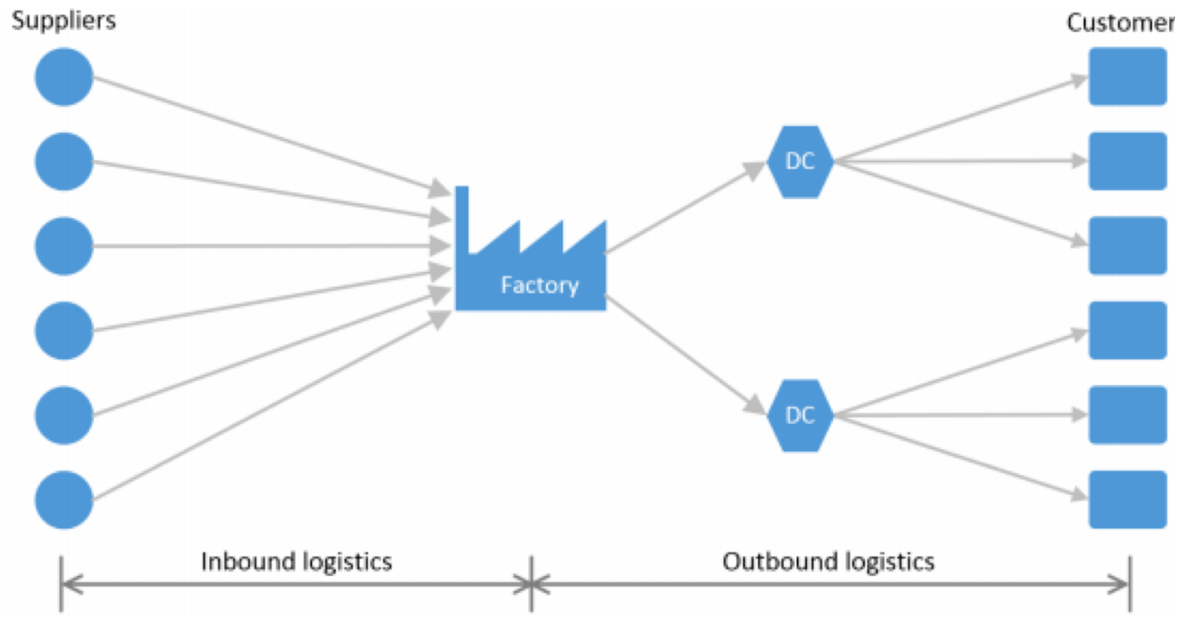

Figure 2-2 Overview of Supply chain (inbound and outbound logistics)

Source: Chopra and Meindl (2013)

Since the focus of this thesis is automotive inbound logistics, Barami (2001) stated that the inbound logistics in the automotive industry is more than transporting the different material through air, land or sea. Having a firm supply network is more demanding that would perform the key activity ensuring the continuous material flow. The rising consumer demand has resulted in forcing the automobile manufacturers to shift their focus from the supply network where the inventory was pushed to the dealerships towards pull products by the consumers. In order to gain competitive edge, the auto manufacturers need to operate with agility and follow a low-cost structure (Barami, 2001). Duguay et al., (1997) explain the stock-push strategies applied in the automotive industry for mass production. The push strategies are designed taking into the benefits of bulk transportation reducing the travel costs but leading to challenges like dead stock, shortage of critical components and high cost of inventory. Therefore, the traditional production in the automotive industry is now turning focus from mass production towards Just-in Time (JIT) and customized productions known as built-to-order (BTO). These companies now implement demand pull and hybrid strategies in their respective inbound logistics. Boysen, Emde, Hoeck and Kauderer (2015) explains the demand pull strategy being more flexible for the IBL with focus on building supplier and manufacturer relationships. Their work presents the operational schemes for the IBL in the automotive industry that includes the milk runs, cross docking and point to point delivery (Boysen et al., 2015).

As the literature points towards transportation as one of the main categories of inbound logistics generating costs, our thesis aims to analyze the deviations caused by the transportation in inbound logistics affecting IBL performance.

2.1.1 Transportation In Inbound Logistics

One of the critical activities in the process of inbound logistics is the ability to transport the materials and goods from suppliers to the manufacturing plant and it reflects on the performance of IBL by affecting the speed, costs and the consistency of delivery (Stock and Lambert, 2001). According to Ballou (2006), transportation is one of key activities contributing to almost one to two third of the logistics costs. The key focus of logistics is movements of the material flows across the transport network. Therefore, transportation modes selection, assigning the contract to the service providers or carriers and contractual management of service providers are critical to the IBL activities. Moreover, planning the routes of transportation, vehicle selection and assigning time are also related to transportation (Crespo de Carvalho, 2014). Transportation networks consist of the nodes and the links interconnecting them. Nodes are the starting point and the ending point of the travel along with some stops made during the travel distance. Different types of vehicles are used as transportation modes for goods to be transported from one point to the other. Air, road, water, sea, rail and intermodal are the main transportation modes used by IBL (Chopra and Meindl, 2013).

While analysing the network design of transportation in logistics, one important consideration is whether to have direct shipment from the supplier to the demand point or to use the consolidation points for the purpose of shipment. The selection of transportation modes is based on the need of the materials and the supply chain strategy of the company. Selection of different transportation modes is based on the characteristics like shipping costs, speed of delivery, flexibility and volume (Chopra and Meindl, 2013). Almost 90% of the transportation takes place through road compared to air transportation being one of the expensive alternatives that is used to ship the products fast from the suppliers to the manufacturer and from manufacturers to the customer. Inbound transportation being critical for the supply chain connects the company with their suppliers and affects the performance of company operations by delivering the required materials on time at the right place for production and distribution (Van Weele, 2018).

Analysing the costs of transportation, Ahumada and Villalobos (2004) stated that the transportation costs along with the inventory costs make up almost 60% of the total logistics costs making it a key component to manage when it comes to costs in an organization. Costs of the inbound logistics are found to be more than 10% of the manufacturing costs of the plant and thereby 1.4% of the vehicle cost. Analysing the transportation costs in inbound logistics in the automotive industry is core as these costs are trade off to the on time delivery of the products and components to the manufacturing site (Miemczyk et al., 2004).

Transportation with the key task of on-time deliveries demands strategic actions to reduce these costs. Successful transport execution results in IBL and SC success. This demands various key decisions pertaining to transportation to be taken into consideration including costs of goods, network design, carrier selection, mode, IT support systems, negotiations and service maintenance (Tracey, 2004). According to Chopra and Meindl (2013), the decisions of IBL transportation affects the company's costs of goods sold (COGS) while, on the other hand, outbound transportations has a major impact on general and the organizational administrative costs. The

2.1.2 Deviations in Supply Chain

Wagner et al., (2012) stated on-time delivery is more critical as Just-In-time (JIT) strategy is mostly adopted for the inbound flows in the automotive sector with recent emphasis on Just-In-Sequence (JIS) method of delivery for almost 40% of the car parts. The disruptions in the supply chain are triggered along the way of the inbound logistics network or during purchasing causing a chain of events with potential to have a major impact on the manufacturing operations. The key strategy is managing the inventory and reducing the production cycle time by optimizing transportation flow especially in the manufacturing industry (Wagner et al., 2012). Deviations are the consequences of transportation disruptions and uncertainties contributing to logistics costs.

Zeimpekis et al. (2013) stated dynamic urban distribution problems leading to deviations in the form of affecting delivery schedules explained as follows:

1. Traffic congestion, changes in weather conditions, road failures and protests lead to increase in the vehicle travel time.

2. Unavailability in the loading and unloading areas along with wrong order of the delivered products causes increase in the customer service time.
3. Accidents and mechanical failures cause vehicle breakdown.
4. The customer delivery or pick up requests during a distribution causes reroute or no service.
5. The amount of requests pertaining to order quantities affecting the delivery schedule by re-routing or no service (Zeimpekis et al. 2013).

These unforeseen events demand making real time adjustments like rerouting or making changes to delivery schedules and adapting to the new needs to meet the objectives. These problems also reflect in the form of time delays affecting the delivery time windows. The key to manage the dynamic fleet involves the ability of monitoring the real time geographic location of the transport vehicles and based on that generating reports of performance of vehicles. The existing systems should possess the ability to identify the changes in the time windows and allow recommendations for preventing them. Similarly, to handle the vehicle breakdowns through providing assistance and look for alternative ways to ensure product delivery. Rerouting the trucks is another key ability to be possessed to handle uncertainty of traffic conditions and to reduces the impact on service quality (Zeimpekis et al., 2013)

Late deliveries or incorrect items delivered pose a challenge for the manufacturing company. According to Ala-Risku and Kärkkäinen (2006), almost 8 to 25 percent of the uncompleted activities in the IBL are due to delivery deviations. The organizations face the challenge of delivery deviations both in the form of costs and time. Therefore, actions are to be in place in order to avoid certain circumstances caused by untimely delivery of components. Darvik and Larsson (2010) explains the large order quantities by the firms contributing inventory piled at the warehouse, extra support required to handle materials, loss, waste and additional costs of materials. In addition, inventory storage also contributes to administration costs along with increasing risk of theft. These deviations ultimately reflect in the delays in product manufacturing that can impact the level of customer satisfaction. states the key role of customer satisfaction by increasing customer retention and showing brand loyalty.

Suppliers, manufacturing and the customers are stated as the three main sources leading to uncertainty in the supply chain (Davis, 1993). A framework developed by David was implemented initially at Hewlett-Packard in the 1990's. This framework analysed the uncertainty in supply chain as a strategic issue affecting performance. Uncertainty circle model was developed through joint work of Mason-Jones and Towill (1998) and Davis stating four main sources as originating points of uncertainty. These sources were namely, supply side, control systems, demand side and the process of manufacturing.

A typology was developed by Van der Vorst and Beulens (2002) where three dimensions were added for each source of supply chain uncertainty. These dimensions are namely quantity, quality and time. The information availability, demand from customers for product quantity, supply quantities and product scrap explain the quantity dimension. Product quality (produced, after storage), accuracy of information, supply quality and product specifications based on customer demands are linked to quantity dimension. Lead time (suppliers and distribution), storing time, throughput time (production and information) are associated with time dimension (Van der Vorst and Beulens, 2002).

Later the uncertainty model was extended, and the manufacturing perspective was added. A logistics triad (figure 2-3) was proposed by Sanchez and his colleagues (2008), taking into account the uncertainty model to determine how uncertainty impacts the transport performance. The logistics triad is developed with the manufacturer's viewpoint with extension towards the perspective of transport. Five main sources are identified during this model namely shipper, carrier, customer, control systems and external that can cause uncertainty.

1. *Shipper Uncertainty*

Shippers are one key source causing uncertainty in the logistics triad. The directly related areas causing shipper uncertainty can be categorized as shipping, storage and inventory management. The inventory management in transport operations is analysed through warehouse capacity acting as a constraint towards transport optimization. Poor flow of information between the carrier and the shipper also affects the transport operations generating uncertainty. Similarly, the shippers can cause uncertainty during the planning of distribution and transport by making very large deliveries or infrequent deliveries to the customers. The variability between the shipment and the delivery time, quality issues to the materials shipped and unnecessary return, lead to shipper's uncertainty (Sanchez et al., 2008).

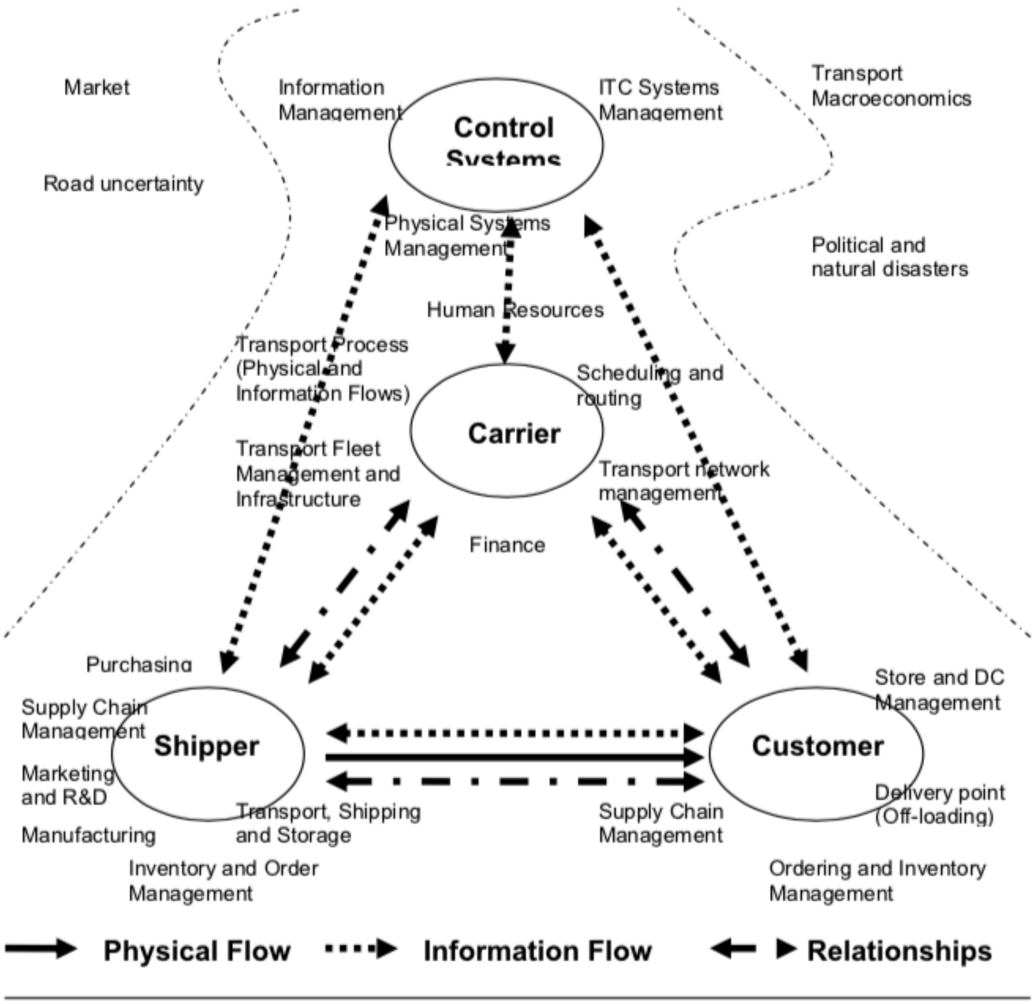

Figure 2-3 Uncertainty Logistics triad model

Source: Sanchez et al., (2008)

2. *Customer Uncertainty*

Customer uncertainty is related to the areas of transport linked to the customers. The direct areas causing customer uncertainty includes order management , inventory management and off-loading process. The variations in freight transport due to customer demand, low frequency order, errors in order consolidation can cause deviations from the standard orders. Another source of uncertainty can be the off-loading process where there are long waiting times or que times between the off-loading times assigned for delivery. Strict delivery windows at the off-loading areas can lead to major problems. Operational concerns including limited workforce at the delivery point also increases the waiting time of vehicles at the customer facilities (Sanchez et al., 2008).

3. *Carrier Uncertainty*

The carrier can also cause uncertainty. Capacity utilization uncertainty can be generated through the empty miles between the destination (inbound) and the origin (outbound). Transport operations face disruptions due to the insufficient fleet capacity. One key carrier uncertainty is due to the lack of information pertaining to drivers location which causes issues of less visibility and delivery process delays. Transport network management is considered to cause uncertainty based on lack of communication between the 3PLs (Sanchez et al., 2008).

4. *Control Systems Uncertainty*

Information uncertainty, ICT or physical systems uncertainty is another name for control systems uncertainty. The main causes of this uncertainty are lack of visibility information pertaining to the inventory (finished goods, material, pipeline), the production plans and information related to order status. Issue faced while handling global suppliers is visibility of information. This affects the demand forecast as well causing inaccuracy. ICT systems cause uncertainty due to the rigid flows of information and non-updated information (Sanchez et al., 2008).

5. *External Uncertainty*

External uncertainty is classified into areas of congestion, transport macroeconomics, demand unpredictability and chaotic. One significant problem affecting the operations of the transport are transport macroeconomics. These are reflected based on changes in the fuel prices, driver shortages and implementation of pollution tax. These along with demand for transport being volatile and increasing demand of reverse logistics are leading causes of uncertainty. Transport operations are affected considerably due to congestion and unavailability of transport routes preferred by customers lead to uncertainty (Sanchez et al., 2008).

Organizations around the globe have to improve their existing supply chain process implemented various continuous improvement strategies including Total Quality Management, Six Sigma, Lean management to name a few. The next section tends to explore the implementation of lean six sigma as a methodology to improve supply chain process and logistics at numerous industries. This further allows the authors to understand whether lean six sigma would allow process optimization for the existing study.

2.2 Lean Six Sigma: Improving Supply Chain and Logistics Operations

A research by Gutierrez, Leeuw and Dubbers (2016) aimed to analyze the implementation of LSS in logistics services. The study was conducted based on the desire to explore whether the combination of both lean philosophy and six sigma would result in continuous improvement for the organization. The research adopted a case study approach and was performed in the electronics company where the need is to have high quality logistics services. LSS was implemented in the organization's two main internal logistics processes namely a payment process and a request to shop process. Some of the key areas of LSS implementation at the logistics processes included strategic analysis, continuous improvement structure and process management. Six sigma DMAIC framework along with tools of VSM (Value stream mapping), SIPOC (supplier, input, process, output, and customer) and process mapping were discussed with the potential they hold in the logistics processes. The findings of the study provide evidence that LSS implementation in the logistics services leads to improvement in the service quality and LSS holds potential for the logistics services to benefit from it. Defining critical to quality (CTQ) objectives and deliverables are key for the service quality concepts to implement LSS. These quality concepts need to be linked with the business strategy. Organizational structure and training are also important for process implementation of LSS (Gutierrez et al., 2016).

Another study by Daniela, Antunes, Sérgio, Sousa, Member, IAENG and Eusébio (2013) studied lean logistics and six sigma. The research aimed to identify the key variables that influence the performance along with quality of a raw material process. A case study was conducted in order to propose process improvement mainly in the form of reducing the number of defects in the process. A six sigma project was adopted by the researchers as it offers a well-organized structure to analyze and solve the problem. The study used lean principle and Six Sigma along with quality tools to identify the key variables affecting the process of raw material supply and to suggest an efficient process for defect reduction. The reason for adopting LSS was to improve the process and reduce the non-added value activities in the organization's supply chain. The results of the research provide an explanation that LSS implementation reduced the defects by 80% and led to increase in productivity of supermarkets areas, repacking areas and also improved the quality of customer service (Daniela et al., 2013).

Vikas and Vinod (2016) conducted a research by deploying Lean Six Sigma framework in an automotive company with the aim that the aim will allow the organization to reduce defects and increase their bottom line. The company was responsible for manufacturing components. The research focused on reaping the benefits from LSS as the authors were of the view that integrating Lean and Six sigma would allow the firm to reduce the defects through eliminating the activities which are non-value adding in the production line. The framework employed in the study was developed by integrating the DMAIC framework. The findings of the study showed through LSS implementation in the automotive company, the defects along with non-value adding activities in the assembly line were reduced (Vikas and Vinod, 2016).

Jayaram (2016) in his research focused on lean six sigma adopted by the global supply chain management. This research analysed the industry 4.0 and Industrial internet of things (IIoT). The authors explained the role of Lean six sigma mainly as to improve the quality along with efficiency of the distribution operations and production in the global supply chain. LSS allows the elimination of processes that are unnecessary and reduce the defects allowing the firms to reduce their costs and minimum wastage of the resources. The current phenomenon of Industry 4.0 explains the data exchange between logistics and supply chain due automation in industries. The recent studies provide evidence that Lean six sigma can lead to creation of ideal process flows using the industry 4.0 in the global supply chains making them highly optimized and with almost zero defects (Jayaram, 2016).

Zhang, Luo, Shi, Chia and Sim (2016) aimed to analyze the implementation of LSS in manufacturing and healthcare industries. The authors consider LSS as the most critical methodologies adopted by firms to improve processes. LSS has been employed in the industries to improve quality and considerable savings in costs. The research by Zhang et al.,(2016) investigated LSS implementation to improve the logistics operation. 410 companies were part of the research study registered at Singapore Logistics Association. The results of the study showed that almost 37.5% respondents have Lean management implemented and most of the organizations have implemented lean and six sigma both. All the companies consider achieving major cost saving and improvement in productivity through LSS implementation. The large companies found more inclination towards implementing LSS and companies striving to achieve higher service standards focused mainly towards Six Sigma implementation (Zhang et al., 2016).

2.2.1 Lean Six Sigma

Lean Six Sigma is known to be a management system that combines lean philosophy and six sigma. Lean six sigma is defined as a methodology which focuses on waste elimination through adopting DMAIC in order to increase customer satisfaction in context of cost and quality (Salah et al., 2010). The focus of LSS is to improve the processes, satisfy the organization's customers and to achieve the bottom line results of the company. Drohomeretski et al., (2014) stated both lean and six sigma can be used as complementary strategies as they converge with the same aim despite the difference in their starting points.

Lean Six Sigma originated from Xerox. The leaders of Xerox committed all their resources in 2002 to integrate lean in their existing six sigma programs in the entire corporation to create extensive development. Xerox was able to train 400 black belts till 2004 along with 700 projects delivering high business and generating significant financial results (Fornari and Maszle, 2004). The research case study conducted in UK among small engineering company shows that lean six sigma implementation in the production results in reducing the scrap costs by 55%, an increase from 34% to almost 55% in the OEE (overall equipment effectiveness), more than 34% time available for the manufacturing and almost 12% decrease in the consumption of energy every year (Drohomeretski et al., 2014).

Albliwi and Antony (2013) explained that LSS provides an organization with key features that enables them to improve their performance. However, critical is to have well implemented LSS to reap the real gains as a poor attempt without well executed and strategized LSS can lead to ineffective implementation of LSS. By focusing on the critical factors and by directing the efforts on the key processes, organizations tend to increase their performance and sustain the existing success. The literature provides evidence that LSS implementation calls for focus on critical success factors (CSF) along with communication, management involvement and organizational commitment (Albliwi and Antony, 2013).

An effective lean six sigma implementation in an organization aims at capitalizing the strengths of lean philosophy and six sigma (Arnheiter and Malayeff, 2005). The primary tenets of lean management that are incorporated in an LSS organization includes a corporate philosophy that aims to maximize the value added from main operations, for global optimization constant evaluation of the different incentive programs, developing a process of decision making for management which the focus of decision should be how it would impact the customer. The main tenets for six sigma in the LSS organization tends to focus on methodologies that are data driven for the process of decision making and scientific data is the main element and the selected methodologies work on minimizing the quality variations (Arnheiter and Malayeff, 2005).

2.2.2 Six Sigma

Bill Smith made his first attempt to conceptualize Six Sigma framework in 1987 for problem solving. According to Schroeder and colleagues (2008), Six sigma attempt was derived from Total Quality Management. The tools for quality control and problem formulation and diagnostics that are commonly used in total quality management were utilized in six sigma. However, later the concept six sigma looked deeper into continuous process improvement practices merged into scientific work (Pepper and Spedding, 2010) instead of just focusing on quality management programs. It ensures the quality of services was improved by reducing the variation in the entire process (Pande et al., 2000).

Six sigma initiative and strategic decisions to gain results are much dependent on executives' commitment and ability to make it happen for long term benefits. Further it requires mindset across the functions with customer centric approach and statistical knowledge (Bergman, Korslid and Magnusson, 2003). The application areas for six sigma focuses on reducing defects, minimize cycle time and improve customer satisfaction, eventually organizations also benefit from cost reduction with the implementation of six sigma. This framework was adopted by General Electric, Ford and American Express among others to improve their organizational processes and business performance (Schroeder et al., 2008; Bergman et al., 2003).

More specifically the authors use the Define, Measure, Analyze, Improve, and Control (DMAIC) approach to evaluate the inbound logistics process in an automotive company.

Motorola at one point was experiencing exponentially growing quality issues and cost issues. To make Motorola capable for producing higher quality products and services at a lower cost, sigma six methodology was created and applied by using the same workforce, technology and designs. However later management realized that a top down approach to make six sigma success is significant to realize (Tjahjono, et al. 2010). Prior practices in industries in the context of total quality management faded due to the fact that traditional approach was considered the only solution to address the issues (Coronado and Antony, 2002). However, with six sigma, it's not about conformance to internal requirements, rather it's more about addressing the quality and cost cutting in a different way. Potential quality is the known maximum possible value added per unit of input, however, actual quality is the current value added per unit of input. The difference between potential quality and actual quality is known as *waste*. Primarily, Six Sigma focuses on continuous improvement of quality by identifying and eliminating costs that provide no value to customers (Coronado and Antony, 2002).

Six Sigma adopts Deming's cycle Plan-Do-Check-Act and presents a five-stage cycle Define, Measure, Analyze, Improve, Control which is widely known as DMAIC (Bergman et al., 2003). Kwak and Anbari (2006) defines DMAIC as a closed-loop process that eliminates unproductive steps, rather focuses on new measurements, and applies technology for continuous improvement.

Define the project goals and customer deliverables, set up a schedule. The goals of given improvement activity e.g., at executive level it might be strategic objectives and at operations level the goal might be to increase the throughput of a production department and at project level to reduce the defect and increase throughput. At define stage, apply data mining techniques to identify potential improvement opportunities (Schroeder et al., 2008). The most common method that can be used during define stage is brainstorming that is done through conducting interviews, focus groups, kano model, Critical to quality tress and surveys.

Measure the process to determine current performance by establishing valid and reliable metrics to monitor progress towards the goal i.e., defined at stage 1. Further data can be understood by using the exploratory and descriptive data analysis approach. Value stream mapping and SIPOC are used to investigate the process by visualizing the inputs and outputs of the factors.

Analyze and determine the root causes of the defects. The system to identify ways to eliminate the gap between current performance of the system and the desired goal. This can be done by utilizing the statistical tools to guide the analysis. Various tools can be used during analyse phase. These tools can be graphical as well as numerical. Case and effect diagram, regression analysis, pareto charts, pie charts, tree diagram, stratification and correlation analysis are few of the tools used to identify the causes.

Improve the process by permanently eliminating the defects. With creative approach to find new ways of doing tasks better, faster and cheaper. This can be done by using project management or planning management tools to implement the new approach. Then use the statistical methods to validate the improvement.

Control the improved process performance to ensure sustainable results. The new system, meaning institutionalization of the improved system by modifying compensation, incentive systems, policies, budgets. This can be supported by utilizing the ISO 9000 to assure that documentation is correct (Schroeder et al., 2008).

3 Research Methodology

The research choices and approach used for this thesis are presented in this chapter. Initially the research approach and research strategy are discussed. A detailed explanation to the data collection methods and methods of data analysis are later presented in this chapter. Lastly, research validity and reliability are discussed.

3.1 Research Approach

A study can adopt either a deductive approach or an inductive approach. This research adopts a deductive approach. Saunders et al., (2016) explained the two traditional relationships that exist between the research and the theory; as in either the theory is guided through the research or the theory comes as a result of a research study. The deductive research uses empirical data to support the existing theories and the inductive research approach uses the empirical data to create and formulate new theories. The deductive research approach tends to support the theories using empirical evidence (Yin, 2014). The purpose of this research is defined beforehand along with the selected methods in the research that are already examined, this research can follow a deductive approach.

Multi method research is considered to be applicable for this research study. Both qualitative and quantitative data is obtained and analysed to meet the research objectives.

3.1.1 Qualitative Research

Qualitative method of research is found to be suitable to analyze the deviations handling process. Saunders et al., (2016) explained that qualitative research tends to understand the process as opposed to measuring certain variables which makes the research quantitative. The qualitative research aims to examine the why and how of the research purpose and the quantitative method examines the what, when and where. The qualitative research allows the researchers to get a deeper understanding about the case in view by conducting interviews and going back and forth with questions in order to get a deeper knowledge about the problem area (Saunders et al., 2016).

A qualitative research approach is considered appropriate for this research keeping in view the complexity of the subject matter that requires in depth understanding of the deviations process at the focal firm and analysing the process more deeply through interviews. The selected method of research allows the authors to gain extensive knowledge about the actual problem by looking at various processes applied by other organizations through literature and observations.

3.1.2 Quantitative Research

Quantitative data is data that includes numbers and statistics. This data is mostly analysed with the help of graphs, tables or statistical tests. Quantitative data is mostly used to get a proper understanding about variable relationships and to analyze the trends (Saunders et al., 2016). Similar to qualitative data, quantitative data hold a key role in this research. This data is mainly obtained to analyze the performance of IBL affected by deviations and the deviations handling process. The quantitative data is analysed using the deviations log provided by the company.

3.2 Research Strategy

A research strategy as defined by Saunders et al., (2016) is a plan on how to conduct a research study. A well-defined research strategy is the key to meet the aim of the research study and to fulfil the research purpose. The research purpose and the available research resources allow the researcher to adopt the different research strategies namely; experiments, action study, archival study, case study, surveys and ethnography. Yin (2014) stated that while selecting the research strategy it is critical to analyze the research purpose, whether behavioural events are to be controlled and if the focus is on existing events.

Considering the research question of this project, the case study has been selected as a research strategy. According to Yin (2014), a case study "is an empirical inquiry that investigates a contemporary phenomenon within some real-life context, especially when the boundaries between phenomenon and context are not clearly evident.", This definition of the case study methodology is aligned with this research project since the purpose is **to assess the deviations handling process currently being employed at the Inbound logistics of an Original Equipment Manufacturer (OEM) and suggest improvements for process optimization**. Furthermore, the fact that the research question has the word "how", makes the case study research strategy appropriate in this project, since "how" and "why" questions have a more explanatory nature and are related to operational matters that must be evaluated over a period of time (Yin, 2014).

One major risk when using case study as the research strategy is lack of ability to make generalizations to be applied to other similar scenarios. However, this research tends to study the process and not make generalizations. The findings of the study can be used by firms with similar business structures and characteristics.

3.3 Time Horizon

This research employs a cross sectional approach. Saunders et al., (2009) stated a research time horizon is either cross-sectional or longitudinal. The longitudinal research study tends to study the research subject over a period of time keeping in view the development and changes. The cross-sectional study focuses on a certain point of time and is more like a snapshot approach. Considering the time limitation and resources available for the research thesis, cross sectional study seems favourable. The purpose of the study is to study the existing process of deviations handling in order to optimize the process, the cross-sectional time horizon is employed because the purpose does not demand studying the development over a longer time span.

3.4 Data Collection

Data collection for this research study is based on both primary data and secondary data. Primary data is obtained through observations and semi structured interviews. Secondary data is gathered through company archival records and literature databases to meet the research aim.

3.4.1 Primary Data

3.4.1.1 Observations

In order to achieve the objectives of this research project, on-site observations are carried out to map and evaluate the current deviations handling process and to identify the key internal and external factors leading to deviations in the material/parts in the inbound logistics department in the evaluated company.

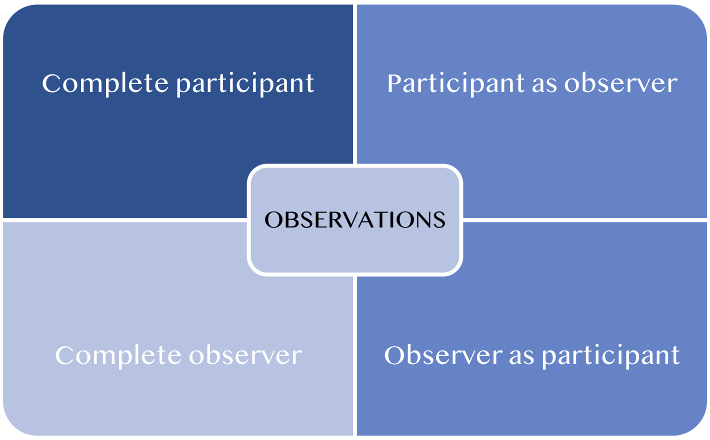

Figure 3-1 Roles as observer

Source: Gill and Johnson (2010)

There are four roles that can be adopted by the observer as stated by Gill and Johnson (2010); complete participant, complete observer, observer as participant and participant as observer (figure 3-1). In the current research project, the authors have adopted the role of observer as a complete participant as the logistics engineers and the entire process observed at the focal firm were aware of the observer's presence and the purpose of the study. The data obtained through observations were explained while defining the research problem and problem mapping. During the thesis, observations are conducted at the inbound logistics department of the OEM while observing the process of the operational team 1 and operational team 2. Observations are conducted to complement the interviews taken by the authors to obtain information related to the deviations handling process and process performance.

3.4.1.2 Interviews

Saunders et al., (2016) presented three main types of interviews namely structured, semi structured and unstructured. Structured interviews demand the interviewer to follow a set of predetermined questions during the interview. Unstructured interviews are usually known as qualitative research interviews with non-standardized questions. Semi structured interviews allow the interviewer to ask the questions based on the flow of information without following the sequence of questions strictly. This allows the interviewer to adjust the questions and adapt the appropriate role to get maximum information (Saunders et al., 2016).

In this thesis, semi structured interviews are conducted from the logistics engineers who are in charge of the deviation handling process. The aim of these interviews was to gain maximum understanding about the process and get the perspectives that each one has in this regard.

Semi Structured Interviews

In order to get a comprehensive understanding about the process of deviations handling at the IBL and how it is being performed, semi structured interviews were conducted among the logistics engineers at the focal firm. As the selected methods of data collection is considered most suitable for qualitative data, therefore, primary data for this research is collected through semi structured interviews. The questionnaire for the semi structured interview (Appendix A and B) was designed to cover a variety of questions to ensure maximum information is obtained during the interviews from both teams, operational team 1 and , operational team 2.

Interview Procedure and Intervieews

At the OEM, the interviews were conducted among seven logistics engineers, two team leaders and two managers from inbound logistics operations. Four interviews were conducted face to face ranging from 30-40 mins at the focal firm in Gothenburg. With the change in situation due to coronavirus, the rest of the interviews took place through Skype. Communication on email was considered as a main source of obtaining data pertaining to questions that emerged post interviews (Table 3-1).

Another skype interview was conducted with a supply chain expert with a duration of 180 minutes. An interview for a duration of 60 minutes was conducted with an IT solution provider for the automotive industry.

Ethical principles were taken into account while conducting the interviews. The interviewees were informed about the aim of the study and their consent was taken to conduct interviews. The interviewees approved being part of the research and permission was obtained to use the information shared by them.

Respondent	Method of interview	place	Duration	Team
Logistics Engineer	face to face	IBL Got	60 mins	Operational team 1
Logistics Engineer	face to face	IBL Got	35 mins	Operational team 1
Logistics Engineer	face to face	IBL Got	30 mins	Operational team 2
Logistics Engineer	skype	home	30 mins	Operational team 1
Logistics Engineer	skype	home	30 mins	Operational team 1
Logistics Engineer	skype	home	30 mins	Operational team 2
Logistics Engineer	skype	home	35 mins	Operational team 2
Manager	face to face	IBL Got	30 mins	Operational team 1
Manager	face to face	IBL Got	30 mins	Operational team 2
Team Leader	face to face	IBL Got	60 mins	Operational team 1
Team Leader	face to face	IBL Got	40 mins	Operational team 2

Table 3-1 Details of interview respondents

3.4.2 Secondary Data

3.4.2.1 Literature Studies

The literature review for the research tends to focus on providing a brief overview of the concepts of inbound logistics, transportation in inbound logistics, delivery deviations and lean six sigma. The data gathered for the literature review is compiled to provide an overview to the study and does not exactly meet the objectives of the research. This is the reason literature studies comprise secondary data. However, critical thinking is adopted while conducting the literature review of this research. The literature review of this research allowed the researcher to map the existing knowledge of the main area in order to build a research framework for reference.

The literature has been obtained through major databases namely, Emerald, Science Direct, EBSCO to name a few. These databases were used to search for relevant journal articles related to inbound logistics, transportation, delivery deviations. Lean six sigma, automotive industry, supply chain uncertainty and transportation. In addition, relevant articles were found using different combinations of keywords.

3.4.2.2 Internal Documentation and Presentations

Among other sources of data, internal presentations from the IBL department of the automotive company that are related to the operational team 1 and operational team 2 and its deviations handling processes are used in the study. These presentations are mainly used to get initial understanding about the entire work operations at the IBL and more specifically to understand the process of deviations reporting at the organization. These presentations are secondary data sources of information used to meet the research objectives. Similarly, internal documentation in the form of reports and excel files are also used as secondary data sources to examine the deviations handling process. The documents tend to offer similar or related data to presentations, however, allowing the researcher a credible source of information of study to meet the research objectives.

3.5 Data Analysis

The qualitative data for this research consisted of semi structured interviews and analysing documents and presentations. Analysing company internal documents provided significant evidence and were linked to the case study research. Bryman and Bell (2007) stated content analysis as one of the most common and effective ways of qualitative data analysis. For this study, content analysis has been conducted to study the aspects that are most appropriate for the research context. The responses from interviews were analysed keeping with codes like deviation handling, tools, process information, process time.

As for quantitative data analysis, descriptive data analysis has been conducted for this research using Microsoft Excel. Descriptive analysis allows analysing the complete data or a certain summarized numerical data (Saunders et al., 2016). The quantitative data in the form of Excel sheets was obtained from the OEM providing a database of deviations incurred by the IBL during the last three months. The data was further arranged in Excel format tables and graphs are presented in this report to examine the process performance of deviations handling.

3.6 Validity and Reliability

3.6.1 Validity

Validity evaluates the extent to which the project reflects what the researchers intend to evaluate according to the research project purposes (Collis and Hussey, 2014). Validity tends to assess whether the findings of the research are trustworthy, data has been collected in the right way and whether conclusions are linked to the data obtained for the research (Saunders et al., 2016). In this research study, methodological triangulation has been used in order to ensure internal validity. By collecting data from more than one data source namely through observations and semi structured interviews, the research focused on securing validity.

A challenge with the external validity and it concerns the generalizability e.g. the applicability of the result into other contexts. However, it is also said that due to the possibility to establish observed patterns, qualitative research and especially case studies can be more generalizable when compared to quantitative studies. In order to secure the external validity and generate a generalizable result the author decided to go with a case study and believe that the result is applicable on firms with similar characteristics. External validation is very difficult to carry out since it is a case study focused on the company evaluated, therefore the results cannot be generalized (Yin, 2014); however, being a topic that different industries can face, this research can help to better understand the problem.

3.6.2 Reliability

Reliability works on analysing the probability of the selected research strategy and whether the selected methodology is random errors free. Reliability refers to the precision and accuracy of the project results if the case study is repeated under the same parameters in the future (Collis and Hussey, 2014). Reliability of the study can be secured through different ways. In this research study, DMAIC methodology has been used along with Value Stream mapping. The selected methodology is known to be one of the tested frameworks that allow companies to improve their processes. Semi structured interviews are conducted to secure reliability and triangulation which leads to increase in reliability. To increase the research reliability, extensive data has been gathered and analysed using tools like Pareto charts. Interviews were conducted among respondents with knowledge of the subject area.

One main consideration during the research was the impact of Coronavirus (Covid-19) on the focal firm's work environment. The organization went through changes and that could have impact on the operations and ultimately affects the information shared by the respondents.

3.7 Research Model

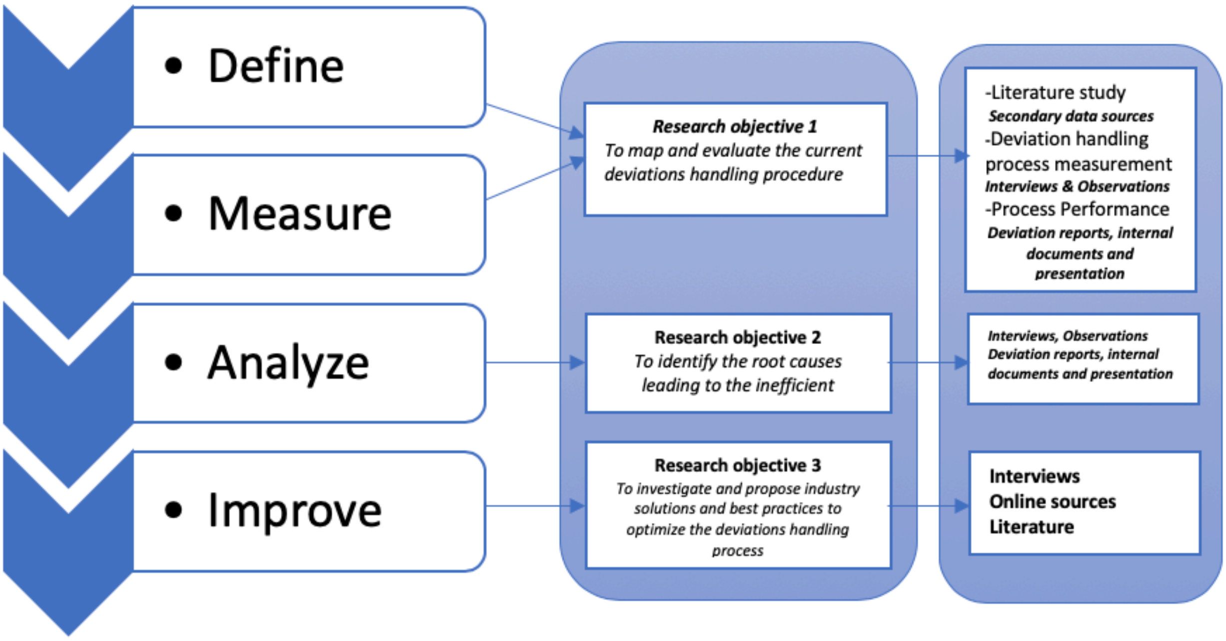

Figure 3-2 Research methodology

Source : Authors own elaboration

4 Measure

After defining the problem in the previous chapters, a fundamental aspect within the Lean Six Sigma methodology is the Measurement Phase, which is focused on understanding how the process is currently performed and what is the magnitude of the problem. In this stage it is intended to collect the data and information that later allow the authors to analyse the process, its performance and possible solutions.

The first step in this phase will be to create the data collection plan in order to ensure that the outcomes are aligned with the purpose of this study; this is a key aspect since reliable and precise information is fundamental for good decision making. Subsequently, it will be necessary to define the current state of the process and determine how it is currently performed, so that a baseline measure will be obtained with which the company can later compare the results of improvement suggestions in case they will be implemented.

4.1 Data Collection Plan

The data collection plan is an extremely crucial process within the Lean Six Sigma methodology, which has as main approach, gathering relevant information and accurate data for the baseline measure; furthermore, provides the authors with a strong understanding of the process under evaluation (Ehrlich, 2002).

In this case, the data collection plan includes the operational definition of what will be measured, where the data will be collected, how to collect it, when to collect it, and the people who will be involved in collecting all the information. The data collection plan is summarized in Table 4-1.

In order to carry out the measurements according to the data collection plan; firstly, for the *deviation handling procedure* measurement, with which it is intended to obtain all the information about the current deviations handling process, interviews with the team leaders within the Inbound Logistics department were planned; who through detailed information, explained the operations of both teams (operational team 1 and 2), providing the authors with an introduction to the deviations handling process.

Measurement	Data type	Operational definition	Where	How	When	Who
Deviation Handling Procedure	Qualitative Nominal	Current process in which the registration of deviations arising in the transportation process is carried out	Inbound Logistics Department	• Interviews • Observations • Archives	March – April, 2020	Thesis Authors
Process Performance – Information quality	Quantitative discrete	How the process is being performed by measuring the information quality	Inbound Logistics Department	• Deviations reports database • Interviews	April, 2020	Thesis Authors
Process Performance – Deviations by stakeholder	Quantitative discrete	How the process is being performed by measuring the quantity of deviations by stakeholder	Inbound Logistics Department	• Deviations reports database • Interviews	April, 2020	Thesis Authors
Process Performance – Deviations by type	Quantitative discrete	How the process is being performed by measuring the quantity of deviations by type	Inbound Logistics Department	• Deviations reports database • Interviews	April, 2020	Thesis Authors
Process Performance – Deviations by reason codes	Quantitative discrete	How the process is being performed by measuring the quantity of deviations by reason codes	Inbound Logistics Department	• Deviations reports database • Interviews	April, 2020	Thesis Authors

Table 4-1 Data collection plan

Source: Own elaboration

Also, to have a better and deeper understanding of this process, interviews (Appendix A and B) with logistics engineers, who are in charge of day-to-day operation, were conducted. Subsequently, on-site observations were made to the deviation handling processes, in which the logistics engineers in charge performed and explained the steps and tasks; furthermore, the shortcomings of the current process were verified by the authors. Finally, archives with information about the deviation handling process were reviewed. These files helped to verify the information and instructions given to the different stakeholders and how they must perform the tasks within the process. The information gathered through these different tools corresponds to the qualitative nominal type.

Then, in order to measure how the process is being performed, the authors reviewed the available deviations reports database, obtaining measures regarding the *information quality, quantity of deviations by stakeholders, by type and by reasons codes.* This kind of data, quantitative discrete, is based on counts and can be categorized into classifications which will be explained thereupon.

4.2 Baseline Measure

Through the data collection according to the previously established plan, a baseline measure is obtained, which are the measures of how the process is being carried out at this project's starting point (Tetteh and Uzochukwu, 2015). In order to capture all the information and to get a better understanding of the process, value stream maps for each operation, operational team 1 and operational team 2, were created by the authors. The value stream map is a tool that shows a set of all the activities/steps that must be followed within a process and allows to understand the work carried out on each of these actions in addition to identify where value is generated and where waste occurs (Myerson, 2012). Furthermore, the authors tend to measure how the process is being performed according to the current procedures. This data is accessed from the OEM - Inbound Logistics deviations report database, according to the data collection plan.

4.2.1 Operational team 1

A. Deviation Handling Procedure

Figure 4-1 shows the value stream map for the deviation handling process in the operational team 1. In this process are involved the road transport service providers, the service desk team and the transport control team.

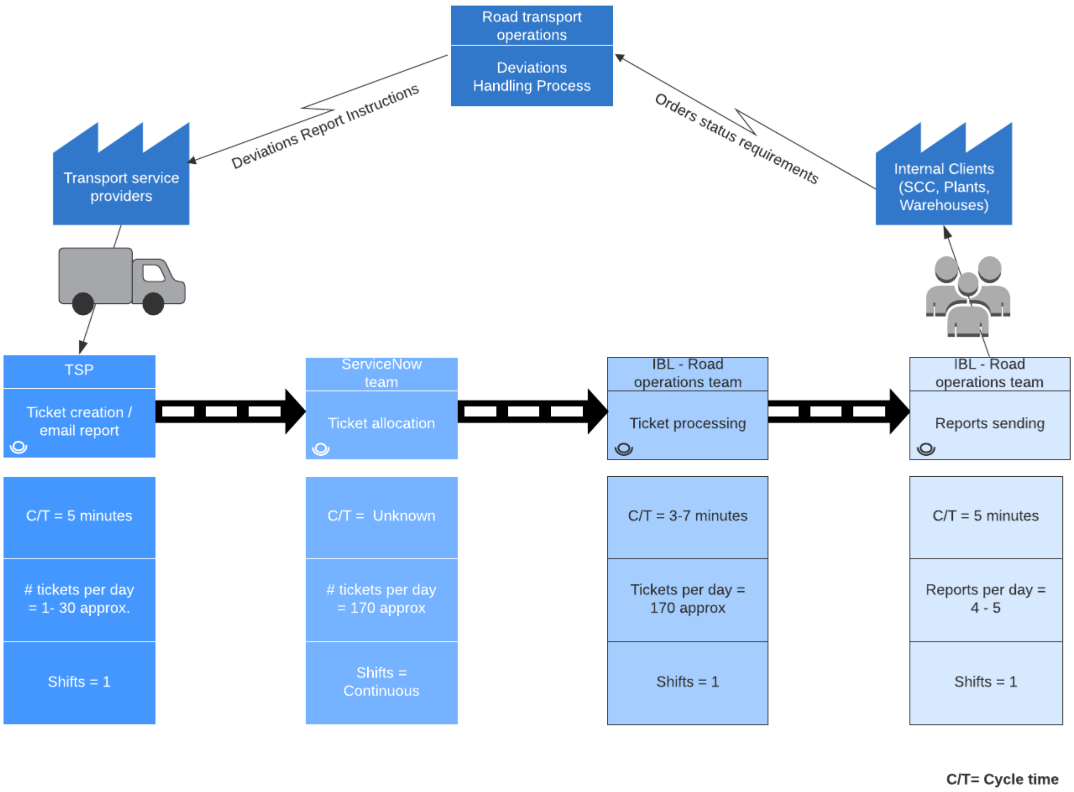

Figure 4-1 Value stream map – Operational team 1

Source: Own elaboration

The process begins when a deviation occurs, and the transport service provider reports the deviation according to the procedure compiled into an operational guide. This procedure indicates how the deviations must be fulfilled according to the deviation type; being the report for certain types of deviations, through the creation of incident tickets in the Service Now system, and the report for other types of deviations, through email. In this operational guide, the transport service providers will also find the templates that must be used to report deviations, which considers details such as the number of orders, new pick-up or delivery dates, and the reason for the deviation according to the codes established by the OEM's Inbound Logistics. The execution of this activity can take up to 5 minutes approximately for each deviation and the tickets quantity reported by each transport service provider can vary between 1 to 30 tickets per carrier per day. This is an approximate figure since the number of tickets can be more or less frequent according to each transport service provider and the deviations that may arise. TSP’s generally report deviations during a single work shift.

Deviations in the operational team 1 mainly consist of pick up lead time deviations, delivery lead time deviations, quantity deviations and pick up address deviations. Based on the data obtained according to the data collection plan, the deviations differ from each other in different aspects. These deviations usually are unequal and have different consequences on the performance in terms of time and costs. Based on the information provided by the OEM's Inbound Logistic, the main deviations faced by this operational team are explained in the Table 4-2.

Once the incident tickets have been created by the transport service providers, they proceed to be handled by the ServiceNow system team, who assign these to the teams in charge of solving the incidents, in this case the operational team 1. Since this activity is out of control of the IBL team, it does not have a specific processing time; therefore, it may take minutes or hours to be correctly assigned. This situation is very risky for the operation, since the lack of timely information about deviations can generate fluctuations in material inventories, affecting supply and production planning. The approximate number of tickets corresponding to IBL – operational team 1 that the ServiceNow team receives is 170 tickets per day and these are allocated in continuous shifts.

When the tickets have been assigned to the operational team 1, they are handled by the logistics engineer in charge of the deviations. The information of the deviation tickets is processed in an Excel sheet according to the established template for the deviations report. In this Excel sheet, the logistic engineer has to categorize the deviations by stakeholder (OEM, TSP, Supplier, Other) and copy all the information provided in the ticket, that is the orders number, new collection or delivery date and the reason code according to the deviation. This is a critical part of the process, since besides being a time-consuming task, it is a manual activity which highly depends on the person executing the process, which means that it is also subject

Deviation Type		Reported by	Processing time (Approximately)
Quantity deviations	Deviations regarding inaccurate product quantity, where the TSP report the loads of **additional or less quantity** than the specified amount in the order.	Incident ticket in Service Now System	3 minutes
	In case the entire order quantity has not been loaded, the TSP must report this deviation as **Empty run**.	Incident ticket in Service Now System	7 minutes
Pick-up deviations	These deviations imply that the collections will not be made according to the established time in the transport management system.	Incident ticket in Service Now System	5 minutes
Delivery deviations	Reports the orders that will not be delivered according to the **required delivery date (days)** in the transport management system.	Incident ticket in Service Now System	5 minutes
	Reports the orders that will not be delivered according to the **tactical window (hours)** in the transport management system.	Email	3 minutes
Pick-up address deviations	Deviations related to certain errors in the collection address which differs from the established in the transport management system	Incident ticket in Service Now System	5 minutes

Table 4-2 Deviation Types – Operational team 1

Source: Own elaboration

to errors. According to the type of deviation, this activity can be carried out between 3-7 minutes per ticket, being processed approximately an average of 170 tickets per day in one shift.

Finally, the report generated in the Excel sheet is sent by the logistics engineer to all internal clients: supply chain coordinators, warehouses, plants, inbound logistics team; who need to be aware of any deviations that may arise in the transport process, since as mentioned above, this information is very important for the supply and production planning execution. This action can be carried out in up to 5 minutes and the report is sent 4 to 5 times a day, depending on the number of tickets per day

B. Process Performance

In order to measure the process performance by using the deviations reports database from the first quarter of 2020 (January - March); first, it was necessary to classify all the data according to the current reason codes established in the operational guide, since as was verified, the transport service providers are not reporting the deviations according to the given instructions. Subsequently, through the use of pivot tables in Excel, the process performance was classified by information quality, by stakeholders, by deviations type and by the reason codes. The latter, due to the amount of information, was only focused on delivery deviations, since, as explained previously, these could alter the supply planning and production operations in addition to creating extra costs . The results are shown in the following tables:

Information Quality	Percentage
No Repeated Information	69%
Repeated or duplicate information	31%
Total	100%

Table 4-3 Process performance by information quality

Source: Own elaboration

Information Quality by stated reason codes	Percentage
Incorrect/unclear reason code	68%
Correct reason code	26%
No reason stated	6%
Total	100%

Table 4-4 Process performance by information quality in the stated reasons

Source: Own elaboration

Deviations by stakeholder	Percentage
No stated	50%
TSP	36%
Supplier	6%
Other	6%
OEM	2%
Total	100%

Table 4-5 Process performance - deviations by stakeholders

Source: Own elaboration

Deviations by type	Percentage
Pick up deviations	42%
Delivery deviations	39%
Quantity deviations - Empty run	15%
Pick up & delivery deviations	4%
Total	100%

Table 4-6 Process performance - deviations by type

Source: Own elaboration

Deviations by Reason codes	Percentage
Ferry/train delay	28%
Carrier truck breakdown	10%
Capacity Issues	10%
Other: Deviations due to Coronavirus (Borders problems, quarantines, delays)	9%
Carrier internal planning	9%
Missed ferry/train	7%
Weather condition	7%
No reason stated	6%
Supplier/packaging terminal did not load on time	3%
Carrier delayed at previous VCC loading/unloading point	2%
Wrong pick up date/Leadtime in TMS	2%
Delayed at customs/borders	2%
Late delivery out of tactical window	1%
Traffic jam / accident on the road	1%
Total	100%

Table 4-7 Process performance - deviations by Reason codes

Source: Own elaboration

All this data processed into the information detailed above will be analysed in the next chapter.

4.2.2 Operational team 2

A. Deviation Handling Procedure

In the case of this operations, the deviation handling process is somehow different compared with the operational team 1, as shown in the value stream map considering the standard orders (figure 4-2).

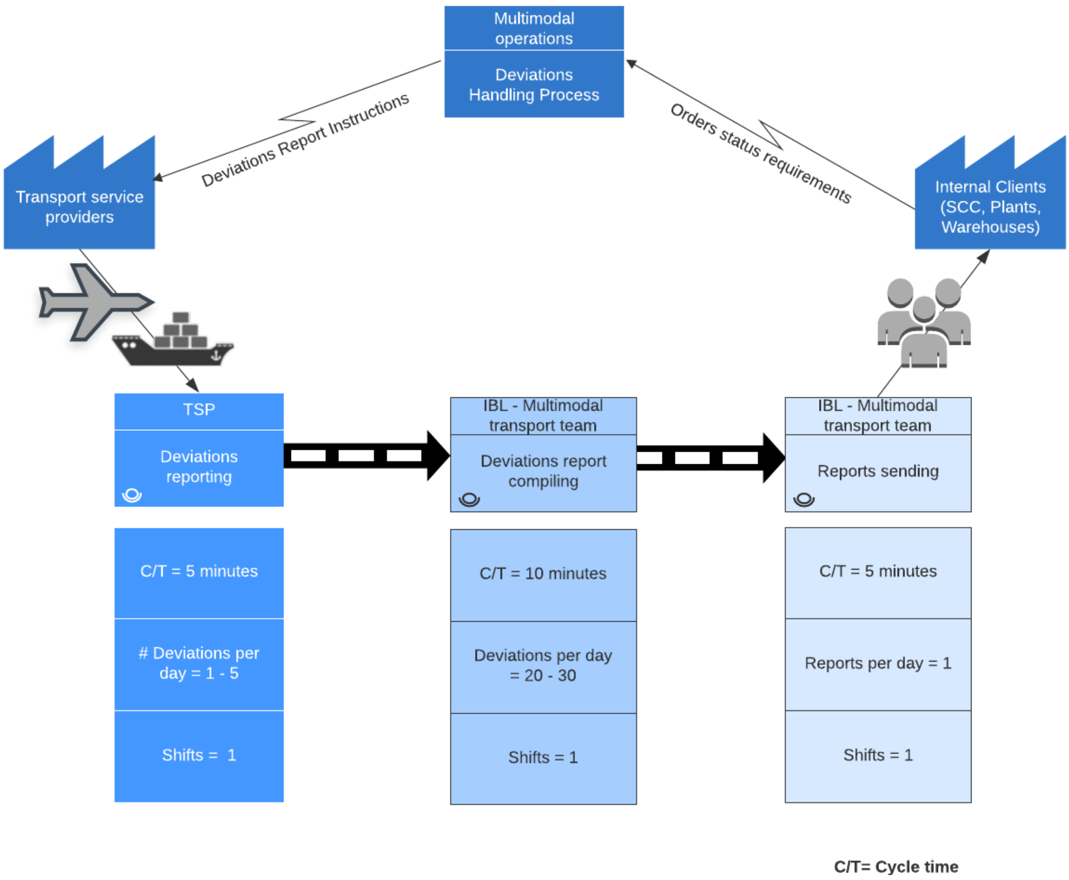

Figure 4-2 Value stream map Deviation Handling Process – Operational team 2

Source: Own elaboration

Within this operations, although the quantity of transportations is not as large as the operational team 1, the transport orders in this team are very important, especially the Premium orders, since these are urgent and expensive transports that derive from deviations arising in the standard orders of the different modes of transport (Road, Air, Sea) which for different reasons cannot be delivered according to the required delivery date. Therefore, taking this situation into account, the different transport service providers must immediately report the deviations to this team. On the other hand, the transport orders corresponding to the Air & Sea team (standard orders) have more flexible lead times due to the long distances they travel up to the delivery points; however, this situation can also lead to different deviations in the transportation process.

When a deviation occurs in the transportation process within the operational team 2, the transport service providers must fill out an Excel form in a pre-established template, providing information about the orders number, new collection or delivery date, the deviation type (Table 4-8) and its corresponding reason code. Finally, this deviations report must be sent by email to the IBL team before 3 p.m. every day. Filling this Excel template can take up to the TSP's around 5 minutes per deviation.

Deviation Type		Reported by
Pick-up deviations	Deviations regarding late pick up collections which are subcategorized in reason codes according to the stakeholder (TSP, OEM or Force majeure)	Email
Delivery deviations	Deviations regarding late deliveries which are subcategorized in reason codes according to the stakeholder (TSP, OEM or Force majeure)	Email

Table 4-8 Deviation Types – Operational team 2

Source: Own elaboration

Once the operational team 2 receives all the deviations reports, the logistics engineer in charge compiles all TSP's deviations creating two final reports, one for Air orders and the other for Sea orders.

In the case of deviations corresponding to Premium orders, as previously explained, because they have not very flexible lead times; when a deviation occurs, the TSP's must immediately send the deviation report by mail. Once the Premium team receives any kind of deviation, it is immediately forwarded to internal clients by email, in case they could affect the supply and production planning.

B. Process Performance

In the case of the operational team 2, the deviation reports handled on a daily basis are not saved in a database, therefore it is not possible to measure the process performance with the discrete quantitative data. However, through observations and interviews, the authors obtained some conclusions that will be evaluated in the next chapter.

Although the lack of this type of information creates a risk for the research results; the authors consider this situation as an important point to evaluate in the analysis and improvement phase.

5 Analyze

After measurement stage, in which important data was collected and the baseline measure was set through the value stream maps and the tables with the process performance; the analyze phase for this research aimed to evaluate all the information gathered in the previous chapter and present the root causes of the problem, so that later, possible solutions will be presented in order to improve the current processes and its performance. The "analyze" phase has been divided into four parts.

1. **Analysis of deviations handling procedure**
2. **Analysis of deviation handling process performance**
3. **Definition of the possible root causes of the problems**
4. **Verification of the causes of the problems**

5.1 Analysis of Deviations Handling Procedure

The first part focuses on evaluating the value stream maps created in the previous chapter, where the variables affecting the delivery deviations handling process at both operations will be identified. This is necessary to determine what could be the potential waste occurring during the process of delivery deviations handling to improve the process and its performance.

This evaluation is presented through the Value-Added Flow Analysis, where the value analysis focuses on verifying whether each of the steps add value to the process or not and the flow analysis evaluates the time spent on each step. This reveals activities that consume time and effort but do not generate value to the process, clarifying where wastes should be reduced or eliminated. (Franchetti, 2015)

Through the information obtained according to the data collection plan and the evaluation of the value stream map of the operational team 1, the activities have been categorized into those that add value to the process and those that do not and its associated times (table 5-1).

#	Process Step	Performed by	Tools	Step Label (Value Added or Non-Value Added)	Time
1	Ticket creation	Transport Service Providers	• Service Now system	VA	2 – 4 hrs.
2	Ticket allocation	Service Now team	• Service Now system	NVA	Uncertain (minutes – hours)
3	Ticket processing	Logistic Engineer	• Service Now system • TMS • Excel • Email	NVA	8 hrs.
4	Reports sending	Logistic Engineer	• Excel • Email	VA	25 mins.

Table 5-1 Value-Added Flow Analysis – Operational team 1

Source: Own elaboration

Firstly, the step of the process *"Ticket creation"* , in which transport service providers must report any deviation, has been classified as an activity that generates value, since information about deviations in the transport process is an important element in order to keep all the stakeholders within the supply chain informed and in order to find opportunely solutions and prevent the operation from being affected by the deviations.

The next step in the process, *"Ticket allocation to IBL"*, which is performed by the team that handles the tickets in the Service Now system, has been classified as an activity that does not generate value to the process, since it acts as an unnecessary intermediate step that difficult the direct communication between the stakeholders. Although this activity was implemented in order to report deviations in a structured way, over time, it has become a bottleneck, since it depends on a team that is not among the stakeholders, the tickets allocation to the IBL operations team may take an uncertain time according to the handling of these tickets by the Service Now team, which may affect the operation if the tickets that contain the deviation information are not assigned opportunely. It is important to mention that although the ServiceNow system is used to create transport deviations tickets, it is a tool that was not implemented for that purpose, since the objective of this is to report IT related problems.

The third step of the process, *"Ticket Processing",* carried out by a logistics engineer from the operation team 1, has been categorized as a process that does not add value. Although information processing is very important, the manual tasks carried out through different tools (TMS, ServiceNow System, Excel, Email) in this part of the process are time consuming and increase the risk of processing the information in the wrong way, turning this step into another bottleneck that creates a blurred layer in the information flow.

Finally, the last step of the deviations handling process within the operational team 1 is the deviations *"Reports sending"*, which after the analysis made according to the information obtained, and despite the fact that this process also involves manual work, it was determined that it does add value, since it is in this step that the purpose of the entire process is fulfilled, which is to inform and alert in opportunely about the deviations that arise in the transportation process.

Table 5-2 shows the Value-Added Flow Analysis for the operational team 2. The initial step in this process, *"Deviations reporting"*, which is carried out by transport service providers, has been classified as a step that adds value to the process; since as mentioned above, sending timely information is essential in order to act on the deviations before they affect operations. Subsequently, the *"Compilation of reported deviations"* performed by a Logistic Engineer from the operational team 2, has been categorized as a step that does not add value to the deviation handling process, since although it is not a process that takes a long time despite being a manual work, it only groups the information provided by the different transport service providers; adding an unnecessary step in the communication process that could be automated. Finally, "*Reports sending"* is the essential step in the process, since it is in this stage, that the purpose of sharing information with the stakeholders is fulfilled, for this reason it has been classified as a step that adds value to the operation.

#	Process Step	Performed by	Tools	Step Label (Value Added or Non-Value Added)	Value Added Time
1	Deviations reporting	Transport Service Providers	• Excel • Email	VA	30 minutes
2	Compilation of reported deviations	Logistic Engineer	•Email •Excel •TMS	NVA	10 minutes
3	Reports sending	Logistic Engineer	•Email •Excel	VA	5 minutes

Table 5-2 Value-Added Flow Analysis – Operational team 2

Source: Own elaboration

5.2 Analysis of Deviation Handling Process Performance

In this part of the analysis, the information on the deviations that affect the operations performance, presented in tables 4- 8 in the measurement phase, are transformed into graphs that will allow the authors obtaining a visual understanding of the main causes that affect performance. Pie and Pareto charts are used for this purpose, being the second, bar graphs that show the most important categories of deviations in descending order. This chart allows the authors to focus on the results that cause 80% of the problems.

A. Operational team 1

Figure 5-1 and figure 5-2, show the results regarding the information quality provided by the Transport service providers through the deviations incident tickets. Once these results are analysed, it can be concluded:

- The information processed in the deviations report database is not totally reliable since 31% percent of the information is repeated or duplicated.
- The transport service providers are not complying with the deviations report according to the established procedure in the operational guide, since 68% of the deviations are reported with an incorrect or unclear reason code, which makes the process even more difficult to handle and categorize the deviations.

- The deviation reporting activity seems to be unclear to transport service providers, one of the main reasons could be confusion due to the lack of a standard procedure, since the deviation report varies according to the type.

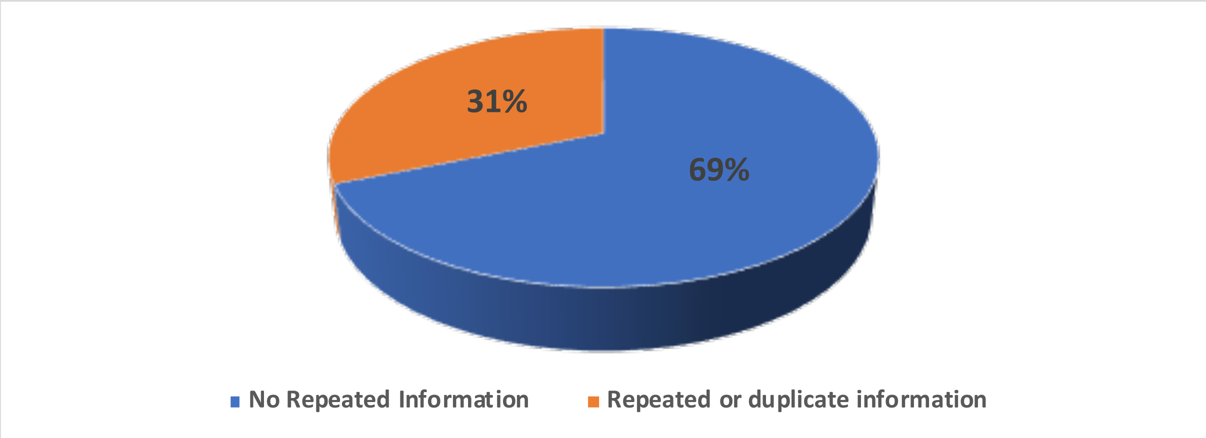

Figure 5-1 Information quality

Source: Own elaboration

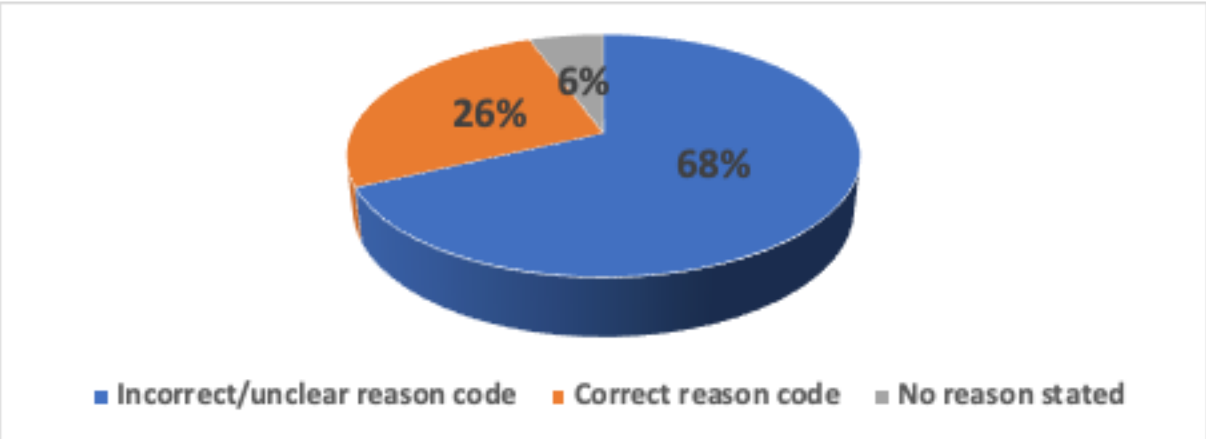

Figure 5-2 Information quality by reason

Source: Own elaboration

The pareto chart shown in the figure 5-3, allows to obtain as results of the analysis:

- The deviations categorization by stakeholder is not correctly performed since 50 % of the deviations do not state the stakeholder. This failure in the deviations processing could be a consequence of the incorrect or unclear reason codes provided by the transport service providers.

- According to the deviations reports database, the stakeholder that causes the most deviations would be the transport service providers with a 36% of the total.

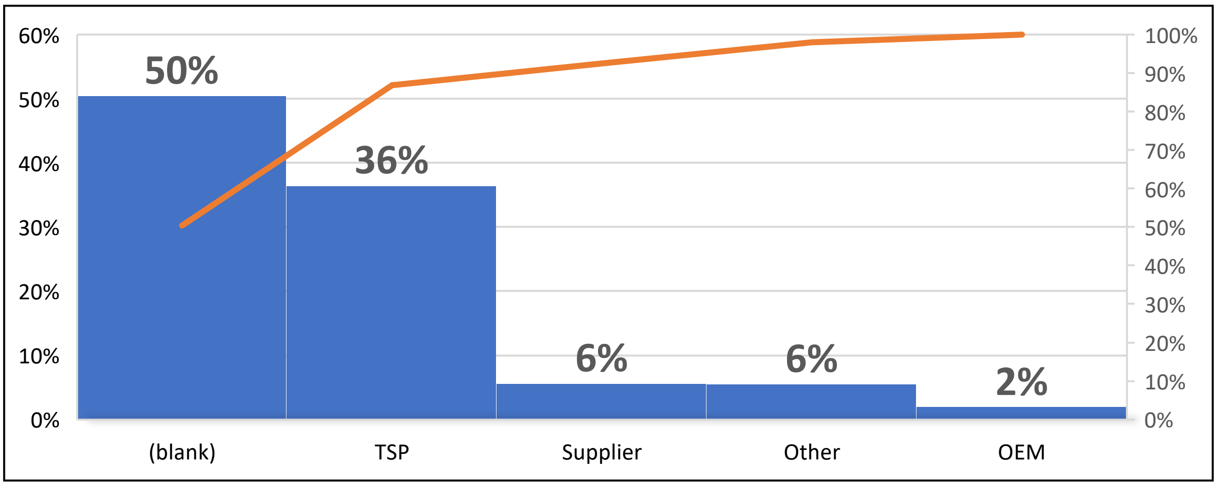

Figure 5-3 Deviations by stakeholder

Source: Own elaboration

Regarding the deviations by type, shown in figure 5-4, it can be concluded that the two main types that cause 80% of the deviations are ***Pick-up deviations*** and ***delivery deviations.***

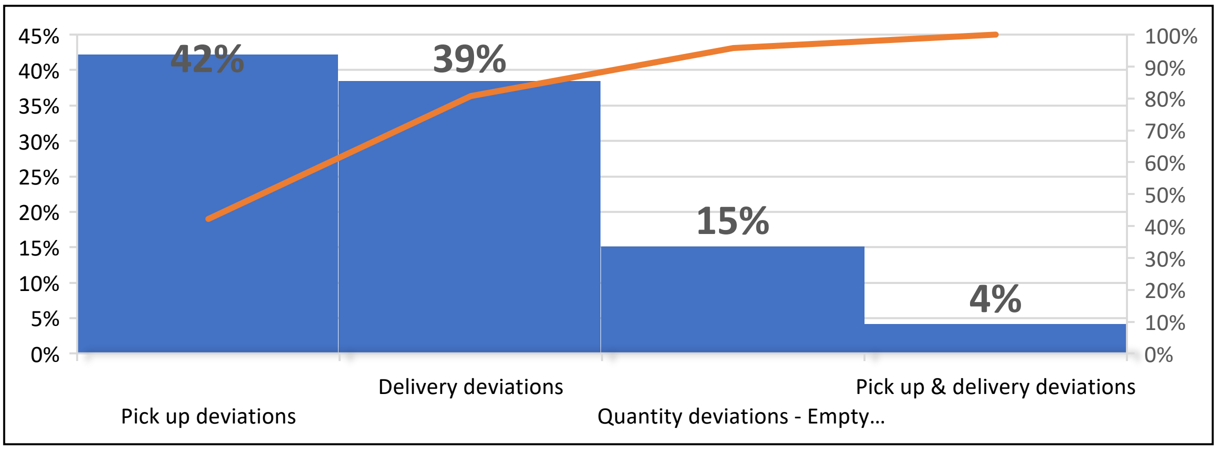

Figure 5-4 Deviations by type

Source: Own elaboration

The deviations pareto diagram by reason code (figure 5-5), allow the authors to analyze and conclude that 80% of the deviations occur for the reasons categorized in the following reason codes:

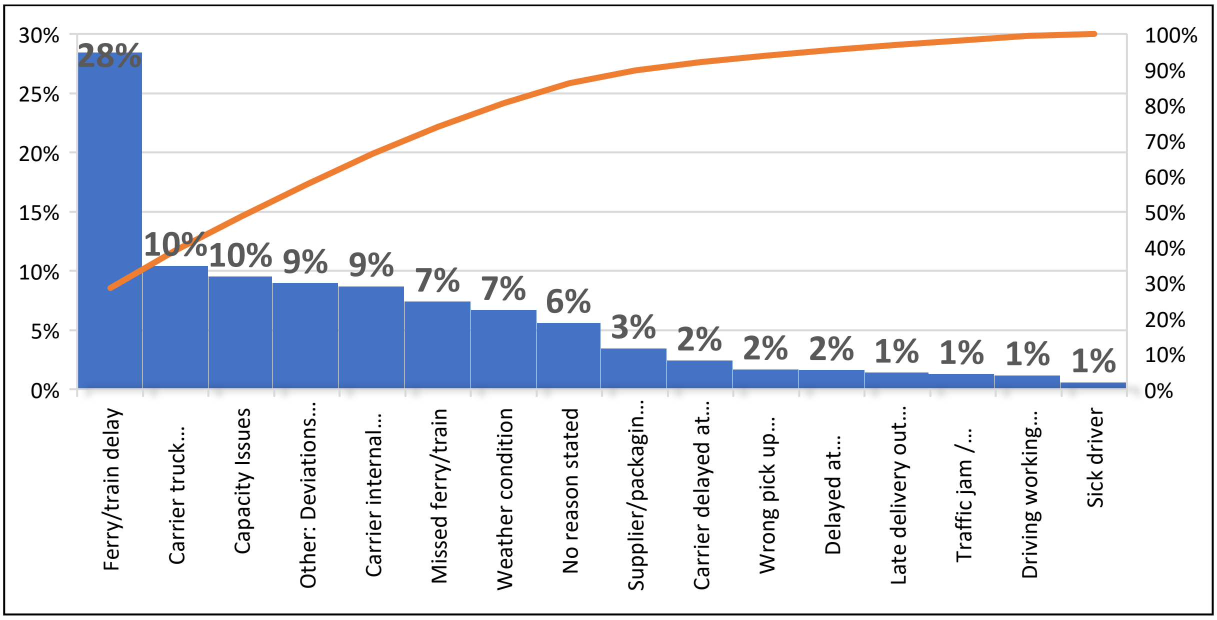

Figure 5-5 Deviations by reason codes

Source: Own elaboration

- ***Ferry/train delay***, deliveries that were affected by delays in the intermodal transport connection by road and ferries and by road and trains.
- ***Carrier truck breakdown,*** deliveries affected by mechanical failures in the transport service providers trucks.
- ***Capacity issues,*** these deviations refer to the lack of capacity of the transport service providers, in this case, the lack of trucks.
- ***Other: deviations due to Coronavirus,*** deviations that affected the deliveries lead time due to various incidents derived from the Coronavirus, for example, long queues at the borders, quarantines, suppliers' closure.
- ***Carrier internal planning*** refers to delivery issues due to planning problems of the transport service providers, such as, error in the allocation of trucks, error in the transport management system of the transport service provider, among others.
- ***Missed ferry/train,*** deliveries deviations due to the transport service provider missed the intermodal connection either with ferries or trains.
- ***Weather conditions,*** transports that have been delayed due to weather conditions such as snowstorms, rain, among others.

B. Operational team 2

In the absence of quantitative-discrete data for the operational team 2, the authors carried out the analysis based on the interviews and on-site observations, obtaining the following conclusions:

- It is not possible to carry out a performance evaluation of the operational team 2 based on daily deviation reports, since this information is not stored in a database and is only used for the purpose of providing information to internal clients such as: supply chain coordinators, plants, warehouses and others.
- The information quality provided by the transport service providers in the daily reports is the required by Inbound Logistics - operational team 2, since the Excel template provides a drop-down list containing reason codes according to the procedure. However, since some of the stakeholders of the operational team 2 orders are located on different continents, the difference in the time zone may generate a delay in the response regarding the deviations and the actions that must be taken to minimize the impact of these.
- The most frequent type of deviation in Air & Sea operations are the ***Delivery deviations,*** being the most frequent reason codes ***Late delivery due to the Transport Service provider, Force majeure and incorrect booking.*** The most frequent reason codes when it comes about the ***Pick-up deviations*** are ***Incorrect booking, late pick up due to the Transport Service provider*** and ***Late pick up due to the Supplier***
- The most common deviations regarding Premium orders are ***Pick-up deviations,*** being the most frequent reason code, ***goods not ready due to supplier issues.***

5.3 Definition of the Possible Root Causes of the Problems

After analysing the process and the data related to deviations that affect the performance of both operations, the authors put their findings into a cause-and-effect diagram (Figure 5-6). This diagram in tandem with the 5 Why's (Table 5-3) method allowed the authors to investigate in a structured way the possible root causes that lead to the problem.

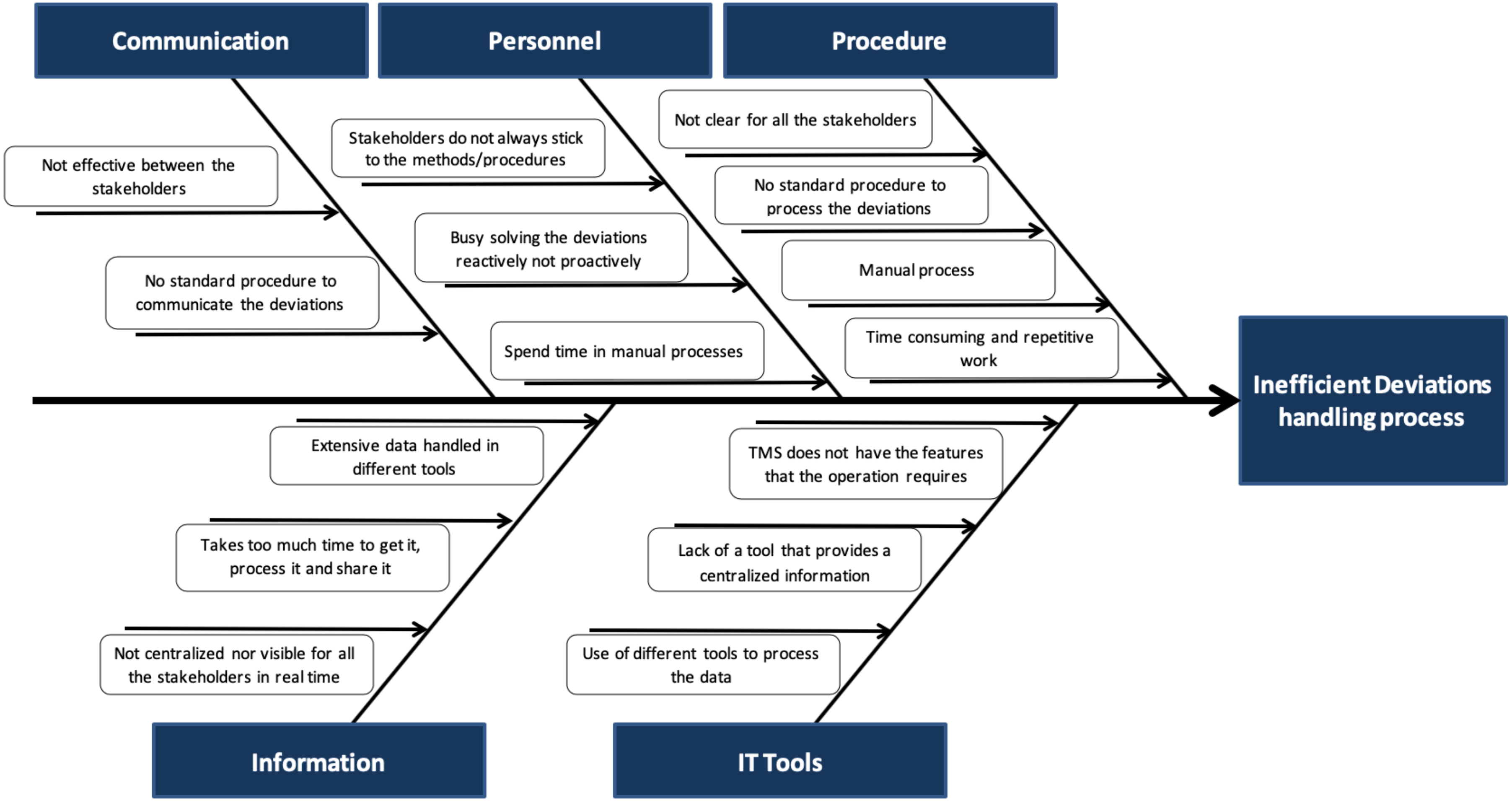

Figure 5-6 Fishbone diagram

Source: Own elaboration

5 Whys									
Why 1		Why 2		Why 3		Why 4		Why 5	
Why?	**Because**	**Why?**	**Because**	**Why?**	**Because**	**Why?**	**Because**	**Why?**	**Because**
Why the deviations handling process is inefficient?	Because it takes too much time to process all the information	Why does it take too much time?	Because it involves manual handling of a lot of information	Why is the process manual?	Because it requires the use of tools that are not linked to TMS (Excel-Email)	Why cannot the information be processed directly in the TMS?	Because the TMS does not have the features to process that kind of information	Why the TMS does not provide those features?	The TMS requires an upgrade
Why is there a lot of information to process?	Because many deviations can occur in the transportation processes	Why are there many deviations?	Because the process could be affected for different reasons	Why are these reasons not eliminated or reduced opportunely?	Because the process is more reactive than proactive	Why cannot the deviations be reduced or eliminated proactively?	Difficult to get the information, process it and analyze it.	Why is difficult to get and process the information?	Because is necessary the use of different tools besides the TMS
Why stakeholders do not stick to the procedures?	Because the procedure is not clear for all the stakeholders	Why the procedure is not clear?	Because it is not standardized for all types of deviations	Why is the process not standardized?	Because the information is handled according to the type of deviation	Why is not possible to have a standardized process for all types of deviations?	Because it is handled in different tools	Why is it handled in different tools?	Because the TMS does not have the features to process that kind of information

Table 5-3 5 Whys analysis *Source: Own elaboration*

Based on these applied methods , five key areas are identified as the possible major root causes:

A. IT Tools

The use of different tools to process the large quantities of data generated in both operations (operational team 1 and operational team 2) can be one of the most critical areas to be taken into consideration while analysing the deviations handling process. The use of different support tools such as the ServiceNow System, Excel sheets, Email and Power BI, reflect the lack of a tool capable of centralizing and processing data to generate the necessary information in real time. In this case, the system that should provide all these characteristics should be the transport management system, which although centralizes the data regarding the planning, execution and transport costs management, has limited characteristics in relation to automated reports and analytics dashboards.

B. Procedure

The analysis made to the data and information obtained about the current deviation handling process shows that this is not clear to all stakeholders, resulting in reports that are far from what is established in the instructions. In this case, the transport service providers do not report the deviations according to the agreements and reason codes established by the Inbound logistics department. This situation may be the result of the lack of training of the different transport providers control towers and also the absence of an exhaustive follow-up to the correct deviations report fulfilment. Another factor that hinders transportation service providers in relation to the reporting of deviations, is that the IBL department does not have a standardized process since it differs according to the operation, operational team 1 and operational team 2, and also according to the deviation type; forcing carriers to follow different procedures and use of different tools, making the process tedious, time consuming and repetitive; considering also that the deviations reporting require manual entry of data from all the stakeholders.

Another important fact is that although the effort that is invested in the deviations handling procedure could be used to review the performance of the transport service providers and improve the overall operation, it is only carried out in order to create reports that make deviations visible to all stakeholders. To measure the IBL operations performance, both teams, operational team 1 and operational team 2, send excel files to transport service providers weekly. These files contain information about all the executed orders during the week, and in case they show deviations in relation to the pick-up and delivery dates, the transport service providers must report once again, the reasons for the deviations. This task generates additional and repetitive work not only for carriers but also for the IBL team.

C. Information

Considering that the large quantity of data is not centralized in a single IT Tool and that it is not easily visible in real-time to all the stakeholders in case one of these requires the orders status and the deviations associated to them; results, as mentioned above, in the need to resort to different tools to process the information, which takes a long time to be obtained, processed and shared under these conditions; also putting at risk the information quality, which needs to be complete, timely and correct to make the process efficient.

D. Personnel

The current handling process of deviations demands time and imposes additional workload on the stakeholders. Since the operation requires to face high pressure of dealing with numerous uncertainties along the transportation processes corresponding to supply needs of the organization, this task of handling deviations demands time and at certain points it gets difficult for the stakeholders to stick to the established procedures; turning the deviations handling in a reactive process rather than proactive.

In addition, the individuals processing the information manually might have different variables or activities at the same time, exerting pressure or affecting the data handling, leading to more processing time, human errors and to breach the procedures.

E. Communication

Cross functional teams and communications are key to have efficient processes especially related to logistics and supply chain. In the current process under examination, the carriers need to inform deviations to both operational teams by different ways. The reported deviations are processed and are communicated to the engineers in IBL, warehouses, supply chain partners and plants. However, this information is delayed as it moves through the different stakeholders and activities within the procedure.

5.4 Verification of the Causes of the Problem

The purpose of this last step is to verify that the hypotheses related to the possible root causes are true or false. For this, a hypothesis testing evaluation is adopted to this case study; this tool is applied by cross-checking all the collected information and data from observations, interviews, files, reporting databases and process analysis that help the authors to conclude whether the hypothesis are true or false. Table 5-4

#	Possible root Cause	Root cause Hypothesis	True or False	Verification (How was it prove the theory)
1.	IT tools	The lack of features for handling deviations within the TMS requires the use of other support tools	**True**	• Value added analysis • Observations • Interviews
2.	Procedure	There are different procedures regarding the deviations that make it difficult to stick to them	**True**	• Value added analysis • Observations • Interviews • Reports database
3.	Information	Lack of centralized and real-time information makes the deviation handling process more reactive than proactive	**True**	• Observations • Interviews • Reports database
4.	Personnel	Breach of procedures by personnel leads to the process inefficiency	**False**	• Observations • Reports database • Interviews • Archives
5.	Communication	There is no effective communication between stakeholders regarding deviations	**False**	• Observations • Interviews

Table 5-4 Root cause hypothesis confirmation

Source: Own elaboration

In the case of the possible root causes related to the *IT tools, Procedure and Information*, their associated hypotheses were confirmed as TRUE, since the different analysis, information and data collection tools verified that they clearly are root causes leading to the inefficient deviation handling process.

The hypotheses associated with *Personnel and Communication* were confirmed as FALSE, since when analysing and crossing the information obtained through the different tools, the authors concluded that although these hypotheses were related to the inefficient deviation handling process, they are rather derived consequences of the hypotheses confirmed as true (*IT tools, Procedure and Information)*.

In the case of the hypothesis related with *Personnel,* even though the evaluation of the deviations reports database shows that there is a breach of the procedures by the stakeholders, the authors confirmed through observations, interviews and file reviews, that this is not a root cause, but rather a consequence that derives from the root cause related to the procedure, since the existence of different procedures regarding the deviations, difficult the compliance of these by the personnel. The hypothesis regarding *Communication,* it has been confirmed by the authors as false, since it does not turn out to be a root cause directly related to the problem, but rather, it is the result of the lack of features for handling deviations within the TMS, the lack of centralized information and different procedures related to deviations. This has been confirmed through interviews and observations.

6 IMPROVE

In this chapter, improve phase of the DMAIC cycle is presented. This phase the findings obtained from the analysis stage are used to suggest certain solutions for improving the process under discussion. In this case study, the improve phase tends to explore through content analysis and literature review the technological opportunities, a standardized procedure and recommendations regarding centralized information that can be implemented by the OEM to optimize their deviations handling in IBL.

The analysis provided clear evidence stating IT tools as one of the possible root causes with the potential to optimize the delivery deviations process when it meets the needs of the organization. With the need to ensure information is followed while managing deviations and related IBL procedures, standardized procedures need to be adopted throughout the department and shared with the stakeholders. Information is another key area observed through analysis as the root causes with the potential to optimize the deviations handling process. The increased complexity in supply chains demands systems that can provide centralized and real-time information to continuously monitor the execution of ongoing transports and its associated deviations, enabling proactive decision-making environments.

6.1 The Right TMS For OEM Needs

One of the key areas under discussion of this research is Transport Management System (TMS). While focusing on the implementation of TMS, the key is to implement a TMS that fulfils an organizations' specific needs, specifically in this case, a TMS in which the transport deviations can be easily handled and reported.

The technology of TMS according to Gartner is on a rise with expected growth of 11.12% from 2018 to 2023. The key factors that determine the growth includes the company's desire to reduce costs, increase visibility, effective use of capacity, improve customer service and internal productivity. It has been expected that the spend on the TMS applications will be $1.94 billion by 2022 which would account for 31% of the billion-supply chain execution (SCE) market total budget of $6.2 billion (Gartner, 2020).

Future demands TMS with advanced planning and optimization capabilities. The first step towards analysing the TMS is understanding the level of complexity. Based on Gartner's Model for holistic multi modal TMS, there are five levels of transportation complexity (TMS Overview, 2018) (table 6-1) .

Level 1	Most of the transportation operations are local and manual processes are executed with limited visibility. Limited transportation capabilities through TMS solutions.
Level 2	Most of the processes are manual and straightforward transportation operations. ERP provides some information about transportation with TMS offer core capabilities
Level 3	Expanded transportation solutions similar to closed loop TMS allowing operational planning, track and trace, carrier management, contract management and freight analytics.
Level 4	Core TMS with automated processes to enhance and maximize decision support capabilities like transportation modeling, freight procurement, load consolidation, carrier selection and greater levels of transportation planning.
Level 5	The focus is on global transportation operations with global logistics. TMS handles the complexities faced due to global operations as the organizations demand support for managing multiple modes spanning various countries.

Table 6-1 five levels of transportation complexity (TMS)

Source: Gartner 2018

The TMS that could offer major cost advantage and transport optimization for an organization at Level 5 transportation complexity should be equipped with the following functions (TMS Overview, 2018) (Figure 6-1)

Figure 6-1 Key areas of TMS for Level 5 complexity

Source: TMS Overview (2018)

The OEM under analysis with global operations and high level of complexity (level 5 transportation complexity) requires an End-to-end TMS with a private cloud platform. The vendors offering TMS capturing the advancements in technologies and meeting market needs are suggested by Gartner. Gartner provides a picture of the vendors in the TMS market stating that SaaS will dominate the TMS market by possessing 65% share by 2022 (Gartner, 2020) (figure 6-2).

Figure 6-2 TMS vendors 2020

Source: Gartner TMS 2020

The research provides clear evidence of SAP, Oracle and Blue Yonder stands as leaders in the TMS market. These leaders are defined to have a reliable, deep, compelling vision with offerings addressing the need of a broad user base. Challengers including Alpega Group that offers a TMS used by the focal firm, also offers reliable solutions with support to manage complex transportation requirements but as challengers usually these companies look towards the leaders. The leaders offer the organizations advanced technology, functional and business support. The challengers are also observed to lag in capturing the company's vision for future TMS. The need of the OEM is to ensure supply chain convergence and meeting the vision throughout the company, which is usually the characteristic offered by companies like Oracle and SAP (leaders) (Gartner TMS, 2020).

The authors, according to literature and interviews conducted with a supply chain expert and IT supply chain solution providers, point towards adopting digital technology cloud-based solutions. These cloud-based solutions tend to possess the capability to optimize not only de deviations handling process but the overall performance at IBL of OEM.

The most important improvement suggested by the authors, would be implementing an end-to-end TMS that provides a real time visibility and integrated solutions related to the transportation deviations/incidents in order to reduce the manual procedures, centralize information and share it with stakeholders in real time. This tool can offer IBL with real time information in the form of automatic dashboards and notifications about the transport service providers, locations, incidents and transport execution which would enable them to take actions by handling the logistics problems and informing all the stakeholders about the possible transport disruptions. Implementing a real time visibility solution from the existing TMS provider is one option as the TMS provider understands the needs of the organization and would offer services customized to the needs of IBL. Some success cases of companies that decided to work with the end-to-end TMS offered by Alpega (2019) are shown in the Table 6-2.

Company	Description
Asahi	As one of the biggest companies in the world decided to implement end-to-end TMS; this due to as their volumes increased, managing all of their inbound transports became more difficult. The solution provided by the end-to-end TMS to carry out the deviation handling process, allowed the company to quickly resolve the issues and react immediately to find alternatives. The end-to-end TMS provides instantaneous alerts when unforeseen things occur. This implementation reduces the internal processing time in their transport operations by 50%; furthermore, enabled the company to save 150000 € per year and ROI within 2 months. (Alpega, 2020)

Norske Skog	One of the most important players within the paper industry, was looking for solutions to manage the inbound and outbound transport operations, managing more than 200 trucks per day. Implementing the end-to-end TMS, the company achieved the centralization of all the key information, enabling faster communication with the stakeholders regarding the incoming and outgoing transportation orders; in addition to getting rid of the manual processes of cleaning and compiling data to then transform it into information. All these processes were automated by the end-to-end TMS reducing transportation planning and execution operations by 65%.(Alpega, 2020)
Hartmann Group	Leading supplier of health care and hygiene products implemented the end-to-end TMS in order to improve the logistics operations. The solution provided by this complete transport management system enabled the efficient planning and management of all their logistics facilities and the optimization in the communication process between the stakeholders. The following results were obtained: reduction in transport management time of up to 2 hours / day, 6% reduction in security stock savings of around € 1 million, in addition to the automatic generation of KPIs reports related to the transport service providers performance. (Alpega, 2020)
Rexam	Leading can maker in Europe and South America, and number two in the US. Their need to improve the control of shipping operations, warehousing availability, among others, made this company rethink their needs regarding IT operating platforms. Once the TMS end-to-end was installed, they benefited from real-time status updates, event notification, as well as centralized information that provided the full operations visibility to the stakeholders enabling a faster decision-making environment. Furthermore, the internal processing time for transport operations was reduced by 50%, saving large quantities of money and fast ROI. (Alpega, 2020)

Table 6-2 Alpega's end-to-end TMS case studies

Source: Own elaboration

Moreso, different service providers offer real time visibility solutions in the external market that can be integrated with OEMs existing TMS and can greatly benefit IBL in their current operations through reaping benefits of real time and advanced analytics.

Visibility technology is being adopted increasingly and organizations now view implementation of transportation visibility central part of technology strategy in order to deal with the supply chain deviations. According to Gartner (2019), visibility is found as one of the top three supply chain initiatives and almost 46% leaders in supply chain view visibility as a major investment priority. Shippers use advanced visibility in order to get insight about the inbound shipments along with the inbound shipments to optimize the resources and labour. The real time visibility platforms allow the organization to connect all the stakeholders through increase in communication. The information shared through these platforms allows the shippers, carriers, supply chain analysts and related stakeholders to see both short term and long-term results that build the supply chain of the future. Table 6-3 provides an insight to real time visibility implementation at different companies.

Industry/Company	Description
Original equipment manufacturers	Many of the companies within the automotive industry have implemented different IT modules provided by Inform. The solutions Syncro Supply – SyncroTESS offered by this company, optimize different logistics processes along with the TMS, such as: Event management, Real-time visualisation, Graphical view of transport operations, Online KPIS, Analytics and Process Monitoring.
	A company within this industry has chosen to combine tools from different IT providers. For transport planning and network optimization, they are using Oracle TMS, and on the other hand, they implemented Transporeon-Sixfold to get real time visibility of their operations. Among the improvements obtained with these implementations are: Successfully reduced transportation costs and streamlined inbound transportation flows—including by truck and ocean—to this truck manufacturer factories and warehouses around the world. Enabled proactive control of transport flows. Introduced opportunities to automate manual administrative procedures. Alerts and notifications about predicted delays can be sent to authorized parties by creating specific mailing lists. Real-time status updates are displayed and transmitted by email and text, enabling proactive response and rapid conflict resolution. Live tracking and map display of vehicle and shipment geopositions for an end-to-end overview of status and progress. Ongoing calculation of the estimated time of arrival (ETA), taking into account traffic, weather, driver breaks and more.
BMW - DHL	BMW in partnership with DHL, its most important transport service provider, implemented the "CSC - Connected Supply Chain" system, which provides this automotive company with integrated transparency and control of all logistics processes through cloud-based IT solutions. The main benefits of this system are the quick and easy obtaining of real-time information, then, as a second important component is the control tower associated with DHL, which is not only designed to counteract and quickly solve possible disruptions in

	the transportation flow but to identify potential savings and evaluate the suppliers performance.
Coca-Cola Bottling Co.	Coca-Cola Bottling Co. Consolidated (CCBCC) improved their stock performance by 99% through implementation of real time visibility in its inbound freight. This enabled Coca Cola to share information effectively and supplements cross-functional collaboration. The implementation of real time visibility at the manufacturing and distribution resulted in managing the labour and time of front-line personnel that used to wait for shipments which were behind their scheduled times of delivery.
Tesla	Tesla, with the use of **Elementum**, their mobile supply chain app gets real time visibility at the IBL. Tesla has designed the app using the combination of carrier Electronic Data Interchange (EDI) messages and the Advance Shipping Notifications from suppliers. This provides Tesla with a real time view of their shipments at their assembly operations taking place at Fremont. This app provides the company with information about an expected shipping delay and how it could impact the manufacturing operation. This full visibility and maximum control in the in-transit inventory allows Tesla to reduce their inventory levels and improve the customer service.

Table 6-3 Real time visibility in supply chain: industry cases

Source: Own elaboration

OEMs to stay competitive with changing market needs like autonomous and hybrid vehicles, need to re-examine their existing business models to devise new strategies and implement new technologies making them rely on advanced analytics. These analytics offer the logistics leaders with various business intelligence opportunities that include besides the deviations handling, route optimization, carrier management, forecasting and personnel management. The data from analytics facilitated decision making during both busy as well slow work periods allowing logistic leaders to reduce their costs and determine future requirements.

Advanced analytics offers the OEMs with areas to improve their operations by developing new products and improving customer services by reducing costs. A research by deloitte provides evidence that a market leading OEMs usually incurs 1-2% of their annual revenue on the warranty costs which makes £13-25 billion costs of warranties worldwide for the 10 biggest global OEMs. Advanced analytics implementation reduced the costs of warranty by 15-20%. For an OEM, this makes an annual saving of £200 million (Deloitte, 2019). Advanced analytics offers IBL smart decision-making using data to manage and plan ahead for the future requirements of logistics ensuring dealing with transportation disruptions proactively. Table 6-4 provides an insight to advanced analytics implementation at BMW and Audi.

Company	Description
BMW	BMW group with the use of Smart Data Analytics analyses the intelligent data in their operations at Munich and consider this makes a significant contribution to the areas of logistics and production specially to create efficient processes and maximize premium quality (Garnsey, 2019). In addition, Artificial intelligence is observed to be critical for the logistics operation which implements AI control applications at their factory in Austria. AI use makes the process of logistics efficient by facilitating factory, transport systems and planning on various events based on real data. AI also allows the company to plan different scenarios without incurring additional costs. BMW has implemented AI in their existing planning and autonomous transport systems known as smart planning (Garnsey, 2019).
Audi	Audi in their Neckarsum Plant (South west Germany) with the use of analytics tools are focusing on analysing the time spent on every production stage in order to have more precise timing of vehicle release to be shared with the truck carriers. The aim is to use the data to notify the carriers in advance about the collection of the vehicle which is within the duration of 2 to 4 hours as compared to giving them several days to collect the new vehicle. Audi has implemented analytics by creating a bridge between plant and brand logistics. The data can further be used to improve the inbound and outbound visibility by using satellite tracking and telematics in the vehicles. The company focuses on automating the finished vehicle logistics (outbound) that still is an extremely manual operation (Ludwig, 2018).

Table 6-4 Advanced Analytics in supply chain: industry cases

Source: Own elaboration

Keeping in view the above-mentioned technologies and level of transportation complexity, upscaling the existing TMS can provide the OEM with advantages for real time shipment tracking and handling deviations effectively. As mentioned above, ALPEGA TMS currently offers many of this different solutions. This cloud-based SaaS transport management system is designed with the aim to manage end to end logistics and deliver flexible solutions to transform the supply chain. This TMS streamlines network design, strategic sourcing, tactical planning, dynamic planning, spot sourcing, shipment execution, cost management and advanced analytics. The smart booking allows use of real time data (spot sourcing) and advanced analytics (Alpega, 2020). All of these IT solutions can be adopted in their entirety or only certain modules according to the company requirements.

6.2 Procedure Standardization

As verified in the previous chapter, the existence of different procedures to report and handle the deviations according to the mode of transport (operational team 1 and operational team 2) and types of deviations, can cause confusion in the stakeholders, making it difficult for them to comply with all the OEM requirements and needs. According to Stajniak and Koliński (2016), the continuous improvement of logistics operations is obtained through the constant standardization of transport processes, which, in turn also generates improvements throughout the supply chain, since transport processes are a key factor that ensures the physical provision of the materials.

With the need to ensure procedures are followed while managing deviations, the authors suggest the adoption of a standard procedure for deviations handling throughout the department and its internal and external clients. A standard inbound deviation handling procedure would offer a set of guidelines, reason codes, transportation rules and practices to ensure maximum level of engagement among the stakeholders, so they can focus on solving the deviations in a timely and proactive manner. Ensuring standardized procedures are developed and communicated is the key to improve process performance.

Since the standardization of procedures optimizes the logistics operations favouring the efficient data collection and fast generation of information, the authors propose in Figure 6-3, a standard reference model for the deviations handling process in the Inbound logistics department of the OEM evaluated in this case study. The referential model is a tool that, in addition to reflecting the process, creates flexibility to experiment and evaluate improvement suggestions before implementing them, also allowing the process to evolve according to future requirements (Stajniak and Koliński, 2016).

Based on the study carried out by Stajniak and Koliński (2016), about the development of referential models for the main transport processes; the authors consider, in the referential model of the deviations handling procedure, the collection, transport execution and delivery processes, also including the main stakeholders: supplier, transport service providers, IBL control tower, supply chain coordinators and plants. This deviation handling referential model already contemplates the improvements suggested above in relation to the IT tools that the operation requires.

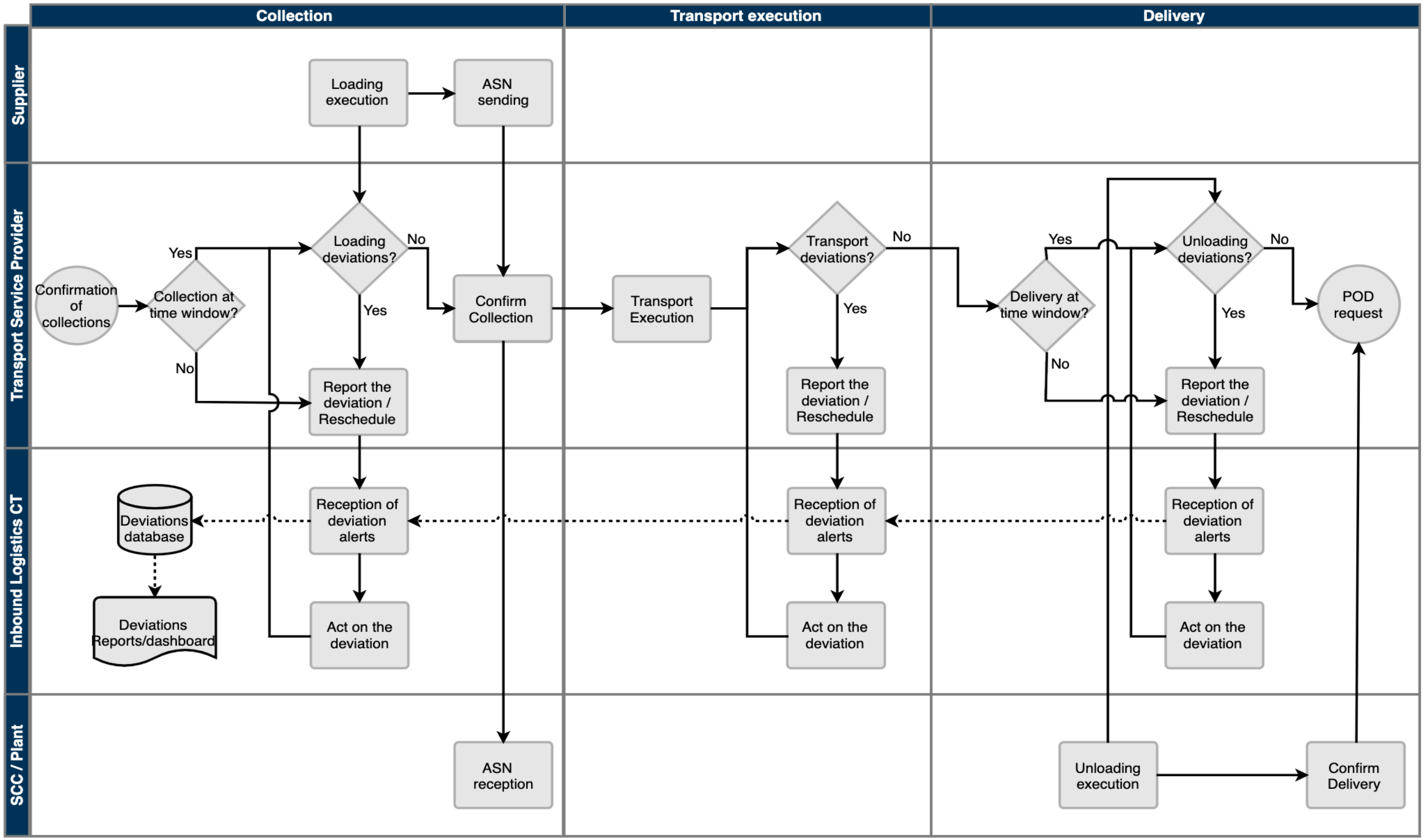

Figure 6-3 Referential model – Deviations handling process

Source: Own elaboration

The suggested procedure begins with the collection process, in which the transport service providers confirm the collection of orders; subsequently, the situations in which collection deviations may arise are evaluated, such as arrival at the pick-up point within the time window and the loading process. Then, within the transportation execution process, the transport service provider must ensure the reporting of any deviation that may affect the transportation planning according to the lead times. Finally, in the delivery process, each of the activities that could originate a deviation are also considered, such as delivery out of the time window and the unloading process. It is important to mention that each of the deviations that arise within the 3 main processes must be reported opportunely by the transport service providers in the TMS or the integrated IT tool, which will automatically send notifications to the inbound logistics control tower specifying the stakeholder causing the deviation, the type of deviation and the respective reason code. This information, apart from being notified, will be automatically stored in the TMS or the integrated IT tool, which will allow the stakeholders to access dashboards related to deviations in real time, in addition to generating the reports that could be required.

A very important part within the standardization of the deviations handling procedure, is the creation of a standard categorization of the deviations that may arise in the processes of collection, transport execution and delivery. As mentioned in the previous chapters, the fact that the deviations categorization is not clear to all the stakeholders, may lead to the transmission of incorrect information, making blurry the visibility of problems and hindering opportune actions on them. Based on the current categorizations used by both operational teams and the literature review regarding deviations and uncertainties in the transport processes, the authors recommend to IBL department, a standardized categorization for both teams, shown in Table 6-5.

By Stakeholder	By Deviation type	By reason code
OEM	*Collection*	*Early collection request*
		Early collection due to incorrect booking (TMS lead time)
		Late collection request
		Late collection due to incorrect booking (TMS lead time, address, volume, weight)
		Late collection due to delays at previous OEM loading/unloading point
		Collection cancelled due to OEM
	Delivery	*Early delivery request (Speed up)*
		Late delivery due to late collection (Caused by the OEM)
		Late delivery request
		Early delivery due to incorrect booking (TMS lead time)
		Late delivery due to incorrect booking (TMS lead time, address)
		Late delivery due to long queues/congestion at the delivery point
	Quality	*Damaged goods in the unloading process*
TSP	*Collection*	*Early collection*
		Late collection due to wrong internal planning
		Late collection due to capacity issues
		Late collection due to IT issues
		Late collection due to mechanical failure in the transport unit
		Late collection due to internal issues (Sick drivers, driving working hours)
		Collection cancelled due to TSP
	Delivery	*Early delivery*
		Late delivery due to late collection (Caused by the TSP)
		Late delivery due to wrong internal planning
		Late delivery due to capacity issues
		Late delivery due to IT issues
		Late delivery due to mechanical failure in the transport unit
		Late delivery due to internal issues (Sick drivers, driving working hours)
		Late delivery – Missed intermodal connection (Ferry/train)

		Late delivery due to goods lost in transit
	Quantity	*Less quantity due to lost in transit*
	Quality	*Damaged goods in the transportation process*
SUPPLIER	*Collection*	*Early collection request*
		Late collection request
		Late collection due to supplier premises closed before the agreed time window
		Late collection due to late loading process
		Late collection due to goods not ready
		Late collection due to IT issues
		Late collection due to documents issues
		Late collection due to lack of packaging
	Delivery	*Late delivery due to late collection (Caused by the Supplier)*
	Quantity	*Less quantity due to goods not ready*
		More quantity due to supplier request
	Quality	*Damaged goods due to supplier processes (Manufacturing, loading)*
OTHER	*Collection*	*Late collection due to traffic jams/closed routes*
		Late collection due to weather conditions
		Late collection due to force majeure (strikes, fires, derailment, earthquakes, etc)
	Delivery	*Late delivery due to traffic jams/closed routes*
		Late delivery due to weather conditions
		Late delivery due to customs issues
		Late delivery due to force majeure (strikes, driving ban, fires, derailment, earthquakes, etc)
	Quantity	*Less quantity due to a non-frequent cause*
	Quality	*Quality affected by a non-frequent cause*

Table 6-5 Deviations categorization

Source: Own elaboration

Firstly, the deviations should be categorized by the stakeholder causing them. Based on the uncertainty logistics triad model (Sanchez Rodrigues et al., 2008) and considering all the participants in the procedure, the authors suggest as main stakeholders causing the deviations: *OEM (Original Equipment Manufacturer), TSP (transport Service providers), Suppliers* and *Others*, in case another non-frequent stakeholder causing deviations arise.

Subsequently, according to the typology of uncertainties or deviations in the supply chain, mentioned by Sanchez Rodrigues et al. (2008), the authors suggest the categorization of deviations in lead time, in this case in *Collection* and *Delivery*, in addition to deviations related to *Quality* and *Quantity*.

Finally, regarding the reason codes, the authors, according to the information provided by IBL department and considering the incidents that arise in the logistics processes according to Zeimpekis et al. (2013) and Sanchez Rodrigues et al. (2008), suggest including in the categorization, the reason codes that are more frequent. Having many infrequent reason codes makes it difficult to categorize and use them, creating confusion among stakeholders as well as undermining the performance analysis. Infrequent reason codes could be classified as others or force majeure.

It is very important to mention that the categorization shown in Table 6-5 is a suggestion by the authors based on the information obtained during this case study. However, it will be necessary to review this categorization before implementation and periodically, since the frequent deviations causes and reason codes can change, appear or disappear along the time and according to different situations.

6.3 Centralized Information

Information is another key area observed through analysis as one of the possible root causes with the potential to optimize the deviations handling process. The increased complexity in the supply chains demand centralized and real time information to enable proactive decision-making environments. While the implementation of the required TMS and integrated software combined with analytics can centralize data and automatically transform it into information for decision-making, this may be threatened by the large number of stakeholders involved in the process and the performance of their work regarding this matter.

Considering this situation and based on the uncertainty logistics triad model (Sanchez Rodrigues et al., 2008) and the new integrated supply chain ecosystem (Schrauf and Berttram, 2016), the authors suggest the centralized information model shown in figure 19.

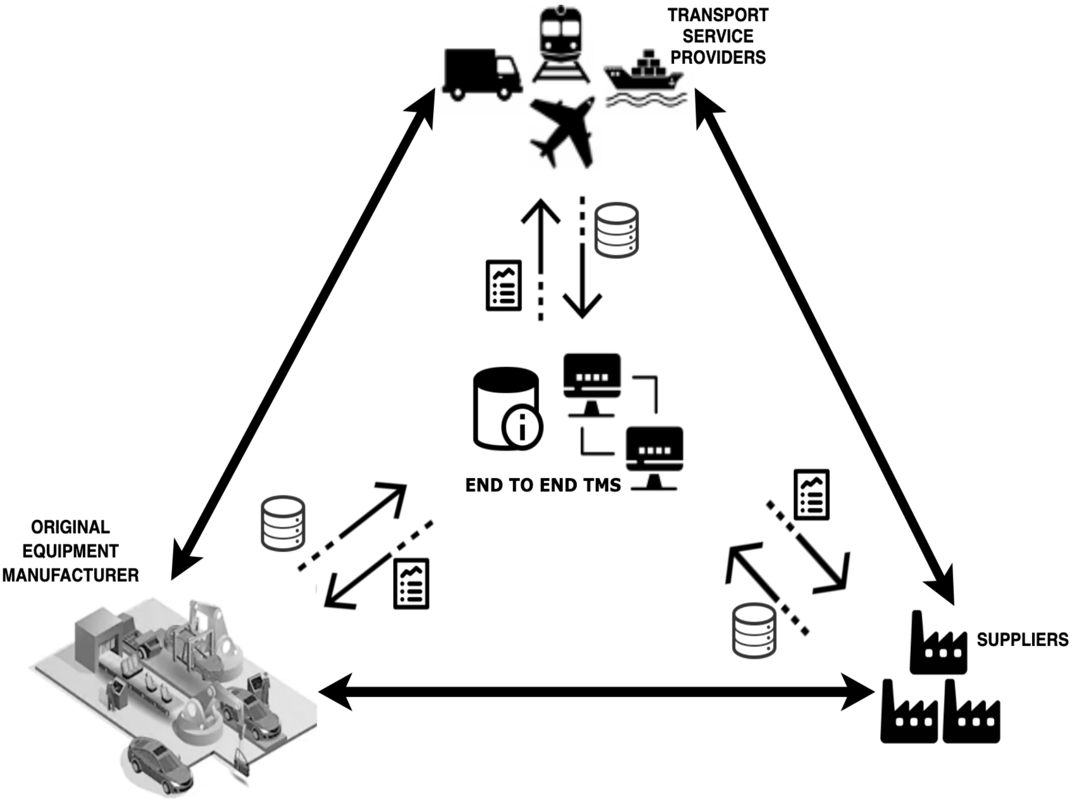

Table 6-6 Centralized information model

Source: Own elaboration

This model based on centralized information through an end-to-end TMS, would holistically connect the stakeholders participating in the process, integrating the data and transforming it into information automatically and in real time, also creating an agility environment in the entire process; switching from being firefighter, solving each problem as it pops up, to a process orchestrator: seeing, managing, and optimizing the entire chain. (Schrauf and Berttram, 2016) This level of integrated information will allow the IBL department of this OEM to improve the following aspects:

Transparency - This means that all the stakeholders involved in the process will be able to know and understand in real time the activities, needs and difficulties that others are going through.

Communication – The centralized information undoubtedly will promote and optimize communication between stakeholders since the information will be available to all of them simultaneously.

Collaboration - By sharing information in a centralized platform, IBL department and the rest of the stakeholders could achieve the highest level of collaboration; improving the process for the common benefit by taking advantage of the analytics provided by the end-to-end TMS.

Flexibility and Responsiveness – will allow the IBL department not only to react to deviations that may arise in the process, but also to anticipate them. Any change that may create disruption to the transportation planning will be proactively and rapidly assessed, creating real-time responses on planning and execution level.

Finally, it is very important to recommend that centralized and real-time visibility of information not only depends on IT tools, but also on the partnership between all stakeholders, based on integration and exchange (Hensher and Brewer, 2004). Each of the stakeholders must perform their work and make sure to share the information according to the established agreements in order to keep the entire chain informed. By assuming this commitment, the benefits provided by IT tools would be obtained.

7 Conclusion and Future Work

In this chapter, the case study findings are summarized by explaining each of the research objectives, followed by the recommendations and additional thoughts regarding the delimitations and proposal of future work.

7.1 Conclusion

The purpose of the study was to assess the deviations handling process currently being employed at the Inbound logistics of the evaluated company and to provide suggestions on how the process can be optimized to improve the overall performance. To achieve this purpose, the authors applied the Lean Six Sigma methodology along with the DMAIC framework, which through a set of different tools, clearly allowed to meet the case study objectives detailed below.

The first objective, to map and evaluate the current deviations handling procedure, has been a very important part within the case study, since it allowed to obtain a better understanding about the OEM structure, its inbound logistics operations and the process under examination. Following the applied methodology of Lean Six Sigma and DMAIC framework, the first three chapters allowed the development of the *"define phase",* where were explained the company and problem background, the literary review required to carry out the project and the details of the research methodology applied in the case study. Then, in chapter 4, the *"measure phase"*, the deviation management process was mapped and detailed through the value stream maps and the process performance review. This chapter allowed the authors to acquire in-depth knowledge of inbound logistics operations and to verify the shortcomings of the current process. Moreover, as a result of this chapter, the baseline measure was established, which specifies the details of how the process is currently performed and then compares these details with the suggested improvements in case the company decides to implement them.

The second case study objective, to identify the root causes leading to the inefficient deviations handling process, is fulfilled in chapter 5, the *"analyze phase"*. At this stage of the case study, the main root causes leading to the problem were identified. For this purpose, the process and performance analysis were carried out using characteristic tools of the Lean Six Sigma methodology, which allowed identifying the activities that generate waste, in addition to obtaining results that demonstrated how the process is currently being performed.

Subsequently, through a cause and effect analysis, hypotheses of the possible root causes were obtained, which were later confirmed as True or False. As a result of this phase, it was determined that the main root causes leading to the inefficient deviations handling process are *problems related to IT tools, procedure and information.*

Finally, considering the results obtained in the analysis, the "improve phase" detailed in chapter 6, the third objective is met, to investigate and propose industry solutions and best practices to optimize the deviations handling process. Considering the root causes, the authors focus on suggesting improvements related to the implementation of the Right TMS for the OEM Needs, where case studies of different industries show the benefits of implementing modern IT tools, optimizing different processes within inbound logistics including the deviations handling. Considering the implementation of the required information technologies, the adoption of a standardized procedure for the deviations handling is also suggested in addition to recommending a centralized information model that would not only depend on updating the IT tools, but also on the commitment of all stakeholders involved in the process.

The development of this project not only contributes to the evaluated OEM in this case study, but also demonstrates how the Lean Six Sigma methodology, based on the DMAIC framework and waste reductions, can be adopted and applied in the different logistics processes. On the other hand, the developed models regarding the deviation handling process and centralized information in this thesis project can be adopted not only by automotive companies, but also by any type of industry in which transport operations are carried out by third party logistics; since most of the deviations and incidents in the transportation processes within inbound logistics can be generalized.

Last but not least, the OEM supervisors concluded the importance of this document, since it reflects through a tangible evaluation the problems that are often assumed only through perceptions and feelings; furthermore, that the improvement suggestions open the opportunity to evaluate the different IT solutions of which they were not aware of their existence in addition to review the current operations procedures.

7.2 Recommendations

Due to the nature of the transportation process, the deviations to which it is exposed will never completely disappear, even worse when the process is carried out by third party logistics. Therefore, the most important is to implement solutions that information technology provides nowadays, allowing the integration of all stakeholders, thus achieving the real time information exchange that allows opportune identification and faster reactions on any disruption within the process. The adoption of digitalized logistics solutions and procedures based on automated lT tools, would eliminate those manual tasks that saturate the workload without adding value to the process, subtracting time from core management activities.

The following steps to this project, in case the company decides to implement the suggestions provided by the authors, would be to carry out a more detailed evaluation of different end-to-end TMS vendors that are best adopted to the company's requirements, including deviations handling in real time, and compare the obtained results with the baseline measure of this project. In this way, the DMAIC cycle of the Lean Six Sigma methodology would be completed, with the last phase: *"control"*.

It is also important to periodically update the operations models/procedures and review the performance of stakeholders in relation to information management, verifying that the established procedures and agreements are being complied, since as mentioned above, the process optimization does not only depend on technological tools but also on the commitment of the stakeholders.

7.3 Delimitations

The development of this project has had limitations due to the Coronavirus (Covid-19) that has not only affected the society, but also the operations of the evaluated company. That is why the delimitations have changed during time. Initially, part of the data collection, such as on-site observations, was planned to be carried out more frequently, but for the reason previously mentioned, these were altered, and the information had to be accessed through other means. Despite this situation, the managers, team leaders and logistics engineers of the company made sure to provide all the information according to their possibilities.

7.4 Future Work

An interesting avenue for future studies would be the evaluation of success case studies in which the benefits of information technology tools and digitalization are evaluated in different logistics and supply chain operations, since it is a field that is constantly growing providing industries with different kind of solutions.

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Appendix

A- Questionnaire Operational team 1

General questions

1. What is your name?
2. What is your title and job responsibilities?

Questions regarding the deviations handling process

1. Are deviations handling a regular part of your job?
   - If yes, to what extent of your daily tasks time is spent handling delivery deviations ?
   - If no, to what extent dealing/solving deviations is part of your daily activities? and to what extent do you perform the carrier management process?
2. What kind of tasks do you perform related to deviations?
3. What tools are used to process and report deviations?
4. What do you think about the deviations handling through the tickets on Service Now? is it effective, helpful?
5. How often are deviations reports (based on the tickets) shared within your department and cross functional?
6. Do you use the deviation report database for the carrier management process?
7. To what extent do you consider the current TMS as an effective tool for managing deviations?

Other questions

1. What do you consider are the main challenges while dealing with the deviations ?
2. Do you have some suggestions to improve the process of handling deviations ?

About Performance

1. According to your perception, what were the most frequent deviations in IBL – operational team 1, in the last quarter from Jan to March?

2. Perhaps you have thought or have some idea of how you can reduce or eliminate this type of deviation?

B- Questionnaire operational team 2

General questions

1. What is your name?
2. What is your title and job responsibilities?

Questions regarding the deviations handling process

1. Are deviations handling a regular part of your job?
2. To what extent of your daily activities time is spent handling deviations? (%)
3. What tools are used to process and report deviations? (mail, excel sheets, Power BI, tickets)
4. Are there any deviations report database within the operational team 2op?

If yes,

- What type of information does this report contain?
- How often is this report shared with the stakeholders (IBL team, SCC, etc)?
- Can you briefly explain the entire process and the time does it takes? (from receiving information regarding the deviations from the carriers to sharing it with the stakeholders)
- Do you use this deviation report database for the carrier's management (measure carriers' performance)?

If no,

- How the deviations are handled and reported and how often?
- What kind of tools are used for the carrier's management (measure carriers' performance)?

5. To what extent do you consider the current TMS as an effective tool for managing the deviations?

6. What do you consider are the main challenges while dealing with the deviations? (Poor communication, lack of tools, time consuming tasks, etc)

7. Do you have some suggestions to improve the deviations handling process?

8. What were the most frequent delivery deviations in IBL Premium/A&S in the last quarter, from January 2020 to March 2020?

9. Perhaps you have thought or have some idea of how the deviations mentioned previously (question 8) could be reduced or eliminated

C- Checklist for observations

Check the entire IBL process

- KPIs and its performance
- Process steps in IBL process
- Different functions included in IBL process

Check the deviations handling process

- Responsible to handle the deviations
- Check if the deviations are being handled according to the established process
- Which are the stakeholders involved in the deviation handling process?
- What terminology do they use in the deviations handling process?
- What KPIs are used to measure the deviations handling performance?
- Objectives of that measurements
- Responsible to manage and report the deviations
- What tools are used to handle the deviations? (Excel, website)
- How are the KPI's or deviations presented/reported? (by country, plant, warehouse)
- What kind of tools are used to present/report deviations? (Dashboards)
- Strategies to work on/improve deviations.
- How often are the deviations handled and reported?