Škoda Auto Vysoká škola o.p.s.

Course: N0413A050001 Business Administration

Field of study/specialisation: International Supply Chain Management

Optimization of emergency logistics management in FAURECIA INTERIOR SYSTEMS BOHEMIA s.r.o.

Diploma Thesis

Naveej Azhamchalil

Thesis Supervisor: Ing. Tomáš Malčic, Ph.D.

Škoda Auto Vysoká škola o.p.s.
111

Academic year: 2023/2024

Škoda Auto Vysoká škola

REGISTRATION FOR FINAL THESIS

Candidate: **Naveej Azhamchalil**

Study programme: Business Administration

Track: International Supply Chain Management

Thesis title: **Optimization of emergency logistics management in FAURECIA INTERIOR SYSTEMS BOHEMIA s.r.o.**

Aim: The aim of the thesis is to analyse and optimize current emergency logisitcs management system in company FAURECIA INTERIOR SYSTEMS BOHEMIA s.r.o. with focus on frequency, costs and causes of emergency tansports. For identified root causes of emergency transport the optimization measures will be proposed with evaluation of expected economical benefits.

Content areas:

1. Conduct literature review from fields of industrial and emergency logistics.
2. Analyse current system of emergency logistics in the company FAURECIA INTERIOR SYSTEMS BOHEMIA s.r.o. by assessing the master data from the plant regarding special transport.
3. Identify the causes for special transportation orders using the master data from the plant and performing a root cause analysis on each case.
4. Propose optimization measures for elimination of causes of special transport and evaluate expected economical benefits of proposals.

Length of thesis: 55 – 65 pages

Recommended literature:

1. CROUCHER, Phil; BAKER, Peter; RUSHTON, Alan. *The Handbook of Logistics and Distribution Management*. London: Kogan Page, 2022. ISBN 978-0-7494-6627-5.
2. RUDD, Jerry. *A practical guide to logistics: an introduction to transport, warehousing, trade and distribution*. New York: Kogan Page, 2019. 384 p.
3. GIBSON, Brian; NOVACK, Robert; LANGLEY, John. *Supply Chain Management: A Logistics Perspective*. Boston: Cengage, 2021. 628 p.
4. MONTGOMERY, Douglas C. *Introduction to statistical quality control*. Wiley, 2020. 644 p. ISBN 978-1-119-65711-8.

Date of registration: April 2023

Date of submission: May 2024

L. S.

Electronic approval: 12. 4. 2023 **Naveej Azhamchalil** Author of thesis	Electronic approval: 12. 4. 2023 **Ing. Tomáš Malčic, Ph.D.** Thesis supervisor
Electronic approval: 20. 4. 2023 **doc. Ing. Jan Fábry, Ph.D.** Study track supervisor	Electronic approval: 20. 4. 2023 **doc. Ing. Pavel Mertlík, CSc.** Rector ŠAUni

I declare that I have prepared this thesis on my own and listed all the sources used in the bibliography. I declare that, while preparing the thesis, I followed the internal regulation of Škoda Auto Vysoká škola o.p.s. (hereinafter referred to as ŠAVŠ), directive Thesis guidelines.

I am aware that this thesis is covered by Act No. 121/2000 Coll., the Copyright Act, that it is schoolwork within the meaning of Section 60 and that under Section 35 (3) ŠAVŠ is entitled to use my thesis for educational purposes or internal requirements. I agree with my thesis being published in accordance with Section 47b of Act No. 111/1998 Coll., on Higher Education Institutions.

I understand that ŠAVŠ has the right to enter into a licence agreement for this work under standard conditions. If I use this thesis or grant a licence for its use, I agree to inform ŠAVŠ about it. In this case, ŠAVŠ is entitled to demand a contribution to cover the costs incurred in the creation of this work up to their actual amount.

Mladá Boleslav, Date .... *Signature*

I would like to thank Ing. Tomáš Malčic, Ph.D. for his professional supervision of my thesis, advice and information. I also want to thank FAURECIA Interior Systems Bohemia s.r.o. and the PC&L department for the opportunity and support on for the thesis.

Contents

List of abbreviations and symbols

FIS	Faurecia Interior Systems
FTL	Full Truck Load
KLT	Kleinladungsträger
LTL	Low truck load
BOP	Bought Out Parts
SpT	Special Transport
EDI	Electronic Data Interchange
MFID	Material Flow and Information Diagram
BOM	Bill Of Materials
TPA	Truck Preparation Area

Introduction

Emergency logistics is a critical aspect of any factory's operations, especially when it comes to the transportation of essential goods and equipment during urgent situations. In such cases, the use of special transports becomes necessary to ensure the timely and safe delivery of vital items. Special transports in case of an Industrial point of view are vehicles specifically designed and equipped to handle oversized or heavy loads as well as the smaller loads in case the normal transports which are planned isn't enough. They are often used in emergency logistics to move critical equipment, materials, and machinery to and from the factory. This type of transportation requires specialized planning, coordination, and execution to ensure the delivery is completed safely and efficiently.

The aim of the work is to explore the role of special transports (hereinafter referred to as SpT) in emergency logistics and the considerations that go into planning and executing such operations in a modern factory or industry while optimising it for the company's benefit. The current supply chain practises are very complex and requires a thorough understanding of the current best practises of the entire industry and the help in understanding how the emergency logistics play a vital role in the overall expenses to the company Faurecia Interior Systems Bohemia S.R.O. (hereinafter referred to as FIS) as there are a lot of these special transports being arranged frequently and this was a priority to the company. Special transport which are important part of the emergency logistics and is the core of the thesis topic.

The problem with special transports is that they amount to a huge expense if the root cause of them being ordered are not solved. The process of ordering the special transport involves the employees in the company coming across the need for an additional transport apart from the normal transports that are scheduled. The normal transports are part of the company's supply chain process for the company to have a smooth logistics. The need for special transports starts from the employee who understands that the normal transport can't over for the Ad hoc issue that has come up. Special transports were ordered after a request was put forwarded by the person in need or he forwards the request to someone who has the authority to use the specialised external software for ordering transports called EASY4PRO used by FIS. After the special transport is requested to the central team in Portugal, the team then puts the order for bidding to the international forwarders. On weekdays this isn't a big problem as many forwarders compete for the bidding and FIS has many options but during the holidays or weekends the forwarders can manipulate the price due to the heavy demand and fewer options. Besides the financial cost there is a lot of waste involved as well for example time, human resources, Customer KPI's such as satisfaction factor etc. If the issues are not plugged then this contributes to the extra work of ordering the special transports and moreover there is a possibility of penalty from customers side for the problem that could have originated from supplier's side at the first place. The analysis and proposal were aimed at reducing the root causes thorough Root Cause Analysis and the focus is on the problems which are frequently being repeated in the plant and are of high degree of priority to the management's eye.

At first, an individual questionnaire was sent individually to each person who ordered special transport because of emergency and then the responsible person was given 2 to 4 days to answer the provided questionnaire. Based on the reply to the questionnaire an excel chart was prepared and a preliminary analysis was performed on those cases. For the ease of understanding of the main issues more than 500 cases were studied over a period of 5 months. RCA was done with the help of Pareto charts and fishbone diagram to plot and highlight the root causes and its effects. 5 Why tool was used to find the root causes. The end goal is to provide proposal to the company where they can concentrate to minimize the cost of the special transports, optimize the logistics and improve on the current practices in the factory. This study contributes practical and theoretical significance to the development of the emergency logistics in industries and enriches the emergency logistic industry's research system.

This thesis is divided into two parts where the first part focuses on the theoretical aspects of the Emergency logistics in Industrial logistics. After that there is a detailed information on the company FIS where all information available to the press are briefly written and the later chapters will focus more on practical aspect of the thesis. Based on those Top3 of the root causes, suggestions or proposals were put forward to the company.

1 Industrial logistics

Industrial Logistics management was originated by the British Army far before the outbreak of the First World war where a military supply chain system was developed by building infrastructure such as; roads, railroads, ports, airfields, supply stores and vehicles to transport weapons and troops. Industrial logistics refers to the management of the flow of goods and materials within a company's operations. (Jwd, 2023).

As previously stated, logistics was created by the british military and there are historical evidences that they were used by the Roman and Greek militaries as well. Rome, in particular, had a complex logistics system that they used to support their troops and transport food, weapons, and other equipment during wars and military campaigns. In fact, Rome had special personnel called "logistakas" who's main duties were to allocate and transport resources for the legions. Although logistics was used by the military for many years, especially during World War I and World War II, it wasn't until the 1960's that businesses began to use logistics with shipping. "*In the United States, which started its agricultural produce distribution across the continent in the late 19th Century, there was a development of industrial goods distribution system. This eventually led to the start of the official Logistics Management Science in the US in 1964. The public sector has adapted the logistics management into their business practice up until now*" (DTSone, 2023).

For businesses, logistics involved filing orders, production planning, distributing products, warehousing, storing, and even customer service. They discovered that logistics made their shipping process much more streamlined, cost-efficient, and allowed them to transport goods quickly to their customer. The term logistics management or Industrial logistics management are coherient.

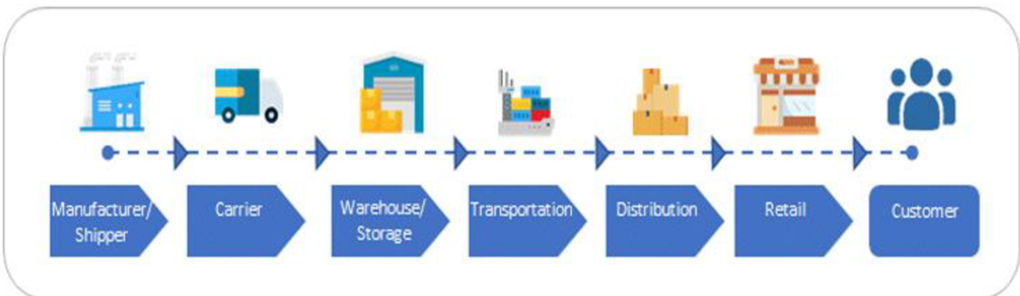
In traditional supply chain situations, downstream facilities make decisions about their order quantities without regard to the actual inventory available upstream. If the upstream facilities do not have enough inventory on hand to fill the orders, it is often assumed that the downstream facility will take what it can get and backorder the rest. In order to avoid these shortages, the upstream facilities have traditionally set their inventory levels high enough so that the likelihood of not meeting downstream demand is low. However, the shift towards lean inventory has caused a reduction in inventories, possibly increasing the likelihood of these shortages. Moreover, the cost of backorders (already high, though hard to estimate) is certainly not decreasing in today’s competitive markets. Therefore, many facilities use various forms of expediting to meet supply requests when shortages occur (Gunasekaran A, Agarwal A & Biswas S, 2011).

Industrial Logistics involves planning, organizing, implementing, and controlling the movement of products from the point of origin to the point of consumption in and outside the indsutry. The primary goal of industrial logistics is to optimize the supply chain process to achieve maximum efficiency and cost-effectiveness. There are mainly six subtopics related to industrial logistics (Types of logistics management, 2023):

- Supply Chain Management
- Green Supply chain Management
- Warehouse Management
- Transportation Management
- Inventory Management
- Reverse Logistics

1.1 Supply chain management

SCM involves the coordination and integration of various processes across the entire supply chain, from suppliers to manufacturers to distributors to retailers. The goal of SCM is to streamline the flow of goods and information between each parties invocled to reduce costs, improve quality customer satisfaction (see Figure 1).



Source: Frost and Sullivan, 2020

Figure 1 SCM Flow

The dynamics of the global environment changed dramatically during the 1990s, and organizations had to adapt to these changes or perish. Unfortunately, there were a number of casualties a long the way. Some previously successful companies did not survive in the more competitive global marketplace because they did not adapt and change“. Leading companies such as Westinghouse, Bethlehem Steel are no longer in business. Successful companies like IBM, General Electric, and McDonald's are currently having difficulty surviving while attempting to modify their business models appropriately. Some people contend that the phrase "*disrupt or be disrupted*" is a suitable motto for businesses, which may be an extension of the proverb "*think outside the box*" (Coyle et al., pp 6, 2016).

Effective supply chain management requires a deep understanding of the various processes involved in the supply chain. This includes identifying suppliers, negotiating contracts, managing inventory levels, forecasting demand, and monitoring supplier performance. Companies also need to have the right technology and tools in place to manage the supply chain effectively. This may include software for inventory management, transportation management, and warehouse management. One of the biggest challenges in supply chain management is ensuring that all parties in the supply chain are working together effectively. Communication is critical, as is the ability to manage expectations and resolve conflicts quickly. Companies need to be able to adapt to changes in demand or supply, such as changes in customer demand, disruptions in supply chains, or unexpected events such as natural disasters.

1.2 Green supply chain management

Green Supply Chain Management (hereinafter referred to as GSCM) is a practice that integrates environmental concerns into supply chain management processes. The major reason for the greening of corporate supply chains is to address environmental burdens caused by industry and its operations. The environmental burdens can occur in different media such as air, water, or land and at various levels, such as global, regional, and local levels (Sarkis and Dou, 2018). A Increasing logistics services have intensified the environmental impacts of transportation activities (Rondinelli and Berry, 2000). For example, transportation plays a role in climate change, and it is estimated that 15 percent of global CO_2 emissions are from the transportation sector (Rodrigue et al., 2013). In the United States, the transportation sector is responsible for over 50 percent of NOx total emissions inventory, over 30 percent of volatile organic compounds emissions, and over 20 percent of particulate matter emissions (EPA, 2017).

The importance of GSCM is rising as people become more conscious of environmental problems and the risks they pose to businesses. Companies can reap numerous advantages from it, such as lower expenses due to decreased energy and waste consumption, enhanced brand equity, and heightened customer allegiance. GSCM is a proactive strategy for handling supply chain operations in an eco-friendly way. All parties involved must work together to identify and apply sustainable practices all the way through the supply chain. It is stated that in order for businesses to remain competitive in the market today, green supply chain management is not just a trend, but a necessity.

"*As the world economy grows, so does international trade and transportation*" (Martin, 2017). Clearly different transport modes have different impacts on carbon and other emissions. The design of vehicles and vessels is also increasingly influenced by the need to improve fuel efficiency. There are also arguments for increasing the size of vehicle or the vessel to achieve lower transport intensity per unit.

Research has highlighted that vehicle capacity is often poorly utilised. It is suggested that empty running because of the lack of return loads means that up to a third of the trucks on the roads of Europe are running empty. More use of shared distribution, better vehicle routing and scheduling, and better loading can also dramatically improve transport-intensity.

If standard, generic products can be shipped in bulk from their point of origin and then assembled, customised, or configured for local requirements nearer the point of use, there may be an opportunity to reduce overall transport-intensity.

1.3 Warehouse management

Warehouse management is another critical component of industrial logistics. The goal of warehouse management is to optimize the use of warehouse space and resources to maximize efficiency and minimize costs. This involves managing inventory levels, organizing the warehouse layout, and coordinating the movement of goods within the warehouse.

“Effective warehouse management requires the use of technology and automation to streamline warehouse operations. This may include the use of barcoding and RFID technology to track inventory levels and automate the movement of goods within the warehouse. It may also involve the use of robotics and automated material handling equipment to move and organize inventory. Only 19% of retailers use automated picking. Reduce costs and get products to customers faster using AI to identify the number of pick trips and then prioritize picking using specific business rules while identifying the shortest picking route“ (seabird logistics, 2023).

Warehouse management also involves the management of personnel. This includes hiring and training warehouse workers, scheduling shifts, and ensuring that workers are following safety protocols. Effective communication is critical in warehouse management, as is the ability to adapt to changes in demand or supply.

Warehousing is a critical component of Warehouse management that ensures the smooth flow of goods from the manufacturer to the end consumer. The primary function of warehousing is to provide a secure and centralized location for storing goods until they are ready for distribution. Warehousing plays a pivotal role in the supply chain by offering several essential functions, including storage and inventory.

Warehousing provides a centralized location for storing finsished goods as well, allowing businesses to manage inventory levels effectively. This ensures that businesses always have enough stock to meet customer demands.

1.4 Transportation management

“Transportation can be viewed as the glue that helps the supply chain system function. The critical outcomes of the supply chain are to deliver the right product at the right time, in the right quantity and quality, at the right cost, and to the right destination. Transportation plays an important role in making these rights happen“ (Coyle et al., 2016).

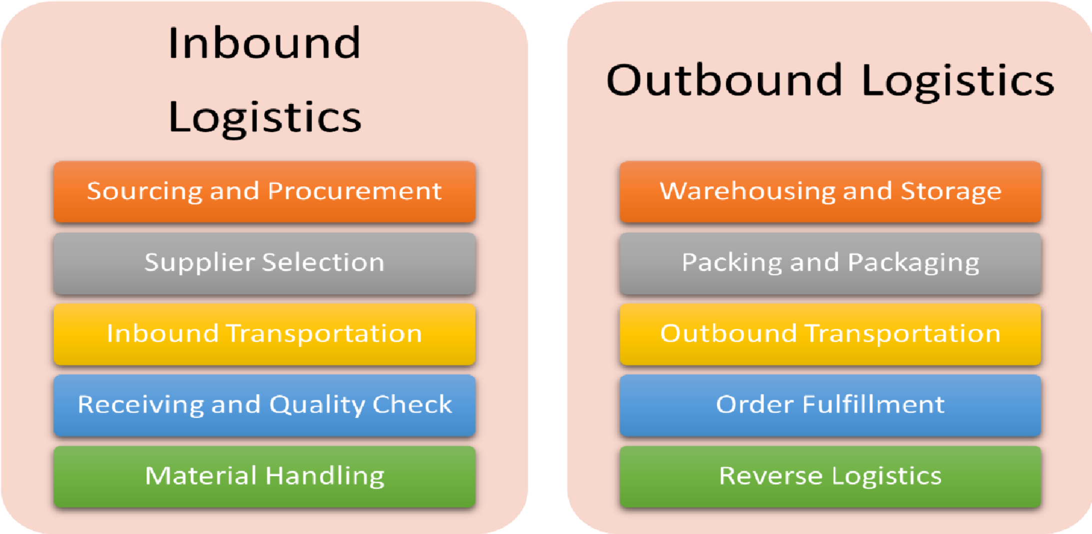
This kind of management is another critical component of industrial logistics where the goal of transportation management is to optimize the movement of goods from one location to another while minimizing costs and maximizing efficiency. This involves managing the transportation of goods via various modes of transportation, including trucks, trains, ships, and planes. “*The design of the transportation systems* *requiring both pickup and delivery services becomes crucial for companies to minimize transportation costs*" (Kara, Sabuncuoglu and Bidanda, 2021).

Effective transportation management requires the use of technology to track shipments and optimize transportation routes. This may include the use of GPS technology to track the location of trucks and planes, as well as software to optimize transportation routes and schedules. Companies may also use transportation management software to manage carrier contracts and negotiate rates.

Transportation is a very important activity in the logistics system and is often the largest variable logistics cost. A major focus in logistics and supply chains is on the physical movement or flow of goods in the network that moves the product. The network is usually composed of transportation organizations and related service organizations that are evaluated, selected and used in moving raw materials, components, and ﬁnished goods or developing private transportation as an alternative. It is important to note that transportation is a very important component of supply since it provides the physical link among the various organizations in a supply chain (Coyle et. al, 2016).

Transportation management also involves managing relationships with carriers and suppliers. This includes negotiating contracts, monitoring carrier performance, and resolving disputes. Effective communication is critical in transportation management, as is the ability to adapt to changes in demand or supply. In FIS the transports are planned by a central material planning team which is situated in Portugal, and they are the ones responsible for optimising the container load to come up with the type of Trucks, Container length, loading factors which include weight height and type of loading possible, Loading Bay allocation, FTL ad LTL, number of deliveries to and from, and the routing solutions (Kara, Sabuncuoglu and Bidanda, 2021).

Transportation management in Industrial logistics can be further classified as Inbound, Outbound and Production logistics process based on the stage of logistics from the point of view of an industry or factory. The difference between inbound and outbound logistics can be understood from the figure given below (see Figure 2).



Source: (Kaur and Luliia, 2022)

Figure 2 Transportation types

Inbound logistics

Inbound logistics are the actions a business takes to acquire raw materials or goods from a vendor or warehouse and the data from those actions. Here are some key features of inbound logistics:

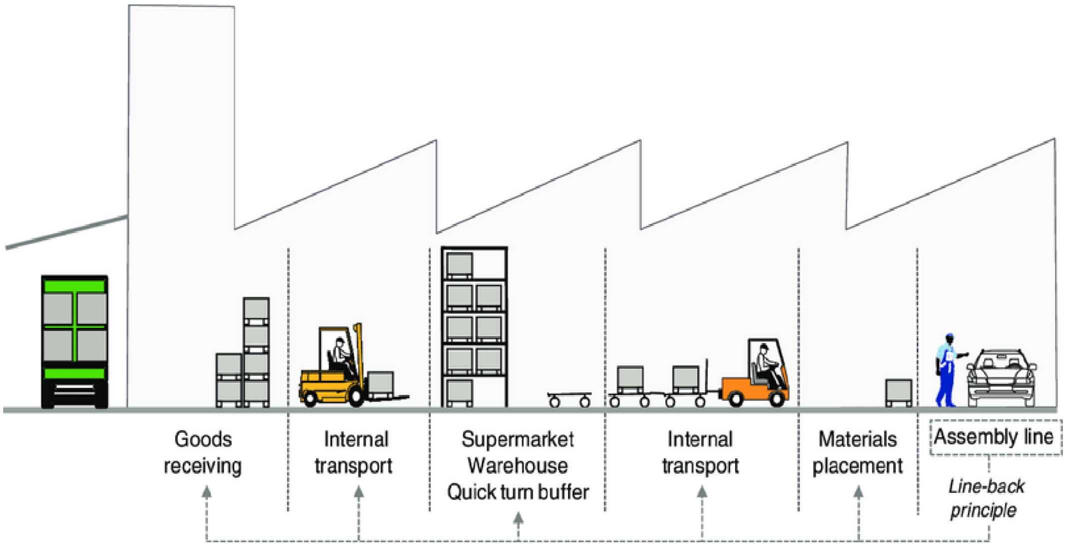
I. Purchasing materials: Inbound logistics covers the costs and processes for purchasing raw materials from a vendor for the company to use in producing its primary products.

II. Receiving materials: Inbound logistics also cover the process of receiving raw materials at the company's facilities, including shipping costs and vendor fees for raw materials.

III. Assigning materials: Inbound logistics cover the assigning of raw materials to storage, job sites or production centers, including the storage or shipment costs to move raw materials.

IV. Returning or exchanging: Inbound logistics also cover returns or exchanges, or "reverse logistics," including the cost of returns and exchanges and updating inventory.

Inbound logistics flow in an automotive plant can be seen from the figure given below (see Figure 3).



Source: (Klug, 2012)

Figure 3 Inbound logistics

Logistics can be seen as a business function responsible for "getting the right goods in the right quantity at the right time in the right place at the right price and in the right condition for the right customer." (Burganova et al., 2021).

Production logistics or internal logistics characterises the phase between procurement logistics and distribution logistics. Production logistics can be understood as the planning, control and execution of the transport and storage of raw materials, auxiliary materials, operating materials, purchased parts, spare parts, semi-finished and finished products, and the associated supporting activities within a company's production system.

Outbound logistics

Outbound logistics are the actions any business takes to deliver the final product to its customers and the data from those actions. Outbound Logistics work closely on the demand side of the market. It would include order processing, Storage Management, Packing, Distribution and Reverse Logistics. Let’s discuss these activities in detail (Global Value Chain, 2022).

I. Processing orders: Outbound logistics cover the processing of customer orders from the time the customer places an order to the time of fulfilment from the company's fulfilment or manufacturing centre.

II. Picking and Packaging products: Outbound logistics cover product packaging, including the labour the company requires for packaging its products, the time it takes to do so and the costs of packaging.

III. Warehousing and storing products: Outbound logistics can also cover any items the company sends to storage, such as excess inventory, and includes the cost of storage and shipping and the value of stored items.

IV. Outbound Transportation: Outbound logistics also cover the shipping of goods from production or fulfilment centres to the customer and the costs or other factors that govern shipping practices.

1.5 Inventory management

It is important for a company to successfully manage its inventory using all the techniques that it has available and those the firm sees fit for its type of business. By doing this the company can lower costs such as overhead and increase customer satisfaction by improving inventory availability. Both physical and logical inventories require accurate and up-to-date information in order to be managed adequately. Carrying the right amount of inventory and ensuring that neither overstocking nor shortages occur is the ultimate goal of inventory management. Strong inventory control is also dependent on accurate forecasts and timely replenishments. Managed and organized information leads to better forecasting, improved inventory turns, lower costs, system efficiencies, increased customer satisfaction, and the list goes on. Information systems are established and maintained in a variety of ways. A company must ascertain its needs and develop or acquire an information system that supports its current and future business strategies. While these systems can be costly, a company must weigh the costs and benefits and determine the best solution to meet their goals. Nonetheless, a company must manage information to be efficient and ultimately to remain competitive in today's marketplace (Edmund, and Whitehead, 2013).

Figure below shows how the inventory transfers looks like and what are the key components in an automotive industry. The same can be said about other industries as well (see Figure 4).

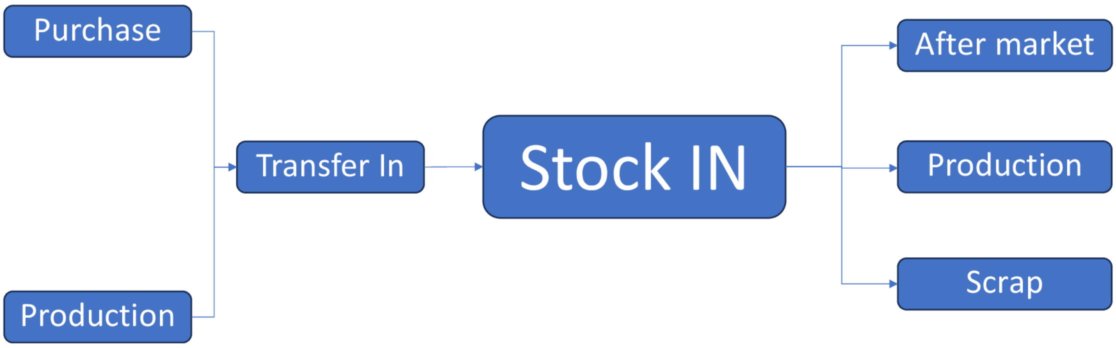
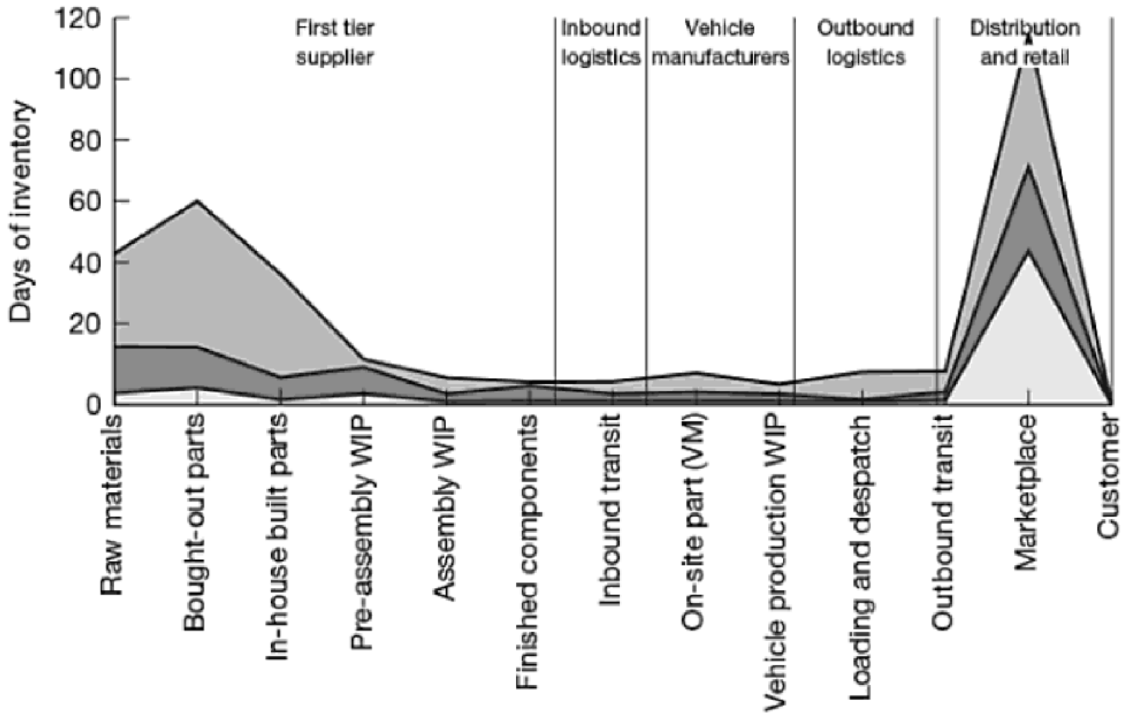


Figure 4 Inventory management operation

It is a crucial component of industrial logistics that involves the planning, organizing, and controlling of materials, goods, and products in storage. It plays a vital role in the smooth and efficient operation of the supply chain, ensuring that goods are available when needed and minimizing the costs associated with inventory holding. Effective inventory management requires a deep understanding of the demand for products, the lead times for supply, and the costs associated with holding inventory (Coyle et. al, 2016).

"The primary objective of inventory management is to ensure that the right products are available at the right time and in the right quantities" (Christopher, 2016). This requires careful forecasting and planning, which involves analysing historical sales data, monitoring market trends, and anticipating changes in demand. By accurately forecasting demand, companies can optimize their inventory levels and avoid stockouts or excess inventory. This, in turn, helps to reduce the costs associated with inventory holding, such as storage, handling, and obsolescence. It also involves several critical activities, including stock replenishment, stock monitoring, and stock control. Stock replenishment involves ordering new products to replace inventory that has been depleted, while stock monitoring involves tracking inventory levels and identifying potential stockouts or overstock situations. Stock control involves implementing strategies to manage inventory levels, such as safety stock levels, reorder points, and economic order quantities (Christopher, 2016).

The figure below shows how stock accumulates at different instances of the supply chain and who is the one holding onto most of the stocks in the whole chain. Suppliers hold the stockthe most as they have tendency to get affected the most during some sudden emergencies and then the stock is found higher at the retail side (see Figure 5).



Source: (Christopher, 2016)

Figure 5 Inbound logistics

Effective inventory management requires the use of advanced technologies and tools, such as inventory management software, RFID tags, and barcode scanners. These technologies help to automate the inventory management process, enabling companies to track inventory levels in real-time, monitor stock movements, and optimize stock levels. This, in turn, helps to reduce the costs associated with inventory holding and improve the accuracy and efficiency of inventory management (Edmund and Whitehead, 2013).

Inventory management also plays a critical role in ensuring the quality and safety of products. By implementing effective inventory management strategies, companies can minimize the risk of product spoilage, damage, or contamination, and ensure that products are delivered to customers in optimal condition. This is particularly important for products that have a limited shelf life, such as food and pharmaceuticals.

1.6 Reverse logistics

This is a critical aspect of industrial logistics, which involves managing the movement of goods from their destination back to the manufacturer or retailer. Unlike traditional logistics, which focuses on moving products from the manufacturer to the end customer, reverse logistics is concerned with managing the flow of goods in the opposite direction. Besides the flow of reusable empties such as KLT boxes, this can also include products that have been returned due to defects, damages, or recalls, as well as excess inventory, expired goods, or items that need to be refurbished or recycled.

Reverse logistics plays an essential role in improving the sustainability and efficiency of industrial supply chains. By effectively managing the return of products, companies can reduce waste, recover value, and minimize their environmental footprint. For instance, when a product is returned to the manufacturer, it can be inspected, repaired, repackaged, and resold as a refurbished item, rather than being discarded or scrapped. This can help reduce the amount of waste generated and improve the overall profitability of the supply chain. Tracking the reusables or return packages helps in having robust supply chain for the just in time model of production (Luo, Zhang and Yang, 2022).

The first step in reverse logistics is to establish a robust returns management system, which includes clear policies, procedures, and guidelines for handling returns. This can involve setting up dedicated return center, establishing partnerships with third-party logistics providers, and implementing tracking and tracing technologies to monitor the movement of goods.

Once the products have been collected, they need to be sorted and categorized based on their condition and disposition. Products that can be refurbished or resold as refurbished items are sent to the refurbishment or repair center, while products that are no longer usable or have reached the end of their life cycle are sent for recycling or disposal. In some cases, products may be returned to the original manufacturer for repairs or replacement, while in other cases, they may be resold through secondary markets or online channels.

Reverse logistics is a complex and dynamic process that requires a deep understanding of the product lifecycle, supply chain dynamics, and customer needs.

It also requires effective communication and collaboration between different stakeholders, including manufacturers, retailers, logistics providers, and customers. To optimize the benefits of reverse logistics, companies need to invest in advanced technologies, such as AI, machine learning, and data analytics, to improve the efficiency and accuracy of their operations.

In conclusion, reverse logistics is a critical component of industrial logistics, which involves managing the movement of goods from their destination back to the manufacturer or retailer. By effectively managing the return of products, companies can reduce waste, recover value, and minimize their environmental footprint. The process of reverse logistics requires careful planning, coordination, and execution to ensure that the products are handled efficiently and effectively (Luo, Zhang and Yang, 2022).

To optimize the benefits of reverse logistics, companies need to invest in advanced technologies, such as AI, machine learning, and data analytics, to improve the efficiency and accuracy of their operations.

Reverse logistics plays a major role in emergency transports as most of the special transports are ordered because of the lack of empties reaching the plant and therefore the product could not be packed or sent via normal transports. There is wastage of time here as well because the Production might be waiting for the empties to arrive before they can pack the produced parts.

Therefore, when the empties do arrive then it’s very late and the normal transport might have already left the loading bay and the only option left is to order a special transport to meet the customers demand. The reverse logistics can be further explained with the help of Evolutionary game theory (Herbert, 1950).

Evolutionary Game Theory

In the 1950s, Herbert A. Simon, the pioneer of behavioral decision theory, published a book entitled “Administrative Behavior”. In it, he argued that, impacted by perceptual bias (relying on intuition more than logic), the limitations of objective resources, personal capability, and attitudes to risk, decision-makers cannot make the most optimal decisions in extreme, uncertain, and complicated situations.

Evolutionary game theory is generated with the combination of game theory and evolutionary concepts. It considers the bounded rationality and incomplete information of all parties in the game and could describe the dynamic nature of the participants' strategy evolution process comprehensively. In recent years, evolutionary game theory has been widely used in the research of reverse logistics.

(Gu, Wei, 2019) W GU and L Wei built a two-party evolutionary game model to investigate the cooperation relationship of NREI (natural resource- and energy-intensive industries) companies which use self-operation or joint venture reverse logistics operating strategy.

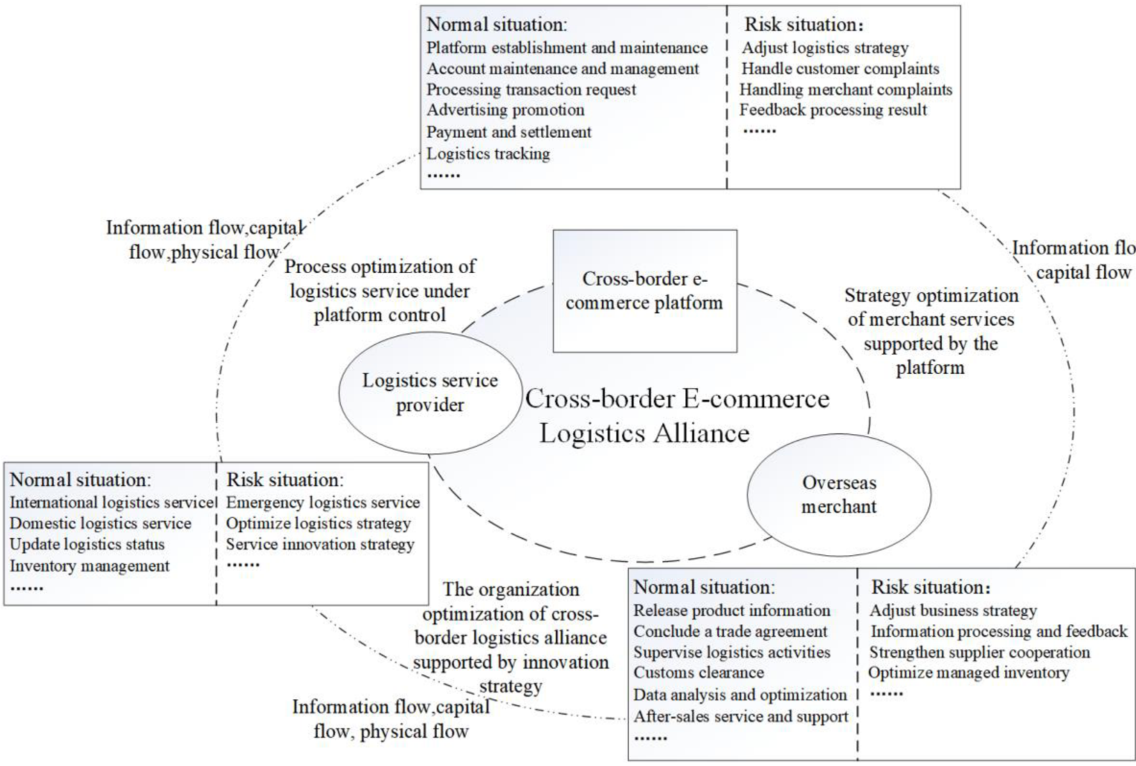
Focusing on the WEEE (waste electrical and electronic equipment) recycling, (Zhao X, 2021) Zhao established evolutionary game models and analyzed strategies evolution process of producers and recyclers under two different fund policies.

To explore the major influencing factors of reverse logistics in e-commerce, (Gong, 2021) Gong established an evolutionary game model of local country government and third-party logistics enterprises to discuss the major influencing factors of government–enterprise collaboration under COVID-19.

He et al. (He, 2021) built an evolutionary game model of e-commerce companies and consumers on the reverse logistics of express packing under government regulations. (Li, 2017) Li J. generated a tripartite evolutionary game model of government, pharmaceutical companies, and consumers for the reverse logistics of drugs.

These studies do contribute to the advancement of research on the integration of evolutionary game theory and reverse logistics. However, most of them merely construct evolutionary game models to analyse the interaction of enterprises, the government, and customers, while ignoring the involvement of environmental NGOs and issues involved in reverse emergency logistics.

As per author Yang and Chen (2013) depict the game theory into a chart for showing how the alliance between logistics service provider, cross border merchant, cross border e-commerce platform and cross border logistics works and how they are well connected in terms of standard as well as in case of emergencies or risk situation (see Figure 6).



Source: (Yang, Jiang and Chen, 2023)

Figure 6 Game theory in Emergency logistics

1.7 Industry 4.0 tools used in industrial logistics

Industry 4.0 is characteristic of a networked environment where extensive communication facilitates seamless information exchange among autonomous components, leading to self-organization (Oztemel and Gursev, 2020). The concept of a self-organizing system, initially articulated by Ashby (1947), refers to a system capable of modifying its own structure. Specifically, self-organization is a spontaneous process wherein firms organize themselves to generate new patterns, properties, or structures without a predefined plan (Stacey, 1996; Silva and Guerrini, 2018; Espinosa et al., 2019).

In the context of self-organization, agents emerge as either autonomous or nonautonomous actors within a developing organizational system (Espejo and Reyes, 2011). Goldstein (Goldstein, 1994) similarly contends that the collective behavior of self-organized agents gives rise to novel and unexpected structures, patterns, properties, or processes referred to as emergence. Essentially, self-organized interactions among agents enable the spontaneous emergence of a coherent spatial structure without external coordination, devoid of a command-and-control hierarchy, and with no monitoring agents, either internal or external, overseeing the process (Heylighen, 2008).

Within the realm of supply chain dynamics, emergence, driven by the self-organized actions of its constituents in service triads, results in new properties arising from complex interactions among all system actors. Consequently, emergence generates characteristics not present in any individual elements of the system, positioning supply chain emergence as a fundamental component of Industry 4.0 (Roblek et al., 2016).

Industry 4.0 technologies possess the capability to integrate self-awareness, self-optimization, and self-configuration, thereby enabling the decentralization of machine decisions (Santos and Martinho, 2020). This decentralization enhances the attainment of a self-organizing status for companies in supply chains, facilitating real-time responses (Qin et al., 2016). Mrugalska and Wyrwicka (2017) argue that Industry 4.0 technologies can introduce decentralized self-organization, replacing traditional hierarchies. Essentially, these technologies promote the decentralization of companies, operational staff, and devices, empowering them to make independent decisions rather than relying on centralized decision-making processes (Marques et al., 2017).

While advocating against overall control, Kamble et al. (2018) emphasize that embedded control can empower system components to make independent decisions, enhancing the modularity and flexibility of the entire emergent structure (Swierczek, 2022).

According to Industry 4.0 represents a fundamental shift from traditional manufacturing practices to smart factories that leverage advanced technologies and data analytics to improve efficiency, productivity, and overall performance. Industry 4.0 enables the creation of highly flexible and customizable manufacturing processes that are capable of producing personalized products in small batches at a cost-effective scale.

Here are some new technologies that may impact this industry in the future (Ustundag and Cevikcan, 2018):

- Autonomous vehicles

- Artificial intelligence
- Cloud-based systems
- Machine learning
- Blockchain technology
- The Internet of Things (IoT)
- Big Data

I. **Autonomous vehicles**: They are self-driving machines or vehicles that use a combination of sensors, cameras, and software to navigate roads and highways without human intervention. These vehicles have the potential to reduce accidents, improve traffic flow, and increase mobility for people with disabilities or limited mobility. Although it has been a decade since some companies have started using automated vehicles there is still a lot of scope of improvement and advancement in technology.

II. **Artificial intelligence**: Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to learn, reason, and make decisions based on data. AI has numerous numbers of applications which includes image and speech recognition, natural language processing, and predictive analytics.

III. **Cloud-based systems**: They are computing platforms that provide on-demand access to computing resources, storage, and software applications over the internet. These systems offer scalability, flexibility, and cost savings, as users only pay for the resources they need.

IV. **Machine learning**: It is a subset of AI that involves training algorithms to learn from data and make predictions or decisions without being explicitly programmed. This technology has numerous applications, including image and speech recognition, fraud detection, and recommendation systems.

V. **Blockchain technology**: Blockchain technology is a decentralized system of distributed ledgers that allows for secure and transparent transactions without the need for intermediaries. This technology is having already applications in finance, supply chain management, and digital identity verification.

VI. **The Internet of Things (IoT)**: The interconnected network of physical devices, vehicles, home appliances, and other objects that are embedded with sensors, software, and connectivity all contribute to IoT. This technology enables data collection, analysis, and control of these devices, leading to increased efficiency, productivity, and convenience.

VII. **Big Data**: Big Data refers to the large and complex data sets that are generated from various sources, including social media, sensors, and other digital platforms. Analysing Big Data can provide insights and trends that can inform business decisions, improve customer experiences, and optimize operations.

1.8 Emergency logistics

Although the current practices in Industrial logistics are very much well defined for each type of industry, every now and then there happens to be ad hoc issue emerging or problems occurred due to some unforeseen circumstances. These could be anticipated but not purely avoided. And thus, can be said that the extent of damage that occurs in terms of financial expenses could be decreased with the proper action plans. Now that's where the growing interest of emergency logistics comes into action.

The role of Emergency logistics in providing a competitive advantage for companies in a networked economy and market is crucial. Industrial logistics systems, which consist of resources such as people, organization, and technology, including information technology/systems, manage the inbound logistics, production, and outbound logistics to create value for customers. In a decentralized and geographically dispersed manufacturing/service environment, the importance of emergency logistics becomes much more significant in reducing the time to reach the market by effectively managing the information and material flow along the supply chain (Saetta et al., 2012).

In any industrial environment, the ability to respond quickly and efficiently to emergencies is critical to minimizing disruptions and ensuring the safety of workers and the surrounding community. Emergency logistics plays a crucial role in this process, providing the necessary tools and resources to respond effectively to unforeseen events. Ultimately, the success of emergency logistics in a factory depends on a coordinated effort between several different departments and stakeholders. By implementing effective logistics planning and utilizing specialized transportation vehicles, factories can ensure a safe and efficient response to emergencies and minimize disruptions to their operations.

Performance analysis allows the development of decision support systems for the design, planning, and management of the supply chain. For instance, in the book "A decomposition approach for performance analysis of a serial multi-echelon supply chain" Saetta et al. (2012) presents an analytical approach for performance analysis based on a decomposition principle. This approach approximates the calculation of performance indicators, considering all the interactions between the different echelons of the supply chain, such as customer satisfaction and inventory levels.

In a factory setting, emergency logistics includes a range of activities, including the transportation of equipment and materials, the management of supply chains, and the coordination of personnel. One of the most important aspects of emergency logistics in a factory is the use of specialized transportation vehicles, such as special transports, that can handle oversized or heavy loads that cannot be transported by regular means. The humanitarian aspect of emergency logistics isn't considered for a factory environment in general. This is a separate topic altogether.

Some common reasons for ordering emergency transports in a factory include (Saetta et al., 2012):

- Equipment failure: When critical equipment fails unexpectedly, it can result in significant disruptions to production and may require rapid replacement or repair. Specialized transport vehicles can quickly transport replacement equipment or parts to the site, minimizing downtime and reducing the impact on production.
- Natural disasters: Floods, earthquakes, and other natural disasters can cause significant damage to a factory and its infrastructure, disrupting operations and posing risks to workers and the surrounding community. In these situations, special transports can be used to transport critical supplies and equipment needed for recovery efforts, such as generators, pumps, and building materials. Sometimes the suppleir companies can be affected or our

factory because of which there is needed to be arranged an emergency transport (Rondinelli and Berry, 2000).

- Product recalls: In the event of a product recall, it may be necessary to transport large quantities of products or materials to a designated disposal or recycling site. Specialized transport vehicles can safely and efficiently transport these materials to their destination, minimizing the risk of further contamination or damage.
- Urgent customer orders: In some cases, a factory may receive an urgent customer order that requires the rapid transportation of equipment or materials to a specific location. Specialized transport vehicles can provide the necessary capacity and capabilities to meet these urgent needs, ensuring timely delivery and maintaining customer satisfaction.
- Environmental hazards: Hazardous materials, such as chemicals or radioactive materials, require specialized handling and transportation to ensure safety and compliance with regulations. Specialized transport vehicles can provide the necessary safety features, such as sealed compartments and ventilation systems, to transport these materials safely and securely.This is not required all the time but sometimes when the quality of already delivered chemicals are not upto the mark then the company needs to source them fast (Rondinelli and Berry, 2000).

The process of emergency logistics in a factory typically involves several key steps. First, the emergency must be identified and assessed to determine the extent of the damage and the resources needed to address it. This may involve a coordinated response from several different departments within the factory, including maintenance, safety, and logistics.

Once the extent of the emergency has been determined, a plan of action is developed to address it. This may involve the procurement of specialized equipment and materials, the coordination of transportation and delivery, and the deployment of trained personnel to assist with the response effort.

To ensure the safe and effective use of special transports, it is essential to have a well-coordinated logistics plan in place. This may involve identifying suitable routes and ensuring that they are free of obstructions, coordinating with local authorities to obtain necessary permits, and ensuring that the transport is properly secured and accompanied by trained personnel.

In addition to the transportation of equipment and materials, emergency logistics in a factory may also involve the management of supply chains. This may involve coordinating with suppliers to ensure that necessary materials and equipment are available, managing inventory levels to ensure that critical supplies are on hand, and developing contingency plans in case of supply chain disruptions. Specialized transportation vehicles, such as special transports, play a critical role in emergency logistics in a factory. These vehicles are designed to handle oversized or heavy loads, such as machinery or equipment, that cannot be transported by regular means. They are typically equipped with specialized features such as hydraulic lifts, adjustable axles, and reinforced frames to ensure safe and efficient transport. In many cases, the use of special transports is critical to the success of emergency logistics in a factory. These vehicles are designed to handle oversized or heavy loads, such as machinery or equipment, that cannot be transported by regular means. They are typically equipped with specialized features such as hydraulic lifts, adjustable axles, and reinforced frames to ensure safe and efficient transport.

Despite their significance, Emergency logistics systems have not received adequate attention from researchers, unlike other aspects of manufacturing/services such as production and purchasing or even the Industrial Logistics.

To address this gap, there needs to be a special focus on special transports ordered while a company goes through emergency situation to emphasize the importance of Emergency logistics systems in the competitiveness of the 21st century companies.Together with the Industry 4.0 tools the extend of need for emergency logistics can be minimized. These tools further help in improving the overall process when emergency logistics are required.

For data analysis the company’s order management tools are helpful. The bigger the company the bigger they would have invested in the resources to build a transport mangement software. Its a wide known truth that this requires extensive R&D costs and workforce. To bypass the time and effort as well as the enormous costs, the companies always opt for external tools or software solution for transport management.

2 Methodology and tools

The root cause analysis (hereinafter referred to as RCA) will be used extensively in this thesis, but the root cause analysis is a vast topic and the topic can be broke into two halves with the first half explaining about the RCA process and the later about the tools used.

2.1 Root cause analysis and data visualisation

Root Cause Analysis is a systematic approach used to identify the underlying causes of a problem or event. It is commonly employed in various fields, including quality management, process improvement, and incident investigation. When applied to a data set, RCA helps to uncover the root causes behind observed trends, patterns, or anomalies, providing valuable insights for problem-solving and decision-making. Since this is a very well know topic , as a refresher the next part will run you through the basic steps of this type of analysis as seen in the figure given below (see Figure 7).

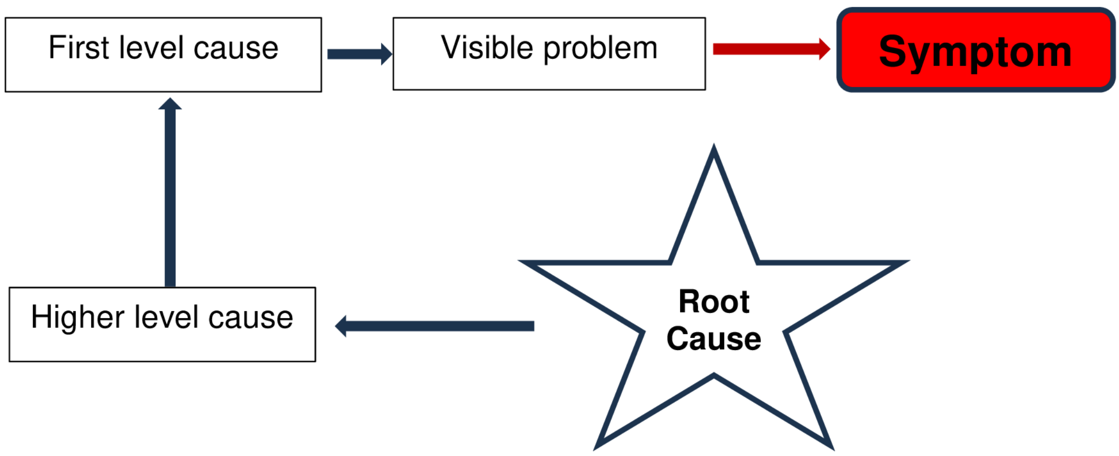


Figure 7 Root cause analysis

To perform a root cause analysis on a data set, various tools used are Fishbone diagram, 5 why, Histogram, Scatter plot etc. Basically the steps that must be followed inorder to reach the rootcause of a problem are as follow (Andersen and Fagerhaug, 2022).

- Define the Problem: Clearly articulate the problem or issue that you want to investigate. This could be a recurring error, a performance decline, or any other anomaly observed in the data.
- Gather Data: Collect relevant data related to the problem. This could include quantitative data, such as metrics, measurements, or performance indicators, as well as qualitative data, such as feedback, customer complaints, or incident reports.
- Analyze the Data: Use statistical techniques, data visualization tools, and exploratory analysis methods to examine the data set. Look for patterns, trends, outliers, or correlations that might indicate potential causes.
- Identify Possible Causes: Based on the data analysis, generate a list of potential causes that might be contributing to the observed problem. This step involves brainstorming and considering various factors, processes, or events that could be influencing the issue.
- Prioritize the Causes: Evaluate the potential causes and prioritize them based on their likelihood and impact. Focus on the causes that are most significant or have the highest potential for improvement.
- Fishbone Diagram: The Fishbone Diagram, also known as the Ishikawa Diagram or Cause-and-Effect Diagram, is a visual tool used to organize and categorize potential causes. It was developed by Dr. Kaoru Ishikawa in the 1960s. The diagram resembles a fish skeleton, with the problem or effect at the head and several potential causes branching out like fishbones.

2.2 Tools used in root cause analysis

For performing the root cause analysis various kinds of test and analysis can be performed and the lean management tools can also be applied at the same time as following:

I. Fishbone diagram

The Fishbone Diagram or ISHIKAWA diagram provides a structured approach to identify potential causes across various categories, commonly known as the 6Ms: Manpower (people), Method (processes), Materials, Machines, Measurements, and

Mother Nature. These categories can be customized based on the context and nature of the problem.

Its historical significance lies in the fact that it was popularized by Dr. Kaoru Ishikawa, a Japanese quality management expert, as part of his efforts to improve quality. A simple fishbone digram can be seen in the figure below with its bones as Man, Machine, Mother Nature, Method, Material and measurement (see Figure 8).

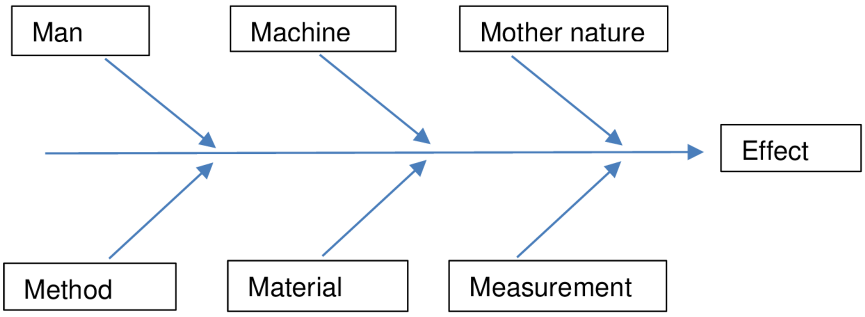


Figure 8 ISHIKAWA or Fishbone diagram

To create a Fishbone Diagram, follow these steps (Serrat, 2017):

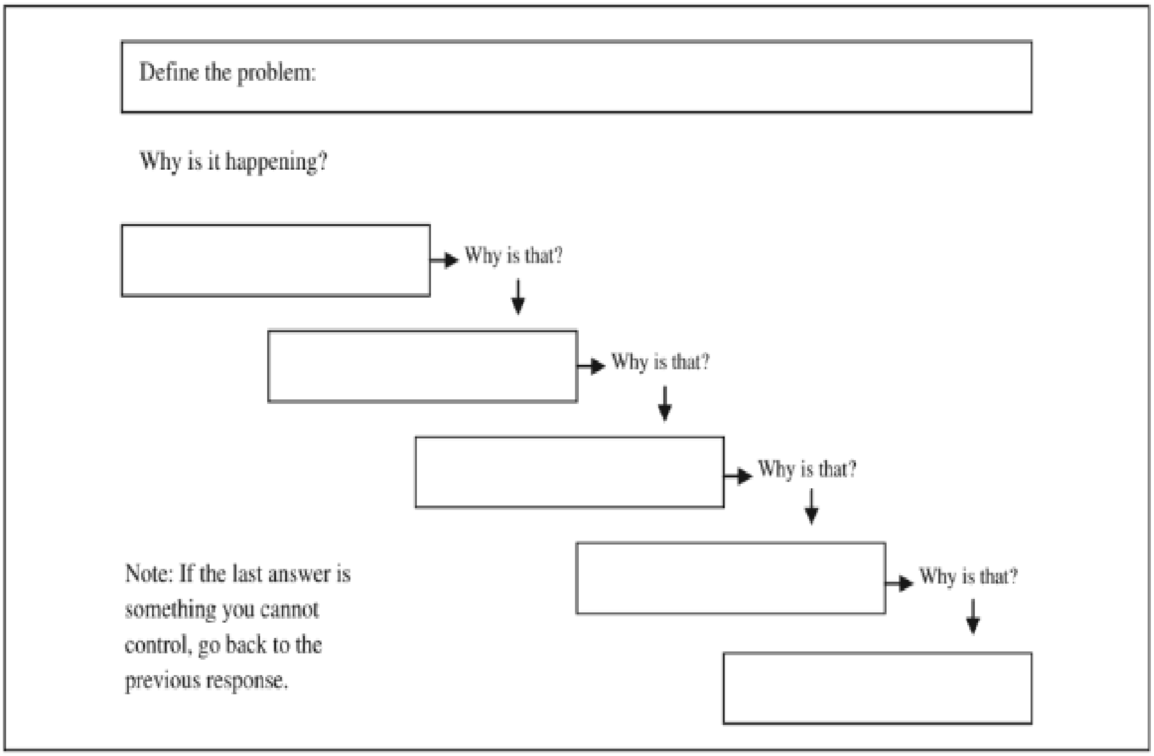
- Draw the "head" of the fish on the right side of the diagram and write down the problem or effect being analyzed.
- Draw the main "bones" of the fish as horizontal lines extending from the head.
- Label each bone with one of the categories (e.g., Manpower, Method, Materials, etc.).
- Brainstorm and add potential causes or factors under each category, branching out from the respective bones.
- Continue to drill down and add sub-causes or contributing factors to each main cause, creating a comprehensive map of potential causes.
- Analyze Root Causes: Once the Fishbone Diagram is complete, analyze the potential causes to determine the root causes that are most likely to be contributing to the problem. Consider the relationships, dependencies, and interactions among the causes identified. Look for commonalities or underlying factors that might explain multiple causes.

- Validate and Verify: Validate the identified root causes by conducting further investigation, data analysis, or experiments if necessary. Ensure that the identified root causes align with the observed data and evidence.
- Implement Corrective Actions: Develop and implement appropriate corrective actions to address the root causes. Monitor the effectiveness of these actions and track improvements in the data over time.

For a better visulaisation of the cause and effect analysis the Fishbone Diagram, combined with a thorough root cause analysis, provides a structured and visual framework to identify and understand the causes behind a problem.

II. 5 WHY

The 5 Whys is a problem-solving technique that aims to identify the root cause of a problem by asking "why" multiple times (see Figure 9). The "5 Whys" technique is part of the lean manufacturing and Six Sigma methodologies and is widely used in various industries for root cause analysis and continuous improvement.



Source: (Serrat, 2017)

Figure 9 5 Why technique

The primary goal of the 5 Whys is to get to the fundamental cause of an issue rather than addressing its symptoms. It was originally developed by Sakichi Toyoda, the founder of Toyota Industries, as a key component of the Toyota Production System.

"*In a Word When confronted with a problem, have you ever stopped and asked "why" five times? The. Five Whys technique is a simple but powerful way to troubleshoot problems by exploring cause and effect relationships*" (Serrat, 2017).

The Five-Whys exercise is vastly improved when applied by a team and there are five basic steps to conducting it (Serrat, 2017):

- Gather a team and develop the problem statement in agreement. After this is done, decide whether or not additional individuals are needed to resolve the problem.
- Ask the first "why" of the team: why is this or that problem taking place? There will probably be three or four sensible answers: record them all on a flip chart or whiteboard, or use index cards taped to a wall.
- Ask four more successive 'whys,'" repeating the process for every statement on the flip chart, whiteboard, or index cards. Post each answer near its "parent" Follow up on all plausible answers. You will have identified the root cause when asking "why* yields no further useful information. If necessary, continue to ask questions beyond the arbitrary five layers to get to the root cause.
- Among the dozen or so answers to the last asked "why" look for systemic causes of the problem. Discuss these and settle on the most likely systemic cause. Follow the team session with a debriefing and show the product to others to confirm that they see logic in the analysis.
- After setling on the most probable root cause of the problem and obtaining confirmation of the logic behind the analysis, develop appropriate corrective actions to remove the root cause from the system. The actions can (as the case demands) be undertaken by others but planning and implementation will benefit from team inputs.

The above Figure 9 can be also picturised as below in 2 Dimensions as shown below (see Figure 10).

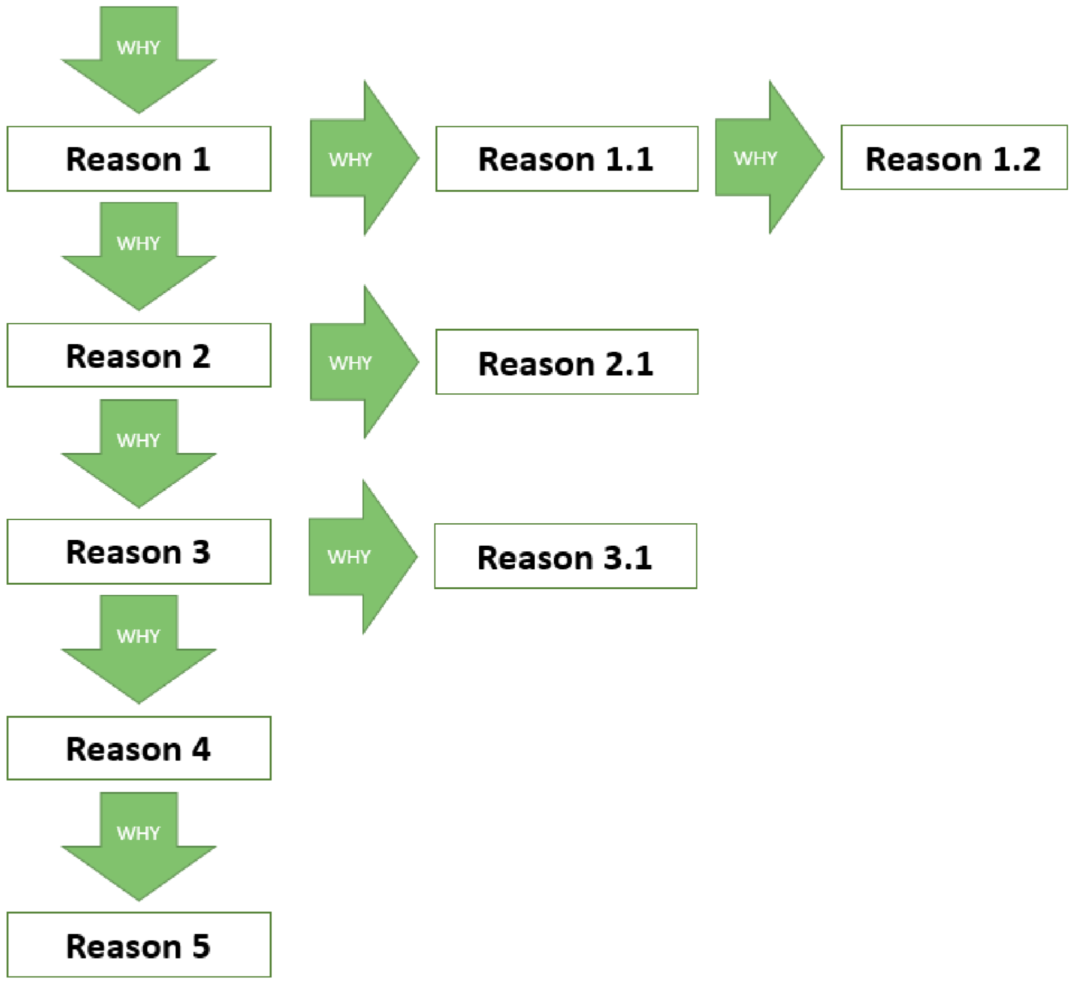


Figure 10 5 Why technique in 2 Dimensions

III. Criticality Analysis

Criticality score in failure modes, effects, and criticality analysis (FMECA) was developed in the late 1940s by the United States military to transition from an "identify failure and fix it" approach to an "anticipate failure and prevent it" approach. This methodology was later standardized and published as a military standard: MIL-STD_ 1629A. FMECA involves quantitative failure analysis, meaning it uses quantities and numbers to assess risk and failure potential. Number ranges from 0 the least susceptible to the 5 or 10 as highest in the scoring chart. Once you have your criticality ratings, a criticality analysis can help you choose a proper risk mitigation strategy that you can apply to each asset.

3 Analysis of system of management of special transports in the company FAURECIA Interior Systems Bohemia s.r.o.

Special transports are very easy to order when any emergency happens but they cost a huge expense and when the expenses build up then it means that there are few problems inside the company interms of the process that they follow or the operations. The company FAURECIA Interior Systems Bohemia s.r.o. is currently facing a significant expense due to the utilization of special transports, which is costing them over 100,000 to 250,000 euros per month. This situation indicates that there might be inefficiencies or issues within the company's system, suppliers, or customers, processes, or operations that necessitate optimization or change.

3.1 The company FAURECIA Interior Systems Bohemia s.r.o.

Faurecia, together with HELLA, is a company of the Group FORVIA. As per (Forvia website, 2023) Faurecia's history stretches back to 1914, when Bertrand Faure opened his first workshop on the outskirts of Paris, manufacturing seats for trams and the metro. The company has since grown into one of the 10 largest automotive suppliers. Its expertise ranges from full interiors and seating systems to ultra-low and zero-emissions mobility solutions, and technologies for automated vehicles. Until 2021, Groupe PSA, the French multinational that produced the Peugeot, Citroën, DS, Opel and Vauxhall brands, was a majority shareholder in Faurecia. When Groupe PSA merged with Fiat Chrysler to form Stellantis, Faurecia became independent and acquired a controlling interest in HELLA.

Founded in Germany in 1899, HELLA is a leading supplier for cutting-edge lighting technology and vehicle electronics. At the same time, the company covers a broad service and product portfolio for the spare parts and workshop business as well as for manufacturers of various special vehicles, for example from the construction, agricultural or transportation sectors. HELLA is a listed company that was held with a majority stake of the Hueck and Roepke families before Faurecia became the majority shareholder.

Current CEO of FORVIA is Mr. Patrick Koller. The board of directors include a 14 member committe which consists of total 6 nationalites out of which 43% are female. The chairman of board of directors is Mr. Michel De Rosen.

With over 300 industrial sites and 63 R&D centers, 150,000 people, including more than 35,000 engineers across 40+ countries, FORVIA provides a unique and comprehensive approach to the automotive challenges of today and tomorrow. Composed of 6 business groups with 24 product lines, FORVIA is focused on becoming the preferred innovation and integration partner for OEMs worldwide. FORVIA aims to be a change maker committed to foreseeing and making the mobility transformation happen.

The main strategy behind FORVIA's business is that the mobility is evolving fast. Global megatrends are changing our industry: onboard experiences, automated driving, zero-emissions mobility, and sustainable automotive design. In order to respond to these challenges, Faurecia acquired a controlling interest in HELLA, accelerating its transformation and creating the FORVIA Group.

Faurecia a busniess division of Forvia, their mission is to develop technologies for safe, sustainable, advanced, and customized mobility. With 111,000 employees in 33 countries, Faurecia is a top ten global automotive supplier and inspires mobility through its four Business Groups: Seating, Interiors, Clean Mobility, and Electronics. At the same time, Faurecia offers solutions to meet the challenges of future generations in line with our Convictions and Values.

The business division and their Product portfolio are as follows:

- Lighting
    - Front headlamps
    - Rear headlamps
    - Car body & interior lighting Interiors
- Interiors
    - Instrument & door panels
    - Center consoles
    - Cockpit modules
- Seating
    - Complete seats

• Mechanisms & frames

• Safety & comfort solutions

- Clean Mobility

• Ultra-low emissions solutions for passenger & commercial vehicles

• Zero-emission solutions for battery & fuel cell vehicles

- Lifecycle Solutions

• Parts & accessories for the independent aftermarket as well as special original equipment

• Diagnostic services for testing & repair

The data on special transports ordered is collected from the company Faurecia Interior Systems Bohemia S.R.O. (hereinafter referred to as FIS) and the thesis focus on the practical work done at the Czech republic division in the heart of town Mlada Boleslav. Table below shows the financial results of year 2022 of Faurecia (see Figure 11).

in €m	Seating	Interiors		Clean Mobility	Electronics	Lighting	Lifecycle Sol.	GROUP	
		As previously released	IFRS 5*					As released April 2022	IFRS 5*
Q1 2022	1,675	1,187	1,015	1,094	678	518	169	5,322	5,149
Q2 2022	1,855	1,374	1,157	1,191	872	764	246	6,302	6,085
Q3 2022	1,960	1,334	1,111	1,207	1,000	850	240	6,591	6,369
Q4 2022	2,215	1,635	1,361	1,244	971	942	238	7,244	6,971
FY 2022	7,705	5,530	4,645	4,736	3,521	3,074	893	25,458	24,573

Source: (Forvia, 2023)

Figure 11 Faurecia 2022 Financial statement

At the FIS Plazy, Mlada Boleslav plant the main products are Instrument panels which are produced in serial production and related aftermarket parts. The factory works on a 3 shift basis 5 times a week.

Faurecia Interiors Plazy - The construction of the plant began in 1995. The actual production started in 1996 with deliveries of instrument panels for the Škoda Octavia model. In 2000, the plant also started producing door panels for the VW Polo model. With an increase in the number of customers and production volume, the plant had to be expanded several times over the following years. In recent years, not only new customers but also new production technologies have been added. The recent layout of the plant is given in figure as given below (see Figure 12):

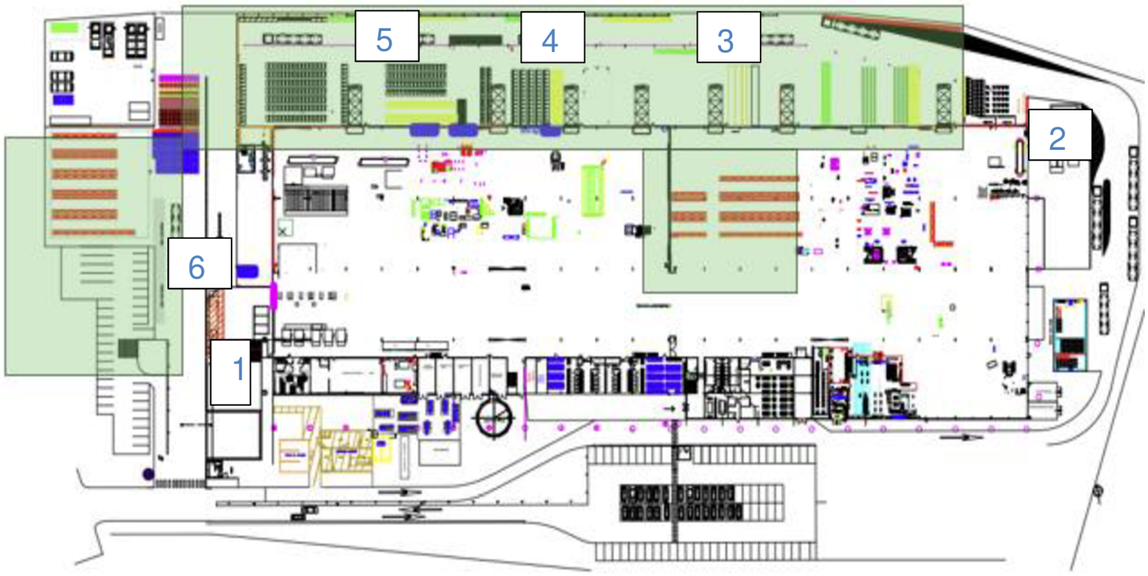


Figure 12 FIS Plazy, Mlada Boleslav layout

Customers of the FIS Plazy are situated all over in Europe, India and China. The plant went onto a change in layout recently for production optimization. In figure xx the area marked in green denotes the logistics area and the rest is for production, ofices, facilities etc.

The reception and expedition office can be seen adjacent to each other at the point 2 in the layout.

The numbers 2,3,4,5,6 signify the loading and unloading bay for vehicles which are particlulary trucks. Plant employees around 70 white collar staffs and 300 bluecollar employees. The organisation of the plant is such that at the top sits Plant manager under which the PC&L manager, Engineering manager, Quality manager, Production managers can be found. The managers handle work with the help of supervisors or coordinators. The GAP leader report to the supervisors and they manage a team of operators.

3.2 Analysis of current state of process of ordering special transport

Data collection plays a vital role in the evaluation of special transport operations. By systematically collecting and analysing data related to various aspects such as load types, distances travelled, modes of transportation, and time required, valuable insights can be gained to identify patterns and trends. Currently, FIS relies on third-party software and Microsoft Excel to develop logistic solutions and manage their special transport operations. From FIS point of view, the previous year cases were different as new projects were introduced recently and there was a major change to the production layout as well. Thus, the previous year study isn't really required. The focus will be with the current data in the next section.

The special transports ordered by FIS are currently facilitated using a third-party software called Easy4pro. This online tool serves a dual purpose, acting as both the ordering platform for special transports and the source of the data required for analysis. Information such as the type of load being transported, the distance it needs to cover, and the selected mode of transportation is captured within Easy4pro. This data can be extracted and used to gain insights into the special transport operations. Currently a budget of CZK 19000 is allocated from the managements side for special transports and clearly each month for the plan this number is hit in mere one week itself.

With the implementation of FORVIA's proprietary software, FIS aims to enhance their logistic capabilities further. This software, which remains undisclosed due to its confidential nature, will provide advanced simulation capabilities for optimizing truck or container utilization. By utilizing this software, FIS can simulate different scenarios, consider various factors such as load distribution, route planning, and resource allocation, and ultimately develop more efficient and cost-effective transport solutions.

By combining the data extracted from Easy4pro with the insights gained using the proprietary software, FIS can conduct more comprehensive evaluations of their special transport operations. This integrated approach will enable them to identify inefficiencies, optimize their logistics processes, and make informed decisions to improve overall performance.

Below in the screenshot of the website of easy4pro, you can see how the webpage looks like and how the data is arranged. Data is extracted by using the statistics button on the left tab and then filtering the data which is required (see Figure 13).

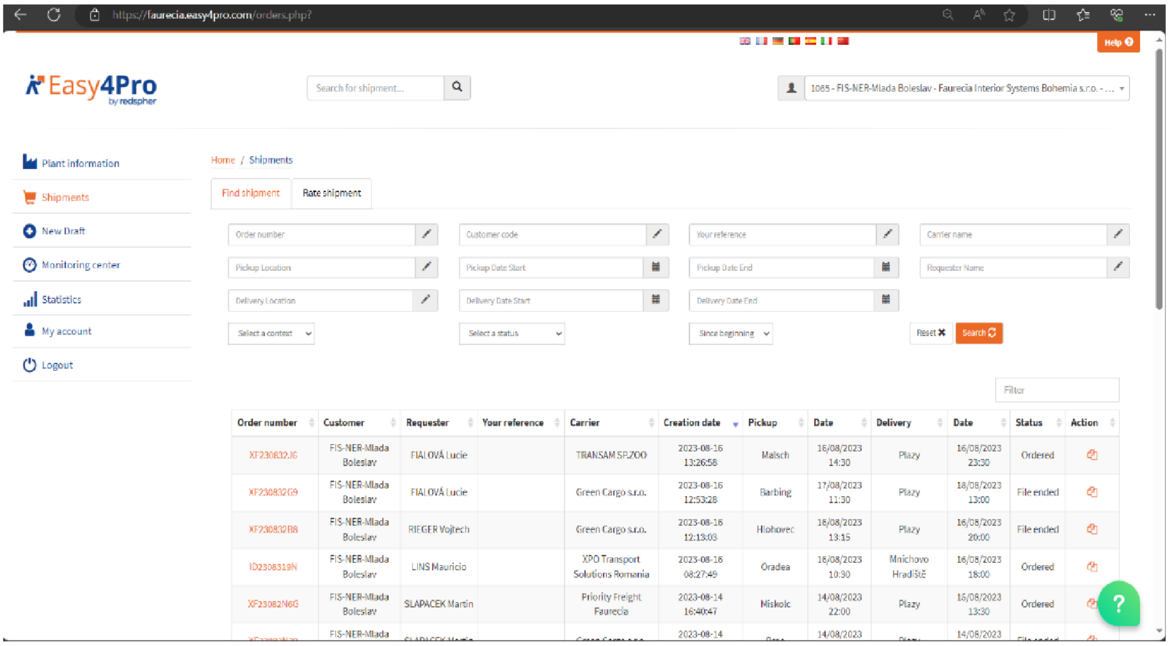


Figure 13 Easy4pro cases

Figure 13 shows the layout of the easy4pro website and the tracking of individual cases using the order number in the column one. The excel file generated after extraction can be further used the start of the RCA operation. The scoring method that will be used here is defined so as to measure the different time required for performing some specific actions while ordering the special transports and the same can be seen from the below (see Table 1).

Table 1 Scoring chart for the operation of SpT

Man-hours in mins	
Type	**Minutes**
Movement of employee	2
Transfer in EDI	1
Time taken for documenting issue	5
Handling(loading/unloading)	2
Average RCA time taken	5
Total	**15**

The scoring chart was derived from previous orders, and this helped understand that on an average 2 minutes of handling time for loading and unloading at the reception area for the truck is required. The movement of employees during such an emergency is unavoidable and they were seen on an average 2 minutes for quality checks and reception related activities. Transfer in EDI took an average of 1 minutes. Time taken to fully document this issue which includes observation of issue, reaction time was 5 minutes. The above scoring minutes can be multiplied by the criticality with any type of final root cause category to derive the final total of the man-hours spent because of the effect. This will help us understand how much of man-hours gets wasted because of the underlying same kind of repeated problems.

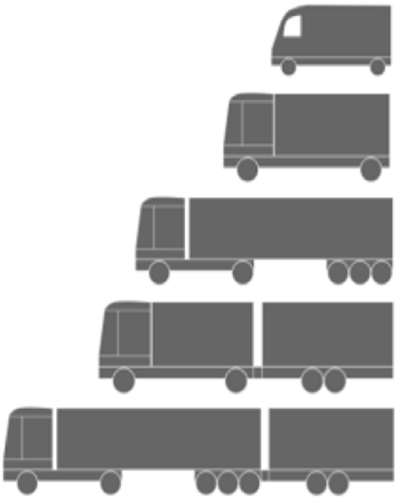
The step of ordering a special transport is not so hard but it requires authentication or valid access. Not everyone is given the access as the cost of operating the platform is there which is undisclosed due to FIS requirement. Each step can be calculated in nterms of time taken to do them (see Table 2).

Table 2 Total time taken for the SpT ordering process.

Man-hours in mins	
SpT Order ID and data extraction	1
SpT Order creation	3
SpT Time for finding carrier	10
Managers signature for approval of SpT	1
Total	**15**

The above scores were found after performing the RCA and fixing the values based on how much time it takes to perform the step. The score is chosen from Non decimal integer values ranging between 1 to 10 where 1 means low score and 10 the highest.

On an average the special transport ordering takes 15 mins of which 10 mins is for data entry and the rest 5 mins for the order upload to the portal and data extraction afterwards. After the order is successfully placed by the employee, the central team comes up with quotations from different carriers based on the data input by the person ordering the transport. The person must mention in their order the total pallets, box size, size of pallets, stack ability of the pallets. Upon this the central team in Portugal chooses from one of the below mentioned trucks (see Figure 14).



Type of truck	Truck dimensions
Van / Curtain side van	4 m x 4 m x 2 m
Solo	6.5 m x 2.42 m x 2.5 m
Standard	13.6 m x 2.42 m x 2.40 m
Mega truck	15.9 m x 2.42 m x 2.40 m
Jumbo truck	13.6+7.7 m x 2.42 m x 2.40 m

Figure 14 Truck types

Apart from this nonstandard truck sizes can also be chosen if the carrier proposes something. From emergency transport point of view this isn't any issue if the demand for the handling and movement of the parts are met. Always the orders with the least price in the quotation is chosen. Although this is the best practise a list of carriers participates, and the weight of time taken to reach to the place of loading and unloading is also taken into consideration due to the emergency. The special transport can be finally approved by the Production control and Logistics or PC&L manager in short. He has the right to approve the orders which fall below 1000 EUR and for all other orders above this amount a plant manager approval is required.

4 Identification of root causes of special transports using preliminary analysis

It is essential to consider the entire chain of operations involved in the special transports. This includes assessing the initial request for special transport, the planning and scheduling processes, the execution and tracking of the transports, and the receiving end of the goods. By closely examining each stage, FIS can identify potential bottlenecks, inefficiencies, or errors that might be driving up the costs.

In addition to data analysis, it can be beneficial to engage with relevant stakeholders, including employees directly involved in the special transport operations, logistics personnel, and management. These individuals can provide valuable insights and firsthand experiences that may shed light on the root causes of the high expenses. Conducting interviews, surveys, or workshops can facilitate a collaborative approach to problem-solving and help generate ideas for improvement.

4.1 Analysis of frequency of causes of special transport

The first step in evaluating special transports is to determine the purpose and need for these operations. Special transports may be required due to the size, weight, or shape of the load, or because of limited space or access to the site. Understanding the specific needs and requirements will help in identifying appropriate methods for measurement and analysis.

A questionnaire with below mentioned questions are sent to the person who requested the special transports.

- According to you, are the same parts frequently being arranged for transports?
- If yes, is this problem occurring at some time of the day, season?
- Do we have supplier backlog for these parts?
- Do you think there are recurring problems with some particular Freight forwarders? If yes, then please briefly describe.

- According to you what was the root cause of the special transport being arranged? Please explain it in your best possible way.

The figure shows part of the list of all special transports ordered between the data collected from 13th March 2023 to 30th Aug 2023 which is a period from week 11 to week 35 (see Appendix 1).

Column 1 shows the order ID against the person who ordered the special transport in the column 2. The column 3, 4 and 5 includes data from the questionnaire send to the corresponding person who ordered the special transport.

It can also be seen that the special transports are divided primarily based on whether its Inbound or Outbound and then secondarily divided into the department or persons who ordered the transport. This thesis or analysis doesn't concentrate on the person involved in the special transports but focuses more on the problems that led to them being ordered.

The below text shows a typical questionnaire email which was sent to the persons ordering the special transports. The method of questionnaire through google forms was also considered but due to Faurecia's strict IT policies of data collection and managerial decision the email method for questionnaire was chosen.

Risk assessment is also an essential component of special transport evaluation. Potential risks that the thesis covers are primarily involving the extent to which the expenses can accumulate if the problem is not addressed. Also, the risk assessment paves a way to understand the possible outcomes of a single problem or effect.

To measure the effectiveness and efficiency of special transports, key performance indicators (KPIs) should be developed. These KPIs may include on-time delivery, cycle time, cost per ton, and transport capacity utilization. By tracking and analysing these metrics, companies can identify areas for improvement and make data-driven decisions. This can help the company choose and close the best deals for ordering the special transports.

Finally, continuous improvement is an essential part of special transport evaluation. By analysing the data collected, companies can identify areas for improvement and implement corrective actions. Quality improvement methodologies such as Six Sigma or Lean can be used to optimize the special transport process, reduce waste and variability, and improve customer satisfaction. The result is a cause-and-effect diagram or fishbone diagram or Ishikawa diagram which will summarize the risk associated with the common causes or problems. This is used to provide the proposals on how to solve those issues.

Based on the questionnaire preliminary issues are namely divided into following categories:

- MRP controller
- Supplier
- Production
- Logistics
- Customer
- Others

MRP Controller: In an automobile factory, the MRP (Material Requirements Planning) controller is like the person who makes sure everything runs smoothly. They use special software to plan when materials are needed for making cars. They make sure that plant has enough raw materials at the right time, so that there is no waste, and the factory works well.

Supplier: Suppliers are super important for an automotive plant. They're like our life support, providing us with good quality materials and parts. Having a good relationship with them is key. Proper communication making sure that the materials are good and they deliver on time is a must. This helps manufacturers make cars that are high quality and meet what people want.

Production: The core of an automotive plant is making cars or car parts. From cutting and welding to putting everything together and painting, each step needs careful planning. An automobile manufacturing plant want to make cars efficiently, avoid delays, and make sure they're top-notch. They always try to get better by using new ideas, machines, and training our workers.

Logistics: Making sure things move smoothly in an automotive plant is vital. This involves organizing how things are transported, stored, and distributed. The logistics team tries to make our supply chain better, reduce waiting times, and spend less on moving things around. They use real-time tracking and data to keep things running smoothly and adapt quickly to changes.

Customer: Making customers happy is the main goal in Industry 4.0. Suppliers or firms need to understand what they want and deliver it – good quality cars, on time, and with good service after they buy. Being customer-focused means not just making cars but also talking with customers, giving them options, and listening to what they think. This helps us build a good reputation and keeps people loyal to our brand.

Others: This category includes all the testing works, tooling works and other management decisions which required the usage of special transports.

After the preliminary analysis there needs to be done the 5 Why approach to find the root cause. Figure below shows the RCA flow, starting from the special transport order got to categorising them into the preliminary 6 categories of the root causes and then furthermore upon 5 Why analysis the root causes are derived into 10 categories (see Figure 15).

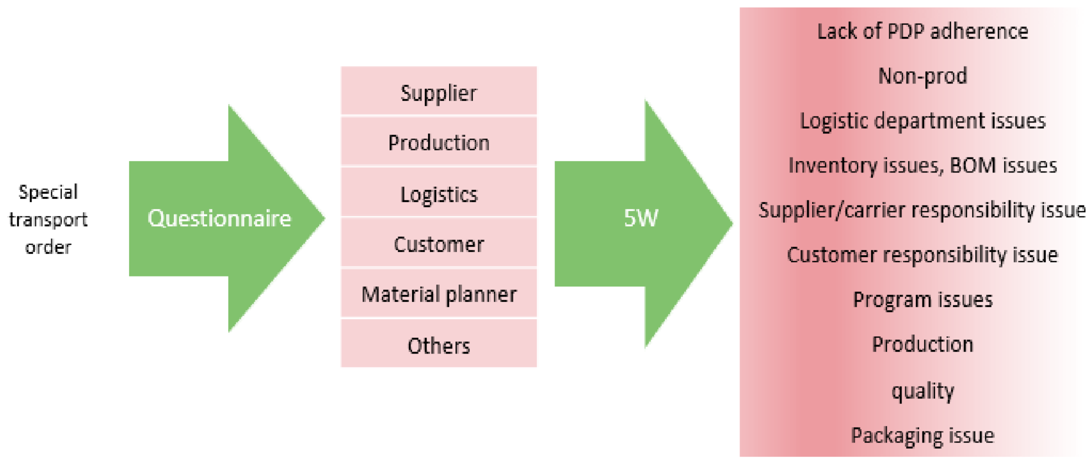


Figure 15 RCA flow

The 5 Why Analysis

The 5 why analysis helps in determining the root cause of the problem after considering from where the problem originated. Once the preliminary analysis is done, move forward to the 5 why step where individual cases are explored by asking more than one or 2 why's. It all starts from the questionnaire which is sent to the person who ordered the special transport once the feedback is got and a series of why questions are asked to the person the end goal is to determine the hidden root cause sometimes the root cause is evident from the first why itself. Examples of asking more than one why can be seen as given below (see Figure 16).

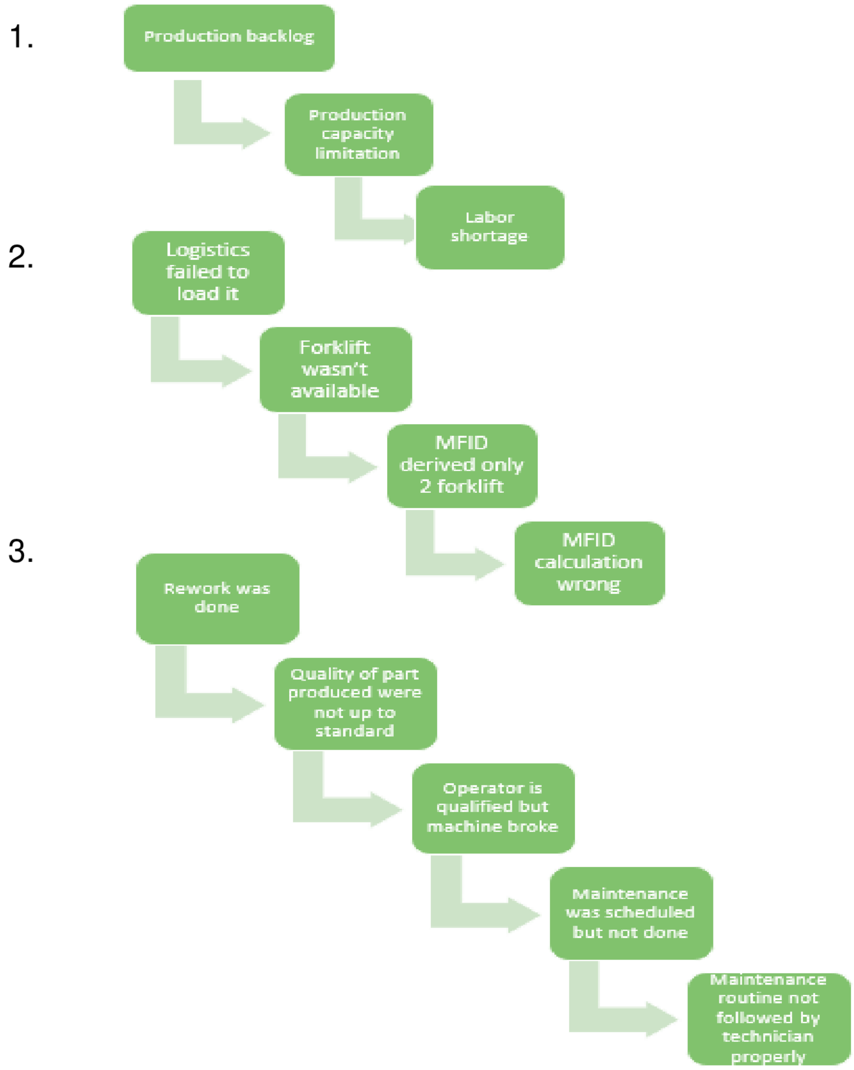


Figure 16 Real case e.g. of 5 why analysis

The above figure 14 shows the root causes which were seen after performing the 5 why analysis. In first example when the production issue due to production backlog was seen, then first "why" gave us the root cause as production capacity limitation but upon one more "why" analysis and that root is that the capacity limitation was due to labour shortage. This is a production issue category.

In the second case the feedback that was received that the logistics forklift operator failed to load the boxes or pellets. Upon being asked another "why" the answer was that the forklift wasn't available. In the next "why" the answer was that the Material flow and information diagram or MFID calculation derived only 2 forklifts where there was need for 3 forklifts and upon the last “why” it was found that the MFID calculation was wrong, and this is logistics issue.

In the third example the production issue was there because when the first “why” was asked the feedback was that there was a revoke done and that took some time. Now upon asking one more “why” the issue was because the quality of the product produced were not up to standard. Another “why” gave us the issue to be as operator is qualified, but machine broke. Upon asking one more why, records the issue to be because maintenance was scheduled but not done on time. Another “why” question give us the root cause of the problem to be that maintenance routine was not followed by the technician properly. This is a non-production issue category.

After performing the 5 why like this based on all the recorded feedback, all the root causes can be categorised into 10 different final root cause. These 10 issues are the main offenders behind ordering the emergency transports in the factory.

The final RCA has 10 categories which are listed in the table below (see Table 3):

Table 3 List of final root causes

Root cause type:
Lack of PDP adherence issues
Non-production issues
Logistic department issues
Inventory issues, BOM issues
Supplier/carrier responsibility issues
Customer responsibility issues
Program issues
Production issues
Quality issues
Packaging issues

Lack of PDP adherence issues: PDP is the process of planning the optimal production of goods or services. Lack of PDP adherence means deviating from the plan, which can cause problems such as delays, waste, quality issues, and customer dissatisfaction. To prevent this, production managers should monitor, correct, and communicate the production performance.

Non-production issues: They are the processes that does not involve processing the daily work or operations of an organization. Non-production environments are used for testing, development, staging, or training purposes. They can improve the quality and reliability of the products or services, but they also require resources and management.

Logistic department issues: Logistic department issues are the problems or challenges faced by the logistic department, which manages the flow of goods and materials from the origin to the consumption. Some of the issues include inefficient warehouse operations, transportation delays and disruptions, supply chain complexity and uncertainty, customer service and satisfaction, and cost and profitability.

Inventory issues, BOM issues: Inventory issues are the problems or challenges related to managing the stock of goods and materials. BOM issues are the problems or challenges related to creating and maintaining the bill of materials, which lists the components, parts, and materials required to make a product. Some of the issues include overstocking and understocking, inaccurate forecasting and planning, ineffective inventory control and tracking, inconsistent or outdated BOM data, and BOM errors and changes.

Supplier/carrier responsibility issues: This is the problem of ensuring that the suppliers and carriers of goods and materials comply with the laws, regulations, contracts, and standards that govern their activities. It involves dealing with issues such as damage, loss, theft, delay, disruption, liability, insurance, quality, safety, environmental, customs, and communication.

Customer responsibility issues: This is the problem of meeting the expectations and obligations of customers who purchase or use products or services. It involves providing customer satisfaction, loyalty, feedback, complaints, privacy, data protection, education, awareness, behaviour, ethics, advocacy, and social responsibility.

Program issues: These are the problems or challenges that may arise from the design, development, implementation, or evaluation of a program, project, or software. They may include issues such as scope, budget, schedule, quality, risk, communication, stakeholder, resource, change, and performance management.

Production issues: This is the process of combining various inputs, such as land, labour, capital, and materials, to create outputs, such as goods or services, that have value and utility for individuals. It involves factors of production, production function, production theory, production costs, and production efficiency.

Quality issues: This is the degree of excellence or superiority of something, such as a product, service, or process. It involves quality standards, quality control, quality assurance, quality management, quality improvement, and quality measurement.

Packaging issues: This is the problem of designing and using packaging materials that are efficient, effective, convenient, and sustainable for the products they contain. It involves packaging types, functions, materials, costs, benefits, regulations, innovations, and impacts. It also includes whether the packaging quality is sufficient to cover the daily demand or not.

4.2 Classification of root causes of the special transports

The data from the final analysis is then tabularised into pivot tables and then it is graphically represented into the pie chart as shown below (see Figure 17).

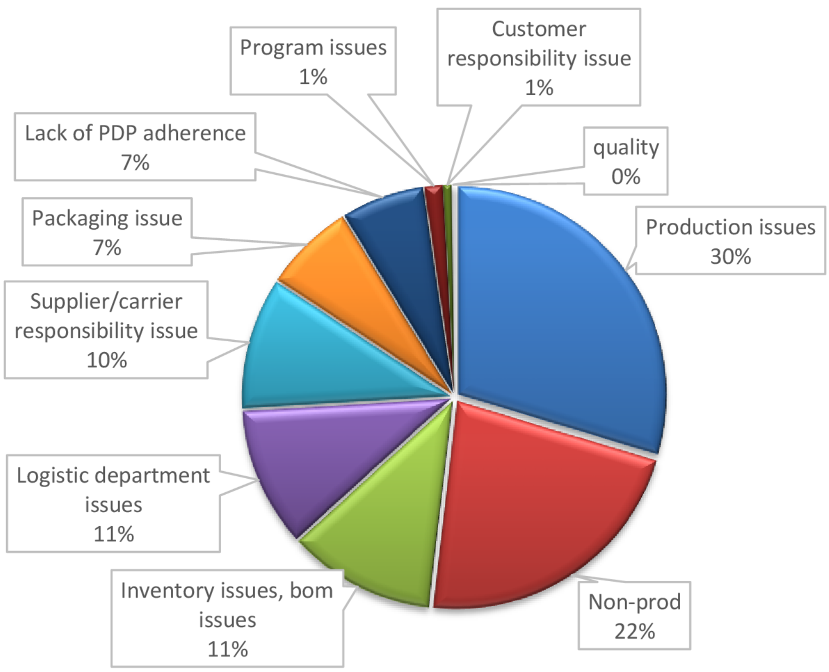


Figure 17 Pie chart for the Final RCA

The above chart was prepared from the pivot table of the RCA excel sheet given below (see Table 4). The Total expense in terms of the main root cause were as follows for week 11 to 35 as shown below.

Table 4 Breakdown of the costs in each category

Root cause department	Sum of Expenses
Production issues	103776
Non-production issues	77650.18
Inventory issues, BOM issues	39926
Logistic department issues	37852.97
Supplier/carrier responsibility issue	35632.79
Packaging issues	24524
Lack of PDP adherence issues	22548.5
Program issues	5002
Customer responsibility issues	2290
Quality issues	800
Grand Total	**350002.44 EUR**

From the above table it can be seen that a total of 350k Euro were spent for ordering the special transports during the week 11 to 35. The final total is representative of the total amount spent for the SpT as the values were already multiplied by a factor for data privacy purpose. In the long run a negative trend was seen upon tackling most of the problems as mentioned above in the categories (Non production issues as Non Prod in the graph, Inventory issues/ BOM issues, Logistic Department issues, Lack of PDP adherance and Customer responsibitily issue (see Figure 18).

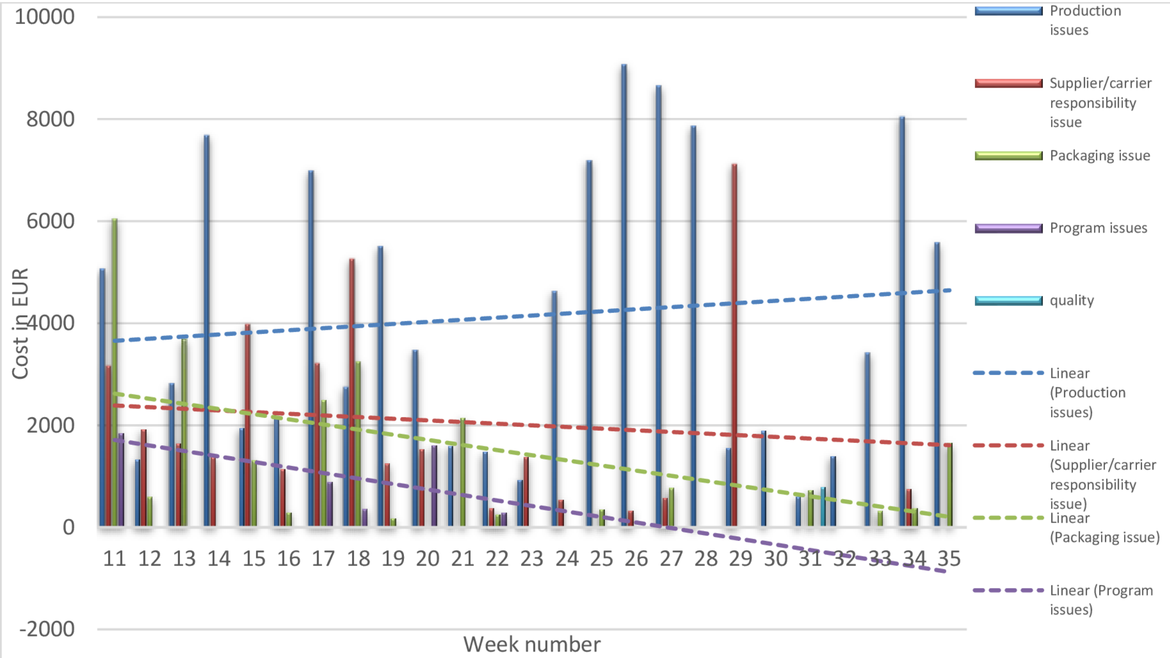


Figure 18 Weekly cost of final root causes, week 11 to 35

The next set of categories can be plotted in the next graph (See Figure 19).

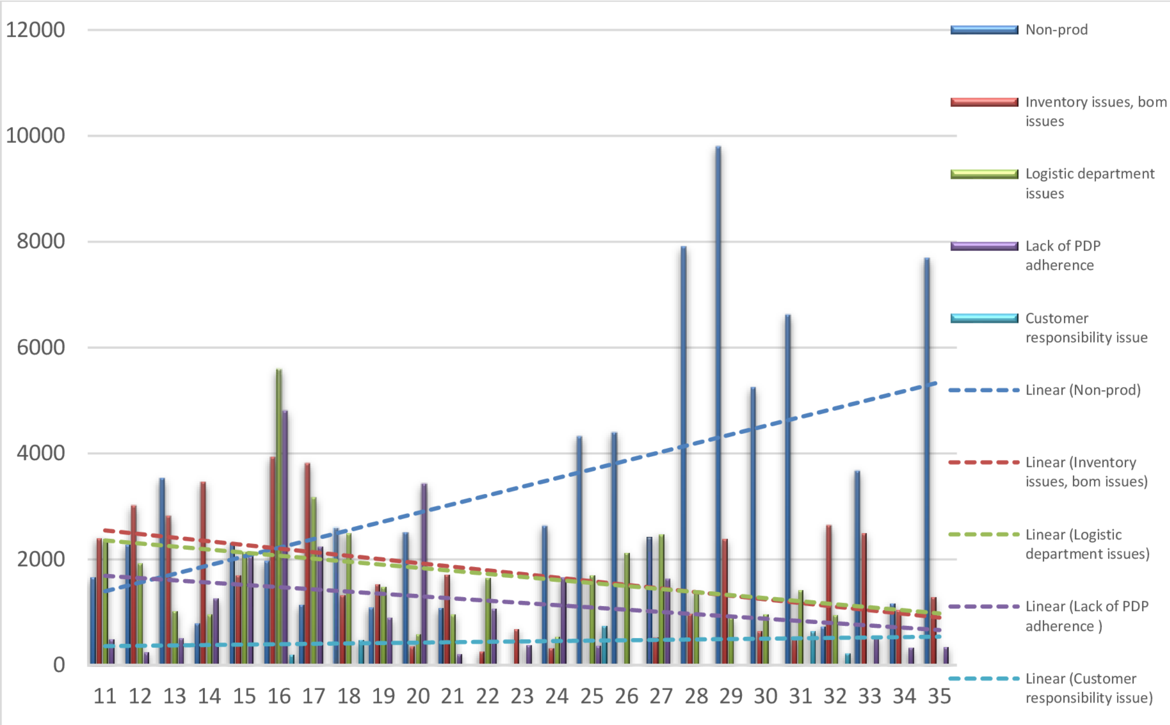


Figure 19 Weekly cost of final root causes, week 11 to 35

4.3 Selection of top 3 causes from the root cause analysis

It can be clearly seen that FIS Plazy is accumulating a lot of expenses. It was management decision to forego other root causes and just take top3 of the categories which needs to be focused and solution to be found. Management decision was to concentrate on production issues, suppliers/carrier issues and Inventory issues. Although from above table (see table 4) the Top3 were identified to be Production issues, non-prod issues and Inventory, BOM issues after sorting the excel pivot table according to the cost of transport in each categories and their subsequent total. Non-production issues can be avoided as they were mostly planned special transports as the use of normal transport or planning weren't possible due to reasons as management decisions, occasional cost etc. This means this category can be taken out. Logistic department issues which get into the list after the above step isn't considered now as this had mostly to do with MFID, change of the layout in warehouse and the loading and unloading bays, routing issues, lack of staff, issues related due to poor planning etc which were straight forward and required less RCA. Then comes into the list the inventory or BOM issues which is a major offender as this means accumulated costs in a long run if kept disclosed or unattended.

The table below shows the breakage of the costs associated in terms of Euros with the Top 3 issues and the total of the SpT in each categories from week 11 to week 35. The blank cells means no issues were found in those week in that category.(see Figure 20).

Week Number	Production issues	Inventory issues, bom issues	Supplier/carrier responsibility issue	Grand Total
11	5071	2401	3170	10642
12	1337	3019.25	1924	6280.25
13	2826	2824	1651	7301
14	7691	3465	1387	12543
15	1950	1705	3983	7638
16	2165	3934	1148.89	7247.89
17	6997	3822	3219	14038
18	2752	1326	5267	9345
19	5508	1536.75	1256.9	8301.65
20	3478	357	1536	5371
21	1603	1718		3321
22	1486	260	374	2120
23	931	688	1380	2999
24	4632	328	540	5500
25	7196.5			7196.5
26	9081		328	9409
27	8662	530	583	9775
28	7876	975.5		8851.5
29	1559	2385	7129	11073
30	1899	648		2547
31	609	517		1126
32	1400	2647		4047
33	3427.5	2495		5922.5
34	8058	1053	756	9867
35	5581	1291.5		6872.5
Grand Total	103776	39926	35632.79	179334.79

Figure 20 Top 3 categories week 11 to 35 costs

The above table can also be picturised into the pareto chart.

A pareto helps us understand that production issues are increasing in the long run while the supplier's issues, Inventory and BOM issues are decreasing as they are already being tackled during the time of thesis. The increase in Production issues were more to do with the incapacity of the production lines to keep up with the demands and additional shift were put up for the increase demand (see Figure 21).

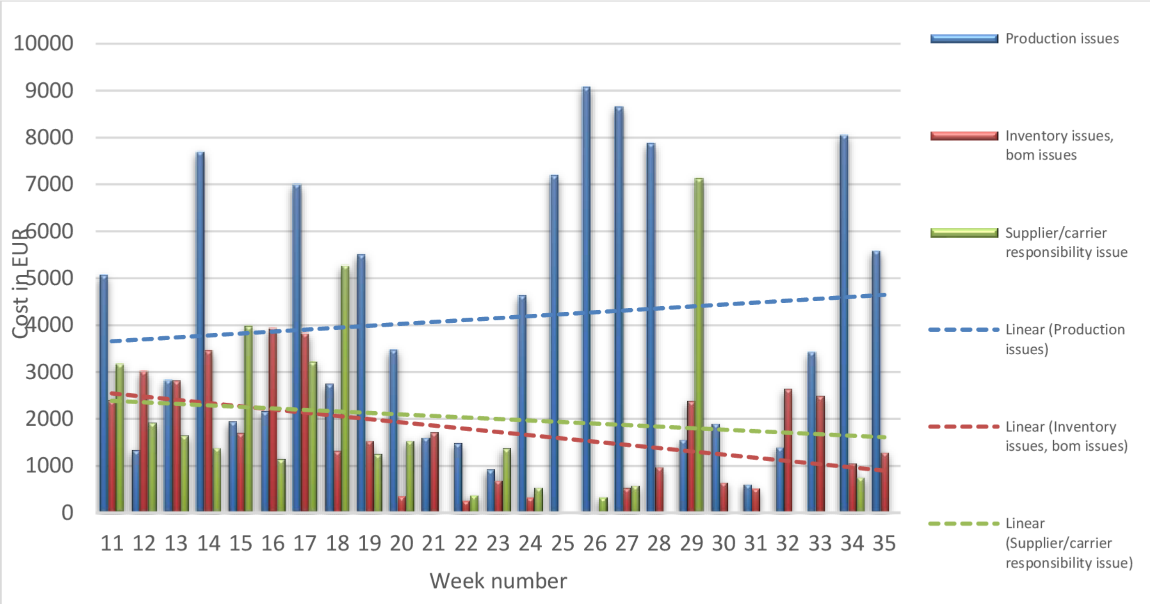


Figure 21 Pareto chart for the Final RCA

From table 4 and Figure 20 above, it can be seen that the top 3 constitutes of 46 % of the overall cost of the special transports ordered as total cost of top 3 from figure 20 which is 179,334.79 EUR divided by total of the cost of 10 root causes in table 4 is roughly equal to 46% . Blue bars are Production issues, Red are Supplier/carrier responsibility issue, and the green are Inventory/BOM issues.Calculation of the man-hours based on the criticality of each step in ordering an emergency transport from table 2 are as below (see Table 5):

Table 5 Criticality scores

Criticality scores			
Type	**Production issues**	**Supplier/carrier issues**	**Inventory/BOM issues**
Movement of employee	5	4	8
Transfer in EDI	1	1	1
Time taken for documenting issue	4	8	7
Handling(loading/unloading)	8	4	5
Average RCA time taken	5	3	5
Total	**23**	**13**	**16**

The above scores were found after performing the RCA and fixing the values based on how critical the step-in terms of cost. The score is chosen from Non decimal integer values ranging between 1 to 10 where 1 means low score and 10 the highest.

By multiplying table 2 with table , its easy to get the total man-hours spent in minutes as can be seen below (see Table 6).

Table 6 Final score of operations

	Man-hours spent in mins		
Type	**Production issues**	**Supplier/carrier issues**	**Inventory/BOM issues**
Movement of employee	10	8	16
Transfer in EDI	1	1	1
Time taken for documenting issue	20	40	35
Handling(loading/unloading)	16	8	10
Average RCA time taken	25	15	25
Total	**72**	**49**	**52**

So, for Production issues the final score is 72, for Supplier/carrier issues its 49 and then for Inventory/BOM issues its 52. To this from table 8 add the 15 minutes (average total order time in man-hours) to each which gives the total as 87 mins, 64 mins and 67 minutes respectively.

If to this it is multiplied the total number of cases, it can result in getting the total man-hours that were spent in each final root cause types. All the final values are in minutes. The same can be determined in terms of cost of salaries but that outside the scope of the thesis.

4.4 Evaluation of total time wasted because of the Top 3 issues

For production issues there were a total of 179 issues which were found. Similarly for Inventory, BOM issues 101 issues and 60 cases from the Supplier/carrier responsibility. These issues could have been avoided using different methods to solve them (see Appendix 3).

Since the total manhour minutes for Production issues, Supplier/carrier responsibility, Inventory/ BOM issues as 87 mins, 64 mins and 67 minutes respectively, multiplying this with the count of special transports in respective final root types gives us the total minutes spent for ordering the transports within each category.

Total minutes of ordering a special transport if the root cause was Production issue = **Total man-hours for the issue * Total Count of cases**

= 87 * 179 **= 15,573 minutes**

Similarly for Supplier / Carrier responsibility issues

= 64 * 60 **= 3840 minutes**

Similarly for Inventory/BOM issues

= 67 * 101 **= 6767 minutes**

The above data can be tabularised as following (see Table 7):

Table 7 Total time spent on top 3 issues while ordering SpT

Issue type	**Production issues**	**Supplier / Carrier responsibility issues**	**Inventory / BOM Issues**
Total time spent for orders in minutes	15,573	3840	6767

A total of 15,573 minutes were spent in ordering SpT related to the production issues, 3840 minutes for supplier/carrier responsibility issues and finally 6767 minutes for the inventory/BOM issues. The table below shows the vital few which is also the Top 3. The main issues behind these categories were found but only one main underlying issues were selected from the excel sheet (see Appendix 1) upon the repeatability seen. They were seen the most repetitive ones and must be tackled to further reduce the transport costs (see Table 8).

Table 8 Top 3 type of root causes and the main issue inside them

S. No	Top 3 root causes	Issues to be resolved
1	Production Issue	Production backlogs
2	Inventory issues, BOM issues	Inventory discrepancy
3	Supplier/carrier responsibility issue	Quality of the parts received

5 Proposals for elimination of root causes of special transports

Once the causes of the Top3 of emergency transports costs are identified, FIS can develop a comprehensive action plan to optimize or change the processes and operations accordingly. This plan may involve implementing modern technologies or systems, streamlining workflows, improving communication and coordination among teams, or exploring alternative transportation methods. It is essential to monitor the impact of these changes closely and continuously assess their effectiveness to ensure ongoing improvements.

The proposals were formulated after standard practices shared from similar plants who were better at managing the issue better than FIS Bohemia and data on these were collected online as well. The proposals were kept in terms of man-hours or cost of hours as cost of salary of different designations of people can't be revealed. Solving these problems would benefit in long term and the proposals are as follows:

I. **Production Backlogs: Avoiding Production backlogs using Pull system.**

This type of issue can be solved by accessing the pull requirements for the project. From the plant the Audi/Seat line to be specific is at bottleneck whose takt is not matching at customer's demand. Therefore, extra shifts are necessary, and this can't be covered using normal shipments. This means sometimes overproduced parts as well which are shipped to customer to anticipate next week's delivery.

Implementing and batch building tool can solve this problem. This process can eliminate the wastes as well as it provides a healthy measure against overproduction.

The tool requires same amount of manpower with the involvement of routine for the forklift operator to follow the pull system. The batch building kanban cards help the production to produce in batches with the help of levelled planning. The shop stock of the finished goods is thus levelled. This levelling is another topic which can't be explored here further however the plant already meets basic requirements for setting up this tool. It can be seen that there is required the same amount of manpower in logistics and considering the area, there is required additional shop stock and a truck preparation area for this which can be got by changing the layout of the current shop stock to match the calculate values. The calculated values must be matching the production line capacity and the customer demand in short term, say 6 months.

The cost of levelling board is 500 EUR, kanban labels are around 20 EUR(depending on batch size), cost of launcher is 120 EUR and cost of batch building board is 300 EUR etc. This can be sourced from other plants at smaller rate, particularly the plants which are using the digital version of this tool. It's not able to include the cost of materials in our calculation here but the effort to improve on this issue can be calculated in terms of man-hours again.

The cost associated in terms of time is calculated as following:

Cost of additional manpower required is **zero**, cost of including this task into normal routines is zero, cost of designing batch building card is **60 mins**, cost of calculation of the batch size is **360 mins**, calculation of area required for shop stock is **60 mins**. The total setup will take **15 days** which is **112.5 hours** considering that the person who setup will work each day 7.5 hours or in **6750 mins** when converted to minutes.

Normal operational costs will include only the extra task for forklift operator which is collecting the kanban labels which is approx. 2 minutes and cost of collecting the customer labels to the final containers for loading into trucks which is another 2 minutes. The transfer of finished good transfer will increase slightly by 5 minutes as the finished good will go to shop stock and then to the TPA. This type of planned operation doesn't affect the salary of the staff as virtually the same amount of work will be done each shift. This type of issue was almost 50% of the production issues and that means **7786 minutes** (see table 8) can be saved in the next semester if the similar trend continues in terms of cost of SpT.

II. Supplier/carrier responsibility issue: By use of Supplier evaluation rating and audits

The main supplier has been identified but the name cannot be revealed due to data privacy and business ethics. To mitigate these kind of risks and maintain a strong supplier base, FIS should strongly employ supplier evaluation ratings and audits. These tools provide a structured approach to assessing and managing supplier performance. Supplier evaluation ratings involve assigning a numerical or qualitative score to each supplier based on their performance across various criteria, such as:

- Product quality: The consistency and adherence to quality standards.
- Delivery performance: Punctuality, reliability, and adherence to agreed-upon delivery schedules.
- Compliance: Alignment with safety, environmental, and ethical standards.
- Communication: Open, transparent, and timely communication.
- Cost-efficiency: Competitive pricing and cost management practices.

Further this evaluation rating must be always checked as part of continiuos improvement plan and these audits are more comprehensive evaluations that involve on-site inspections, documentation reviews, and interviews with supplier personnel. They should delve deeper into specific aspects of the supplier's operations, such as:

- Production processes: Quality control measures, adherence to safety standards, and environmental practices.
- Warehousing and logistics: Inventory management, storage conditions, and shipping procedures.
- Financial records: Accuracy of financial information, adherence to payment terms, and financial stability.
- Compliance documentation: Proof of regulatory compliance, certifications, and safety permits.

Audits provide a more detailed understanding of a supplier's operations and help to identify potential issues or areas for improvement. They also serve as a way to demonstrate due diligence and accountability in managing supplier relationships.

The supplier audits will require a full day of audit which is **8 hours** and can be done by a single representative from FIS preferably from Quality department as most of the issues were related to the quality of the parts received. The rejected parts per million (RPPM) of a supplier is determined by comparing the number of rejected parts to the total quantity of parts received during a specific fiscal month. The calculation is then adjusted to represent a continuous basis equivalent to one million units received. This can also be used to measure the performance.

The audit result must be shared with the supplier and let them know where they need to improve. Continuous improvement plan and tracking those improvements should be planned for the supplier and measured in real time. The KPI for this supplier must be updated only if they pass the second audit. Nealry 100% of the supplier issues were due to quality defects and by reducing the quality defects, we can reduce **3840 minutes** (see table 8) of the cost of ordering special transports for this type of issues. On top of the suggestion it is preferable to have an inbound transport quality inspection which will require 1 additional manpower for each shift and then salary associated with that. A minimum basic qualification for this person will be required although he can be trained as well by utilizing any operator who can be transferred here. 100% check is not necessary and only random checck can be performed for which the quality representative must provide the list from the manifest of the inbound truck which is to be checked. This must be created on Thursday (previous week) from the delivery when the manifest are usually prepared.

III. Inventory or BOM issue: Avoiding Inventory discrepancy using proper alert management.

The inventory discrepancy consists of the 100% of the total issues in the root type of Inventory/ BOM issues. The solution for inventory issues is to cautiously track BOP materials or parts so you usually have important parts handy with out being overstocked as well. In other cases the understock issues can also The first step in dealing with your warehouses is to carry out an stock audit.

Inventory audits may be tedious and time-consuming, however strategies and present day software program can lessen the load even as presenting you with the important insights to enhance your operation. These issues can be solved using proper alert management and use of Warehouse management software. This can significantly reduce the discrepancy issues as proper alerts will be sent to the responsible persons. Cost of incorporating an alert management software in terms of time taken will be as follows:

Since FIS can use the inhouse software that other plants use then that means the plant will get the software for zero cost. Caluction of total minutes taken for implementing the tool is as follows. This data was taken by a similar plant which implemented the same tool.

Cost of changing the language of the tool to the regional language Czech will be **120 minutes** and time taken for alert setup will be **10 days** which is **112.5 hours** or in terms of minutes it can be said as **6750 minutes** taken to implement the tool and finally go live. This is less than total time costed ordering for this type of issue which was **6767 minutes** (see Table . Additionaly in long term this will have significant benefit to the company. Other setup charges such as T.V for alert board setup and operational costs are negligible as this can be sourced quickly and cheaply. Further alert labels costs are also not significant in the long term as they are reusable and cheap. Setting up the software will be done by the IT team for which there is no extra expense in terms of salary.

After the process of setting up of proper alert menagement the issue which were raised needs to be studied futher and the rootcause on those issues needs to be done in parallel with all the responsible persons in the concerned program. When you have the methods setup to tacle those issues then this should be copied or replicated in other program as well which will help the other programs in not face them.

Finaly after the results are tacled and documented then comes the important step of auditing the BOM in the warehouse as well as production lines. Continious audit untill deviation is below 5 %, although this decision is management based and not a preferred value at this point.Also it is wise to converge and reduce the inventory according to Faurecia excelence systems topics , FIS needs to understand and hold onto only the inventory which has at least one of the following which can be true.

- It must contribute at least 0.5% to sales income and 1% to total assets.
- 1–2% of total pre-tax income.
- 2%–5% of shareholders equity;.
- or 5%–10% of gross profit.

Although this decision is also based on the lead times of the suppliers as well , If balanced properly then this will provide optimization of the inventory.

Conclusion

The thesis helped company FAURECIA Interior Systems Bohemia s.r.o. understand the vital few of the problems that the company can improve upon to reduce the cost of emergency or special transports. In the long run after tackling most of the problems there was seen a negative trend in most of the cases in terms of emergency transport costs.

Suggestions or proposal were given to the company to tackle the Top3 of the issues which were Production issues, Inventory/BOM issues and Supplier/ Carrier issues. In conclusion, the evaluation of total time wasted due to the top three issues revealed the significant impact they had on operational efficiency. By addressing the root causes identified as Production Backlogs, Inventory Discrepancy/BOM Issues, and Supplier/Carrier Responsibility Issues, the company can make substantial improvements.

The proposed solutions offer practical approaches to eliminate these issues. Implementing a pull system and batch building tool for production backlogs, conducting supplier audits and implementing evaluation ratings for supplier/carrier responsibility issues, and utilizing proper alert management and warehouse management software for inventory discrepancy/BOM issues can significantly reduce time wastage and associated costs.

These proposals not only address the immediate challenges but also aim for long-term benefits by improving processes, reducing waste, and enhancing overall performance. By implementing these solutions, the company can enhance operational efficiency, minimize the need for special transports, save valuable time, and ultimately reduce costs.

In addition to the proposal there is a suggestion to improve on the current practise of RCA by moving ahead from the initial questionnaire format to instead having the feedback directly when a person orders. This can be done by utilising the comment section of the website while ordering speccial transports. Also from logistics point of view since there were seen loading and unloading delay because of trucks waiting at the same time, levelling of inbound are neccesary and this would give the opportunity of further improvement in the receiving operations.

Bibliography

ANDERSEN, Bjorn and Tom FAGERHAUG. Root Cause Analysis: Simplified Tools and Techniques. *Journal For Healthcare Quality* [online]. 2002, 46-47 [cit. 2023-12-21]. ISSN 1062-2551. Available from: doi:10.1097/01445442-200205000-00012.

BURGANOVA, Natalia, Patrik GRZAR, Milan GREGOR and Štefan MOZOL. Optimalisation of Internal Logistics Transport Time Through Warehouse Management: Case Study. *Transportation Research Procedia.* 2021. Vol. 55, p. 553–560. DOI 10.1016/j.trpro.2021.07.021.

EDMUND, Prater and Kim WHITEHEAD. *An Introduction to Supply Chain Management: A Global Supply Chain Support Perspective.* 2013, p. 60, ISBN-13: 978-1-60649-376-2.

FANG, Y, W WEI, F LIU, S MEI, L CHEN and J LI. Improving solar power usage with electric vehicles: Analysing a public-private partnership cooperation scheme based on evolutionary game theory. 2019, pp. 1284-1297. [DOI: https://dx.doi.org/10.1016/j.jclepro.2019.06.001].

Financial result release for the press [Online]. Forvia, 2023, available from: https://www.faurecia.com/en/investors/investors-analysts/financial-results.

GONG, Y and He Y.T. Co-evolutionary simulation regarding emergency logistics in major public health risk governance. *J. Comput. Appl.* 2021, 41, pp. 2754-2760.

GU, W, L WEI, W ZHANG, X YAN. Evolutionary game analysis of cooperation between natural resource- and energy-intensive companies in reverse logistics operations. Int, 2019; pp. 159-169, [DOI: https://dx.doi.org/10.1016/j.ijpe.2019.05.001].

GUNASEKARAN, Angappa, A. AGARWAL and S. BISWAS. Modeling and analysis of build-to-order supply chains. *Science direct* [online]. 2011. https://www.sciencedirect.com/science/article/abs/pii/S0377221708003366/.

GUNASEKARAN, Angappa and King-Lun CHOY. Industrial logistics systems: theory and applications. *International Journal of Production Research* [online]. 2012, 50 (9), 2377-2379, ISSN 0020-7543. Available from: doi:10.1080/00207543.2011.581001.

HE, H.L. and M.K Li. *A* Tripartite Game Analysis on Reverse Logistics of Express Packaging under Restricted Control Policies. *Ind. Eng. Manag.* 2021, 26, pp. 157-164.

CHRISTOPHER, Martin. Logistics & supply chain management. *Harlow: Pearson*, 2016. XIV, pp. 310 stran. ISBN 978-1-292-08379-7.

Integrated Supply Chain Visibility Solutions for Connected Freight Management *Frost* [Online]. available from: https://www.frost.com/frost-perspectives/integrated-supply-chain-visibility-solutions-for-connected-freight-management/.

COYLE, John Joseph, C John Langley, Novack, R.A. and Gibson, B.J., Supply chain management a logistics perspective, 2016, *10th ed. Boston, Mass. Cengage Learning*, p.6. 978-1-305-85997-5.

KARA, Bahar Y., Ihsan SABUNCUOGLU and Bopaya BIDANDA. Global Logistics Management, 2021, p. 32, ISBN 9780367783648.

KAUR, Dr. Kiranjot and Iuliia KAU. Global Value Chain. *NSCC* [Online]. 2022, available from: https://pressbooks.nscc.ca/valuechain/chapter/2-3-inbound-and-outbound-logistics/.

LUO, Yumei, Yuke ZHANG and Lei YANG. How to Promote Logistics Enterprises to Participate in Reverse Emergency Logistics: A Tripartite Evolutionary Game Analysis. *Sustainability* [online]. 2022, *41*, pp. 859–863, 870. [cit. 2023-12-21]. ISSN 2071-1050. Available from: doi:10.3390/su141912132.

Outbound vs. Inbound Logistics: What's the Difference?. 2022, *Indeed* [online], available from: https://www.indeed.com/career-advice/career-development/outbound-vs-inbound-logistics.

OZTEMEL, Ercan and Samet GURSEV. Literature Review of Industry 4.0 and Related Technologies. *Journal of Intelligent Manufacturing*, 2018, Vol. 31, no. 1p. 127–182. DOI 10.1007/s10845-018-1433-8.

Production logistics: the heart of controlled efficient production., *Intralogistics BITO* [Online] Available from: https://www.bito.com/en-us/expert-knowledge/article/what-is-production-logistics/?mwg_rnd=2530976.

RODRIGUE, Jean-Paul, Claude COMTOIS, and Brian SLACK. Methods in transport geography. In: *The Geography of Transport Systems* [online]. Routledge, 2016, 2016-12-19, pp. 340-392 [cit. 2023-12-21]. ISBN 9781315618159. Available from: doi:10.4324/9781315618159-10.

RONDINELLI, D., & M BERRY. Multimodal transportation, logistics, and the environment: Managing interactions in a global economy. *European Management Journal*, 18(4), 2000, p. 398–410.

SAETTA, Stefano, Leonardo PAOLINI, Lorenzo TIACCI, and Tayfur ALTIOK. A decomposition approach for the performance analysis of a serial multi-echelon supply chain. *International Journal of Production Research* [online]. 2012, 50 (9), 2380-2395 [cit. 2023-12-21]. ISSN 0020-7543. Available from: doi:10.1080/00207543.2011.581002.

SARKIS Joseph and Yijie DOU. GREEN SUPPLY CHAIN MANAGEMENT A Concise Introduction. 2018, 1st edition, pp. 3, ISBN: 978-1-138-30281-5.

Seabird logistics, Role of warehousing in the supply chain and logistics management. *Linkedin* [Online]. 2023, https://www.linkedin.com/pulse/role-warehousing-supply-chain-logistics/.

SERRAT, Olivier. Knowledge solutions: tools, methods, and approaches to drive organizational performance. *Singapore: Springer*. [2017], 307 s. ISBN 978-981-10-0983-9.

The history of the logistics and shipping industry*. DTSone* [online]. 2023, Available from: https://www.dtsone.com/blog/the-history-of-the-logistics-and-shipping-industry/.

The origin and history of logistics which you might not have heard of. 2023, *JWD Group* [online], Available from: https://jwd-group.com/en/knowledge_bases/aboutlogistics/.

Types of logistics management. *Inbound Logistics* [online] 2023, https://www.inboundlogistics.com/articles/types-of-logistics-management/.

ÜSTÜNDAĞ, Alp and Emre ÇEVIKCAN. Industry 4.0: managing the digital transformation. *XVIII. Cham, Switzerland: Springer,* [2018]. *Springer series in advanced manufacturing*. ISBN 978-3-319-57869-9.

Zhao, X.; X. Bai. How to motivate the producers' green innovation in WEEE recycling in China? —An analysis based on evolutionary game theory. *Waste Manag.* 2021, 122, pp. 26-35, [DOI: https://dx.doi.org/10.1016/j.wasman.2020.12.027].

List of figures and tables

List of figures

List of tables

List of appendices

Appendix 1 RCA excel sheet

Order ID	contact person	date ordered	Expenses	Shipment from	Shipment To	Rootcause mentioned in email	Additional Comments	Preliminary analysis	RCA comments	INBOUND/OUTBOUND	Final Analysis	week num
XF23037C52	[redacted]	12-03-2023	€ 330.00	Gumotex Automotive Myjava s.r.o.	Faurecia interior Systems	supplier backlogs for these parts? Yes	We increased the requirements from item B00257G and the supplier doesn´t have capacity.	Supplier	Supplier GUMOTEX	Inbound	Supplier/carrier responsibility issue	11
ID23037F9I	[redacted]	13-03-2023	€ 800.00	DB Schenker	BMW AG Werk Regensburg	After the move of the trade parts to Schenker the BMW trucking company wasn,t able to send trucks to the new address. Fault by BMW not to update their system, we are unable to recharge the cost due to outstanding invoices from the trucking company to us.	Changes are made, truck ordering works at the moment	Logistics		Outbound	Program issues	11
ID23037FB0	[redacted]	13-03-2023	€ 1,050.00	DB Schenker	BMW AG Werk Regensburg	After the move of the trade parts to Schenker the BMW trucking company wasn,t able to send trucks to the new address. Fault by BMW not to update their system, we are unable to recharge the cost due to outstanding invoices from the trucking company to us.	Changes are made, truck ordering works at the moment	Logistics		Outbound	Program issues	11
ID23037CNK	[redacted]	13-03-2023	€ 374.00	Gumotex Automotive Myjava s.r.o.	Faurecia Interior Systems Bohemia	They don´t have capacity to supply our demands.		Supplier		Inbound	Supplier/carrier responsibility issue	11
AP23037G9M	[redacted]	13-03-2023	€ 700.00	Raben Transport s.r.o.	Faurecia interior Systems	unable to unload the empties. Forwarders refused to unload.	solved. The logistics area was imp[roed and regular flow was established.	Logistics		Inbound	Supplier/carrier responsibility issue	11
AP23037GAI	[redacted]	13-03-2023	€ 700.00	Raben Transport s.r.o.	Faurecia interior Systems	unable to unload the empties. Forwarders refused to unload.	solved. The logistics flow was improved and regular flow was established.	Logistics		Inbound	Supplier/carrier responsibility issue	11
AP23037H30	[redacted]	13-03-2023	€ 647.00	Faurecia Int. Syst.	D+D park					Outbound		11
ID23037C68	[redacted]	13-03-2023	€ 245.00	Faurecia Int. Syst. Bohemia	Jaguar Land Rover Slovakia s.r.o.					Outbound		11

Appendix 2 Total weekly special transports costs

Week number	Total cost
11	24661
12	12039.25
13	16071.47
14	15550
15	17294.61
16	22074.89
17	29648.68
18	19277
19	13345.65
20	15418
21	9860
22	5389
23	3383
24	10664.25
25	15349.5
26	16820.25
27	20173
28	22018.5
29	27159
30	9465
31	11343
32	5954
33	10471.5
34	11748
35	16573.5

Appendix 3 Count of top 3 root cause issues on a weekly basis

Week Number	Production issues	Inventory issues, bom issues	Supplier/carrier responsibility issue
11	7	5	5
12	4	9	7
13	7	9	5
14	10	8	4
15	4	4	5
16	5	9	4
17	11	10	3
18	4	3	6
19	11	4	3
20	7	2	2
21	5	4	
22	6	1	1
23	3	2	1
24	7	1	1
25	13		
26	10		1
27	10	1	2
28	13	3	
29	4	6	7
30	2	2	
31	2	2	
32	2	3	
33	6	3	
34	6	3	2
35	6	2	
36	3	2	
37	11	1	1
39		1	
40		1	
Grand Total	**179**	**101**	**60**

ANNOTATION

AUTHOR	**Naveej Azhamchalil**		
FIELD	**International Supply Chain Management**		
THESIS TITLE	**Optimization of emergency logistics management in FAURECIA Interior Systems Bohemia s.r.o.**		
SUPERVISOR	Ing. Tomáš Malčic, Ph.D.		
DEPARTMENT	**KRVLK - Department of Production, Logistics and Quality Management**	**YEAR**	**2024**

NUMBER OF PAGES	**74**
NUMBER OF PICTURES	**21**
NUMBER OF TABLES	**8**
NUMBER OF APPENDICES	**3**

SUMMARY	The main aim is to analyse and optimize current emergency logistics management system in company FAURECIA Interior Systems Bohemia s.r.o. with focus on frequency, costs and causes of emergency transports. The thesis paper starts from the theoretical part where the current literature is given on this topic and then the methodology or tools used. Final part is concentrated on the practical part about the analysis done. For identified root causes of emergency transport the optimization measures were proposed with evaluation of expected economic benefits.
KEY WORDS	**Special Transports, Emergency logistics, Root cause analysis, Man-hours, 5 Why analysis**