TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING
Department of Mechanical and Industrial Engineering

CONTROL AND ENFORCEMENT OF EXECUTION PROCESS WITHIN ORGANIZATION VIA "EXPEDITING" FUNCTION IMPLEMENTATION IN SUPPLY CHAIN PROCESS

TÄITMISPROTSESSI KONTROLL JA JÕUSTAMINE ORGANISATSIOONIS LÄBI "EKSPEDEERIMISE" FUNKTSIOONI RAKENDAMISE TARNEAHELA PROTSESSIS

MASTER'S THESIS

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Tallinn 2023

(*On the reverse side of title page*)

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"21" Mai 2023.

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Department of Mechanical and Industrial Engineering

THESIS TASK

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Study programme, MARM06/18 - Industrial Engineering and Management

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Thesis topic:

(in English) *CONTROL AND ENFORCEMENT OF EXECUTION PROCESS WITHIN ORGANIZATION VIA "EXPEDITING" FUNCTION IMPLEMENTATION*

(in Estonian) *TÄITMISPROTSESSI KONTROLL JA JÕUSTAMINE ORGANISATSIOONIS LÄBI "EKSPEDEERIMISE" FUNKTSIOONI RAKENDAMISE TARNEAHELA PROTSESSIS*

Thesis main objectives:

1. To analyze how supply chain of production companies got affected by world events of last several years
2. To review benefits of new "expediting" for production companies and ways of their management for project execution
3. To bring examples and scenarios of project execution using different types of expediting and conclude on their efficiency

Thesis tasks and time schedule:

No	Task description	Deadline
1.	Literature Review	End of March 2023
2.	Expediting function	End of April 2023
3.	Data analysis/market analysis	Mid of May 2023

Language: English **Deadline for submission of thesis:** "22"Mai 2023 a

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1 PREFACE

This thesis is an original work done by Alyona Vershinina. It is done in collaboration with supervisor Rivo Lemmik and includes analysis which are linked to several organizations without direct naming. Spending several years in Supply Chain area working for big organization, going down the Supply Chain and noticing the impact which is brought by one or another event to the process requires attention. This work topic is inspired by the need to help organization to take quicker control over their process to adapt to recent market changes and struggles faced worldwide. It reviews aspect of work combination using human resource and simplification of the work via usage of automatic machine learning solutions, digitalization.

2 LIST OF ABBREVIATIONS

PM - Project Management

RFQ - Request for quotation

ROI - Return on investment

SCOR -Supply Chain Operations

KPI - Key Performance Indicators

SC - Supply Chain

S&OP - Sales and Operations planning

SCM - Supply Chain Management

ML - Machine Learning

ADA - Advanced Data Analytics

RL - Reinforcement Learning

AI - Artificial Intelligence

DSC - Digital Supply Chain

SME - Small Medium Size Enterprise

ERP - Enterprise Resource Planning

PO - Purchase Order

OTD - On Time Delivery

SRM - Supplier Relationship Management

BPM - Business Process Modelling

3 INTRODUCTION

Supply Chain Management is very broad topic which covers full chain of processes inside and outside of any organization. Looking at supply chain process within any organization, performing risk assessment and stakeholder analysis, main highlights come exactly from outside of organization which adds additional concerns to internal performance. Risk assessment is very important part of organization performance. Analysis, identification, and containment of risks is one of the main criteria to keep successful and healthy business. The main question in this case is really about risks which come outside of organization.

How to keep those risks under control and predict them on time, prior any serious harm is given to the company? This thesis is focused on understanding of outside risks and during this thesis will be reviewed and proposed several options which help to maintain and minimize the risks coming from outside of organization. This thesis is focused on companies which are specialized in manufacturing/production area. Examples of different industries to be brought out and analyzed.

Constantly changing market doesn't let anyone say that "risk is fully eliminated". Especially looking at the coincidences which appeared in the last several years on the market and gave a serios shake to the World market of supply. Drastically changing market added too many risks for companies which affect reputation, add additional costs in process and lead to inability to meet given to customer promise. However, living several years under high pressure in Supply Chain, there are already available positive examples of companies which managed to survive and even grow their potential profit wise. On the other hand, there are many examples of companies who didn't manage to survive these periods. There are several reasons behind one or another scenario. However, innovations in technology, businesses and society will drive supply chain evolution. Advancements in robotics and product identification technology have already brought to human replacement in several areas like material handling. However, any system still requires a human to be behind the machine to monitor general situation and react in case of any disturbances. People require different set of skills. New methods to capture data are evolving and analytics give options for decision taking in real time. Increasing number of specialists in data management proves the statement. Even though Supply Chains to become more agile and sustainable, communication between stakeholders will always be a key to success in any partnership.

4 SCOPE OF WORK

4.1 The aim

The aim of this thesis is to analyze management of execution phase (from the moment of order placement and until order is ready for dispatch) within companies and review alternative options to control, improve or sustain the process using all identified risks and communicating them on time. The main idea stands around "expediting" process and analysis of its efficiency and simplification via machine learning and digitalization. Several types of expediting to be reviewed and analyzed in this thesis. In addition, possible market solutions to be presented to explain machine learning possibilities in the frame of expediting activities.
Any other organizational process such as production, quality, general management etc. which might influence reviewed during thesis scenarios are considered as out of scope.

4.2 Objectives

- → To analyze impact on supply chain of events occurred in the last several years
- → To analyze typical supply chain structures of organizations and propose their alternatives
- → To review the impact of expediting process as combined or separate function within company structure and bring its outputs
- → To bring several examples of usage of expediting within organizations and its benefits
- → To review digitalization and machine learning possibilities to ease expediting process

4.3 Research questions

→ What are the recent changes which affect reliability of supply chain?
→ How to adapt company structure to market changes and what is required to be done differently to comply and meet customer expectation after order placement?
→ What does new way of expediting process mean in supply chain context and how can company benefit from this function in execution?
→ What are the expediting options? Which systems might improve its efficiency?
→ How can machine learning help with expediting activities?

4.4 Methodology

During compilation of the thesis have been used two main research methods:

- Qualitative research method
  - Literature review – the study of materials was done on the main subject Supply Chain and comparison of different sources was performed to bring out the most relevant statements. To open the topic of the thesis, main issues of recent years in Supply Chain area have been brought out and justified the need for additional control via risk definition.
  - Use case analysis – the interviews were carried out at specific companies to understand the real situation on the market and the way company is operating. Several statements are deduced from interviews related to the subject.
  - Market analysis for digital solutions – current market was analyzed to understand the level of integration currently available, and examples compared.

- Quantitative research method
  - Data analysis – data comparison is done to review process impact with and without expediting put in place. Sources were taken from use cases and actual data is presented in this thesis without direct naming of companies.

5 LITERATURE REVIEW

5.1 Introduction into supply Chain and project management

Supply Chain Management is a process which is responsible for handling of the whole production flow of goods or services. It starts from raw materials and ends with delivery to its final customer. Supply Chain is a key process for every organization. The actual term "SCM" appeared first time in 1982. This term combined such processes as planning, implementing, and controlling of operations in supply chain with the focus on customer satisfaction. Despite the popularity of SCM in academic and business environment, there remains considerable confusion regarding its meaning. Some authors define it in operational terms involving the flow of raw materials and products, while others viewed it as a management philosophy. There exists even third side of viewing SCM as a management process or an integrated system (Albăstroiu & Felea, 2013). Independently of the way one or another person describes what the term SCM is, it does not change the purpose of its performance. Looking at the tremulous and complex environment, all companies require to be putting higher efforts for greater collaboration. Strong structure partnerships between stakeholders are important to achieve fluency and effectiveness in procurement. Supply Chain plays vital role in project success. The procurement process is composed of different stages (pre-acquisition phase, tender process and contract award, contract, and supplier management), each one requiring a specific and careful design capable of guaranteeing the best possible results (Buzzetto et al., 2020). The procurement process is an area of interest to organizations responsible for project delivery for better performance in product quality, cost, cycle time, and responsiveness. Project success directly depends on the strength of project management process defined within organization. Since the beginning of the 2000s, project management (PM) and its issues have been growing in relevance in a more specific way, even being adopted as organizational model. When considerations about project management success are made, it is possible to find and use many different approaches. One of the most traditional ones is the iron triangle approach. It affirms that three main aspects that must be managed together characterize projects: scope, cost, and time (Machado & Martens, 2015).

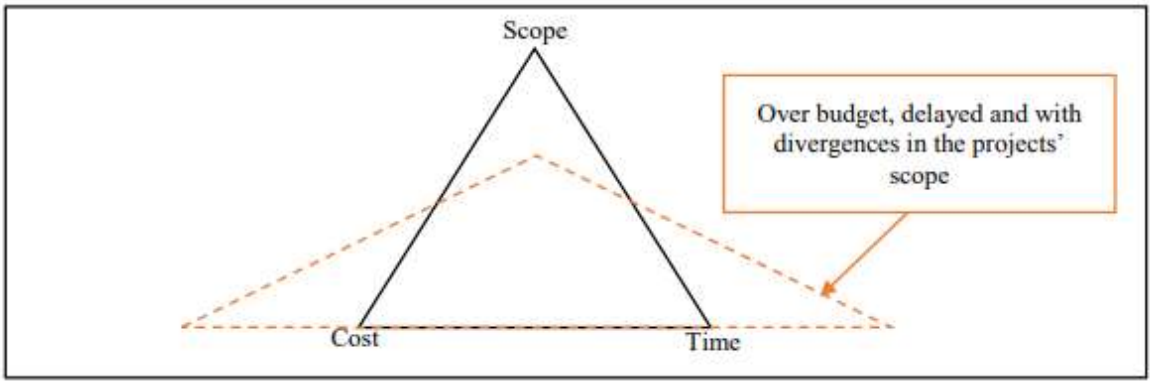

Figure 1: The project management iron triangle

Source: Adapted from Carvalho & Rabechini (2011, p.39)

Project management combines usage of different tools and techniques. The range of project management tools is growing, while the attention is paid to the tools that help implement the basic project parameters effectively: meet project objectives, deliver quality, meet deadlines, and stay within budget. However, the focus is mainly on minimizing the related risks.

Talking back about procurement process, the initial stage is selection of suppliers. Selection of suppliers is the main activity and without a robust process, company increases its own risk in any project from the very beginning. Most companies use "panel of suppliers" divided into groups which can be applied depending on project needs. This panel of suppliers is monitored by responsible people and being updated/re-qualified depending on business needs. However, there are many other factors apart from supplier selection which affect the project. When the need is there, procurement responsible people enter request for quotation (RFQ) phase with specific suppliers. RFQ is the phase when purchaser takes bids. It is important to understand that it is not only about a good price. The right supplier is the one who has the best combination of quality, lead time and price. This is the main milestone and decision which will have a direct impact on the execution of specific project.

5.2 How supply chain works within organization and its struggles

An organizational performance is defined as how well the organization works on improving the company financial condition and be able to compete against its competitors. Performance can be categorized in two ways: financial and non-financial. Financial performance is performance which is related to the financial prospect. It might be increase of share cost, return of investment (ROI), profit etc. Non-financial performance is performance which is related to operational prospect. It might be a raise of customer satisfaction, reduction of lead times or development phases, change of product volumes, reduction of scrap rates etc. which are related to the operational performance that will not be visible in financial report, but will have an impact of the organizational performance. Talking about supply chain process, its performance can be measured in both ways. It is a choice of every organization which exactly processes they put under "Supply Chain" process, and which functions they introduce. The most typical way to construct the structure of Supply Chain organization is via usage of SCOR (Supply Chain Operations) model.

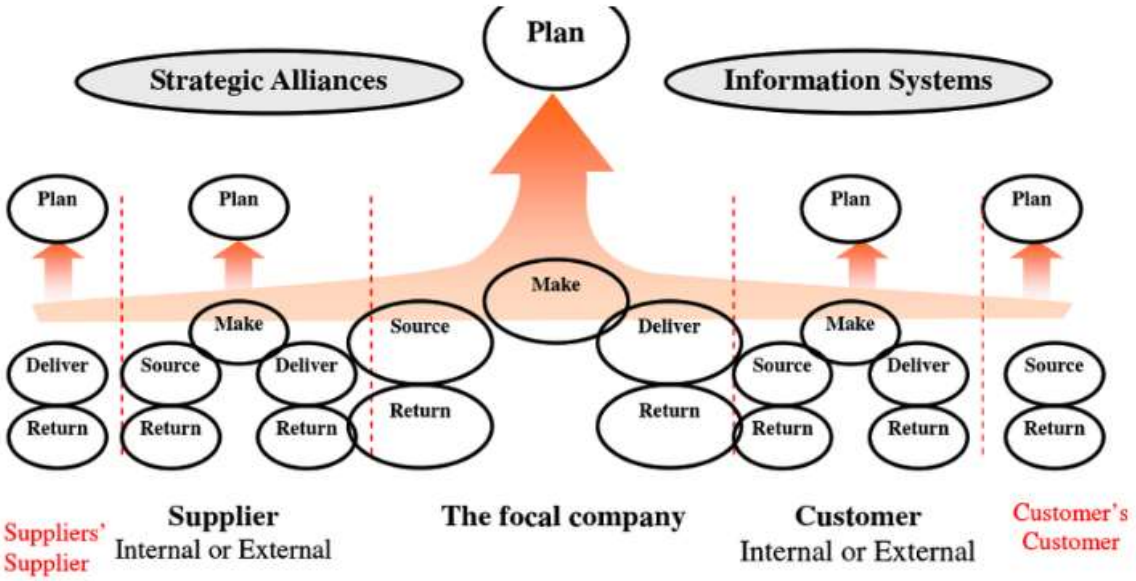

Figure 2: SCOR Model for supply chain linkage

Source: Adapted from Supply Chain Operations Reference Model Version 7, Supply Chain Council, 2005

The SCOR-model is a well-known framework which was developed and endorsed by the Supply-Chain Council to describe the business activities associated with all phases in the supply chain. The SCOR model basically aggregates the major supply chain management tasks into four categories: 'Source', 'Make', 'Deliver' and 'Plan' (Boute et

al., 2011). To meet the model, organization hires responsible functions to satisfy requirements of all four categories. To understand if process performs well or not, organization defines key performance indicators (KPIs). KPIs represent a set of markers focusing on aspects of organizational performance that are critical for the current and future success of the organization. In June 2020 by group of people was conducted a project for evaluation of the main key metrics used in Supply Chain. A complex study was performed using 149 different indicators which were sent to enterprises, and it was requested to classify them based on the internal process perspective. The conclusions state that cash flow was the most critical indicator in the financial perspective. This was not surprising since companies depend upon cash flow to address short- and long-term challenges. The customer perspective had some indicators as satisfaction rates. Service quality is related to the ability of the organization to respond to client needs. Perceived service quality is the second indicator in the ranking of this perspective. In the internal process perspective, rotating inventory was the primary KPI. A lack of inventory can cause shortages in the chain, and an excess can cause problems for customers. This shows that inventory turnover is a critical metric. Finally, the learning perspective relates to the exchange of information throughout SC. Some problems are rooted in a lack of communication; it can, for example, result in excess inventory or order delivery problems (Villazhañay et al., 2020b). Every organization is free to choose any indicator it sees useful to satisfy its evaluation of effectiveness and efficiency. After definition of indicators and its evaluation comes the next step: understanding the reasons behind good/bad performance and work on its enforcement/improvement. Here the next topic is stepping in – supply chain struggles. Supply Chain keeps overcoming huge shocks which change it. There are several sources available which provide list of challenges within supply chain. Henry Canitz stated that millions of supply chains face unique challenges that vary across industries, geographies, and business strategies (Canitz, n.d.), but still made a list of:

- Increased Disruptions – Big factors like earthquakes, hurricanes, wars lead to massive consequences that require extensive mitigation efforts. However, small factors like abnormal weather conditions, accidents, and power outages impact a company’s ability to service.
- Supply Chain Cost Reductions – everyone expects supply chain prices to lower down, but raw material, fuel, energy prices are going up. An increased adoption of supply chain planning, optimization, and execution technology to automate supply chain processes will result in more time value-added activities like process updates, development of system, deeper analysis.

- Customer expectations – the chains are spreading widely, and customers develop those chains. Having more information, customers demand higher product varieties at lower prices. Competition is growing and it becomes harder for companies to meet the requirements from all sides.
- Demand Unpredictability – growth over last several years resulted in growing demand unpredictability. Changing environment, growing technologies, lack of materials creates uncertainties which require more details planning and close look to the market. Software base becomes a key to stay competitive on the market and control sales and operations planning (S&OP) with integrated short-, mid- and long-term views.

5.3 Uncertainties in supply chain for last 4 years

In recent years, the events which have occurred due to natural disasters, the outbreak of COVID-19, political turbulence, a growing complexity of business environment reduced the efficiency of global supply chain and customer service quality. It resulted in increase of operating costs, new requirements for flexibility and sustainability (Zhu & Wu, 2022). The bank of New York introduced index named "Global Supply Chain Pressure Index" (GSCPI). It combines several metrics and provides comprehensive summary of supply chain disruptions. It includes metrics as employee data from Baltic Dry Index (BDI) and the Harpex index. In addition, considers airfreight costs from U.S. Bureau of Labor Statistics. At the end, several supply-chain components from Purchasing Managers' Index surveys are taken in account. The focus is done on seven key economies: China, Europe, Japan, South Korea, UK, US and Taiwan.

Figure 3: Global Supply Chain Pressure Index Data

Sources: Federal Reserve Bank of New York

The peak is observed when Wuhan, China got reported Covid-19 closure (last quarter of 2019) which drastically caused an impact to the whole World. It can be observed that figure started growing which affected every piece of supply chain. On the other side, it is visible that tension on the market got some release from the end of 2021, but still staying above pre-Covid. The most specialists from Supply Chain predict that tension stays until end of 2024. There have been done many articles about situation on the market in 2020. Not to get into details, the chain of events in 2020 is explained below:

- **Covid-19 pandemic** – Lockdowns all over the World and governmental policies almost stopped goods exchange. High illness rates resulted in lack of manpower at every manufacturing company. The key trading countries including China as the main limited regional movements which made global crisis more severe. Covid-19 was hitting with different variants which was putting economy into deeper crisis.
- **Brexit** – The UK voted to leave EU in 2016 and left officially in January 2020. Based on the data from UK Parliament posted on 21st of December 2022, the Great Britain represents 45% of export to European Union. It means that since January 2020 and during all negotiation phase for the further trading between UK and EU, there was impact on all manufacturers reliant on the UK. Several sectors including electronics admitted extra challenges due to Brexit.

The struggles continued in 2021 with the next events:

- **The fire in computer chip factory** – Renasas Electronics factory in Japan caused an international harm with 23 machines being damaged in the factory. The production capacity was drastically reduced with 100 days delay to recover. The company had to outsource production from Taiwan. The main impact was on automotive industry. According to OICA (International Organization of Motor Vehicle Manufacturers) there was a 16% decline of the 2020 production, to less

than 78 million vehicles, which is equivalent to 2010's sales levels. This result takes automotive industry 10 years back.

- **The Ever-Given Blockage** – The ever given is one of the largest container ships in the world. It got stuck in the Suez, Egypt in March 2021 blocking completely the canal and carrying a trade worth 60 billion dollars. The total weight was 220.000 tons, and it took 1 week to unblock the Suez Canal. Due to blockage of whole traffic, the impact was caused to everything starting oil and ending clothing. The total amount of ships amassed counted to 321. Right after Covid19 pandemic, the supply chain was struggling due to lack of shipping containers meaning that re-routing of the ships could have caused more severe damage and delays up to 14 days.
- **Weather conditions** – Weather has not been cooperating with manufacturing in the last years and the drought in Taiwan in 2021 is an example how severe impact can be. In the first half of 2021, Taiwan was hit by the worst drought in the last 56 years (based on official Taiwan statistics). The water level in Baoshan No. 2 Reservoir reached 7 percent (the lowest level based on all records) and being the primary water source for semiconductor production, this caused even higher impact on the industry. Another example is the storm in US in February 2021 which covered 73% of the country in snow (based on data from AIR Worldwide Verisk). According to Bloomberg, weather disruption caused U.S. industrial production to drop by more than two percent in February, while manufacturing output dropped by 3.1 percent.

Main events of 2022:

- **Lockdown in Shanghai** – in March 2022 new variant of Covid-19 Omicron infected more than 10 thousand of people in Shanghai. Strict lockdown was implemented bring the situation under control. In coordination with the lockdown, China's authorities also mobilized enormous amounts of medical resources from outside Shanghai to support the city. In the frame of "Zero Covid" strategy applied by China; this lockdown made a huge impact on the global supply chain. The total closure was from February to August 2022. Firstly, Shanghai is the country's most important manufacturing base with most China exports produced. The lockdown led to product disruptions in the region and directly affected all exports. Secondly, Shanghai port functions to transfer China's shipments to the rest of the world. In this sense, a considerable number of shipments are not produced in Shanghai but in other places in China. As such, the city's lockdown will not only prolong the transportation time from factories to Shanghai port but also hamper the cargo processing at the port. Lastly, part of imports through Shanghai are intermediate goods which will be used as inputs to Chinese exports

in future. Therefore, the bottleneck problem in Shanghai will also affect the imports and hamper Chinese exporters' production, particularly in the form of processing trade (Huang & Xia, 2022).

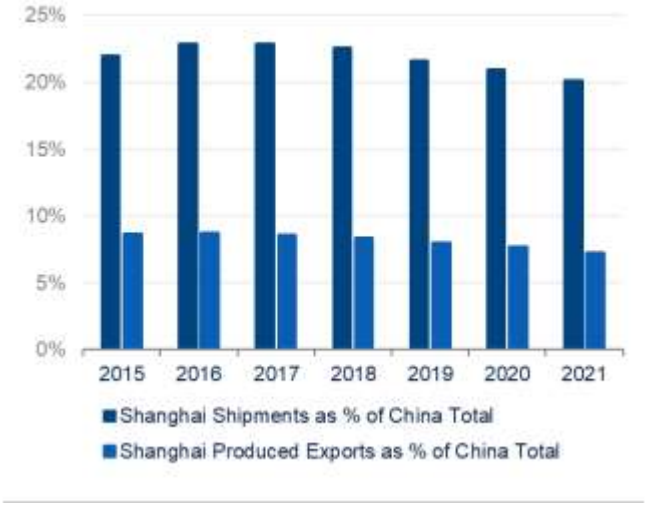

Figure 4: Market Share of Shanghai Produced exports and shipments

Source: WIND and BBVA Research

- **Russia's invasion to Ukraine** - on February 22, 2022, Russian President announced the decision to recognize the independence of the two self-reclaimed countries (DPR and LPR) and sent troops here to carry out "peacekeeping missions". Facing growing security risk after Ukraine is expected to sign a strategic military agreement with Britain and Poland, on February 24, 2022, Russian President continued to declare the opening of "special military operation" in eastern Ukraine, in response to an offer of assistance in ensuring security from the leaders of the two countries Donetsk (DPR) and Luhansk (LPR). In the eyes of Supply Chain, there have been faced the next issues:
    - The sea in Ukraine became inaccessible because Ukrainian and Russian military forces have blocked the entrance. This has resulted in a significant number of ships waiting to pass through the Kerch Strait. "70% of Ukraine's exports are transported by ships. The situation of transportation by air also started facing many similar difficulties. Ukraine's airspace got closed to civil flights and in combination with airlines avoiding flying over Russian airspace, the air freight costs went up, significantly reducing the amount of goods moving through this type of transport.
    - Ukraine has long been the supplier of about 50% neon gas and 40% krypton gas to the world, these are two indispensable by-products in the production of electronic chips. Supply disruptions due to the current war limited this item from reaching manufacturers, making them very difficult to deal with component shortages, late deliveries, and higher raw material costs.

- Payment issues which arose due to Russia being excluded from the SWIFT caused issues in fulfilment of many contracts. The government, business associations and the business community itself needed to learn carefully about the US and EU embargo laws, and at the same time conduct an immediate discussion to avoid sanctions when violating the embargo measures.

The effect of Russia-Ukraine tensions on global trade is inevitable, as supply chain disruptions jeopardize the flow of goods around the world. The impact from this crisis on each industry will vary and depend on the duration of the stress, but they will certainly have a larger impact on global trade flows and supply chains (Nguyen Minh Ngoc et al., 2022). Looking at events discussed above, there was no real opportunity of supply chain to get recovered and businesses which have been suffering with lack of resources prior Covid-19 have experienced more severe impact than those starting crisis with available resources. The issues with transportation, cost of materials, lack of materials will not disappear in one day. Managers of supply chain need to have structured approach to tackle strategically faced issued stepping away from firefighting and focusing on more reliable chains. Key strategy to gain SC resilience is through diversification of suppliers and managing them proactively. Prior these events, many organizations been focusing on development of single sourcing as key to productive partnership, but sequence of events proved that to ensure continuity, it's important to have multiple sources of supply. It is more complex task to manage several suppliers, but they eliminate the vulnerability caused by single sourcing and getting the right balance between these two strategies is crucial (Jemimah Maina & Hannah Wambugu, 2021).

5.4 Machine learning and digitalization in supply Chain

An important and ongoing topic in supply chain management (SCM) is the need to make complex decisions. Furthermore, supply chains are populated by uncertainty and information imbalance. Simply stating, decision-making processes in SCM depend on assorted, unmanageable factors that are blocked by information barriers. The volume and variety of data are constantly increasing, and there is new data available with every day. Trying to be analyzing this data with the use of traditional methods is inefficient or even impossible in many cases. For this reason, new methods and applications are emerging from the field of advanced data analytics

(ADA). One of these methods is machine learning (ML), which deals with the development and application of self-learning algorithms. Many companies have recognized the potential of ML in SCM and, therefore, make their data available for scientific analysis. In addition, publicly available data is often used in analyses with ML to gain new insights in the research area of SCM (Kersten et al., 2021b). Machine Learning relies on different algorithms to solve data problems. The choice of the right algorithm defines the result of data analyses. Data scientists state that there is no single one-size-fits-all type of algorithm that is best to solve a problem. The kind of algorithm employed depends on the kind of problem on the table, the number of variables, the kind of model that would suit it best and so on. There are three main types of algorithms defined: supervised, unsupervised and reinforcement learning (RL). Supervised learning is the machine learning algorithm of learning a function that maps an input to an output based on example input-output pairs. It assumes a function from labelled training data consisting of a set of training examples. The supervised machine learning algorithms requires external assistance. The input dataset gets divided into train and test dataset. The train dataset has output variable which needs to be predicted or classified. All algorithms learn the pattern from the training dataset and apply them to the test dataset for prediction or classification (Mahesh, 2019). Unsupervised learning methods take a collection of data with only inputs and detect structure in it, such as data point grouping or clustering. The algorithms learn from test data which is not classified or labelled. Unsupervised learning algorithms searches for common things in the data and responds depending on defined or not defined matches in each new piece of data. The key application of unsupervised learning is calculating the probability density function which is the area of density estimation in statistics. Simply stating, unsupervised learning comprises various domains that need to be summarized and explained in data aspects (R et al., 2021).

Reinforcement learning helps agents to interact with their environment in an efficient manner, giving opportunity for consecutive decisions to be made. It promotes behavioral decision-making via usage of interaction experience and the subsequent evaluation received feedback. The agent chooses an action based on the current state and receives evaluative feedback which can define the new state. It attempts to learn an optimal path to improve quality of the feedback it receives over time by acquiring knowledge from its experiences and not through any instructions. RL is distinct from classical supervised learning, which makes extensive use of labels and exhaustive signals. RL relies on optimized sequential decisions (Dridi, 2021). Many industries, such as IT, automobile, and manufacturing, are taking advantage of AI and ML's capabilities. However, there are still numerous areas where their potential remains

aside. Industry 4.0 technologies with integrated AI and ML, may be combined with each stage of Intelligent Supply Chains (Supply Chain 4.0 or Supply Chain Digital Transformation) to attain a certain level of maturity might be a further research dimension (Rana & Daultani, 2022). Digital supply chain has several features: speed, flexibility, global connectivity, real-time management, transparency, scalability, innovation, proactivity, sustainability. Speed: refers to the speed with which goods are delivered, which is important for all DSC participants. The implementation of technologies like Internet of Things, Artificial Intelligence or blockchain helped to set up intelligent logistics operations that have reduced inventory costs. Released money are redirected to faster and more reliable deliveries. The study done in May 2022 by Dieaconescu, R. I., Belu, M. G., Paraschiv, D., & Joldes, C demonstrated that the main obstacles in implementing SC digital transformation strategies are:

1. lack of specific skills (41% of respondents)
2. fear of change (28%)
3. quality of data (34%)
4. rigidity of existing technology (28%)
5. uncertainty of economic environment related to the pandemic (28%)

A similar study conducted in 2019 identified fear of change, data quality/lack of data and risk aversion as top three obstacles that respondents consider important setbacks to their company's SC digital transformation (Dieaconescu et al., 2022). The report from Gartner from 14th of April 2021 shows that about 50% of major global companies will invest in technologies to improve supply chain visibility. It means that other 50% and smaller businesses will not proceed with any impactful supply chain digitalization. In addition, report states that by 2024 less than 5% of companies will deploy supply chain control towers. Confidence in supply chain data starts with confidence in its precision and recency. This is the foundation for tackling market volatility through predictive analytics and agile management of inventory. Data accuracy also contributes to overcoming compliance concerns with regulatory bodies (Bouguin, 2022).

5.5 Expediting within supply chain

Customers are normally classified into different priority groups based on their delivery time requirements, contractual obligations, margin levels and so on. Customers with higher level of requirements and strict delivery dates, penalties would be assigned with a higher priority.

At the same time, customers with long-term supply contracts usually receive a higher priority from their supplier over regular customers. Even if the price is same for different customers, the transportation costs and terms will vary for different segments, which results in different profitability for one or another party. Term “expediting” is widely used in several areas including manufacturing, logistics, procurement, project management etc... There are present different meanings and applicability can be brought out from high variety of situations. To reduce the costs coming from backordering, especially for high-priority customers, companies often apply inventory expediting from multiple locations in their supply chains. For example, expediting the delivery of partial or complete orders through either additional control or change of freight types such as application of air freight instead of sea freight. Inventory expediting is also commonly adopted to reduce supply chain costs for the equipment manufacturers and the service parts industry (Shen et al., 2018). Generally, word “expediting” can be explained as the way of control with purpose to control that process is on time or to speed up the process having it executed promptly. The term was introduced in early 2000s when the actual meaning of “Supply Chain and Logistics” was introduced. In the beginning, expediting was used purely in logistics area. In simple words terms was defining the process of goods shipment faster than usual. In addition to faster method, it means also real-time assisted – expediting defines presence of the person who can be making quick reporting and updates or in our dates, the system which does real-time monitoring. Expedited shipping is applied in cases when delivery dates are critical, and its delay might cause higher costs for shipping or liquidated damage costs. A more expensive expedited shipment may be needed to meet shorter deadlines (Wei et al., 2020). However, in more complex manufacturing environment, it was identified that higher savings are possible if control over production by external source (customer or other third party) is taken on earlier stages than just logistics. This triggered implementation of supply chain expediting processes. However, taking few steps back, expediting process implementation within the company is a strategic move which requires the purpose behind. Strategy is fundamental for the future of the company. In the course of time, company changes its focuses and priorities which triggers shift of its strategy. As a loop of continuous improvement, supply chain of any company comes to conclusion at one moment of time that the biggest risk to the internal planning is coming from deliveries from their suppliers. Procurement planning system is divided into two parts: strategic sourcing and operative procurement. The moment when operative procurement takes the lead over production processes triggers implementation of expediting processes within organization. Expediting function within procurement is a

combination of project management with purchasing, logistics. In simple explanation, expediter is playing a role of supplier project manager controlling some key processes of their order execution and marking if any delay/risk is identified which can affect fulfilment of delivery obligations. Expediting is a concept of Risk Management with the key target to identify, prevent and mitigate delays in the sub-ordering, fabrication process and deliveries of purchase orders placed at suppliers. As mentioned earlier, the scope of expediting might be wide or narrow depending on company needs. The role of expediter starts normally when order is placed to supplier and lasts until the order is fully closed – expediter needs to follow fulfilment of all order aspects and report if any issue is identified. There are defined two main ways of expediting: desk expediting and field expediting. Desk Expediting is defined as office-based activities of monitoring the progress of Orders. This can be done via various means of communication such as telephone, email, or other communication platform (Microsoft, Google, ZOOM etc.). This provides a quick and easy method to be informed about the status of an order. Field expediting activities are defined as surveillance visits to the supplier's workshop or those of its sub- suppliers, with the goal to verify the actual status of the purchase order. These activities can either be physical visits performed by the expediter of the company or a third-party service agency, or a virtual visit conducted through any possible application. These days exist many different companies which offer third party expediting services due to all the struggles which have been faced in supply chain in the last years. The need of expediting is growing, and it also requires high level of flexibility of resources in this area. During literature review have been reviewed opened positions for expediting in different companies and below are examples of tasks which need to be covered by the person:

- Siemens – Expediter:
    - Ensure that the required due dates and interim acceptances in the suppliers' production schedule are kept
    - Enable close co-operation with relevant suppliers in the alignment of commodity suppliers' production schedules
    - Timeline by regular meetings with the supplier representatives
    - Material and purchase order tracking of relevant sub-suppliers
    - Monitoring of product status, analysis of deviations

- Hiring agency (customer is a leading manufacturer without name) – Supply Chain Expediter:
    - Contacting with suppliers daily, build good relationships to ensure high level service
    - Expediting orders with suppliers to maintain schedules and progress chase
    - Coordinate the movement of materials and be point of to advise order status and resolve issues accordingly
    - Running regular expediting reports to investigate overdue parts
- L3Harris Technologies – Supply Chain Expediter:
    - Ensure delivery dates are current and obtainable in the system
    - Closely communicates with suppliers to maintain industry best On-Time delivery standards
    - Coordinate part requirements and product needs between several internal groups

There are expediters required in different fields of application. In total have been found more than one hundred different vacancies with similar requirements as mentioned above. Expediting function is gaining popularity and it is only the beginning.

6 EXPEDITING WITHIN THE COMPANY – USE CASES

Expediting function is normally considered as evil, but necessary for many companies. Reasons to launch expediting include missed delivery dates, damages to stock, strict requirements or any supplier issues which cause impact to organization. Absence of formal process for expediting creates extra challenges. Under formal process are understood:

- Ways to communicate
- Frequency of communication
- Way of information recording
- Way of reporting

The quality of output strongly depends on the relationship between customer and supplier. If expediting process doesn't bring desired results, the next step will be an escalation. It is important that organization has a policy for escalation process otherwise expediting will not be bringing full benefits. Expediting is closely related to quality area and root cause analysis help to reduce problems in the long term (Here's Why You Should Pay Attention to Your Expedite Process, 2018).

During this thesis, focus to be done on mid-size company supply chain organization. There is a general term SME (small and medium-sized enterprises) used and according to statistics from European commission, it represents 99% of all businesses in the EU. Gradation of the company is very important to have access to the right support programs and financial resources (SME Definition, n.d.). The main factors determining whether an enterprise is an SME are

- staff headcount
- either turnover or balance sheet total

Company category	**Staff headcount**	**Turnover** or	**Balance sheet total**
Medium-sized	< 250	≤ € 50 m	≤ € 43 m
Small	< 50	≤ € 10 m	≤ € 10 m
Micro	< 10	≤ € 2 m	≤ € 2 m

6.1 Use cases summary

In the frame of this thesis have been done interviews of two people working in Supply Chain on management positions in two different companies. The questions discussed are include in appendices. Below is the general information about companies:

Case Company	General description	Interviewed Position	Supplier Locations, main struggles of Supply Chain	Does it have expediting?	Output of discussion
Company X	Company is working in electronics industry. Main customers are from automotive, telecommunications, civil sectors. Employee count below 300, turnover of the company around 45M Euro.	Sourcing Manager	China, Europe, India, Bulgaria, Ukraine Main difficulties are raised logistics costs and lead time increases due to market tension which leads to loss of business or margin and consequently cut of costs.	No	There is the need to enforce supplier management process including supplier development. Expediting function is discussed on management level, but not integrated into process yet.
Company Y	Company is working in civil sector. Big corporation with offices in many different countries including Estonia. Employee count above 3000, turnover of the company is more than 2B Euro.	Supplier Development Manager	Asia (China, Taiwan, Japan) Europe (Main Germany, Estonia, Poland, France, Czech Republic etc.) Main difficulties are limitation of raw materials on the market which leads to longer lead times and higher efforts. Weak financial situation of suppliers and their organizational changes which affect execution of orders.	Yes	Suppliers are managed on good level, there is no need to improve the process, but mainly required more suppliers to have bigger leverage in negotiations.

Figure 5: Table of Company Use Cases

6.2 Use case of company X

One of the companies was physically visited to perform an interview and analyze its structure. Company name is not disclosed due to privacy reasons. Below is presented an example of process map of this organization (some information which is not related to thesis scope is hidden):

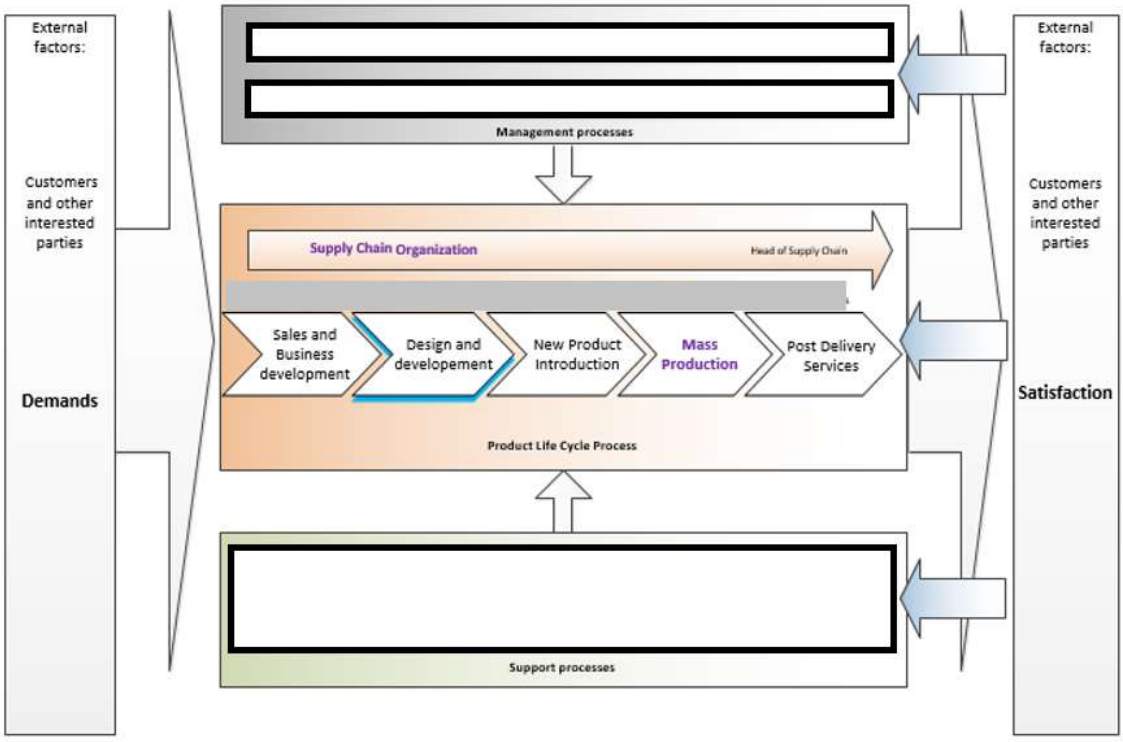

Figure 6: Process Map of one SMEs

This kind of process map demonstrates that Supply Chain process covers every single step of production and participates in full in product life cycle. Further Supply Chain Organization is split into 4 sub-processes:

Process Name	Sub-Process Name
Supply Chain Organization	**Customer Demand** **Production Planning** **Sourcing and Procurement** **Warehouse and logistics**

Figure 7: Supply Chain Organization Sub-processes

In customer demand work customer demand specialists who is responsible for:

- Communication with customer
- Reception of customer orders and its analysis
- Uploading orders into system

Under production planning work planners who is covering the next tasks:

- Short term planning
- Midterm planning
- Demand analysis

In sourcing and procurement (S&P) work buyers who is covering the next tasks:

- RFQ process
- Negotiations
- Placement of Orders
- Control of order until delivery

In Warehouse and Logistics work logistics and other people and perform are responsible for reception and shipment of goods.
Expediting function is not implemented within this company. Doing company analysis, it was identified that expediting tasks are not even mentioned in any of company procedures and not described under any task. However, buyer is responsible for recording and monitoring of any variations in delivery dates. During review of S&P process within this organization, the next activities have been officially recorded under its performance:

Suppliers	Input	Process	Output	Customer
Who do the inputs to the process come from?	What "thing(s)" go into the process to generate the output?	Step by step tasks that apply inputs to make output and bring value	What does the process generate?	Who receives the output of the process?
Please name involved parties (person, group, title)	Please name things which used for input (no actions)	Action which is performed step by step	Please name things which are received at output	Please name involved parties (person, group, title)
		Sourcing and Procurement		
Planning	MRP, Inventory Parameters	Forecasting	Item Forecast	Supplier
Planning, Source of Request	MRP, Inventory Parameters, Requirement	Issuing Purchase Orders	Purchase Order	Supplier
Supplier	Acknowledgment	Confirming Purchase Orders	Component, Delivery Date, Price, Quantity	Procurement, Planning
Planning	Exception Messages	Rescheduling Purchase Orders	New Delivery Date	Supplier

Figure 8: SIPOC of S&P process

Above figure is presented in SIPOC format. SIPOC is the quality tool widely used in quality systems to structure the processes into its tasks. This tool lets the used see who uses the process and what process generates as inputs and outputs. Using SIPOC diagram, companies can identify "waste" processes which are not bringing any benefits to any other process, but only use resources. The company uses SAP as their

ERP system. During the visit sourcing manager explained the way control of delivery dates is performed and here is the short description of the process:

- Sourcing receives confirmation of lead times from the supplier and defines supplier which is used for PO placement
- Procurement places an order and defines delivery date
- Supplier returns order confirmation and provides the date which is feasible
- If date matches requested delivery date, then buyer marks it in the system and deals with another order
- If date does not match with requested delivery date and is later, then buyer contacts the project and verifies the date, speaks with sourcing to double check situation. If date does not satisfy the company, then buyer requests supplier to advance the process. Otherwise, confirmed by supplier date is recorded in the system.
- When final confirmed date is recorded in the system, then planning team takes the lead and follow the date.
- If production requires material earlier, then request comes to buyer, and it triggers another communication loop.
- Around 1 week before material delivery, buyer contacts supplier to check if items are ready for dispatch. If supplier says that goods are delayed, then buyer updates the system with new date. This information gets directly to planning team and they change production schedules.
- In case there is no possibility to adjust production planning, information gets escalated to higher level and Sourcing Manager gets into loop to communicate with supplier.

Explained above process demonstrates that company follows standard supply chain organization process which is focused on buy/sell concept. Company is limited on resources and has high order intake ratio. It means that resources in supply chain organization cannot fit any additional activities like regular expediting. Company follows its KPIs and in relation to supplier, it follows Supplier OTD. The target is defined as 90%, but currently actual values are varied around 85-91%. On the other hand, company follows Customer OTD, and its target is defined based on customer request and equals 95%. The actual value varies from 86 – 91%. This comparison clearly shows that company does not receive enough goods on time from their suppliers to meet customer expectation for delivery. During discussion with sourcing manager, the other reasons for low customer OTD were defined which come from production process itself. However, it was clearly mentioned that company faces issues with punctuality of their suppliers, but it not able to put extra resources into monitoring.

6.3 Use case of company Y

Another company was physically visited to perform an interview and analyze its structure. Company name is not disclosed due to privacy reasons. This company is not a mid-size, but a big corporation. Below is the extract of its Supply Chain Organization (some information which is not related to thesis scope is hidden):

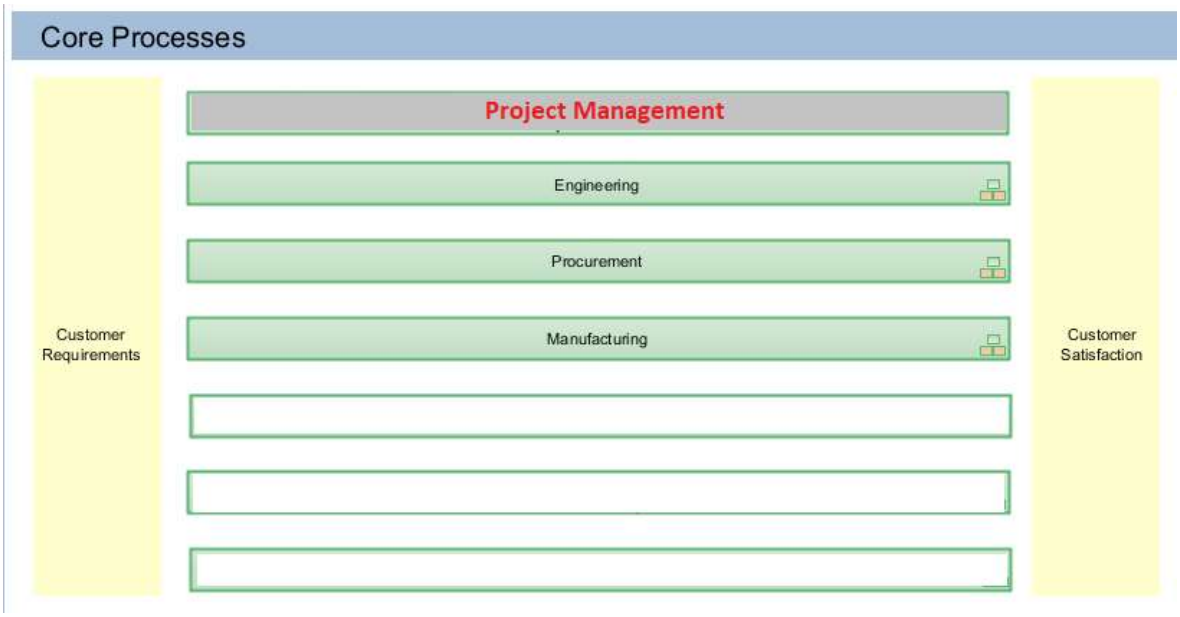

Figure 9: Process Map of Company Y

This company does not use term "Supply Chain Organization" but uses only term "Procurement" to define its supply chain process. Procurement organization further is split into next functions:

- Purchasing
- Expediting
- Logistics

Purchasing process is consisting of buyers and responsible for RFQ, negotiations and order placement. Expediting process is consisting of expediters and responsible for whole execution after order placement. Logistics is responsible for goods transportation. As a difference in comparison to Company X, this organization has separated "expediting" as a function within its quality systems and has assigned expediting tasks to separate people. This company does not have SIPOC diagram, but it has all processes clearly defined and

procedures are created with rules and guidelines for every activity. This company also uses SAP as their ERP system and order placement, and control process is described as below:

- Procurement negotiates terms of delivery with supplier and gathers defined lead times
- Risk assessment process is done for every order to verify if terms match project needs. The supplier with lowest risk receives confirmation in RFQ process
- Buyer places an order, defines delivery date based on negotiated lead times and defines responsible expediter. Every order receives assigned expediter. It is an obligatory step.
- Order is distributed to expediter and supplier. When expediter receives an order, he enters communication loop with supplier.
- Expediter receives confirmation of delivery date for supplier.
- If date matches requested delivery date, then expediter marks it in the system.
- If date does not match with requested delivery date and is later, then expediter contacts the project and verifies the date, speaks with buyer to double check situation. If date does not satisfy the company, then expediter enters communication loop with supplier to improve delivery date. Expediter has several ways to impact supplier. If no way is successful, then situation gets escalated.
- Expediter keeps contact with supplier of monthly/bi-weekly basis (depending on lead time) to receive updates of execution. Expediter follows order schedule, milestones, forecast date compliance.
- If production requires material earlier, then request comes to expediter, and it triggers additional, more strict actions from expediter.
- Expediter keeps updates in the system after every contact with supplier and if any delays are identified, they are timely monitored.

This is shortly described process to point out the main difference between company X and Y. Due to availability of expediting function, there is separate resource who keeps contact with supplier on periodical basis (it is part of their quality systems process) and updates internal system as soon as delay is identified. Company Y is a customer of company X. The order which Company Y places to Company X includes the statement that reporting of order execution should be done on periodical basis and it is related to sub-suppliers. Meaning that due to absence of defined process within Company X, there is a risk of non-compliance to customer requirements. Company Y also monitors its KPIs and Supplier KPI target is defined at 70%. The actual value is

between 75% to 85% which is above the target. Company Y is an OEM, so no Customer OTD is followed. During interview, it was mentioned that additional control of suppliers via expediters helps company to adjust their planning on time and be ready to shuffle activities without direct impact on manufacturing. It was also highlighted that there have been found correlations for logistics that when information about material readiness or delay is reported, then summarizing received data, it is possible to plan activities in cheaper way in advance to have everything well delivered.

6.4 Comparison of company X and company Y

Both companies have been visited with the same purpose to analyze their procurement process and understand the main steps taken for order execution. During interview Company X stated that they cannot fully rely on their suppliers and Company Y said that they have their suppliers under control. Interview results are available under attachments with all questions/answers included.
Based on defined above use cases, the next outputs can be brought out:

- Due to company size difference, there is a clear gap in number of instructions/guidelines available for employees. Company Y has almost every step documented which allows its workers to perform tasks in smooth and clear manner. Company X does not have that detailed procedures and most scenarios are not explained. It was also discussed that it takes much more time to solve extraordinary situations for Company X due to lack of contact with suppliers and last time notices.
- Due to unclear responsibilities in case of extraordinary situations, there happen a lot of "ping-pongs" between employees' prior someone agrees to perform one or another task. Suppliers do not see Company X as their key customer due to rare cases of communication with procurement department. Company Y on the other hand is presented as key customer for Company X due to high demands and requirements for information sharing. Company X takes orders of Company Y on prioritized list because they are aware that if order is delayed, then it will trigger extra loop of communication, meetings, and reporting. Company X during interview also mentioned another customer who does not have expediting function in place and does not demand any extra reporting about execution. Delivery rate to that customer is below 70%.

- Company Y with expediting function in place meets its target for supplier OTD and even has it higher. Even though the actual target is smaller than company X, but complexity and amount of equipment is higher which let's you make 1 to 1 comparison. Company X on the other hand it is falling often below its Supplier OTD target and can hardly meet it on monthly basis. Company X mentioned that during investigation of root causes, they see demand in more strict control of their suppliers and are working on the process to implement it.

Summarizing stated above and topics reviewed during academic reading, it gets clear that frequent communication with suppliers improves performance of the company and helps to increase turnover/profit. There are many benefits of good relationship with suppliers for customers, but the most important are:

- Prioritizing of order execution
- Increase of efficiency and more attractive prices, better lead times
- Better control of production process to meet customer expectation
- Higher trust and openness in discussions and technical clarifications

Mentioned above even not directly, but indirectly bring to business growth. Talking about continuous improvement loop and PDCA (Plan-Do-Check-Act) cycle, for example, there is always feedback included in any activity. The same is in procurement process. After every order execution, there is feedback provided by parties about quality and efforts taken during execution phase which might affect the decision if supplier receives new order or not. Repeatability of bad execution processes might trigger blocking of supplier in the panel and stop of the business. As mentioned earlier, these days competition on the market is big and there will always be found an alternative supplier who is ready to produce, deliver and the most important – meet customer expectation.

6.5 Use case of company Z

In the frame of thesis writing has been agreed additional interview with the company which is located on German market (company name is not disclosed due to privacy reasons). During interview of Company Y, it was advised by the interviewee to get in contact with this supplier and discuss their level of expediting as it was considered very valuable to see the full picture. Company Z is an SME. Its total turnover is slightly above 10M Euros and it

has 35 employees working. Company Y represents more than 70% of its turnover which means that company Y has direct impact on any processes which are done in Company Z. Company Z has patented special product which is very critical for the market segment that Company Y is delivering. Based on information received from the interviewee, this product is unique, and no other company can repeat the level of technical and quality compliance. However, when Covid19 started, Company Z lost several main suppliers and faced deficit of raw materials to run production which resulted in direct impact on projects of Company Y. This event triggered an escalation from Company Y. Company Y defined Company Z as a critical supplier and tightened its expediting process towards Company Z. Company Y received a "one face expediter". During contact with Company Z the next details were figured out:

- Company Y represents 73% of the total turnover
- Apart from Company Y, there are several other customers with biggest share of 7%
- 60% of company Z resources are working for Company Y orders
- In 2020 Company Y performed an audit of Company Z and defined a non-conformity which required to dedicate resources of Supply Chain team on control of order execution (in other words to put in place expediting function and process).
- During 2020 team was working on definition of the process for expediting together with support of Company Y. Company Z placed expediting only for Company Y orders
- The process of expediting was defined with the same functions as Company Y uses it

Discussion of benefits and drawbacks:

- ✓ One face expediting from Company Y triggered extra questions and control which demanded quick reaction from Company Z. Without dedicated resource and taken control down the supplier chain, Company Z would not manage to respond on time and provide updates.

- ✓ Expediter started working on sub-order monitoring for Company Y with task to follow updates on bi-weekly basis with all key suppliers (desk expediting). In the beginning, key suppliers were rejecting requests to provide updates on requested basis, but expediter kept calling, communicating the need, and asking for updates. After several months, suppliers adapted to request was prepared system internally to provide information. Based on feedback from the interviewee, they noticed internally higher commitment of sub-suppliers due to raised frequency of communication.

- ✓ During new negotiations with Company Y and lead time definition, expediter provides an input regarding current situation at the main sub-suppliers which helps to provide realistic promises to Company Y with strong argumentation behind – this helped in performance discussions and root cause identification in case of issues

- × As expediting was defined only for orders of Company Y, then sub-suppliers started prioritizing specific orders towards them to ease the pressure. At one moment, it resulted in high delay of order delivery for another customer which was not identified on time due to absence of communication. This triggered escalation loop with another customer. Company Z interviewee stated that partial expediting implemented for one customer was good for Company Z and Company Y, but company Z was not realizing the whole potential of this job. Escalation with another customer triggered internal discussions in Supply Chain and it was decided to widen the scope of expediting to all orders.

- × Company Z made internal investigation of their supply chain and realized that overview is missing. It blocked them from good analysis of internal issue. They made extra investment for their supply chain digitalization to improve order overview, they invested into expediting solution (used the same their customer uses) and this gave opportunity to have overview and comparison. An interviewee mentioned that it triggered extra discussions and negotiations with suppliers and with 2 years' experience they see benefits in their inventory levels and cash flows.

- ✓ Company Z confirmed that they keep expediting function and proceed working with their suppliers. They involve expediter now in qualification process of their new suppliers to extend the panel and have real time feedback to material groups.

During discussion with Company Z, the next statements have been admitted:

1. Expediting is necessary in the current market situation as it provides direct link to project scheduling. Absence of regular expediting result in time loss and consequently money loss

2. Expediting within buyer function limits resources and does not provide full information due to focus on order placement

3. Expediting as a separate function broadens opportunities to be closer to supplier, observe situation and perform analysis of reports more thoroughly. Expediter gets possibilities to challenge reports without thinking about additional tasks as order placement, negotiation of prices, lead times etc.

4. If expediter gets closer with supplier, then expediter can provide internally more inputs in decision making stages for new orders, frame agreements, resource allocations to jobs or even financial decisions (invoice payments).

6.6 Conclusion of use cases

Each organization which participated in interview admitted that expediting helps to take control over supply chain, but everything depends on the scope which is defined for the expediter. There is no possibility to achieve result right away, any process will require additional time. The newly implemented process might negatively impact the relationship with supplier, but in the long-term view, there will be improvements as actual developments will be happening from both sides. However, organization must be ready for process implementation and support this move until the end. If there is no support from the management with clear targets defined, then output might not be on the expected level.

On initial stages of implementation, it is important to have experienced resources within the team to guide and work into the right direction.

7 EXPEDITING IN ACTION

7.1 Expediting tasks

Talking directly about expediting tasks, then there is a list of possible activities to guarantee 100% load of the person. As mentioned earlier, there are two ways of expediting known: desk and field. If expediter is a separate function, then it normally combines both ways in one person. In this case, expediting activities include, but not limited to:

- Undertaking all reasonable actions to ensure that purchase order is adherence to on time delivery
- Communicate proactively and regularly with suppliers
- Keep close contact with internal stakeholders to be aware of any changes to orders
- Ensuring that there are high-quality and meaningful progress reports available from suppliers on periodical basis (depending on the order complexity)
- Review and ensure that progress reports match the contractual dates, delays are clarified and mitigated. Include into expediting sub-suppliers if necessary if delays occur on their side.
- Identify the needs for more strict control or escalation, demand “action plans” or additional measures in case of risk and issues occurred which affect compliance to delivery date
- Be aware of general situation at the supplier (their current problems) which might affect future orders and provide recommendations to internal stakeholders – participation in risk assessments.
- Keeping the system up to date and pass further information in case of any delays
- Perform field visits to verify that progress report information matches the reality
- Show presence to supplier on periodical basis to keep track of all orders and discuss faced issues
- Observe general situation at supplier and notice any variations/improvements to previous visits, share updates with internal stakeholders.

These are general tasks of expediting which are known in big corporations and are expected to go down the supply chain within all their suppliers, sub-suppliers. Looking at availability of different companies which offer third-party expediting services, it clearly shows that

demand is there. For example, company "Applus+" (www.applus.com) offers expediting services all over the World giving the next opportunities to the customer:

"Applus+ provides a proactive and cost-effective expediting service through our extensive network of experienced field expeditors strategically located close to major manufacturing locations throughout the world. A timely and effective expediting service helps to ensure that:

- Procured equipment is manufactured and delivered on – or ahead of – schedule
- Delays in the supply chain are minimised
- Where a delay has occurred, a contingency plan is immediately put in place to minimise its potential impact on the client
- Cost efficiencies are achieved and, where applicable, penalties are avoided as a result of time savings"

Apart from Applus+, there is company named "Bureau Veritas" (https://group.bureauveritas.com/markets-services/cross-market-services/procurement) which also included expediting services into its portfolio in recent years. Bureau Veritas provides the next statement about expediting on their website:
"Our services are based on proactive expediting assessments, conducted at the suppliers' facilities at pre-agreed milestones, to ensure documentation approvals, materials purchase, manufacturing progression, inspection and testing and preparation for shipment remain on schedule, to purchaser requirements (Procurement, n.d.)." To bring one more example, there is company named "Intertek" (www.intertek.com) which is also offers expediting all over the world with the next promise:

"As your expediting partner, we are your eyes and ears, working with every link in your supply chain to keep you on schedule. Our experienced, qualified professionals are strategically located in the world's most active industrial centers, ready to work directly with your suppliers to make sure your materials and equipment are delivered on time and to specification (Expediting, n.d.)."

Expediting demand does not come from complexity of equipment, but tensions in supply chain. There are several examples available in the industries, when whole project gets delayed only because of small piece (special bolt or nut) missing in manufacturing to complete the product. This means that for expediting can be no limitations put to the type of industry due to supply chain working same way in all directions. Being it food industry,

metal, plastic etc., there are always critical parts and non-critical. It is necessary to separate one or another in terms of efforts and resources put for expediting within the company, but it is also necessary to have expediting in place for both groups to keep the track.

However, it is not always necessary to keep expediting as a separate function within the company. Here are few examples of other functions performing expediting:

1. Procurement specialist (buyer) – After order placement keep in contact with supplier until order is closed. Limits: if there is new quotation coming, then buyer will be mainly focusing on the new order which can affect execution of current order.

2. Planning specialist (planner) – When order is placed and production plan is known, keep periodical check with supplier about delivery date. Limits: if there is an issue in production plan, then planner will be mainly focusing on the plan fixing which can affect execution of current order

3. Sourcing specialist – Due to good contact with supplier for quotation phases, then person can keep periodical checks and progress reviews with suppliers to compare their capability in comparison to quoting phase.

Considering above examples can be seen primary and secondary task of every function. Due to this, expediting functions can be done, but can the quality of expediting be guaranteed? Each function within organization works based on performance indicator. The difference between key performance indicators and performance indicators is that key ones are monitored department based and reviewed during Management Meetings, but performance indicators are monitored within departments and are reviewed directly by department lead with its team members. Closely, there is a topic of ownership being raised within the functions. It is important that each employee understands not just what his/her responsibilities are, but what they are owner of. In other words, which activity to they cause direct impact on and will be responsible to provide explanation in case of any issue appearing. According to ISO 9001 standard, every company is obliged to define the owner of each process – this is done easily by assigning department heads as process owners. However, based on above process maps of companies, there can be seen that main process has its sub-processes. But who is the owner of sub-processes? The answer here: direct executors (buyers, logistic specialists, planners etc.). The head of department is obliged to define who has direct impact on which function and to guarantee strong cooperation within

the team, there should be defined performance indicators for each party based on their primary functions. Talking about buyer: their primary function is to place purchase orders. It means that performance indicator can be either: number of orders placed on time (inside project schedule) or ratio of cost saving in comparison to project budget. These are just examples. However, the main indicator for deliveries in supply chain is always OTD (On Time Delivery) and it is often defined as Supply Chain KPI, but who really takes the main lead of control and improvement of this parameter? Thinking about its performance, delivery accuracy from suppliers is not really in the power of customer to control it and impact, but it can certainly be improved by taking the lead over execution, directly through expediting of suppliers and their development. Meaning that the true ownership of OTD level (or as alternative "amount of days delay") can be put on expediting shoulders.

To summarize stated above, expediting is about schedule control – forecasting as a primary function. The main target is monitoring of forecast dates and mitigation of any impacts. There are several possibilities to implement expediting within organization, but dedication of resource will bring additional benefits and lets organization to enlarge the scope of expediting from pure forecasting to actual improvement and control.

7.2 Types of expediting and their impact

Expediting might be done with focus on different areas. For example:

1. Purchase order number based → any purchase order placed to any supplier gets assigned to random expediter who still has capacity
2. Project based → any purchase order within specific project gets assigned to specific assigned for the project expediter
3. Supplier based → any purchase order of specific supplier gets assigned to specific expediter who deals with mentioned supplier

The decision orders get assigned depend on the final targets company wants to achieve. At initial stages of expediting process implementation, the most standard way is to assigning

orders randomly depending on workload of different expediters. The view of expediter is purely purchase order based and its support is limited for any new projects. Random orders expediter gets integrated the least into processes and has the least possibility to build close contact internally or externally due to high variety of workload.

If orders are assigned project based, then expediter has possibility to align materials within the project and if materials from one supplier depend on materials from another supplier get delayed, expediter might adjust internal planning to focus resources on more critical parts. Depending on the project size, the separation project based might be additionally done material group based. Even through expediter is not responsible for technical aspects on materials, it is always a benefit to have awareness of specific materials for lean execution. Expediting activities project based mean that expediter is very aware of project requirements and can quickly help to supplier in case of any questions related to project without involving other parties. Expediter with project-based separation has possibility to get deeply integrated into internal project execution. In addition, project based split let's expediter see which exactly requirements of the project are the most difficult for different suppliers and have these risks mitigated in advance with other suppliers. It helps to save time and benefits execution processes.

However, when division of orders happens supplier based, then company demonstrates its clear target for supplier development. This way of order splitting is named "One Face" Expediting. One face expediting requires from employee additional knowledge about supplier development aspects, quality aspects, skills of strong negotiation and ability to see big pictures. Supplier based order assignment way is considered as the most advanced in expediting as it happens cross project and keeps link within and outside the company to one person. It enforces control of supplier, eliminates any grey areas in supplier processes due to constant contact and raises level of confidence for the project.

One Face Expediting method is applied for specific suppliers which are key for organization either because:

- Supplier is single source
- Goods are high value and special design
- Goods delivery is critical for project milestone and might result in high penalties
- Variety of goods is too high from one supplier

- Other criteria considered valuable by the company towards its supplier

One Face Expediter has additional goal – development of supplier. It is an interest of expediter to improve supplier performance, so expediter is presented as key contact and in addition to standard tasks, is required to handle management meetings, discuss root causes, and discuss solutions and lessons learned to be sure that every new project is better than previous. On the other hand, one face expediter is a valuable interface from supplier to company processes due to ability to trigger internal improvements if well justified by their key supplier. One face expediting solution from the company is considered as the way to integrate external resource into supplier processes and have higher awareness of their status. In most cases, suppliers do not support this idea on initial stages, but the main purpose of one face expediter is to convince supplier that expediter is on their side. One face expediter spends most of its working time with supplier which also triggers the wish to protect supplier internally and demonstrate its strong points. Due to one face expediter working on different projects, it allows to apply lessons learned cross project and spread them to different teams internally.

To summarize stated above, the type of expediting to apply depends on the business area and final output which company wishes to achieve by implementing it. The most used types are project or supplier based as it provides benefits to the company. However, if company simply desires to have control over the orders and does not want to develop any deep connection with specific supplier or does not consider project as critical, then standard order-based expediting is the right choice.

Building expediting in the company, it is good to consider all mentioned above types within the team and depending on the situation, to perform shuffling of resources and assignments.

8 EFFECTIVENESS OF EXPEDITING – DATA ANALYSES

8.1 Introduction into data analysis

Any statement raised must be proven in quantitative manner. Previous chapters of thesis including soft facts which confirm the benefits of expediting process implementation. However, any business decision must be proven with values. There will be no investment done into any project with only soft facts being on the table. As the main activity of expediter is communication with supplier, then any key performance indicator related to supplier which demonstrates supplier's ability to execute the orders can be evaluated in relation to quality of expediting process in place. During data analysis focus is on three main things:

1. On Time Delivery percentage
2. Number of deliveries
3. Average days of delay

On time delivery indicator demonstrates ability of supplier to be meeting contractual dates. Sometimes the reason for delay is outside of supplier responsibility and occurs due to unpredicted circumstances. This is normal process in supply chain, but the most important in these situations is how exactly it is managed. Number of deliveries has impact on total ability of supplier to allocate resources. Meaning that the more parts need to be delivered, the higher chance of delay is there. Average days of delay demonstrate how well supplier might mitigate the issues which are faced in production or procurement stage. Delay in days demonstrates to customer reliability level of processes at supplier side. It demonstrates if supplier can mobilize extra resources when issue happens as well as demonstrates level of control. The longer the delay in days, the less interest customer has to place new order to this supplier and the higher the chance that customer is impacted with additional penalties. Measurement of the On Time Delivery without measuring Average delay in days does not provide full picture. Demonstrated data is taken from actual company and shows specific suppliers which are not named. Each presented graph has explanation of the actual expediting level which is assigned to supplier.

8.2 Data analysis without expediting in place

Below are presented four graphs from one company and deliveries to this company from one supplier. Graphs include information on quantity of parts delivered and OTD percentage per month.

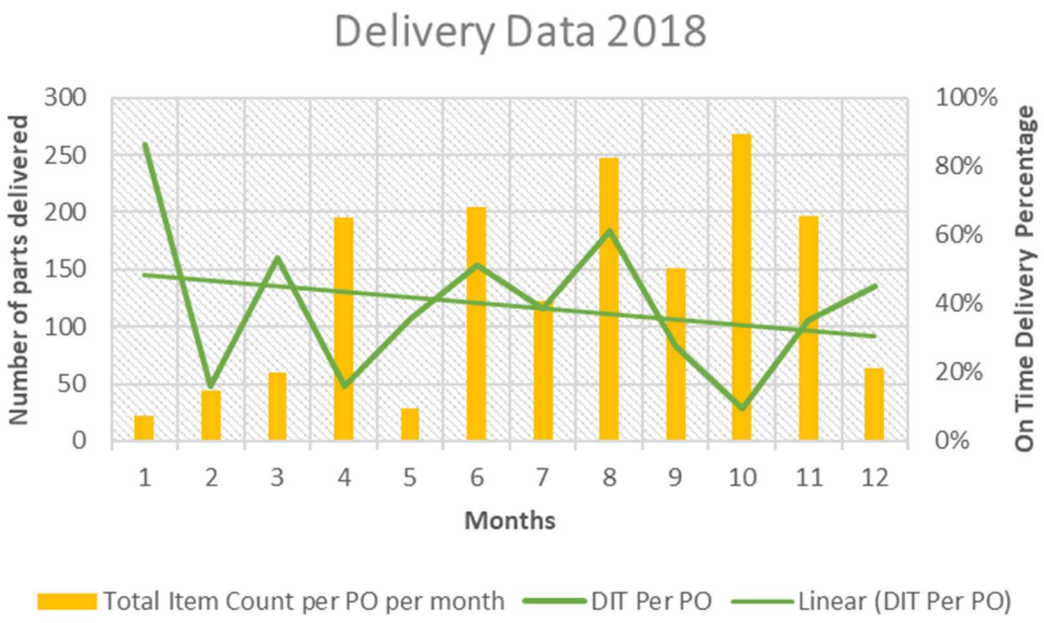

Figure 10: Delivery Data 2018 – no expediting

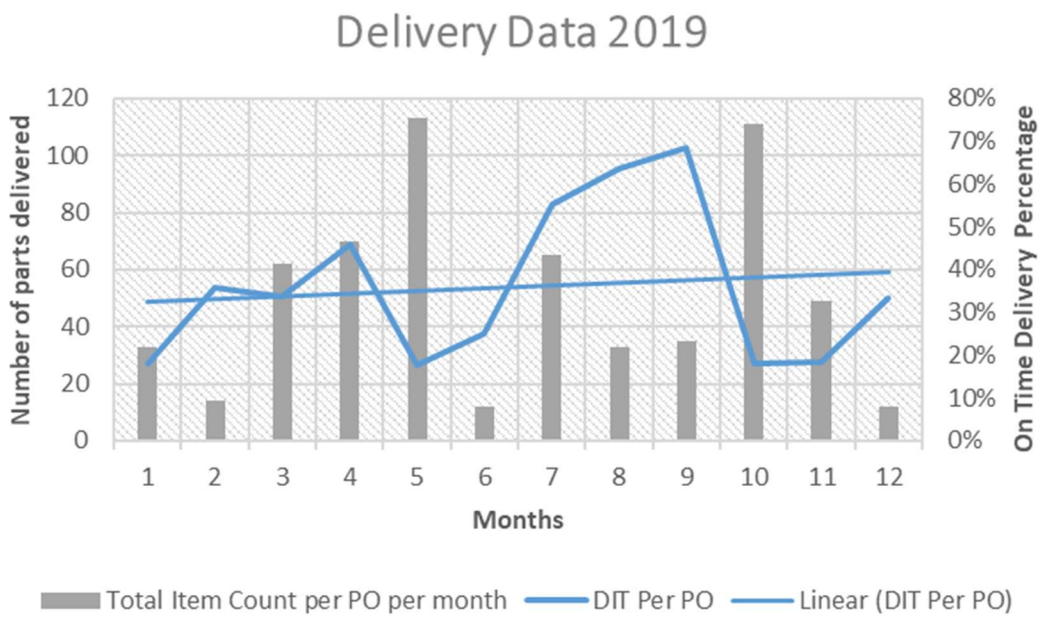

Figure 11: Delivery Data 2019– no expediting

Presented above graphs show that in 2018 delivery data for supplier was varying from month to month, but the trendline is going drastically down by ending the year below 40% delivery accuracy. The year 2019 was started at the same level, but supplier was not able to fully recover deliveries during the year ending 2019 on the same 40%. The company decided to implement expediting activities for the supplier and decision was taken to have "One Face" expediting. The process of expediting started from mid of 2020 and below graphs shows its outputs.

8.3 Data analysis with expediting in place

Expediting activities with supplier were first focused on improvement of situation of deliveries and targeted on satisfaction of project needs with material supply. The expediter was new for supplier and never worked together before, but the process of expediting was familiar to the expediter and already experienced before with another supplier. Based on the data below, the delivery accuracy improvement is clearly visible. The years of data are 2020 and 2021. These are the years of the biggest Covid-19 crisis. However, tight contact with supplier and communication clearly improved general performance.

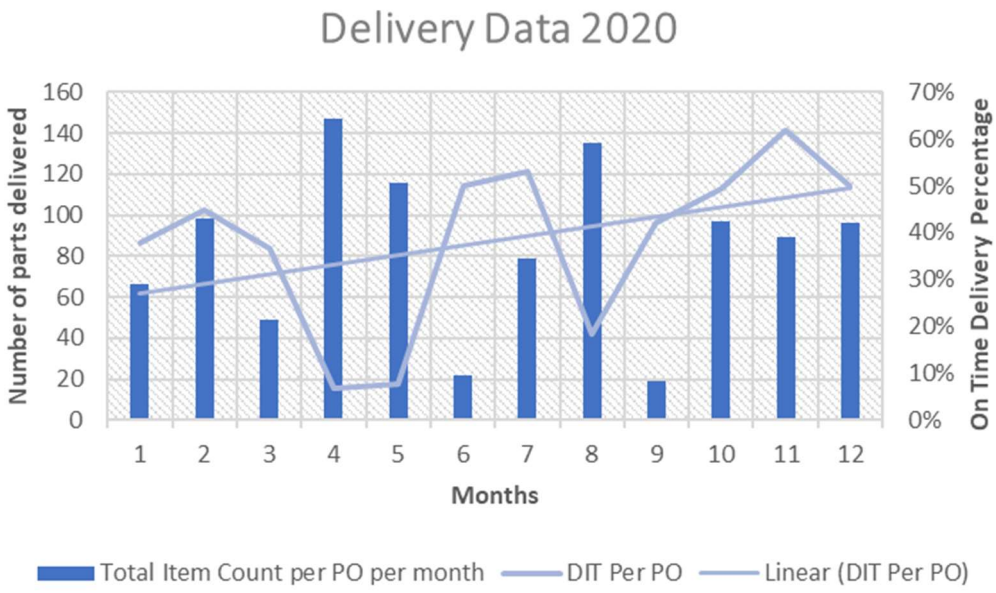

Figure 12: Delivery Data 2020 – with expediting

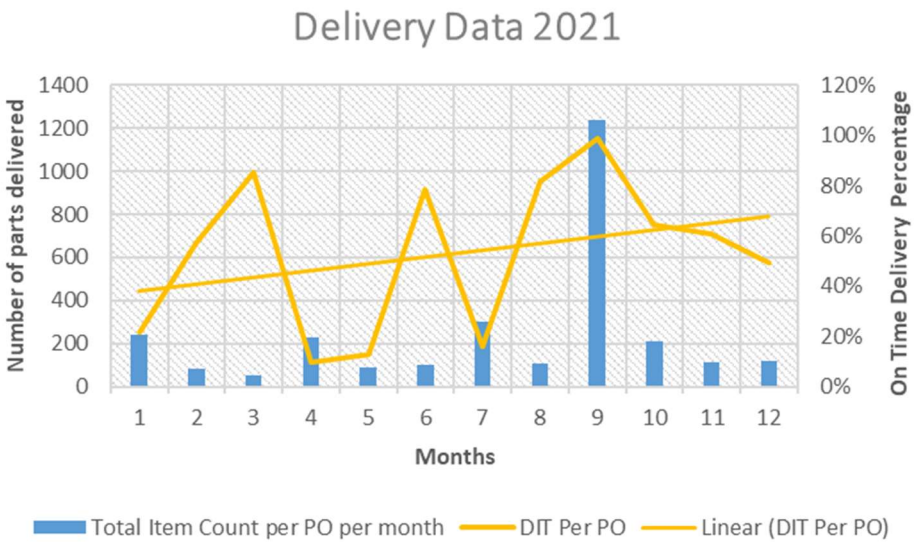

Figure 13: Delivery data 2021– with expediting

Year 2021 was closed based on trendline on data around 80% which demonstrates improvement by almost 40%. Year 2022 was very tough for all businesses which certainly caused impact to delivery accuracy. Below is demonstrated data from the same supplier for 2022. The reduction of delivery accuracy is visible. However, one face expediting approach helped to keep data at the level of 60% which is higher than concept without expediting.

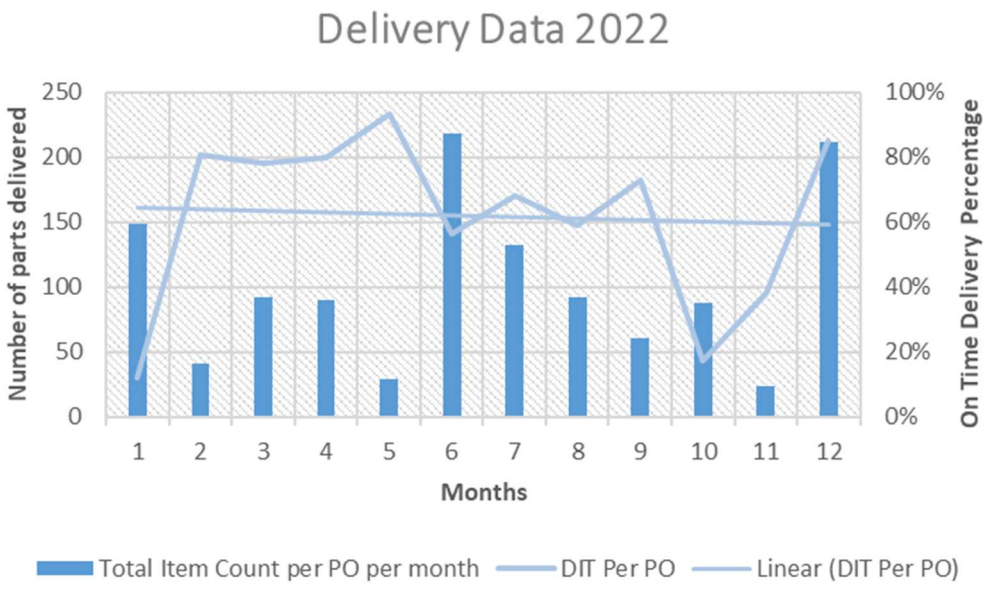

Figure 14: Delivery data 2022 – with expediting

8.4 Data analysis with expediting type change

Below is demonstrated alternative data from another supplier. Presented below supplier was under expediting since many years, but this supplier was expedited standard way based – assignment of purchase orders to different expediters based on workload. However, during supply chain crisis, this supplier was defined as key and "One Face" expediter was assigned in the first quarter of 2021.

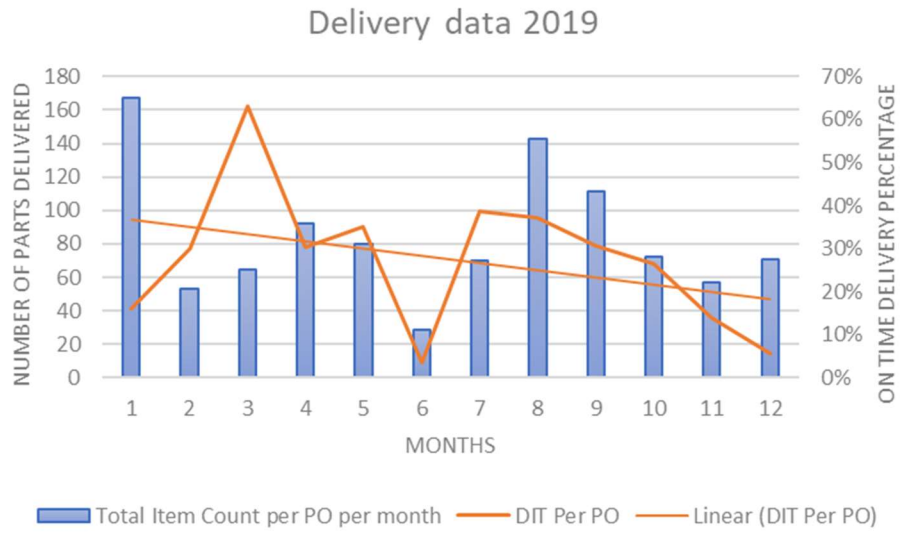

Figure 15: Delivery data 2019 - standard expediting

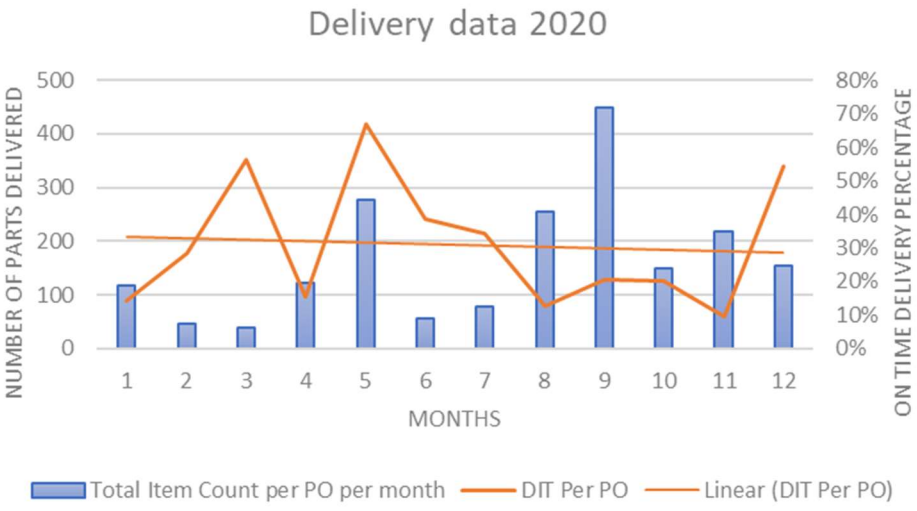

Figure 16: Delivery data 2020 - standard expediting

Two above graphs show trendline going down with delivery accuracy varying between 40 and 25%. Expediting was in place during these years, but expediting purpose was simply to monitor delivery forecast dates and recording of them in the system. As

described under chapter 6.7, this type of expediting does not let expediter to develop any personal approach to supplier and is not linking expediting activity to supplier development process.

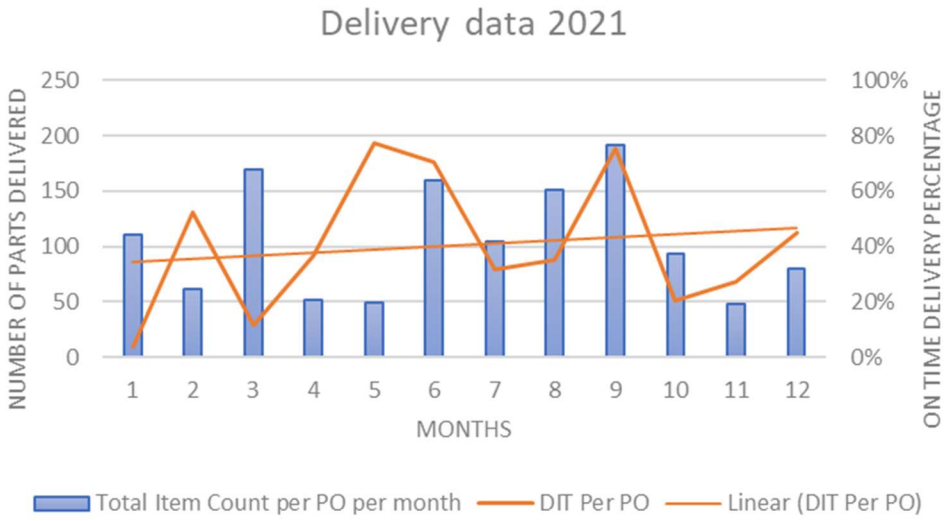

Figure 17: Delivery data 2021 - one face expediting

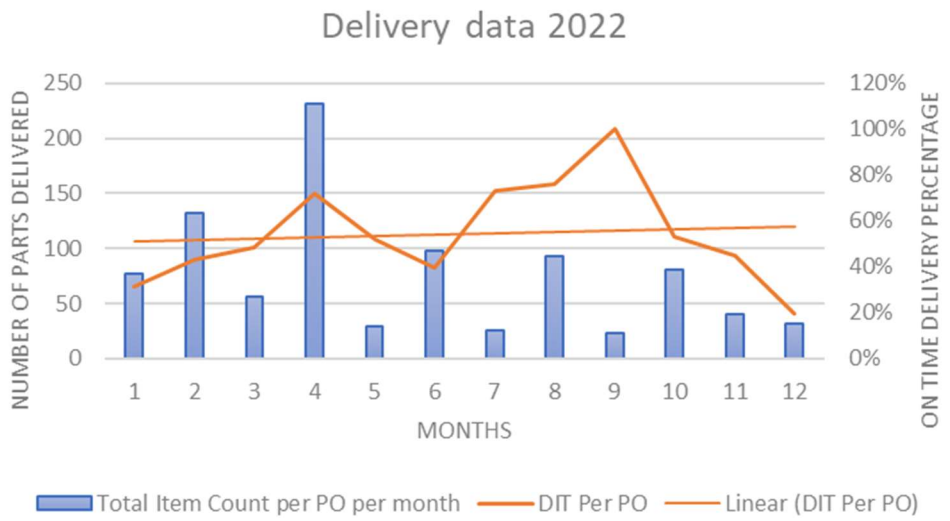

Figure 18: Delivery data 2022 - one face expediting

Two above graphs demonstrate trendline going up and delivery performance improving with year difference. One Face expediting is focused on personal approach development, support of supplier in all aspects and honest communication from both parties. The process of supplier development is ongoing as it is demonstrated to bring benefits.

8.5 Conclusion of data analysis

To summarize, graphs show that expediting in process is better for the company than absence of expediting, but it is very important to choose the right type of expediting for the right supplier. Graphs demonstrate improvement within 2 years of expediting usage. The longer the process in in place, the easier it is for both parties to achieve desired result. Strong partnership needs to be constantly supported and it gets verified only after many years of working together. Graphs also include data for quantities of parts delivered to the customer and directly there is no link identified to quantity delivered vs delivery accuracy evaluation. On the opposite some lines on the graphs demonstrate that higher volume of delivery resulted in higher delivery rates. The reason behind is not hard to be explained. Higher volume of deliveries with high chance means higher turnover for the company at this period. It means that extra resource to be added to meet the dates. However, it means also that customer is more dependent on delivery due to volume increase which triggers extra expediting. This is a constant cycle. Another important aspect which is not demonstrated on the above graphs but is directly used to describe "good" or "bad" expediting. It is number of days delivery was delayed. The On Time Delivery is normally measured with some threshold which each company defined for itself. For example, if parts are delayed less than 7 days, then they are "On Time". However, as soon as part is defined as "Not on Time", then it surely makes difference if delay is 10 days in total or two/three months. If supplier needs to pay penalty due to goods delay and situation with the order reaches the maximum penalty line, then supplier will not himself prioritize products anymore and only expediting can have impact on this process. It depends on the organization which level of leverage is given to expediting function. It might be withheld of invoice payment, reduction of supplier rating, withhold of new order etc. Good expediter will always find the right way to handle negotiation process with supplier independently of the situation and achieve desired for the company result. There is a practice within some organizations that expediter does not really focus on OTD of supplier, but purely on actual need dates of materials which in many cases are not directly linked to contractual delivery dates. This process is often used during project based expediting due to vision of whole project picture and knowledge about status and delays of all suppliers.

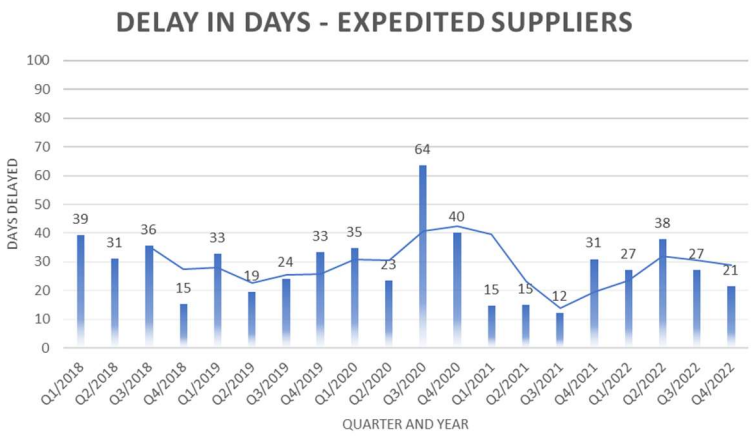

Figure 19: Delay in days with expediting process

Above graph shows variability of days goods are delayed for from the company which has expediting in place. The average value is generally variable between 14 to 30 days which is acceptable period for this business. The graph below through demonstrates the same periods of delivery, but only suppliers which are not expedited at all:

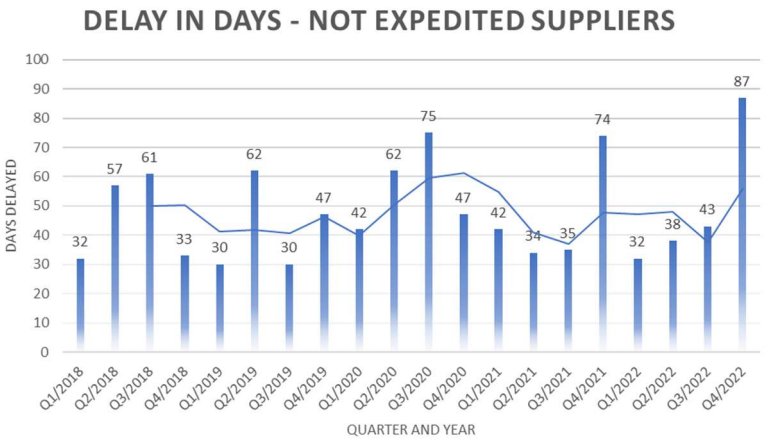

Figure 20: Delay in days without expediting process

Doing comparison, the first noticeable thing is that without expediting average delay varies from 30 to 45 days which is 15% higher than delay with expediting in place. The second noticeable thing are the peaks (values above average) without expediting. Those are much higher than the average and happen more often which makes it much harder to impact them and control. The nature of expediting works in cumulative manner. It means that earlier expediter starts controlling one or another order in its manufacturing phase, the less chance to have it delayed or higher chance to have delay as low as possible. This is the reason why peaks in delay with expediting process implemented has less variability from quarter to quarter.

9 DIGITALIZATION

9.1 Digitalization in supply chain

Advances in technology in the last years, named as the Industrial Revolution 4.0, have forced the digitization in all areas including supply chain. Businesses which do not adapt to the digital rules become obsolete in the market. Transfer requires a strict organization and great effort from human level. However, the reward grants access to global market and high perspectives. Mobility becomes a priority factor for the supply chain, since today the most important thing is to evaluate the information obtained from end to end and to horizontally integrate, convert it into knowledge. The deeper a Supply Chain adapts to this new way of working, the more benefits can be obtained by the company. There are several main drivers based on literature review in Digital Supply Chain:

1. Agility
2. Integration of supply chain stakeholders
3. Real-time performance and visibility
4. Global web-based connectivity
5. Scalability and flexibility
6. Open flow of information
7. Smart processes

The key is information which must be present at any time, independently of the phase of sales, concluding that the ability to respond to customer demand and satisfaction cannot be achieved without the exchange and flow of information (Marmolejo-Saucedo & Hartmann, 2018).

However, talking about purchasing and its digitalization, it is important to understand first the "maturity level" of the company:

- The first maturity level ("Ad-hoc") of procurement is defined as a reactive function only without a strategic direction. Mainly consists of routing transactions.
- At level two ("Independent"), trends and techniques of procurement are adopted. Purchasing acts as a separate entrepreneurial entity. Focus is mainly on cost efficiency.
- When the company's competitive strategy is supported by procurement, this stage is linked to level three ("Supporting"). Suppliers are treated as valuable resource and are regularly analysed. This is the stage when company can start its digitalization journey as well as can easily integrate expediting into its processes.

- At maturity level four (“Integrative”), sourcing plays an integral part of corporate strategy. Formulation of long-term goals anticipate sourcing and procurement needs.
- At maturity level five (“Extended / Digital”), procurement drives the conceptual model of digitization.

Competitive procurement potential is created by establishing a digital SRM (Supplier Relationship Management) system. New technologies enable a flexible and systematic assessment of the performance level of current but also potential suppliers, where concrete information is not yet available within the purchasing function (Fröhlich & Steinbiß, 2020). Recent studies proved that large enterprises differ from SMEs in supply chain digitalization level. Doing comparison of SMEs to big corporations, SMEs lag due to continual shortages in management, communication, or problem-solving skills that are crucial for innovation and technology adoption. In addition, financial investments required for reliable software might be problematic for SMEs. Big corporations denote a higher level of deployment in resources, investment, technology, and expertise which positively affects the plans for improving performance (Liu et al., 2022). However, the main factor is an “intelligent” use of data. This is the only way that can bring benefit. A lot of investment and development happens in this area and market is populated with different options. Artificial intelligence (AI) methods are the most appropriate methods to manage big data. Machine learning (ML) techniques are considered as the popular subdisciplines in AI which identify and automatically extract the patterns among variables using large datasets. In addition, machine learning can detect unknown patterns among data and generate new insights. It is widely used in managing different areas and aspects of the supply chain (Tirkolaee et al., 2021). ML can predict and make the most accurate decisions in the future based on past data. Application of ML lets the people who take decisions to find new data variables that are relevant to their business processes. From this perspective, Machine Learning improves the understanding of problems and enriches all the information used in decision making (Mahraz et al., 2022).

9.2 Digitization in expediting

In expediting, it is required to deal with progress reports on monthly basis and make reviews of any deviations to existing or reported requirements. Depending on the workload and amount of information, this task might demand different efforts. However, the work is

happening with data and the key to success is “reliable and consistent” data. Taking the way of manual data analysis, data collection methods etc., company must admit that chance of human error is much higher. In addition to human error, it triggers situation with missed deadlines, missed risk or even missed order. Manual solutions are suitable until certain level of data, but considering dynamics of the current market, it is always the right choice to go into more digital solutions which in the best approach include AI (artificial intelligence) to take right decisions at the right time. AI is one of innovation types that helps optimize forecasting, customer preferences and cutting costs by automating some repetitive manual tasks. The main benefit is that technology can run for 24/7 in comparison to human being. The study of McKinsey done in 2017 states that AI-enhanced supply chain improves accuracy of forecasting and optimizes granularity. It is also stated that feasible reductions vary from 20 to 50 percent in forecasting errors. Loss of sales if product is not available can be reduced by up to 65 percent.

To talk about the actual usage in the industry, there are several solutions available on the market. Starting from the basic functions which are offered to users and ending with complex solutions which work together with ERP system having information constantly fed and real-time processed between all stakeholders. Supplier relationship management software is used to organize supplier information and maximize supplier benefits and value. Supplier relationship management tools allow you to automate your procurement cycle and centralize everything in one system. It eliminates information inaccuracies, offers instant access to all supplier contracts and information, and improves supplier accountability. If expediting function is integrated into the system, then there are several ways to digitalize this process:

1. Through extension of SRM functions

2. Through investment into independent system

There are benefits in either of these solutions. If expediting part in integrated into SRM system, then it means that information might be accessed by wider group of people eliminating the need to launch extra email or other ways of communication loop to check the information. On the other hand, it creates distraction to the primary function and clears barriers of responsibility. Due to the nature of SRM – it is mainly used for data exchange when order is placed and storing of contact information. While expediting demands constant updates of the system, uploading of additional evidence documentation etc. In case of wide variety of orders, resources of the system will be

heavily used which requires more powerful cloud solutions to maintain the level of quality users are used to. On the other hand, keeping expediting software as separate creates extra needs for its maintenance and support. If systems are not linked, there might be lag of information sharing. In any case, it is important to have ERP system compatible with any solution which is implemented, and data exchange being integrated to any solution. The main functions required for expediting software are:

- Ability to access full information about the order
- Ability to maintain and control delivery dates
- Ability to go down supply chain and keep information about sub-order deliveries
- React to delays of material supply from sub-suppliers
- Ability to access contact information order based (internal contacts and external contacts)
- Ability to upload any evidence documentation and download it
- Ability to create scheduling plan and visually access it
- Automatic notifications for main milestones and reminders in case anything missed

Above list does not cover the demand in full, but defines the main functions required. Every company defines the needs based on its system and demands. There are options available on the market, but there are also companies which decided to develop own system. Possible solutions are compared below.
Talking about key IT factors for the solution, the main criteria are, but not limited to:

- 24/7 access from any network
- Real-time data exchange
- Quick response time
- No system overloading with user amount
- Automatic error-checking, fool-proofing
- System messages

9.3 Market analysis for supplier management tools

9.3.1 NotifyMe – Expediting block implemented

NotifyMe Expediting software solution can help you put all the expediting information related to each Purchase Order in a single place and share it upon the need. The access can be granted to suppliers for projects they participate in, which increases their awareness and commitment. This gives customers and suppliers a comprehensive review of the exact status of their order and an educated projection of the future planning and status. Expeditors may enter all information directly in NotifyMe and upload reports and statuses in the system.

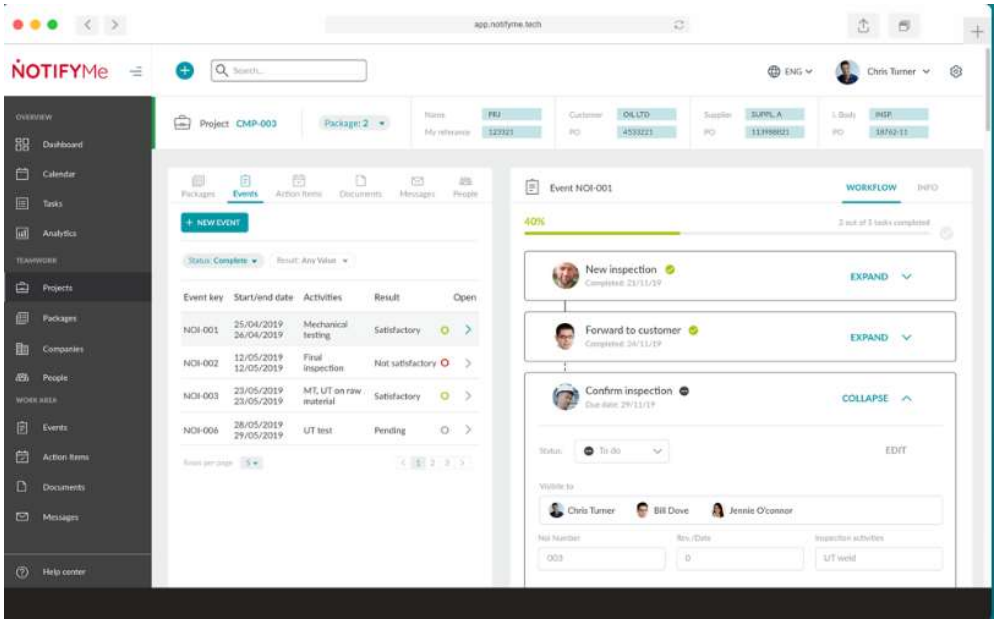

Figure 21: NotifyMe interface example

Why to choose:

- Built on BPM (Business Process Modelling) methodologies
- Amazon Web Service Based – data protected with Amazon RDS encryption
- High availability – database in replicated synchronously and can be quickly recovered
- Integrated with existing systems (Client ERP) and supported by external database
- Integrated with Microsoft Office tools making data extracts easy

NotifyMe is a company from United Kingdom which is working on solution from 2015. All team is coming from industries and solution is developed with focus on industry needs. It was presented on exhibition in Abu Dhabi in 2017 and focused on the digitalization since then. Software is suitable for SMEs.

9.3.2 GEP NEXXE – AI powered

GEP NEXXE is a cloud-based, AI-powered supply chain system built on Microsoft Azure. It gives the ability to monitor supplier performance and the entire purchasing process from quotation to approval. It provides 360 degrees view of direct procurement data across all levels of supply chain, ensures greater flexibility to collaborate with multiple stakeholders, update delivery times, request PO changes, attach documents.

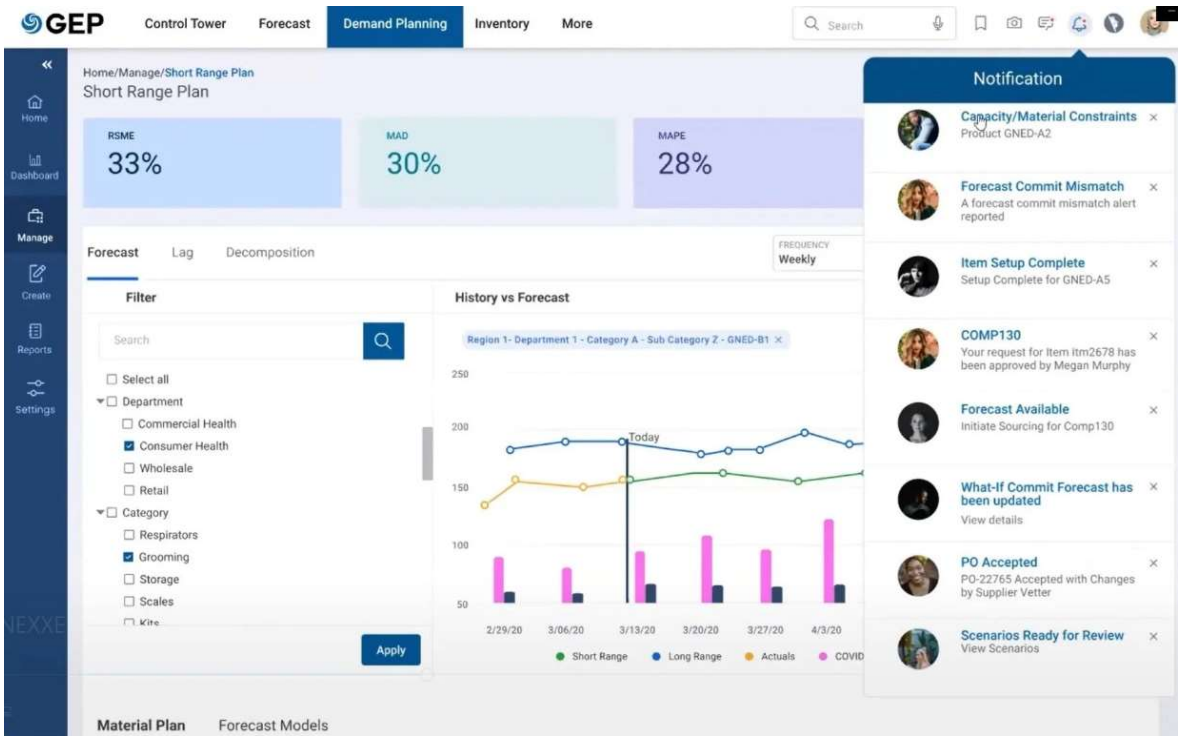

Figure 22: GEP NEXXE Interface example

Why to choose:

- Offers real-time collaboration with multiple partners
- Self-cleansing data lake foundation
- Has prediction function with alerting via pattern analysis
- Action status tracker provides notifications

GEP utilizes all latest development in AI (Artificial Intelligence) supporting all its platforms with updates. It represents a huge boost in business agility and the capacity of the workforce to perform and deliver on desired outcomes. GEP is the global leader in digital supply chain transformation. It was granted with “best procurement software” in 2020 at the World Procurement Awards.

9.3.3 SAP Ariba

In case company uses SAP as their ERP platform, then another market solution is Ariba extension. SAP Ariba is a cloud-based procurement software which controls spend management and supply chain services that enable suppliers and buyers to connect and do business globally. SAP Ariba is focused on supplier management and control, but its features can be extended to purchase order levels and provide limited functionalities within the system. Having SAP main base and expanding with SAP Ariba opens possibility to expand transactions with personally developed functions within SAP platform and combine two solutions providing full service. This solution is suitable only in case of SAP usage and not preferable for SMEs due to complexity of processes.

9.3.4 Precoro

Precoro is a cloud-based solution that can revolutionize the way organizations approach procurement and AP automation.

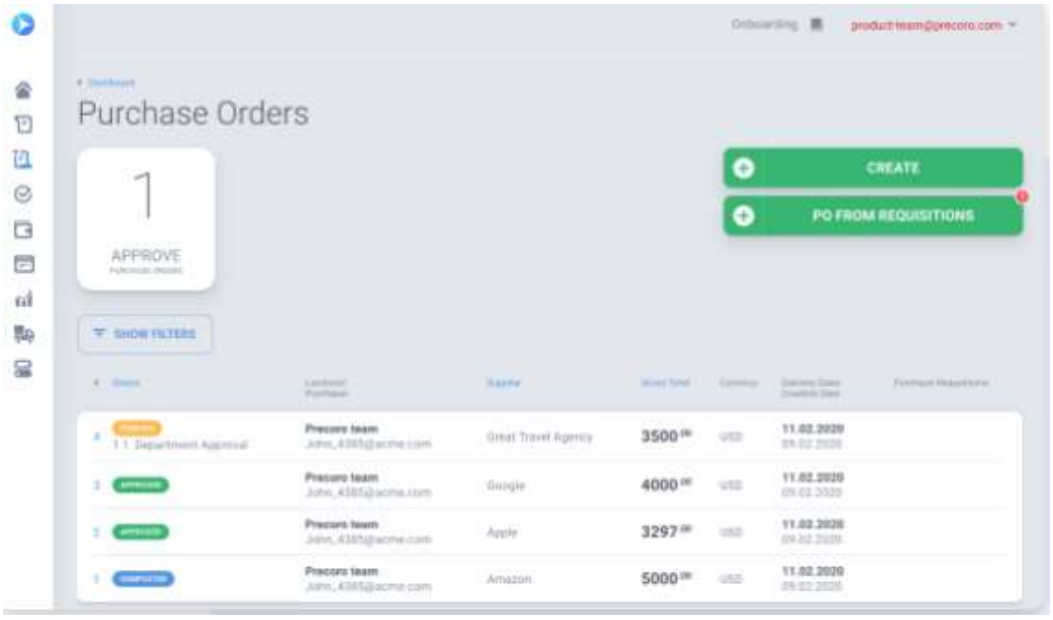

Figure 23: Precoro Interface example

Order Management function in Precoro offers opportunity to track and supervise all deadlines. Its automatic monitoring function informs users in systematic way about any deviations. Workflows are made easy and understandable. Precoro is already

being used by companies to transform their purchasing experience, increase efficiency through digitization, and simplify complex day-to-day operations. Organizations benefit from a streamlined, modern procurement system that is more secure, efficient, and cost effective.
Precoro software is not directly linked to expediting fuction and does not offer the block specialized on expediting.

9.3.5 NetSuite

NetSuite is a hybrid-deployment solution that helps businesses streamline operations using industry-wide best practices to minimize handling costs. NetSuite is used by SME businesses in retail, manufacturing, distribution, and warehousing industries. It has high functionality specter and reliable reporting package.

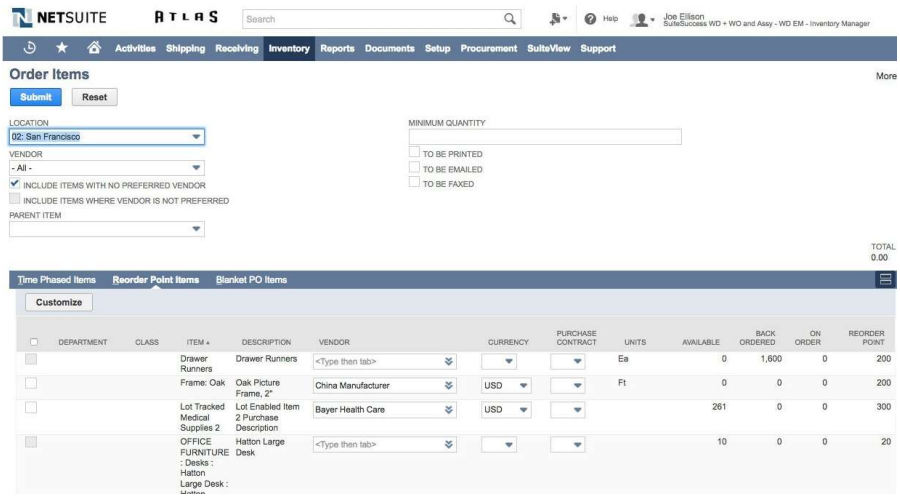

Figure 24: NetSuite WMS Interface example

NetSuite is developed by Oracle and is well compatible with Oracle ERP system, but it can be integrated with others depending on client need. Oracle that same as SAP can be integrated and developed with focus on expediting. The block can be customized, but this process can take same time as development of personal solution.

9.4 Market solutions comparison

The comparison below is done based on specific parameters. There is no ideal solution available on the market. Each has its advantages and disadvantages. Each company can decide which one to choose making comparison of current systems in use. The way to digitization is much simpler when there is a possibility to perform integration of current systems instead of transferring all data to new portals and going through full training.

The prices for every software depend on the package taken. Advanced packages for every company are done offer based considering specific parameters, but all companies also offer standard packages for limited number of users.

All current solutions on the market are available cloud-based, but few still offer server-based deployment. All current market software solutions deploy machine learning in their applications as their main purpose is linked to data configuration. Some solutions directly mention application of AI within their solutions, but some focus more on data representation or intuitive interface.

Making choice, it is important to consider backup options and ease of recovery in case of any cyber-attack or just misbehaviour. These days cyber-attacks are very common and even big corporations with reliable firewalls face different types of cyber-attacks. Digitization creates additional risks for the companies and risk management in IT is one of the most important parameters. The damage might be irretrievable in case of specific attack which might even kill the business. Supply Chain information is related in some cases to sensitive which means that it requires same level of security as personal information.

Program Name	Cost Level	Suitable company size	Expediting options	Integration with other systems	Scalability	Why to or why not
NotifyMe	$	SME	Special Expediting chapter which might be adjusted based on needs	Uses external database which can make extract from ERPs, but no direct link to ERPs	Limited	Customization, company tries to fully match customer needs
GEP NEXXE	$$$	Any	Ability to link suppliers and exchange forecasting data, possibility to alert risks and re-plan based on data update	Deploys special AIs which are patented by company. Compatible with main ERP systems, possibility to link to others with special interface	Any	GEP has many own developed solutions which can be easily extended, but any extra functionality is limited
SAP Ariba	$$$$	Big corporation	Requires special development (investment) and linked to suppliers. Expediting works only with SAP and SAP Ariba combination	Compatible with SAP, possible, but hard to link to other ERP, will be used external database	Limited	Strong support for SAP ERP system with detailed database behind but can hardly be adapted to SMEs.
Precoro	$$	Any	No direct possibility to follow forecasting, mainly focused on order management than order execution	Compatible with most known ERPs, can be linked to any based-on company request	Any	Covers only few requirements of expediting, cannot be used as system on its own
NetSuite	$$$	Any	Uses central dashboard and scalability allows to add functions based on special company needs, but no standard features available	Compatible with most known ERPs, can be linked to any based-on company request	Any	Robust system with clear interface. Due to special development for companies, functionality is limited

Figure 25: Comparison of market solutions

To summarize stated above, there is no ideal solution available on the market for company to take and use. Any available solution is developed focusing on the main customer of specified organization and coverage of the needs of that customer. Due to difference of business processes, organization structures and organization targets, each available solution will always require additional development. There is always a choice company should make:

- to work with ready solution and adapt it for personal needs
- to develop from scratch solution which 100 percent matches company requirements

Thorough analyses must be done for either option prior taking any decision because everything depends on the situation.

9.5 Expediting software use cases

Looking at market solutions, there is no ideal available which can fully cover the needs. Each company develops its knowledge based on customer experience and it is hard to become a new customer with new requirements which fully match the offered option. Due to this fact, SMEs fail in their digitalization step. There are specific requirements present for every company. It might come from business area, from the pool of customers, from the pool of suppliers or even from company strategy. Market is wide, but still limited. The correct decision was taken by big corporation which ended up developing its own internal solution. For example, to talk about Siemens. Based on literature review, Siemens uses standard expediting process with certain steps implemented.

During market analysis, Siemens was identified with personally developed expediting solution which is done by internal IT people and being widely applied for all their suppliers. The name of the tool used is SEE (Siemens Energy Expeditor).
The Siemens Energy Expeditor powered by SCCoTy 2.0 is designed to automate all major expediting activities of operational procurement covering all purchase orders. The tool aims

to support buyers and suppliers in decreasing the risk of overdue deliveries (Siemens Energy Expeditor Powered by SCCoTy 2.0, n.d.).

Figure 26: Siemens Energy Expeditor

The benefits of the tool are:

- Helping to manage orders in a timely manner
- Creating visibility on POs
- Sending alerts if orders need additional attention
- Updating orders with Supplier feedback
- Is easy to use, fully ready solution for supplier

Siemens uses SAP as their main ERP system, but still went for foreign solution for expediting. The reason behind is exactly “the business need”. Coming back to statement above, there is no ready solution on the market which can cover all the needs. Siemens is a good example of this statement. To add to Siemens, there is another big corporation which took the same route and developed its own expediting system. The company is Linde. Linde uses SAP as their ERP system, but also developed own tool named SupplierConnect for Expediting activities. Available 24/7, SupplierConnect is a digital, web-based platform that boosts collaboration, increases transparency and data quality, and enables informed decision-making. In short, it helps Linde connect and engage more effectively with its suppliers. It helps to manage purchase orders during the engineering, manufacturing, and delivery phases. SupplierConnect supports in meeting deadlines and executing purchase orders on time. It also helps to focus attention and resources on open issues and avoid unnecessary work in areas that are progressing according to plan. SupplierConnect provides transparent feedback to its users on incomplete or incorrect information by detailed failure messages. The actual data exchange loop looks like below:

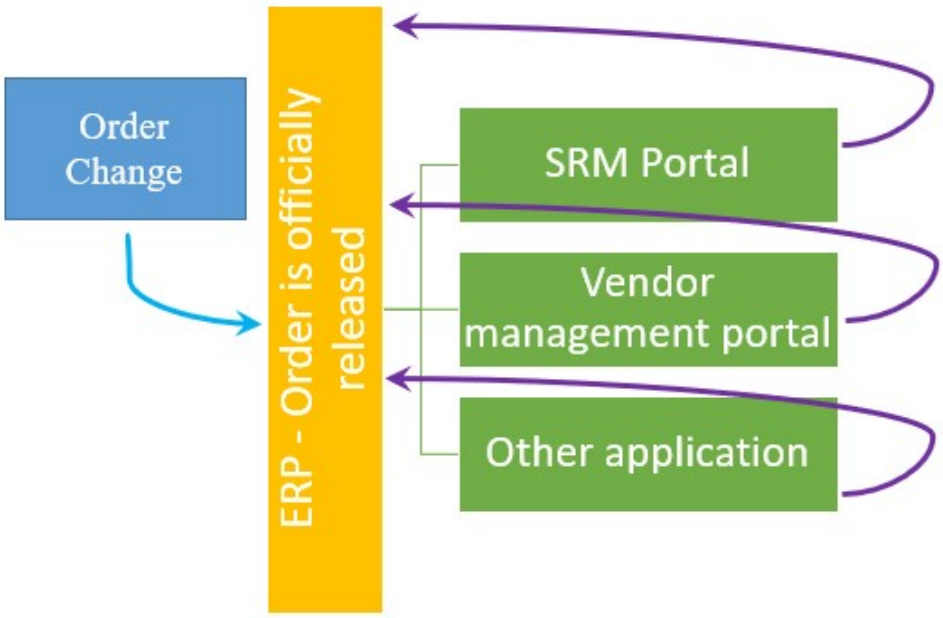

Figure 27: Data exchange loop

It is important that any system within organization has direct link to ERP system with back-and-forth data feeding. If there is no real connection between the systems, then it leads to outdated information exchange. When buyer makes changes to the order and information is not directly updated for expediter, then expediter proceeds wrong expediting which eliminates the real goal. Due to limit in investment, SMEs often miss the link of ERP to other systems which results in time waste of their employees. This affects motivation of workers and results in bigger issues. The nature of any digitalization idea is automatic "linking". Linking goes in two directions. If expediter receives any update of forecast data, then this update must be visible in ERP system because further production planning and other entities work with ERP data.

These are only two examples of many others available. Only internally developed tools which stay supported by internally hired IT specialists (or third party hired) get true development and being used to the full potential. Obviously, there is always an option to proceed with standard Excel tables or Google Sheets, but one main factor which affects the quality is human error. No Excel solution can provide a reliable check of data input as well as there is limited possibility to make any real-time feeding of information. SMEs often take the route of Excel considering it as feasible and cheap solution, but Excel usage is not linked anyhow to digitalization. However, combining Excel with ML can also bring big benefits.

9.6 Self-deployment of machine learning for expediting

As mentioned earlier, it is hard for the company to take ready solution and start using it within organization. Every industry is different and client requirements vary. It means that any solution needs to be adjusted to personal needs. Talking about SMEs, then most cases ready solutions offer too big variety of functions which do not find actual use within organization. At the end, choosing such solution, company does not apply full potential due to limitation factors. The alternative option for organization can be self-deployment of the solution. Via application of ML environment and IT resources, company can develop own BI tools for any process including supply chain. Looking at the perspective, applying ML environment results in high savings due to:

- Same or similar interface for all applications
- After development of one solution, the lessons learned, and ready codes can be used for other solutions
- Constant support from the owner company of ML environment due to their interest of wide application
- Budget saving and clear visibility of implementation plan by usage of internal resources
- Scalability level is unlimited due to required tools being available within the environment

These are the main reasons why it is better to go with personal development. Obviously, there is always another side of this solution which can be a severe reason to choose market options and it is linked to the resources. In other words, if SME does not have resources available to describe the needs for solution, work on project scheduling, IT knowledge, manhours etc., then market solution can be easier to implement. However, as stated earlier, even market solution will require adjustments. Talking specifically about expediting, then ML can help expediter:

1. to understand and predict the future delays
2. structure the data in a specific presentable format
3. analyse past and new data giving information about any variability
4. highlight any risks based on specific materials, parts
5. demonstrate problematic seasons, months which require additional attention from expediting for one or another supplier

These are only few main things which can be gained via usage of ML. Human being will never be able to answer easily highlighted above points without spending hours/days in analysis which might result in an error. ML with integrated AI can do this job in seconds saving high number of manhours which to be used for more complicated activities.

There are several ML environments available on the market. The most global are offered by Google and Microsoft. The choice between one or another depends on the company policy. Google Cloud AI Platform let's you choose within available algorithms activity and perform analysis without single line of coding. Google deployed all of its assets within their AI Platform, covering a wide range of ML services like data preparation, training, tuning, deploying, collaborating, and sharing machine learning models. Its AI Hub gives opportunity to discover, share, and deploy ML models. It's a catalogue of reusable models that can be deployed to one of the execution environments of AI Platform. The most important is that Google AI platform offers an easy-to-use interface which does not require much time to figure the path out. Microsoft Azure Machine Learning tool includes features that allow specialists to pull data from a wide range of sources. It gives experts a possibility to build ML models with simple scripting and human understandable coding practices. One of the top features of the ML software is that it delivers (Machine learning operationalization management) MLOps to help organizations build, test, and deploy ML models quickly. This feature lets ML models to stay reliable and efficient by constant self-learning. Microsoft Aruze offers free product add-ons which can extend potential of application with no extra cost. Apart from two mentioned options, SMEs can choose other environments available on the market. For example, DataRobot which is also AI Cloud Platform which is integrated with other cloud solutions like Google, Amazon, Microsoft etc. and which can be applied as a cheaper alternative to big corporate options. The languages in DataRobot are ahead of many other platforms, but it surely requires extra time to learn the platform and start using it. If company uses Microsoft or Google products in general, then the choice falls to one of those, but DataRobot is a convenient function to choose in case none of mentioned above are used or there is wished to have foreign platform for data analysis.

Below is done comparison of three options:

Criteria	Azure Machine Learning	Datarobot	Google Cloud AI
Pricing	No Free Trial Has free version	Free trial available No free version	Free trial available Free version available
Best For (company size)	Any size	Small or mid-size company	Any size
Awards	No	No	Several awards for the best software
Predictive Modelling	Yes	Yes	Yes
Templates (models)	No	Yes	Yes
Deep Learning	Yes	Yes	Yes
ML Algorithm Library	No	Yes	No
User Ratings (30+ ratings)			
Ease of use	3.9	4.6	4.4
Customer Service	4.0	4.8	4.3
Features	4.3	4.8	4.6
Value for Money	4.4	4.2	4.4
Other aspects	Claimed by users as the most reliable and bug free solutions, has many case studies to ease the training	The highest number of languages, strongest data science background, ability to link to any cloud	Wide range of available models which can be used without any programming, high support level with many communication channels

Figure 28: ML Solutions Summary Table

To summarize stated above, current market offers many possibilities for users to read their data in different ways. Highlighted solutions are the main ones, but possibilities are much wider. There are plenty of free versions of different environments available for SMEs to perform trials prior any decision taking. ML application helps to raise trust in the data via exploitation of different algorithms. Companies are working on improvement of their suggestions and especially Microsoft is advertising their Azure as self-learning environment which adjusts its decisions based on previous experiences giving the highest value to the customer. The area of ML and especially with integrated AI is booming which means that taking path for digitalization, company can be convinced that there will always be interest and support of this journey. The most important is to keep the journey and have resources in place to work towards the goal.

SUMMARY

As topic of the thesis states, it described the benefits of integration of expediting activities into daily supply chain work. During writing of thesis have been analyzed different literature sources to evaluate the severity of impact on supply chains. The screening was done for sources which are not older than five years to consider the most recent events. Several research works have been thoroughly reviewed and main thoughts considered during further evaluation of the needs. Defined objectives are achieved and proof is presented in numerical and analytical forms. Data analyses are done in several formats and considered in variable scenarios. Thesis did not focus on specific use case, but the purpose was to look at the expediting process from different angles and understand different levels of its definition within company organizations. The results of carried out interviews demonstrated that topic is considered valuable by business areas and being under discussion within organizations.

Supply Chain is going through difficult times. Recent years have tested it from all sides and clearly pointed out all weak points which have always been there. The biggest impact on global chains was caused by

- Covid-19
- Russia's invasion to Ukraine

Time gaps between drastic events did not give any chance for recovery to any area. Almost every business has their supply chains set-ups globally. Sanctions, China's Zero Covid policy, delays and ongoing shortages of materials put chains under extreme pressure and caused the biggest disruptions. This is the sign that expediting needs to step in and increase monitoring activities to keep up with project schedules. To manage and control the progress of manufacturing of suppliers for all projects and ensure on-time delivery in conformity with the standards the key for expediting is to be taking the ownership of the orders, be proactive and creative, be collaborative with all disciplines and the most important is to be sure that all relevant information along the supply chain is up to date and available. Successful expediting helps to avoid and minimize any risk that may negatively impact on projects.

However, the key to successful expediting process is its structure and specified targets. There are several ways available to perform expediting and every company needs to well understand what expectations are standing behind the need of expediting. Expediting, the

same as any other process, requires resources which need to be experienced and well-trained to deliver the right output. In the era of human replacement with machines, communication stays a key to success and strong expediter is the person with communication skills on high level. Nonetheless, digitalization is driving the progress and especially in Supply Chain area which needs to be dealing with constantly increasing data amount which requires robust solution to its analyses to take the right decision. Market is full of different software options which help organizations to structure and visualize the data for direction definition. Several solutions have been compared and reviewed in the thesis. Software development companies try to follow trends and actively working on integration of AI and ML into their systems. The choice of the right solution depends on company needs and prior any decision taking, it is required to make deep analyses of the requirements. In addition to ready solutions, there is market niche with ML environments which are cheaper and easy for application. ML environment developers try making their solutions understandable for standard users (not IT people) with self-learning options and ready modules. As it was stated in previous paragraphs, digitalization path is difficult, especially for SMEs which have restrictions from all resource sides, but it is the right course to take which truly will benefit the company in the long perspective.

When “expediting” topic was defined for this thesis and assumptions made for its benefit in modern supply chain, it was not expected to receive such high support from organizations and interest in this topic. Interview results were impressive and wish of supply chain leaders to develop their processes towards implementation, enforcement and structurization of expediting activities proofs that market outlived cardinal changes and risk assessments are seen from the other point of view these days. Expediter is the right contact to foresee risks from down the chain due to constant contact with suppliers during actual executions phases. Data analyses demonstrated benefits of expediting activities from all aspects and no doubt is staying to question the need of expediting.

KOKKUVÕTE

Lõputöös kirjeldati kiirendavate tegevuste integreerimise kasu igapäevasesse tarneahela töösse. Lõputöö kirjutamise käigus on analüüsitud erinevaid kirjandusallikaid, et hinnata mõju raskust tarneahelatele. Sõelumisel võeti arvesse allikaid, mis ei ole vanemad kui viis aastat, et võtta arvesse kõige värskemaid sündmusi. Mitmed uurimistööd on põhjalikult läbi vaadatud ja vajaduste edasisel hindamisel peamisi mõtteid kaalutud. Määratud eesmärgid saavutatakse ja tõestus esitatakse numbrilises ja analüütilises vormis. Andmeanalüüse tehakse mitmes vormingus ja neid käsitletakse muutuvate stsenaariumide järgi. Lõputöö ei keskendunud konkreetsele kasutusjuhtumile, vaid eesmärk oli vaadelda kiirendamisprotsessi erinevate nurkade alt ja mõista selle definitsiooni erinevaid tasemeid ettevõtte organisatsioonides. Läbiviidud intervjuude tulemused näitasid, et teemat peetakse ärivaldkondades väärtuslikuks ja organisatsioonides arutluse all.

Tarneahelal on rasked ajad. Viimased aastad on seda igast küljest proovile pannud ja toonud selgelt välja kõik nõrgad kohad, mis on alati olemas olnud. Suurima mõju globaalsetele kettidele põhjustas

• COVID-19

• Venemaa sissetung Ukrainasse

Ajavahed drastiliste sündmuste vahel ei andnud ühelegi valdkonnale taastumiseks võimalust. Peaaegu igal ettevõttel on oma tarneahelad globaalselt üles ehitatud. Sanktsioonid, Hiina null-Covidi poliitika, viivitused ja jätkuv materjalide nappus panid ketid äärmise surve alla ja põhjustasid suurimaid häireid. See on märk sellest, et kiirendamine peab projekti ajakavaga sammu pidamiseks sekkuma ja suurendama järelevalvetegevust. Tarnijate tootmise edenemise juhtimiseks ja kontrollimiseks kõigi projektide jaoks ning õigeaegse tarne tagamiseks vastavalt standarditele on ekspedeerimise võti võtta tellimuste omanik, olla proaktiivne ja loov, teha koostööd kõigi valdkondadega ja kõige tähtsam on olla kindel, et kogu asjakohane teave kogu tarneahelas on ajakohane ja kättesaadav. Edukas kiirendamine aitab vältida ja minimeerida riske, mis võivad projekte negatiivselt mõjutada. Eduka ekspedeerimise võti on aga selle struktuur ja kindlaksmääratud eesmärgid. Ekspedeerimiseks on saadaval mitu võimalust ja iga ettevõte peab hästi mõistma, millised ootused on ekspedeerimise vajaduse taga. Kiirendamine, nagu mis tahes muu protsess,

nõuab ressursse, mis peavad olema kogenud ja hästi koolitatud, et pakkuda õiget tulemust. Inimeste masinatega asendamise ajastul jääb suhtlemine edu võtmeks ja tugevaks edasiviijaks on kõrgel tasemel suhtlemisoskustega inimene. Sellegipoolest juhib digitaliseerimine edusamme ja eriti tarneahela valdkonnas, mis peab tegelema pidevalt kasvava andmehulgaga, mis nõuab õige otsuse tegemiseks tugevat analüüsilahendust. Turg on täis erinevaid tarkvaravalikuid, mis aitavad organisatsioonidel suuna määratlemiseks andmeid struktureerida ja visualiseerida. Lõputöös on võrreldud ja arvustatud mitmeid lahendusi. Tarkvaraarendusettevõtted püüavad järgida trende ja tegelevad aktiivselt tehisintellekt ja masinõpe integreerimisega oma süsteemidesse. Õige lahenduse valik sõltub ettevõtte vajadustest ja enne otsuste tegemist on vajalik nõuete süvaanalüüs. Lisaks valmislahendustele on turunišš masinaõpe keskkondadega, mis on odavamad ja hõlpsasti rakendatavad. Masinaõpe keskkonnaarendajad püüavad iseõppimise võimaluste ja valmis moodulitega oma lahendused tavakasutajatele (mitte IT-inimestele) arusaadavaks teha. Nagu eelmistes lõikudes öeldud, on digitaliseerimise tee keeruline, eriti VKEde jaoks, kellel on piirangud kõigist ressurssidest, kuid see on õige tee, mis toob ettevõttele pikas perspektiivis tõesti kasu.

Kui selle lõputöö jaoks defineeriti “ekspedeerimise” teema ja tehti eeldusi selle kasuks tänapäeva tarneahelas, ei oodanud see nii suurt toetust organisatsioonidelt ja huvi selle teema vastu. Intervjuu tulemused olid muljetavaldavad ning tarneahela juhtide soov arendada oma protsesse kiirendavate tegevuste juurutamise, jõustamise ja struktureerimise suunas tõendab, et turule elanud kardinaalseid muutusi ja riskihinnanguid nähakse tänapäeval hoopis teisest vaatenurgast. Expediter on õige kontakt, et näha ette riske ahela allosast, mis on tingitud pidevast kontaktist tarnijatega tegelike teostamisetappide ajal. Andmeanalüüsid näitasid tegevuste ekspedeerimise eeliseid kõigist aspektidest ja kahtlemata jääb kahtluse alla ekspedeerimise vajadus.

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APPENDICES

Interview for Master's Thesis -
CONTROL AND ENFORCEMENT OF EXECUTION PROCESS WITHIN ORGANIZATION VIA "EXPEDITING" FUNCTION IMPLEMENTATION IN SUPPLY CHAIN PROCESS

Questions:

Block 1:

1. What is your position in the company?
2. What is the industry of company, main business area and customers?
3. What is the size of the company? What is the turnover?
4. In which countries are your suppliers located?

Block 2:

5. What is the structure of Supply Chain Organization?
6. Which activities are performed by every function?
7. What is detailed process of PO placement until order closure for supply chain?
8. What are the main KPIs of the Supply Chain?
9. Do you achieve your targets?
10. How do you define needed number of resources to fulfil job tasks?
11. Do you feel that your processes are clear and transparent?

Block 3:

12. Do you have expediting within your organization?
13. Do you see the need to control your suppliers and demand from them more information?
14. What benefits do you see if there is established communication loop with suppliers?
15. Do you see the need to implement expediting? Which benefits do you see?
16. How do you see expediting function – within other function or separate?

Block 4:

17. Do you have reliable process for supplier development?
18. What are the key factors in supplier development for your organization?
19. What improvements do you see as the most critical now?

Company X: Interview date 03.03.2023 at 14:00 (interview lasted 2.5 hours)
Company Y: Interview date on 07.03.2023 at 12:00 (interview lasted 1.5 hours)