Master Thesis

"Purchasing and digitalization in an era of turbulence"

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Abstract

Title: Purchasing and digitalization in an era of turbulence

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Background: This research delves into the uncertainties and challenges encountered in global supply chain operations, exacerbated by unpredictable events such as the COVID-19 pandemic and the 2021 Suez Canal obstruction. These disruptions can lead to stock-outs, poor capacity utilization, and the need for expensive buffers. The study centers on Duni, an international company present in over 20 countries. The thesis evaluates Duni's purchasing practices through the lens of digitalization, examining operational processes, digital tools used, turbulence impact, and potential AI automation opportunities. It employs a qualitative approach, building on prior research, but uniquely scrutinizes the impact of turbulence on digitalization of operational activities.

Problem formulation: The thesis underscores the critical role of digitalization in managing these disruptions and discusses its impact on diverse stakeholders - suppliers, governments, retailers, financial institutions, and customers. Effective digitalization can create sustainable competitive advantage, reinvent procurement processes, and enhance transparency, contributing to profitability. However, if poorly implemented, it could sub-optimize the ordering process, damaging trust relationships.

Purpose: The purpose of this Master Thesis is to explore and map the purchasing practices of Duni through the following four lenses of; the operational process, the role of the digitalization tools used, the impact of turbulence, and lastly, possibilities of AI automation.

Methodology: The approach to this research paper is done through the usage of a multiple-case study framework. A data collection protocol is developed using a semi-structured interview guide that covers the different areas of this research paper. Lastly, Data analysis and discussions about limitations are done to touch on quality of research. This research paper is mainly of a qualitative nature.

Conclusion: The research centered on three main questions regarding Duni's supply chain. Firstly, it investigated the operational procurement process, discovering that while Duni uses two Enterprise Resource Planning systems, human intervention remains necessary to accommodate unpredictable

factors in the supply chain. Secondly, the research focused on how Duni evaluates delivery performance. It found that while traditional metrics such as delivery date compliance and order quantity compliance are used, there is a lack of a formal, quantitative supplier delivery performance rating system. Lastly, the research sought to understand the role of digitalization and automation in ensuring adequate delivery performance and mitigating risk. It found that balancing automated systems with human intuition is crucial, particularly in managing unpredictable events that impact the supply chain. There's an opportunity for automation in supplier delivery performance measurement, and handling endogenous turbulence, while exogenous turbulence requires more manual adjustment due to its complexity.

Keywords: *Supplying, digitisation, digitalization, Artificial Intelligence, Turbulence, Delivery performance, Duni Group*

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1. Introduction

The introduction chapter is the foundation by which this thesis subject is built upon. First, the background and previous works within the chosen thesis subject are described. Thereafter, the company which is the main source of empirical information is introduced. Lastly, the thesis project is thoroughly explained with a project description, purpose, research questions, and the limitations of its scope.

1.1 Background

Uncertainty is one of the biggest challenges that a purchaser faces when working with suppliers in its supply chain. With the world becoming increasingly interconnected, and supply chain networks spanning over global distances, an interruption in one part of the network/supply chain may lead to detrimental consequences to the rest of the network. The way in which this can practically express itself is in the form of stock-outs, poor capacity utilization and costly buffers (Christopher & Holweg, 2011). These effects have been increasingly significant with regards to the recent global natural disasters such as COVID-19, or man-made obstructions such as the 2021 Suez Canal obstruction of which its effects were still lingering months after the event (Sauer et al., 2022). Mitigating the impact that these events have had on the global supply chains is of great importance to the case company to ensure that deliveries are fulfilled. In this paper, "Turbulence" will be the term used to describe any event that is an obstruction for the optimal delivery of made orders.

Stakeholders within the digitalization framework consist of suppliers, governments, retailers, financial institutions, customers which are all affected and influenced, as is the deployment of new technologies, with their models, partnerships, and workflow of purchasing processes being relevant to the digitalization framework (Soto-Acosta, 2020; Verhoef et al., 2021; Bowersox et al., 2005; Hahn, 2020; Jahani et al., 2021)). The best benefits are achieved through utilizing organizational resources and allocating them to the relevant area of the organization. This type of effective allocation of resources, when done correctly, may lead to the generation of sustainable competitive advantage (Grant, 1996), this is not easy to imitate, but if done correctly, creates value for the company (Barney, 2001). The whole process of procurement can be reinvented and can start contributing in attaining profit if digitalization is implemented and well connected with supply chain partners (Seyedghorban et al., 2020). Even an implementation of digital procurement readiness in an organization and their supply chain partners will make the overall procurement process simpler and more effective (Kosmol et al., 2019). Digitalization, when done properly will give an organization a competitive edge over its competitors. If not done properly, digitalization has a risk of having a process that sub-optimizes the effectiveness of placing an order, to the detriment of trust in the relationship (Knudsen et al., 2021). This introduces the reason for why digitalization tools are

to be used as proactive tools in turbulence mitigation (Ye et al., 2022; Bonnet & Westerman, 2021; Loonam et al., 2018) In order to be able to introduce traceability and create a more transparent (Kumar & Ganguly, 2020) and traceable (Hastig & Sodhi, 2020; Khan et al., 2022; Khan & Khan et al., 2022) process of the purchasing operations. Lastly, within the context of digital transformation, there have been breakthroughs within AI automation with Bill Gates (2023) describing the importance of these events and their consequences in an article with the description *"Artificial intelligence is as revolutionary as mobile phones and the internet"*.

Alabdali & Salam (2022) have written a research paper with a similar purpose, described as *"This study examined the impact of digital transformation (DT) on supply chain procurement (SCP) for the creation of competitive advantage (CAD)"*. The findings of this research paper show that procurement and its digitalization is a critical function for creating competitive advantages. While this research paper used a quantitative approach to its research, this Master Thesis is of a similar purpose, but with a more qualitative approach. The research gap that is to be studied in this master thesis to explore and map the purchasing practices of Duni through the following four lenses of; the operational process, the role of the digitalization tools used, the impact of turbulence, and lastly, possibilities of AI automation.

1.2 Project description

This Master Thesis will cover the problem of *turbulence* within the scope of *purchasing* through the lens of *digitalization.* This is done by the multiple-case study methodology. First, the sourcing process is described as a process with activities on the side of the purchaser that have corresponding activities on the side of the supplier.
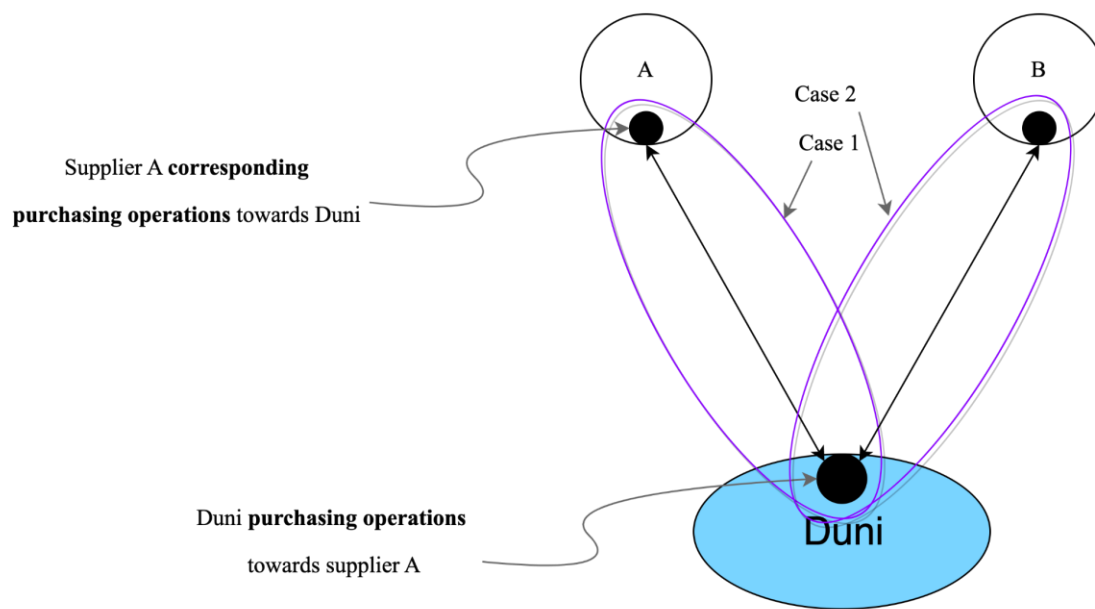
Figure 1. Visualization of the different case studies. Created by authors.

With the help of a theoretical framework for the procurement process, the operational activities of the supplier and the buyer is identified. In all case studies, Duni is the purchaser, which means that the cases will study the relationships between the purchasers of the case company and chosen first tier suppliers. Because the cases are studied through the lens of *digitalization*, the operational activities are rated depending on to what degree they are digitalized. This is done with the help of a digitalization spectrum and characteristics, which is the foundation for the data collection protocol used for collecting information. These digitalization relationships between Duni and first tier suppliers are compared to the delivery performance of respective first tier suppliers. Lastly, the impact of turbulence on digitalization of operational activities is studied. To clarify, Duni is the purchaser in all of the case studies in this paper, as shown in figure 1.

1.3 Duni

Duni is situated in the industry of table setting and take-away products, where they have emerged as a significant player, reaching more than 40 markets globally. The company's purchasing practices, emphasizing sustainability and social responsibility, are a hallmark in this sector. The implementation of their ecoecho concept, prioritizing sustainable materials and processes, serves as an industry example of eco-conscious operations.

Duni as an organization has presence in over 20 countries across Asia, USA and Europe. Purchasing being a crucial part for an organization of this scope plays a major factor in the overall success. The purchasing organization structure at Duni is hybrid as it is centralized for 95% of purchases at country level and decentralized for the rest of 5% for local level. The organization structure of Duni is shown below in figure 2. Duni have purchasing offices in 4 factories present in Sweden and German, with the operational purchasing consisting of placing orders being locally assigned to the international offices, while the strategic long-term purchasing strategy is centralized to the Swedish offices.
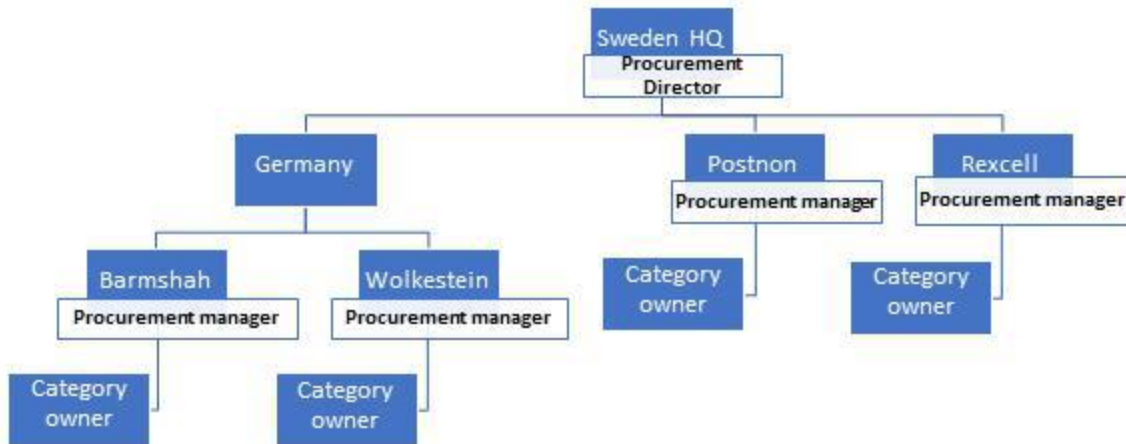
Figure 2. Duni's Organization Structure. Created by authors.

Duni has a central system SAP which is integrated with a system called Jaggaer where all the supplier databases are connected. Business data like purchase orders are created using SAP which is then moved to Jaggaer and shared to all the first-tier suppliers.

1.4 Purpose

The purpose of this Master Thesis is to explore and map the purchasing practices of Duni through the following four lenses of; the operational process, the role of the digitalization tools used, the impact of turbulence, and lastly, possibilities of AI automation.

1.5 Research Questions

- RQ1: How do the operational procurement processes work within Duni's factories and their first-tier suppliers?

- RQ2: How is Duni measuring and evaluating supplier delivery performance?

- RQ3: How does the automation of the operational procurement process ensure adequate delivery performance with mitigation of risk, and what are further possibilities of automation?

1.6 Scope and limitations

Suppliers that are included in the case study are limited to first tier suppliers to Duni. Hereafter, when "supplier" is mentioned in the thesis, this is only adhering to the first-tier suppliers and not further upstream. In the procurement process, only the continuous supplying process of an already

established supplier is studied, excluding the supplier selection and sourcing process. In terms of material, the scope is narrowed to only include direct material that Duni purchases. This will not include indirect material that is for the supportive functions of Duni. In terms of delivery performance, the limit of the scope is to only include delivery of goods and the aspects that are included in this, specifically excluding the payment terms and invoicing of said deliveries. With respect to contracting, the specific contract of a case is only used as an already established framework by which the supplying adheres to, this means not including the negotiation and determining of said agreements in a contract. Below is a visualization of the defined thesis scope within this master thesis.
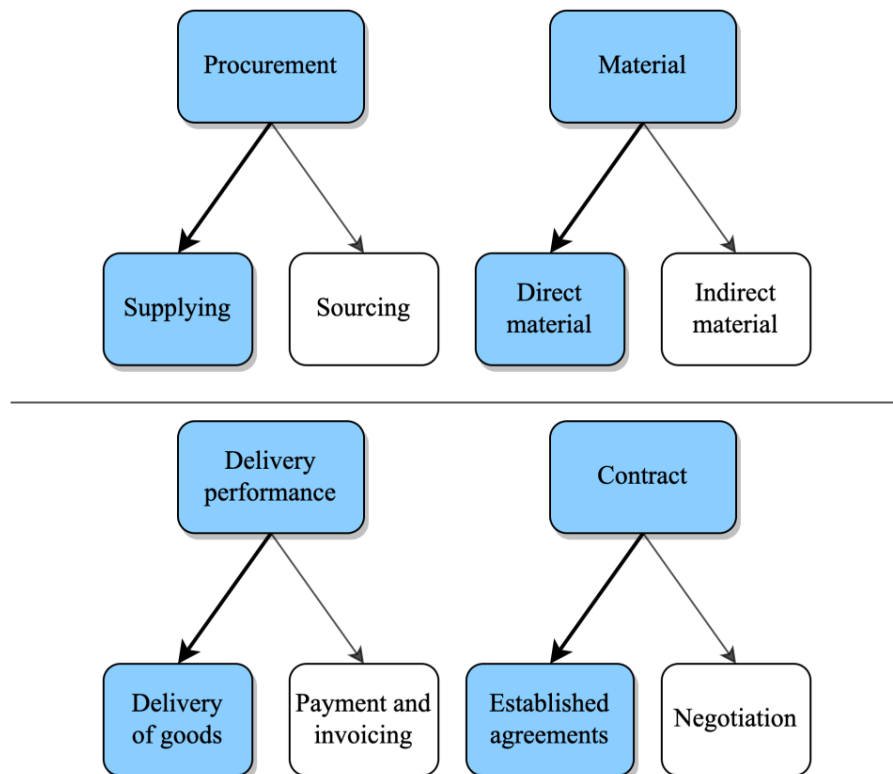
Figure 3. Visualization of the thesis scope with first tier suppliers. Created by authors.

1.7 Report outline

The report will consist of six chapters, following a red thread throughout the report.

Chapter 1: Introduction
This chapter introduces the background and previous works within the scope of the thesis. The introduction of the buying company and a thorough explanation of the description of the project, research questions and limitations of scope is done.

Chapter 2: Method
This chapter gives a detailed description of the procedures used in conducting the research. The methodology of multiple-case study is explained. The overview of the thesis structure is described in this chapter.

Chapter 3: Literature review
This chapter describes the theoretical framework for the thesis. The first three topics of the literature review correspond to each of the research questions previously mentioned. Firstly, the general theory behind a procurement process is written, followed by a limitation of the scope within this general process. Furthermore, the concept of digitalization is clearly defined within this thesis subject. Similarly, to digitalization, turbulence and its different types are explained. Lastly, as an addition to the digitalization tools, the perspective from Artificial Intelligence is explored.

Chapter 4: Empirical data
The chapter of "Empirical" Data will follow a structure of first explaining the sources from which the research material has been collected from. Thereafter, the written individual report of the four cases within this study are presented, following the subjects described in the literature review and interview guide. Thereafter, a holistic cross-case examination is done of the individual cases for finding similarities and differences in regard to the aforementioned subjects of this Master Thesis. Lastly, a summary of the main findings of the research collection is concluded.

Chapter 5: Analysis
The different sub-chapters of the "Analysis" chapter of this master thesis will follow the structure of first tying together the objective empirical findings, with the different aspects and perspectives presented in the literature review. As a complement, if further research is found on the identified patterns within the findings of this thesis, it will also be included for a further nuanced analysis on the subject.

Chapter 6: Discussion
In contrast to the objective and factual nature of the "Analysis" chapter, the "Discussion" chapter will follow a more subjective approach from the perspective of the authors and interviewees of this research study. The different sub-aspects of the study that may need a more informal approach to be explained and explored, is covered. The findings used in this chapter are the findings from the interviews that are of an informal and general nature.

Chapter 7: Conclusion
The purpose of the thesis has been to analyze and map several different areas within the supply chain of Duni Group in. The opportunities for future automation and digitalization have also been analyzed. Finding these results has been accomplished by using three research questions as guidelines for what information is relevant. These research questions are answered below.

2. Method

In the method chapter, a detailed description of the procedures followed in carrying out the research are included. First, the methodology of a multiple-case study is presented. Then the process of Data collection protocol is explained with details of preparing the interview guide. This is followed by Data analysis and Quality of research.

2.1 Qualitative and quantitative approaches

The data obtained or the methodology used can be either qualitative or quantitative. The focus of the qualitative research is on the context of the project. A narrow, clear view is attained with the help of collection and analysis of interviews. (Kotzab et al., 2005).
Whereas quantitative research provides a broader view due to the results that are drawn from the collection of data and statistical analysis. The findings are applied and concluded away from the context of the project which is the purpose of quantitative research. (Kotzab et al., 2005).

Both qualitative and quantitative approaches are used in this thesis. Qualitative description of digitalization would be in terms of digitalization and turbulence impact on the perception of the supplier leadership. Qualitative approach measures digital maturity which refers to the positive impacts in an organization on the transformation and improvement of processes created with the help of digitalization.
Quantitative measure of digitalization would be the amount of manpower required in the purchasing division related to the purchasing scale. For example, the quantitative measure of digitalization in an organization is measured with the improvement of business and its processes, generating revenue, and creating a digital business environment with digital information as the core.

2.1.1 The abductive approach:

A research approach can be classified into two categories as inductive or deductive. The inductive approach generally tends to be qualitative, and the deductive approach will tend to be quantitative. The qualitative inductive approach (Young et al., 2020) tends to have the approach which is equated from data to theory and the quantitative deductive approach tends to follow the approach which is equated from theory to data. The type of phenomenon usually is the deciding factor for the choice of approach. Both the approaches have two different paths that can be alternated between, which creates an abductive approach. (Kotzab et al., 2005)

Inductive path helps to understand the phenomenon by itself. The understanding of the phenomenon in an inductive path starts with collecting data which occurs through phenomenon observation. It is followed by a description phase which uses the point of view of informants to describe the phenomenon. Quantitative data from interviews, documents and observations are the various ways

to gather information which helps to find the phenomenon's thorough description. A theory is built with the help of analyzed data which is the next step named substantive theory. The firstly narrow analysis will transform more generally in the following. The phenomenon reaches an extensive understanding by going through all these steps (Kotzab et al., 2005)

Explanatory theory is used to collect information about the phenomenon which is the crucial aim of the deductive path. Literature is reviewed at the first step to create a framework that consists of applicable perspectives and the understanding of the relation between each other. Building a formal theory which is the next step helps in creating phenomenon's general theories. Each research question is answered with the help of the analysis done as a result of multiple interviews and also by referencing related literature. Field verification, which is the final step, uses experiments or field surveys to collect data. Hypothesis is tested and formal theory is verified in this step. When the deductive path is fulfilled, the phenomenon is broadly understood. (Kotzab et al., 2005).

An abductive research process which is iterative in nature shifts between the inductive and deductive research approach perfectly describes the abductive approach. The analysis in an abductive approach ranges from consequences to explanation. In our thesis, our main focus in terms of approach will be more qualitative than quantitative. The collection and analysis of data will be explained in next chapters.

2.2 Multiple-case Study

The research (Yin, 2009) is to be done through the method of a *multiple-case study*, the multiple cases are different purchasing processes to be studied through the lens of digitalization and the way in which it is implemented in the purchasing process.
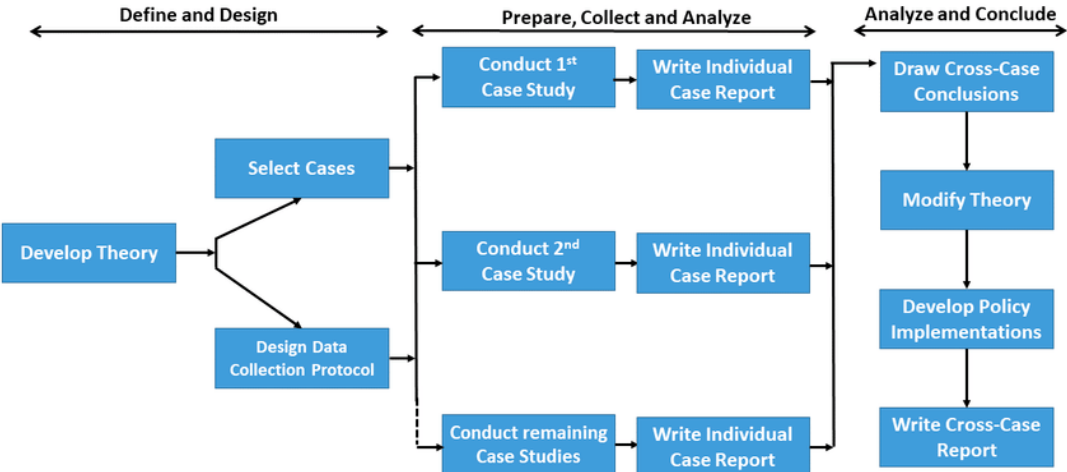
Figure 4. Research design of the four different case studies

2.2.1 Define and design

In the first phase of the MCS (Multiple-case study) research design, the framework of the Master Thesis is to be defined and designed. "Develop Theory" will consist of a first literature review to determine the research gap that exists about the studied subject. The first literature review will also be used to explore and define the problem formulation of the studied phenomenon. This will create an appropriate scope of work where the research gap of current literature and the problem formulation of Duni's purchasing situation adequately intersect to create an appropriate foundation for the Master thesis to be produced.

After developing the theory, designing data collection protocol is done to have a framework when gathering information about the different case studies. This makes it possible, with the help of the data collection protocol, to compare the different case studies and consequently draw cross-case conclusions. Parallel with designing the collection protocol, multiple cases of different scenarios that are relevant to the Master Thesis subject are to be selected for the next phase of the MSC. The cases are selected by our point of contact in Duni.

2.2.2 Prepare, Collect and Analyze

With the definitions and design of the MSC set in place, the conduction of the cases is to start. The studied cases are the purchasing processes between two factories of Duni (buyers) and two suppliers from which the factories have purchasing relationships. The information about their processes is retrieved from various sources, these will consist of interviews with relevant employees within the company and the first-tier suppliers that Duni collaborates with. The interviews will start by being relatively unstructured and open for the interviewee to lead the questioning to the relevant areas of this phenomenon. As the phenomenon and problem formulation becomes defined, the structured interviews are used to reach greater depths of analyzing Duni's procurement process and the role of digitalization in it. There are questions which analyze not only the proactive measures during turbulent times but also the reactive measures when an uncertainty hits. Observations are used to study the practical process of Duni's procurement in order to find additional information that may be relevant to the thesis. Lastly, data on supplier performance in the system is analyzed to examine the agreements between Duni and the suppliers. The information gathered from these methods is concluded in four individual case reports.

2.2.3 Analyze and conclude

After an appropriate amount of general and in-depth information about the phenomenon has been gathered from the Duni case study, the individual case reports are discussed to draw cross-case conclusions. A second literature review is done for the purpose of describing the cross-case conclusions with relevant terms that assimilate the research results with the existing literature, "filling in the research gap". If viable, appropriate policy implementations are made to improve the purchasing process within Duni. Lastly, a cross-case report is written, concluding all the multiple case studies and the results arising from them.

2.3 Data collection protocol

Yin (2009) Suggests six different data collection methods, they are archival records, interviews, direct observation, participant observation and physical artifacts.

For the qualitative research methods, interviews and documentations were used. Since the occurrence of COVID-19, meetings over software such as Microsoft Teams has been preferred by the interviewees and makes it easier for booking meetings with interviewees who may not have the fully needed available time and are easier to reach in digital meetings. In specific instances there have been face-to-face meetings. Videoconferencing in digital meetings has made it possible to retain the ability to read body language and cues that may not have been possible with an audio-only digital meeting. As mentioned by Creswell (2009), it is important to understand the informal communication of the participants such as body language. This is tied with the importance of both authors of this thesis being present in the meetings with interviewees to experience its different aspects. To allow these different expressions of the interviewee to remain genuine, an active unbiased approach for the interview and its open-ended questions has been implemented as recommended by Yin (2009). This is to not unconsciously push the interviewee against the biased direction of e.g., that digitalization has a substantial impact on delivery performance. The meetings are transcribed by a Microsoft Word function which makes it possible to have the audio of the meetings written in text and subjects of discussion easily traced back.

Records of delivery performance with suppliers was used as one of the key delivery performance indicators to which digitalization and turbulence is compared to.

2.3.1 Preparing the interview guide

Voss et al. (2002) explains how developing a case study protocol may increase the reliability and validity of the study. Reliability is defined as the possibility of recreating a measure under similar circumstances and validity is defined as the actual accuracy of the measurement in measuring the studied variable. One of the steps at this stage is to create an interview guide by which all the interviews are based on. The interview guide works as a framework for the interviews where relevant subjects are ensured to be covered with the appropriate questions, while simultaneously having space for a deeper discussion that may be initiated by the interviewee when asked the open-ended questions of the interview guide. Aside from the relevant thesis subjects being covered, which is tied in with the concept of validity. The interview guide also works as an ensurement of reliability because of all interviewees being subject to the same interview guide. With the interview guide being a method of measurement, the measurement can be seen as being replicated under similar circumstances when different interviewees are subject to the same interview guide.

As mentioned, both structured and unstructured interviews were combined to create a semi-structured interview guide. Voss et al. (2002) mention the average interview duration to be around 90 minutes which is what the goal of the interview guide duration has been. The interview guide has also gone through certain iterations based on the experience of the first interviews and a reflection

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on what question formulations have been most relevant to the research questions and purpose. Lastly, the extent to which the interviews have been structured, duration of interview and its general results is affected by the particular qualities of the interviewee such as specific interest, personality and experience. This is discussed further in chapter 6.2.1 explaining the obstacles of the interviews.

2.4 Data Analysis

The initial theory of the study can be efficiently addressed with the help of Data Analysis (Yin, 2009). To arrive at a solid conclusion, the different parts in data analysis that range from examining, categorizing, tabulating, testing, and combining quantitative and qualitative data helps. To analyze the qualitative data acquired from the interviews, explanation building, and pattern matching were used as suggested by Yin (2009).

The acquired data from interviews were put under qualitative analysis with the help of pattern matching technique which is explained below.

2.4.1 Explanatory analysis

The identification of current practices and likely areas of improvement in information sharing were identified with the help of understanding the ways of working, interactions with digitalization tools, conventional tools in place and various other factors that influence information sharing within and between other departments. This will help understand the wide range of impact of different degrees of digitalization on the delivery performance.

2.4.2 Pattern matching

The first literature review works as a kind of framework by which specific patterns are searched for. Once the empirical results of the different cases have been acquired, pattern matching is used, meaning a comparison between case results to distinguish the similarities and differences, and the reasons for it. Lastly, with the inter-case patterns, differences and similarities identified, they are further studied and explained by a second literature review done to further the discussion of the thesis subject. The empirical results obtained from the first literature review are used to find the case A and B empirical results. These two cases will also have a cross-case interaction and the empirical results are explained by a second literature review. Below is a figure made by authors that explain the pattern matching in combination with an abductive approach.
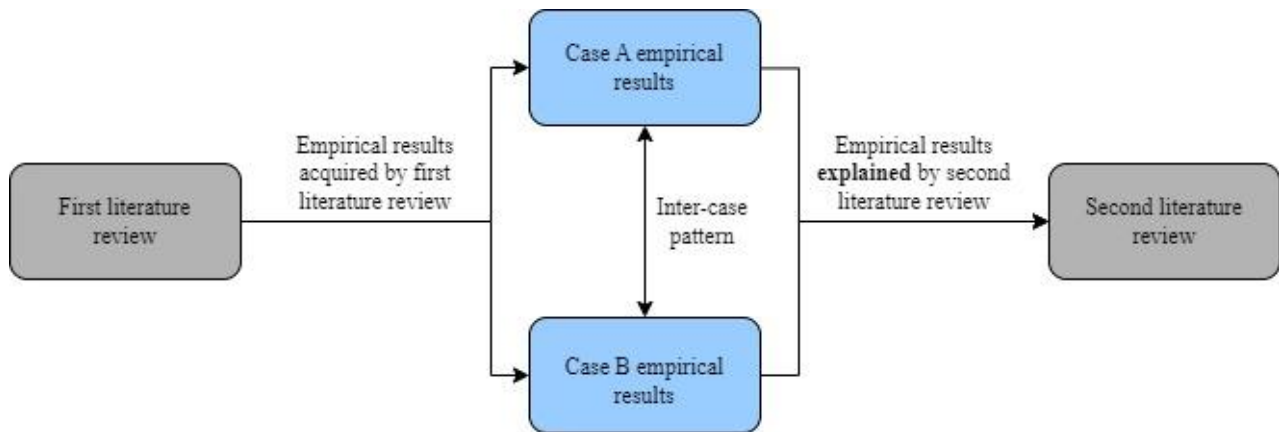
Figure 5. Empirical results and pattern matching by literature reviews. Created by authors.

2.5 Quality of research

The text presents four crucial tests in case study research per Yin (2009): construct validity, internal validity, external validity, and reliability. Construct validity verifies the data collection process and incorporates reviewers' input. Internal validity guarantees accurate correlation interpretations, using pattern matching, explanation building, and logic models. External validity assesses generalizability, arguing for analytical over statistical generalization, accomplished via replication logic and theory application. Lastly, reliability ensures the study can be reproduced by others, facilitated by a detailed case study protocol and database. These steps aim to bolster the integrity of case study research.

Table 1. Case study tactics for four design tests (Source: Yin, 2009)

TESTS	Case Study Tactic	Phase of research in which tactic occurs
Construct validity	- Use multiple sources of evidence - Establish chain of evidence - Have key informants review draft case study report	Data collection Data collection composition
Internal validity	- Do pattern matching - Do explanation building - Address rival explanations - Use logic models	Data analysis Data analysis Data analysis Data analysis
External validity	- Use theory in single-case studies - Use replication logic in multiple-case studies	Research design Research design
Reliability	- Use case study protocol - Develop case study database	Data collection Data collection

2.5.1 First test - Construct validity

In case study research, this first test is demanding. Very often it has been mentioned that the investigator of a case study does not succeed in creating an efficient operational set of measures along with the judgements which are subjective and are used for data collection. A familiar case study topic such as "neighborhood change" can be taken as an example. There are concerns arising over the years on the change of character of urban neighborhoods. Case studies can inspect the different types of changes and their results. But in the absence of critical, operational events' specifications that are responsible for change, it is hard to come to a conclusion if the declared changes in a case study authentically reflect the neighborhood's events or if it's just the impressions of the investigator. In this study, we let respondents read summary after the interview to make sure the data was understood correctly.

2.5.2 Second test - Internal validity

Internal validity is the test ensuring that a correlation between variable *x* and variable *y* is explained with the inclusion of other possible variables impact. In this master thesis, we are discussing the variables of *delivery performance, digitalization* and *turbulence*. To ensure internal validity in this study, it is important to discuss other possible variables that may have an impact on the results of e.g., delivery performance, and explore the different nuances between the main correlations of the

study. As mentioned, this can be done by pattern matching, explanation building, and additionally, addressing rival explanations that produce a risk for affecting the results of a study without being included. Lastly, logic models are used to break down the studied correlation and in detail explain its relationship.

2.5.3 Third test - External validity and transferability

External validity deals with the fact of generalizability of the study's findings. In case-studies, this may be a major barrier and a problem regarding the research quality of case studies. Critics have implicitly mentioned that survey research is necessary for the generalization of a case study's findings. Yin (2009) explains that survey research relies on *statistical generalization,* while case studies are to be generalized with *analytical generalization.* This analytical generalization can be done by replication logic, meaning a repeat of the case study with similar circumstances regarding the subject matter. In replications of case studies, it is possible to change some of the factors outside of the study scope in the replications to ensure that they are not significant in the outcome of the results. This replication logic can be seen in the method of identifying patterns in a multiple-case study that is to be done in this thesis. The results are supported with the help of theory, especially the *second literature review* that is done to generalize findings.

2.5.4 Fourth test - Reliability

As mentioned with external validity, replication logic is one way to ensure external validity of the research findings. This replication logic should not only be available to be done by the study authors. Making it possible for other researchers aside from the authors to replicate the study with only the research material used in the study is defined as *reliability*. To ensure this opportunity, it is essential to document the procedures followed in the earlier case. This can be done by using a *case study protocol* that describes the different steps used in data collection of the case study. Complemented by a *case study database* which documents all the findings of the study in a structured manner. Replication of a case study may be seen as an audit, and the case study protocol with the case study database are seen as tools to ensure a successful outcome of the audit.

3. Literature review

This chapter describes the theoretical framework for the thesis. The first three topics of the literature review correspond to each of the research questions previously mentioned. Firstly, the general theory behind a procurement process is written, followed by a limitation of the scope within this general process. Furthermore, the concept of digitalization is clearly defined within this thesis subject. Similarly, to digitalization, turbulence and its different types are explained. Lastly, as an addition to the digitalization tools, the perspective from Artificial Intelligence is explored.

3.1 Purchasing process

This chapter will describe the conventional framework that is used when describing the purchasing process.

3.1.1 The different steps

The Van Weele (Van Weele, 2014) procurement process consists of several steps ranging from specification definition to evaluation. These steps make sure that the procurement process is done right in a structured way. The very first which is to get specifications will make sure that the functional specifications of the product/service are mentioned clearly. Technical changes are clearly mentioned at this phase which together gives awareness about supplier to engineering. The next stage in sourcing is the supplier selection. This stage makes sure that sufficient suppliers are selected for the product/service. There is a request for quotation from each supplier and a thorough process of pre-qualification is done. Once the supplier is selected, a contract is prepared which consists of all the necessary information and the additional terms and conditions depending on the industry. In the ordering phase which follows, there is an order routine which is established. The main purpose of this stage is to handle orders and develop a structured order routine. Once the ordering process is done, the expediting routine is established in the expediting stage to make sure that the supplier will perform as agreed in the confirmation of purchase order. During the follow-up and evaluation, the supplier is evaluated based on the performance and supplier rating is done. There is a supplier ranking scheme which helps to rank the supplier based on the fulfillment of promises. Preferred list of suppliers is prepared which acts as a guide for the future procurement process. This is shown in figure 6 below.
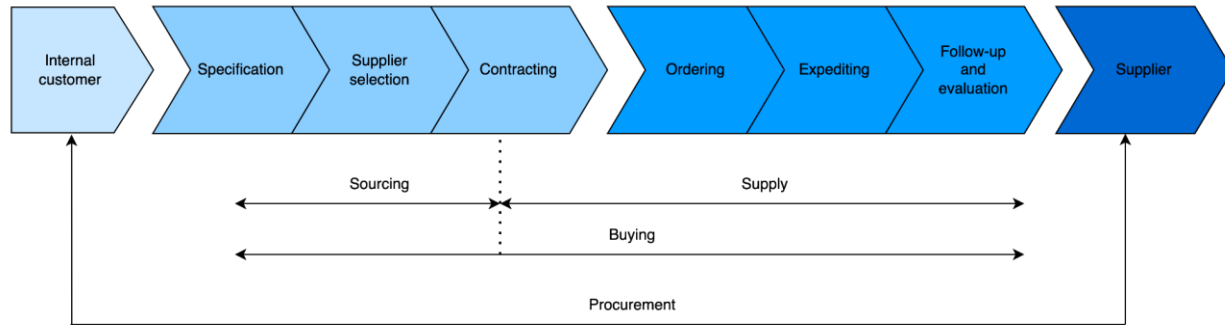
Figure 6. Van Weele procurement process. (Source: Van Weele, 2014)

3.1.2 The scope - Supplying and its subparts.

In this Master thesis, we have determined the scope to be within the *supplying* part of the procurement process. This includes placing the order with the selected supplier and developing sufficient purchase order and handling routines. Monitoring and controlling of the order to secure supply (expediting), and follow-up and evaluation of the supplier and its performance. In contrast to *sourcing*, which is about determining the source of a material from a certain supplier, *supplying* is about the upkeep of the activities with a certain supplier and the striving for improvement (Van Weele, 2014). Terms of payment and invoicing of deliveries will not be included in this thesis. The scope is shown in figure 7 below.
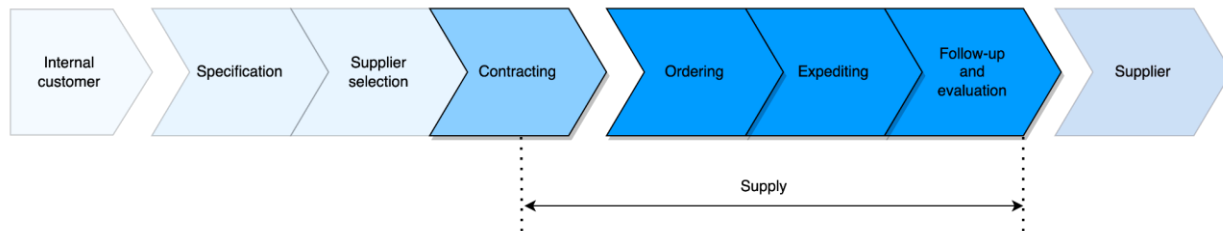
Figure 7. Visualization of the scope in Van Weele procurement process that is to be considered. Inspired by Van Weele (2014).

Contracting

Contracting is partially included in this thesis subject, as a framework by which the supplying adheres to, but not including negotiation. In this thesis, the partial inclusion of contracting is because normally, the contract sets the rules and expectations of what defines the delivery performance of a supplier, in the case of delivery performance being measured from the fulfillment of the specific contract requirements. (Jenkins, 2021). This framework of the contract may give a more nuanced description of delivery performance and its different aspects.

The different types of contracts used in purchasing agreements are mainly cost-specified with corresponding delivery schedules:

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Fixed-price plus incentive fee contract is a type of purchasing agreement where the supplier is paid a fixed price for their goods or services with a potential to earn an additional incentive fee if exceeding performance criteria.

Cost-plus contract means that the supplier is reimbursed for all allowable costs incurred in delivering the goods or services. This flexibility in cost may also lead to a flexibility in delivery schedule.

Cost-reimbursable contract

Similar to a cost-plus contract but the supplier is reimbursed without a fixed fee or profit percentage. Without these incentives the purchaser is more reliant on having inspections of suppliers and terms such as *maximum price* specified in contract.

*Agreement with price-adjustment i*s normally used for long-term contracts where the price of goods may change based on external factors. The price-adjustment is then as a mitigative action to keep the inherent purchase agreement values of the contract when it was made.

Penalty clauses and warranty conditions are the consequences that are to be introduced if the purchasing agreements are not fulfilled. The agreements that are to be fulfilled may be aspects in terms of quality of goods, specifications, and how the deliveries adhere to the delivery constraints of the purchase agreement.

Ordering

Ordering plays an important role in the procurement process as it makes sure that the ordering of materials is done properly with respect to the contract. The order can be placed once the contract's terms and conditions are acknowledged and recorded. Against this agreement, purchase orders are placed and initiated with the help of the purchase order requisition which are processed through an ERP (Enterprise Resource Planning). A purchase order consists of many essential details that range from the order number details, a clear description of the product ordered, total number of units that are needed, delivery address along with invoicing address, price of units to time and date of delivery (Jenkins, 2021). Different products which are to be delivered are mentioned in different order lines in a purchase order. All this information needs to be reflected on the invoice and also on the delivery documents that are sent from the supplier end. The supplier, for every purchase order received, is asked to send in a confirmation to make sure everything is streamlined.

Expediting

Expediting is the next step in the process of procurement once the ordering is done. It is the process of making sure that the outstanding orders are delivered on-time. It also monitors the financial commitments that are outstanding. Expediting is frequently held as per the overdue list which in result requires more attention from the buyer which results in recording every delayed delivery. Expediting is divided into three types.

Exception expediting: The internal customer will let the buyer know on the materials that are delayed. The buyer after getting the information must take quick action which depends on if the

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delayed delivery impacts the operational processes of the internal customer. The buyer takes action after-the-fact every time, hence this is not a recommended method.

Status Check is a method of expediting that is classified into two different approaches.

Routine status check: This is a preventive way of approaching where the buyer will get in touch with the supplier where the request to confirm the date of delivery is made again to ensure that everything is in accord.

Advanced status check: This method suits best for critical suppliers who supply critical parts. All the supplies that occur on the critical path for planning materials or the tight quality tolerated materials that happen to come from troublesome suppliers refers to critical. The progress is regularly checked by the buyer with the help of a work schedule that is time based which has been sent during contract closing by the supplier.

Field expediting: In the case of very costly and high-risk contracts where delivery performance is of highest priority, the purchaser may assign an inspector to be present at the supplier to make sure the operational processes go accordingly and have on-site live expediting.

Lastly, *Acceptance tests* are a way of routinely ensuring that products are of expected quality during the delivery. These can be done at the supplier's site, after delivery to the purchaser, and after the product has been put into operation.

Follow-up and evaluation
The work with the supplier may continue even after the duration of the contract has expired. This may be for maintenance of products, warranty clauses, or excess/minor work that needs to be done between supplier and purchaser. (Jenkins, 2021). Included in this, is the follow-up and evaluation of the specific supplier that the purchaser has been in a purchase agreement with. For a nuanced and extensive evaluation, it is consequently necessary that the information collected about the supplier regarding delivery performance is nuanced and extensive. This mainly includes aspects of delivery performance that were agreed to in the contract but may also be complemented by the supplier's competitiveness and innovativeness. A successful follow-up and evaluation can lead to a reduction in supplier base and a short list of the best performing suppliers for the purchaser. But to achieve this, as mentioned, the information collected of supplier performance has to be thorough and up to date.

3.1.3 Buyer-supplier relationship
An essential definition of the purchasing process for this thesis is the fact that a purchasing process is a process with two different sides of the activities (TFIG, 2012). These involve the buyer of a certain product and the supplier of said product. With this definition of the process having two

mirrored sides, this Master Thesis will approach the work by studying the operational activities of both the supplier and buyer in regard to a certain theoretical activity. Example: the theoretical activity of *ordering* has two operational activities, the buyer placing a certain order, and the supplier managing the order and fulfilling it. With the help of this, interview questions to the purchaser Duni may be mirrored to a corresponding first tier supplier in the supply chain.

3.1.5 Direct and indirect materials

Procurement of materials may have different processes depending on the material, two different types of materials are direct materials and indirect materials. (ControlHub, 2023). Direct materials in a procurement process refer to the necessary materials without which the production of the end product is not possible. (Jenkins, 2021). An organization cannot generate any revenue without direct materials. Whereas indirect materials are the supporting materials which support the process of production and are not necessarily required to produce the end product. (Jenkins, 2021). A purchasing company buys raw material of paper which is an example for direct material which helps to produce their finished product of kitchen napkins. Indirect materials which act as a production process support varies from pens, paper, screws and more. In this thesis paper, the scope is restricted to direct material, excluding indirect material.

3.1.6 Delivery performance

Delivery performance helps an organization measure their own standards which are expected from their customers (Erp-information, 2023). It is mainly categorized into two types which are operational and strategic. The efficient production and supply of goods or services by an organization is measured under operational delivery performance. The alignment of long-term plans with the goals of organization is measured in strategic delivery performance.

The seven various factors which contribute to the delivery performance are described below, according to Elogii (2020).

Number of completed deliveries: The delivery performance could be analyzed with the help of the total number of completed deliveries monthly, quarterly, or yearly. The efficiency of the whole operation of delivery could be measured with the number of deliveries that are completed. The growth potential of an organization could be measured by calculating the average number of deliveries with respect to operational capacities depending on if it goes beyond or lags behind.

Delivery on time: Deliveries made on time would help to measure the quality of the service of the delivery. The source of the problem could be found and addressed by the operations manager once after finding out the late deliveries. On-time delivery Key Performance Indicator (KPI) helps to measure the performance of deliveries of an organization.

Accuracy of the order: The perfect order measurement is determined by the percentage of orders that are delivered without any errors when compared to the total delivered orders. The inaccuracies that happen during the deliveries can be identified. The calculation of order accuracy rate is done by subtracting the total number of orders from the error orders which is divided by the total number of orders. The result value is multiplied by hundred which gives the order accuracy rate.

$$\frac{\text{Total number of orders - Error orders}}{\text{Total number of orders}} \times 100$$

Transport time to distance: This refers to the time spent from the pick-up location to the destination by the drivers and couriers. The efficiency of the routes used for delivery and the outline of the agents' speed could be measured with this metric. The routes affect the drivers on them but also the drivers affect their routes. Hence, the maintenance of effectiveness on both could be measured by tracking this KPI.

Available capacity vs vehicle capacity: This refers to the total capacity related to the vehicle's capacity which is used to deliver products or services. The total amount of inactive space that is not used for fulfillment of orders is shown and in order to calculate it, the capacity available is to be divided by the total capacity of a fleet or vehicle. These last-mile delivery metrics' monitoring process is helpful to find vehicle management which could be used to find the operations' profitability.

Average time taken to deliver: This refers to the average time over a specific period it takes to finish a delivery. The efficiency of the delivery routes that are planned and the effectiveness of the whole network of supply chains could be found by identifying the average time taken to deliver. The different averages compared over equal periods would help managers find out which routes need to be optimized or which drivers they need to talk with.

Average delivery cost: It refers to the average cost required to deliver products or services that are based on key parameters which are specific. The distance, the vehicle type or delivery type are used to calculate the average delivery cost. The changes to the services would be implemented by the companies after finding out the average which in return would decrease the cost without affecting the performance of the output like route optimization software implementation or by using vehicles that are better.

3.2 Digitalization and automation

3.2.1 Definitions

"Digitalization is defined as the use of digital technologies and of data in order to create revenue, improve business, replace/transform business processes and create an environment for digital business, whereby digital information is at the core." (Reis et al., 2020) . This is tied in with the concept of automation with the definition *"The term automation refers to the transfer of process functions and entire process sequences from humans to technical systems."* (makeitfuture, 2020). Since there is no universally agreed definition of either digitalization or automation, while simultaneously being closely related, they might be synonymous concepts. To give an example: The manual process of writing a letter, walking to the mail courier and physically sending it is replaced by the process of using a computer that does the same process but with the storing of digital information and with the press of a button. Has the process been digitalized, automated, or both? In this Master Thesis, these concepts will not be definitively separated. Instead, they are used slightly interchangeable but still with some adherence to their described definitions.

3.2.2 Different technologies

The different technologies (Deloitte, 2017) that are crucial in the process of procurement in an organization are as follows,

eProcurement

eProcurement which refers to electronic procurement is the process of purchasing and selling equipment, supplies, and services with the help of a web interface or other system of networks (Medius, 2023). The main purpose of the technology is to automate and centralize interactions between customers, companies and its value chain partners to enhance the overall efficiency of the procurement process. This technology is core and one of the procurement mainstays for a company to operate a well-structured procurement process.

Contract management

The process of contract management which is connected to procurement and purchasing which are made as a segment of legal documentation of the vendors, customers or partners. (Aavenir, 2023) Term negotiation and contract conditions are a part of it and includes compliance certification consisting of terms and conditions and also completely documenting and acknowledging any changes made by both the parties. It also ensures that the product/service is not sold higher or lower than the agreed-upon price and formally binds the supplier and buyer to a specified delivery time, with the right quantity, to the right destination.

Performance management

Performance management in procurement helps to calculate the spend of procurement teams and efficiency with the main aim of increasing visibility and enhancing the overall procurement value in

an organization. (Per-angusta, 2022). Effective management of performance in the procurement department can be done by identifying opportunities, prioritizing next steps, forecasting company's savings, collaborating with teams, measuring the progress, and communicating the progress and also expectations.

Artificial intelligence

Sammalkorpi & Teppala (2019) Describe how the efficiency and effectiveness of complex problem solving in a procurement organization can be achieved through Artificial Intelligence (AI) which uses algorithms of smart computers. AI can be implanted into several other software applications which ranges from spend analysis to strategic sourcing. AI has the potential to master and adapt their own behavior on a higher level. The main purpose of AI software is to automate human decision-making with the help of a neural network, minimizing human error and potentially minimizing operations cost. AI may transform the whole procurement process of an organization with low investment which makes it belong to the intermediate tier in the degree of digitalization.

AI is also categorized between Weak AI such as customer support robots that direct you to the appropriate department and Strong AI that is able to produce complex output and decisions such as GPT-4 programming an entire website from scratch with only one user input prompt.

Lastly, Artificial intelligence uses databases of information as learning material and builds neural networks that aid in the *prediction of the optimal next step.*

Big Data analytics

Big Data analytics helps a company to combine quantitative methodologies with data. In essence, it is the concept of analyzing exceptional amounts of data for more nuanced information to support decision-making.This technology expands the analysis dataset beyond the internal data that is stored in ERP systems. (Bhatt, 2022). The various areas of procurement where the technology can be used proactively are risk management, predictive analysis, compliance and collaboration. (Hickey, 2019).

Robotic process automation

The end-to-end management of both demand and supply planning in an organization can be effectively done by using Robotic Process Automation (RPA). (Comtecinfo, 2023). RPA eradicates the silos that exist between different departments in an organization. The various departments include procurement management, warehousing, shipping and inventory management which are managed by RPA as one centralized team. The procurement team can handle the situation when the warehouse has full inventories with the help of automatic notification sent from the software.

Internet of Things

In the area of procurement, the Internet of Things (IoT) is the network of physical objects with sensors that provide information that helps operational processes of procurement (Kafil, 2022). IoT in procurement helps in various areas from material tracing, supply chain visibility, monitoring and

alert maintenance, stock management and finer decision making with the help of predictive data analytics.

Crowdsourcing

Crowdsourcing is an alternative way of obtaining market intelligence from buyers. (Sooran, 2019). With the help of a shared and common vendor management system, access to an extensive range of suppliers is readily available. It is a cloud-based platform which provides faster cycles with no predetermined capital expenditure. It delivers a business model which is lined up with both suppliers and buyers' interests which involves business constituencies from finance to engineering.

Digital supplier relationship management / Information management system

The digital technology of supplier relationship management will make sure to store, access the information of suppliers to get an overall picture of the relationship which helps to improve the business of the organization. (Fröhlich & Steinbiß, 2020). The organization can retrieve and check the performance of the suppliers in the process of procurement to evaluate the prospects of placing future orders with this supplier.

Blockchain

Blockchain technology is the underlying technology that forms the existence of cryptocurrency, with it being a decentralized ledge. (GEP, 2023). This technology can provide an advanced level of transparency and trust while optimizing the procurement process to gain operational advantages. Innovations based on blockchain gives a vast range of applications for supply chain and procurement. (GEP, 2023) Enhanced purchase order management, smart contracts and real-time settlement are some of the examples.

To be able to introduce traceability and create a more transparent (Kumar & Ganguly, 2020) and traceable (Hastig & Sodhi, 2020; Khan & Parvaiz et al., 2022; Khan & Khan et al., 2022) process of the purchasing operations. The trust between a buyer and a supplier may be strengthened with increased transparency and openness provided by blockchain technology, benefiting the two businesses by making procurement functions more strategic and supportive of long-term goals.

3.2.3 Spectrum of digitalization tools

When conducting the different case studies, the specific company that is the subject of the case study is to be placed in an appropriate position on the spectrum of digitalization. This is further defined by dividing the spectrum of digitalization into different tiers (Deloitte, 2017), with complementary input from our contact at Duni. The three tiers of digitalization that categorize the spectrum were defined as the following:

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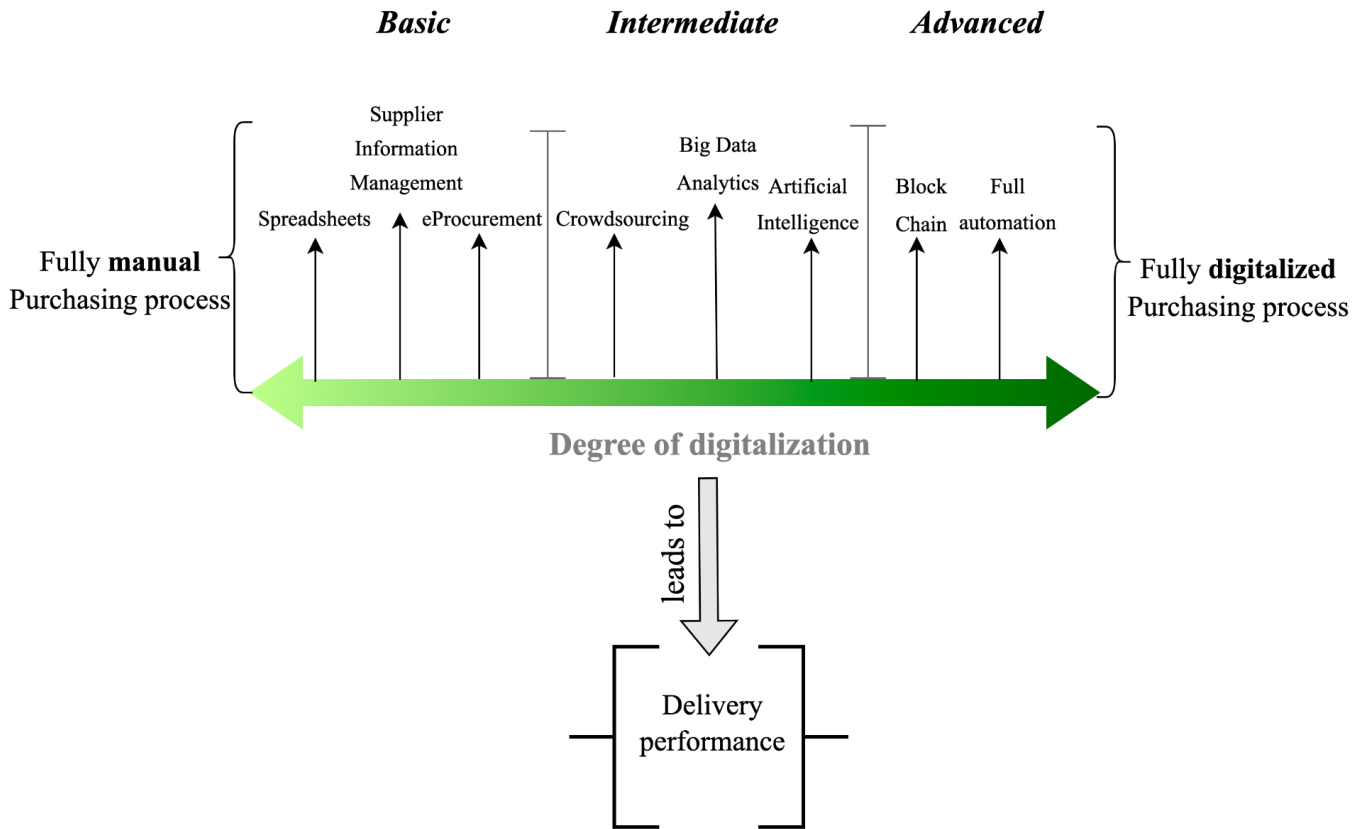
Figure 8. Diagram of the degree of digitalization that leads to the specific delivery performance. Created by authors.

Basic tier

The entirety of the procurement function can be optimized to a varied extent with the help of digitalization. The basic tier consists of Transactional support and Functional excellence. These are the base levels which a company must adhere to. The Transactional support mainly focuses on the operational transactions where the collaboration across other businesses is limited. Functional excellence emphasizes across the company on the already established best practices and policies which are implemented already. *Spreadsheets* is one of the most basic tools for operations along with eInvoicing which covers the fundamental operations through digitalization.

Intermediate tier

The intermediate tier focuses more on the supply chain management process cross functionally. More importance is given to building a world class supplier network which improves the overall efficiency of the procurement process. Cross-functional relationships are consistently studied and improved. In the Intermediate tier, suppliers are given more importance and are actively integrated

as a source of innovation. The market trends and risks of supply are strategically reviewed. Artificial Intelligence and Collaboration networks are the prime examples of Intermediate tier which works cross functionally to monitor and improve the performance of the organization.

Advanced tier

The final tier of the digitalization when implemented provides a business partner to an organization who is digitally empowered completely. Most of the manual transactional activities are automated and the collaboration models both internal and external are digitalized based on technology.

Digital analytics and Big data management are examples of advanced tiers of digitalization as these are used as an essential part of procurement negotiations and decision making in an organization.

3.2.4 Characteristics of digitalization in the procuring process

In order to complement the spectrum of digitalization, the concept of digitalization is described by three different characteristics. These characteristics are used as the foundation for developing the interview questions with which the different case studies are conducted.

As mentioned, digitalization is a concept with no clear borders on its definition. Although a definition has been previously assigned to digitalization which is the most suitable general definition for this paper, there are several others that adhere to different aspects of digitalization. Two different definitions of digitalization are to be used to adequately describe the general concept of digitalization by assigning the two first digitalization characteristics with each chosen definition (Reis et al., 2020). Note that the general definition of digitalization in this paper is used for the first digitalization characteristic. Lastly, the support of the leadership in terms of utilizing digitalization is a significant factor for successful implementation of digitalization (Chatterjee & Chaudhuri, 2022). This can be evaluated by interviewing business executives within the chosen department that use digitalization in their operational processes. The interview questions will then use a mostly qualitative approach and use the respondent's perception of digitalization to describe its role in the operational processes (Gerald et al., 2017). Below is a table showing all the different digitalization characteristics and their definition origins.

Table 2. Definition and characteristics of digitalization. Created by authors.

	Description	Topic	Origin
Dig. Characteristic 1	The extent to which digitalization software is used in the operational process steps.	Software integration	*Digitalization is the growing application of ICT across the economy "encompassing a range of digital technologies, concepts and trends such as artificial intelligence, the "Internet of Things" (IoT) and the Fourth Industrial Revolution"*
Dig. Characteristic 2	The amount of manpower in the purchasing division relative to purchasing scale.	Quantitative measure of digitalization	*Digitalization is defined as the use of digital technologies and of data in order to create revenue, improve business, **replace/transform** business processes and create an environment for digital business, whereby digital information is at the core.*
Dig. Characteristic 3	The perception of the supplier leadership in terms of digitalization and turbulence impact.	Qualitative description of digitalization	*Digital maturity was measured in this year's study similar to the way it was measured in prior years. We asked respondents to "imagine an ideal organization transformed by digital technologies and capabilities that improve processes."*

Similarly to the table above, the figure below shows how the different characteristics relate to the general abstract concept of digitalization.
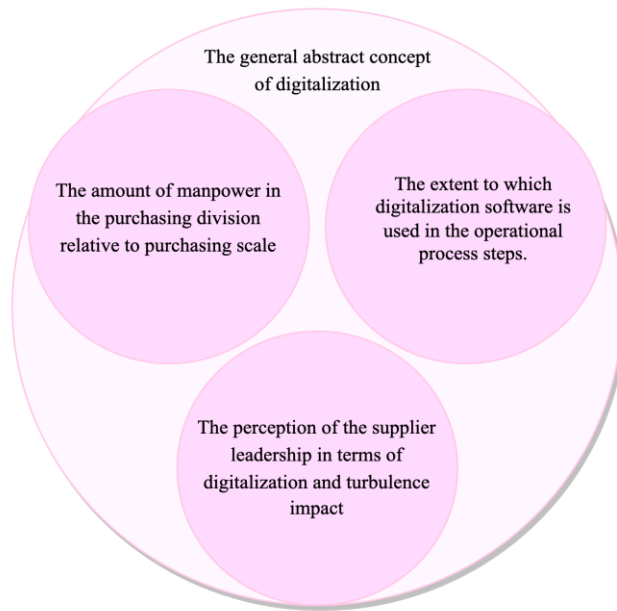
Figure 9. Digitalization and its chosen characteristics. Created by authors.

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3.2.5 General trends of digital transformation within procurement

The authors Alabdali & Salam (2022) published a research paper named "*The Impact of digital transformation on Supply Chain Procurement for Creating Competitive Advantage: An Empirical Study*". With a similar purpose to this Master Thesis, their approach is mainly quantitative, while ours is mainly qualitative. In the paper, they discuss trends and current state of digital transformation with operational processes, with a specific focus on procurement. And how digitalization may provide a competitive advantage. Below are findings and research material

Overview

Stakeholders within the digitalization framework consist of suppliers, governments, retailers, financial institutions, customers which are all affected and influenced, as is the deployment of new technologies, with their models, partnerships and workflow of purchasing processes being relevant to the digitalization framework (Soto-Acosta , 2020; Verhoef et al., 2021; Bowersox et al., 2005; Hahn, 2020; Jahani et al., 2021)). The best benefits are achieved through utilizing organizational resources and allocating them to the relevant area of the organization. This type of effective allocation of resources, when done correctly, may lead to the generation of sustainable competitive advantage (Grant, 1996), this is not easy to imitate, but if done correctly, creates value for the company (Barney, 2001). Teece et. al. categorized the utilization of organizational resources into the category of building and creating dynamic capabilities, e.g., using the implemented technologies to create a sustainable competitive advantage by managing interorganizational relationships (Malhotra et al., 2007).

Digitalization tools and their benefits

With the occurrence of global disasters such as the previously mentioned COVID-19 pandemic, digital transformation has been ranked much higher on the corporate agenda. Before the specific case of COVID-19, companies treated digital tools mainly as tools for information management, including communication and data sharing (Ye et al., 2022; Bonnet & Westerman, 2021). For companies to be able to mitigate turbulence that may affect their processes, they need to start treating technology as not only a tool for communication or data sharing but also as a tool for proactive management of their purchasing processes, which has been further proven by the consequences experienced by the COVID-19 pandemic (Ye et al., 2022; Bonnet & Westerman, 2021; Loonam et al., 2018). A digital transformation includes the crucial component of the organization having a greater reliance on IT and analytical services, allowing for a quicker reaction to turbulent events. DT has been proven to improve the cost efficiency, financial performance, customer-centricity, and the complex management of a network of partnering relationships in Supply Chains. By implementing new tools of DT in procurement, it can better serve supply chains, becoming a crucial function of the organizational processes that rely on Digital Transformation (Sousa-Zomer et al., 2020; Seyedghorban, 2020; Koh et al., 2019; Tortorella et al., 2019; Schrauf & Berttram, 2016; Rubbio et al., 2019; Hastig & Sodhi, 2020; Martinez et al., 2019). In order to be able to introduce traceability and create a more transparent (Kumar & Ganguly, 2020) and traceable (Hastig & Sodhi, 2020; Khan

& Parvaiz et al., 2022; Khan & Khan et al., 2022) process of the purchasing operations. The trust between a buyer and a supplier may be strengthened with increased transparency and openness, benefitting the two businesses by making procurement functions more strategic and supportive of long-term goals. In order for a company to create competitive advantage with the usage of digitalization in their processes, it has to be implemented in the correct way, making it hard for competitors to imitate (Bienhaus & Haddud, 2018; Viale & Zouari, 2020). This ties in with the concept of Contingency Theory (Trkman et al., 2009), a concept arguing that there is no one solution or strategy for a company that is guaranteed to improve e.g. supplier relationships. The strategies used when improving organizational structure and processes, in this case purchasing processes, have to be adjusted to the specific environment, needs and goals of the company that is to be improved. Hallikas (2021) describes how digitalization tools improve purchasing processes by the effective management and accessibility of information, examples of this include the improvement of analytical functions such as spend analytics and visualization of delivery performance.

According to Jahani et al. (2021), inbound and outbound logistics is part of the supply management of a purchaser-supplier relationship. The problem formulation of implementing digitalization tools is how it is to ensure that there are minimal errors in the operational purchasing process of an organization. This includes automating the process to some degree, to ensure right levels of supply, with the right cost, at the right location, to a more efficient process with the digital tools compared to the human process counterpart (Khan & Khan et al., 2022; Khan & Parvaiz, 2022).

3.2.6 Assessment of competitive advantage from a digitalization perspective

The authors Knudsen et.al (2021) published a research paper named *"Stability in turbulent times? The effect of digitalization on the sustainability of competitive advantage"*. This paper explains the sustainability of competitive advantage of an organization with respect to the degree and type of digitalization which is in line with one of the focuses of this Master Thesis. In the paper, they explain the different types of organizations based on digital technologies and how they work. This paper is used as an analytical framework in the *digitalization tools* chapter of our analysis.

The main goal of achieving organizational success is to get a competitive advantage over competitors which is sustainable. This competitive advantage should be consistent and prolong over longer periods of time and not just for a short period of time. This was believed to be possible when the digital technologies were introduced as these technologies focus mainly on increasing the overall efficiency of an organization by improving the quality of the products, cost reduction, increase in the convenience and many more. Digital technologies have constantly evolved and at this present age, it has the ability to fundamentally change the structure of the market. This rapid growth in digitalization also means that the competitive advantage one organization earns will not be sustainable for longer periods of time mainly due to the fact that every organization could compete at the same level with the help of their respective digitalized business process. A clear feature of

modern day's digital technologies is that they are obtainable by every organization, and they are standardized. This leads to different organizations functioning the same way as the digital technologies more broadly embraced and the competitive edge is decided by the complementary assets an organization establishes along with these fresh technologies. A quick rise in the value of competitiveness because of the increase in digitalization has affected two groups of complementary assets which are Big Data and network effects.

Data processing (Beath et al., 2012; Feldman & Sanger, 2007) models used before did not have the essential tools and processing powers to make full use of Big Data but Machine Learning, Cloud Computing and the advancements in analysis have helped to overcome the situation. (Taddy, 2018; Varian, 2014; Witten et al., 2016)

Better Big Data abilities and access may provide several advantages when it comes to competition. The innovation by organizations can be done quicker with greater accuracy which provides superiority when in the process of innovation. Any organization which has clear and superior data about the preferences of their customers, actions and data analyzing abilities can have a better advantage when it comes to attaining fresh customers and also satisfying their existing ones.

When the number of customers of a product or service contributes to the demand of that product or service, there is Network effects. (Katz & Shapiro, 1985) When the product or service's value is directly dependent on the total number of users, then it refers to direct network effects and when the product or service's value is dependent indirectly on the other users, then it is referred to as indirect network effects. (Farrell & Klemperer, 2007; Katz & Shapiro, 1985; McIntyre & Srinivasan, 2017; Rochet & Tirole, 2003).

The degree to which the Big Data and network effects work as a key part of organizations' business models is seen further. This is categorized by dividing the organizations into four distinct categories as shown in figure 10.
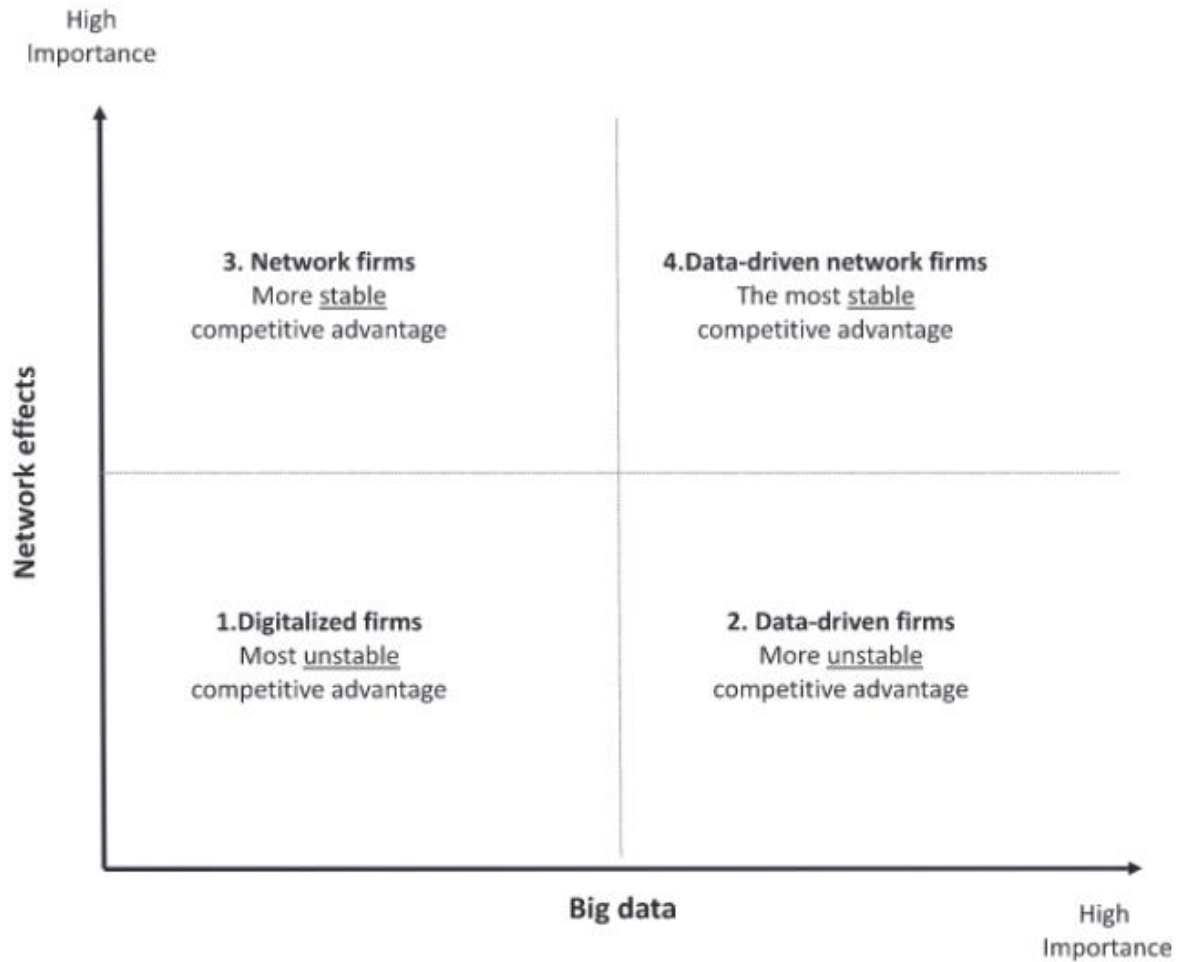
Figure 10. Different types of organizations using digital technologies. (Knudsen et.al, 2021)

The organizations can be classified into four types in Digitalized organization, Data-driven organization, Network organization and Data-driven network organization in different quadrants as seen in Figure 10. The competitive advantage which each organization possesses is discussed here. The business model of digitalized organizations is structured around digital technology. The advantages gained from using Big Data and network effects is of less importance. Manufacturing organizations that use automation to increase the efficiency of in production, organizations that utilizes cloud services for the purpose of communication, processing and storage, organizations that create customized digital solutions fall into this category. (Cenamor et al., 2019)

The competitive advantage which an organization gets by using digital technologies' best practices could not be prolonged for a longer time as the competitors try to utilize the same digital technologies for their own organization when they see the benefits.

More importance on the use and accumulation of Big Data is given by the organizations who are more data driven like the ones mentioned in the lower right quadrant of figure 12. As the name states, data becomes more important to these organizations as they provide services, sell access and

accumulate data. The advantages in the competition gained by these organizations are expected to be more long lasting to the very reason that the data capabilities and the data itself can be hard and rare when it comes to imitation.

Network organizations can be either indirect or direct network effects or both. The size of the installed user base is increased once an organization reaches a certain good number of users which as a result brings value enhancement to the product. The sustainable nature of competitive advantages increases when the digitalization pace increases. The noncomplex network effects' mechanics as it is tough for the competitors when it comes to the recreation of network effects. Switching costs is imposed on users by network effects on a fear that the access of other users or valuable components might be lost. When fresh users enter the market, it will increase the speed of digitalization and superior value is offered to these users by leading network organizations with a huge user base installed. The competitive advantage of the network organization will make it a moving target which is hard to catch up with when the speed of digitalization increases.

And the last type of organization which is mentioned is data-driven network organizations. Big Data and network effects are very much crucial when it comes to the business models of data-driven network organizations. Due to the strong nature of network effects, these organizations can collect data that are exclusive and not available for the competitors. The network effects and big data complementarity is based on two major conditions. The first condition will depend on how the offered quality of services or products is impacted and increased by the usage and increased amount of data. The contributions of the users when it comes to the generation of data is the second condition which determines the network effects and big data complementarity.

3.3 The Era of Artificial Intelligence, and purchasing.

The purpose of this section is to describe the importance and potential behind new developments within the AI space and the relation of AI solutions and purchasing. Because of these groundbreaking developments still being in their infancy, the current literature of AI in purchasing has been written before these breakthroughs. Therefore, an approach to this subject has been made in first describing the impact of these new developments of Artificial Intelligence. Thereafter, literature of *AI in purchasing,* written before the mentioned breakthroughs, is used to develop a framework from which to assess AI implementation opportunities.

3.3.1 Artificial Intelligence breakthrough, OpenAI.

During the writing of this thesis, breakthroughs have been made in the technological space of Artificial Intelligence (AI) with the release of Large Language Models (LLMs) such as ChatGPT, GPT-4 and BingAi. Shortly after the development of these Large Language Models, Bill Gates (2023) describes the importance of these events and their consequences in an article with the description *"Artificial intelligence is as revolutionary as mobile phones and the internet"*. With

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these developments, it is deemed important to include an assessment of the technological space of AI and its potential for implementation within Duni practices.

OpenAI is at the forefront of these developments, being the creator of ChatGPT andGPT-4, with Microsoft using GPT-4 in their newly released BingAI search engine (Mehdi, 2023). This has started a new arena for competition, placing the tech giants Microsoft and Google head-to-head against each other in employing advanced Artificial Intelligence models, with Microsoft having a head-start because of their cooperation with OpenAI and their Large Language Models (Warren, 2023).

GPT-4 is OpenAIs newly released LLM. With the release, a technical paper was published on the technical background and performance of GPT-4. An enormous milestone described in the paper is the performance of GPT-4 in the Uniform Bar Exam (OpenAI, 2023), designed to test knowledge and skills that every lawyer should demonstrate prior to becoming licensed to practice law (NCBE, 2023). GPT performed above the 90th percentile of all human test-takers of this test, being in the range of receiving the highest grade possible on the test.

Another display of its capabilities was displayed at a OpenAI developer livestream, where an example was given of GPT-4s vision abilities by showing it a crudely hand-written note of a website layout, combined with a prompt to the model explaining how it is to produce a live and functioning website from the handwritten note. The model proceeded to implement this prompt and produced a functioning HTML code with the working interactive functions described in the handwritten note included. A similar example has been shown in producing programming code made for creating a simple playable game (Brockman, 2023). In summary, the currently most advanced AI-models are able to achieve the highest grades on specific profession-based tests, and in an instant, develop basic solutions in areas such as web-site creation and programming. The developments of these models proceed at such a rapid pace that during the writing of this Thesis, GPT-4 has been further improved when it is subject to a reiterative function, critiquing itself and its results and repeating the process until sufficient results are achieved (Blain, 2023).

3.3.2 AI presence examples in procurement operations, and softwares that provide AI solutions.

Van Duin & Bakshi (2018) describe how the four main characteristics of an AI system is:
- The capability of processing massive amounts of **unstructured and unstructured data** which can change constantly.
- Ability to reason and to draw inference based on the situation. **Context driven awareness** of the system.
- Ability to **learn** based on historical patterns, expert input and feedback loop.
- Capable of analyzing and **solving complex problems** in special-purpose and general-purpose domains.
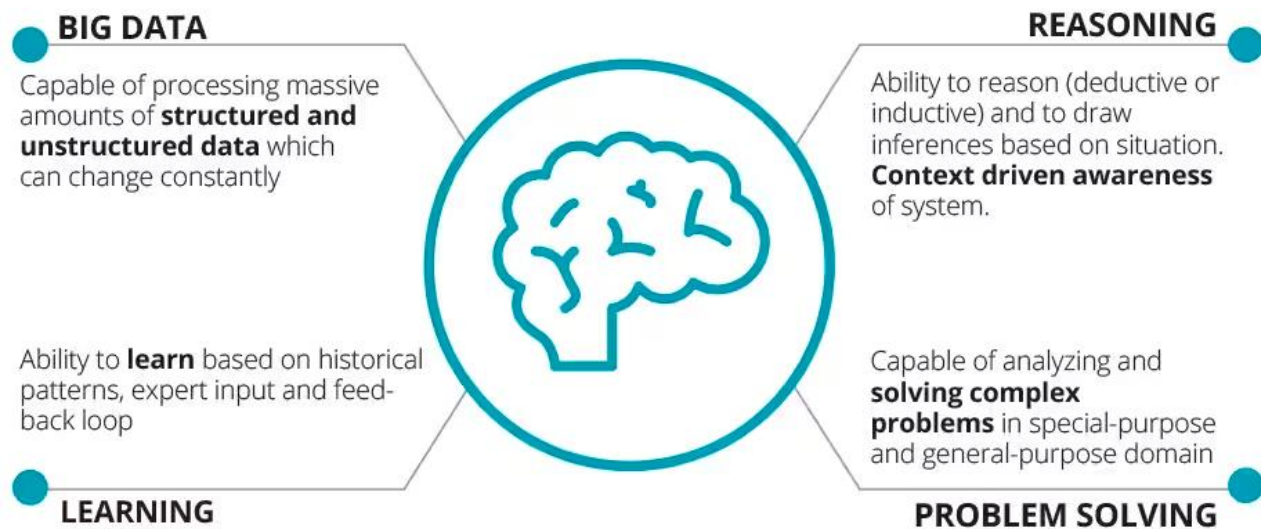
Figure 11. Key Characteristics of an AI system. (Van Duin & Bakshi, 2018)

A comprehensive and general qualitative description and definition of AI, its function, and application in procurement is also described by Sammalkorpi et.al (2019) in the book "AI in Procurement" from 2019. Even though the book is only 4 years old, a critical approach has to be made because of the breakthroughs made in AI technology after the book was written.

Examples are given of how companies of scale such as Amazon, Google and Baidu are the ones employing and being dependent on cutting-edge technology within AI implementation. Examples of this include the following:

Walmart has more than 245 million customers visiting their websites and stores, which would mean a lot of manual work to analyze customer data. With AI doing the analyzing, employees can better focus on the important decisions (ProjectPro, 2023).

Alibaba's logistics affiliate Cainiao uses AI to find the most efficient delivery routes for its logistics, which have resulted in a 10% reduction in vehicle use (Senaar, 2020).

Airline companies are using AI to predict maintenance needed on the fleet's mechanical parts to prevent downtimes and delays (PackTub, 2019).

Deloitte (2018) explains in-detail about how AI may be used in logistics and on-time delivery. Deloitte Netherlands has developed an AI solution for On-time delivery, planning and time-estimation that may be used by logistic companies through their track-and-trace systems. The optimal patterns are found through machine learning with previous man-made decisions.

As of 2019, the most sophisticated procurement organizations have also started to utilize artificial intelligence to improve operational efficiency and aid decision-making.

3.3.3 Areas of purchasing and potential AI solution

Sammalkorpi et al. (2019) explains how AI solutions have to be applied specifically to an area of purchasing, with examples of AI softwares solutions for areas of purchasing within this thesis.

Spend analysis
Machine learning algorithms may be used to improve and speed up the processes within spend analysis. An example of this is if different DHL solutions are used such as DHL Freight, Deutschland DHL, and DHL express. The machine learning algorithm then consolidates these different solutions for increased visibility and data coherence. Sievo is a software solution in this area.

Supplier information management
Information about supplier relationships and previous records may be recorded but not utilized to its potential. Machine learning may use this information to continuously rate and evaluate suppliers in a similar manner as is done by human intuition, only more extensively.

Contract management
By the use of text analytics, contract management may be automated with the processing of text within the contract which is subsequently consolidated and converted into a general standard format. Seal is an example of a software solution for this.

Supplier risk management
When assessing potential supplier risk and disruptions of procurement. AI solutions may greatly contribute with the magnitudes greater processing speed of information and evaluation. To achieve this, information sources have to be digitalized and available. RiskMethods is an example of a software solution for this.

Purchasing
The operational act of purchasing may be automated, with an example of this with indirect material purchasing such as office supplies. When office supplies are running low, an AI solution may automatically order new suppliers without the need for approval, but with the possibility of overview and potential cancellation of made orders. In terms of direct material purchasing, more effective purchasing methods are needed, similarly, an equally advanced AI solution is needed for this. Tradeshift is an example of a software solution for Purchasing.

In the context of using AI to effectivize purchasing operations, Karmehag and Löfnertz (2018) describe how a full process automation in purchasing leads to firstly the operational process being automatized. With the continuous development of the AI automation solution, more abstract and strategic factors are included in the solution.

3.3.4 The End Game in the far future

Sammalkorpi et al. (2019) describes how when discussing the subject of AI, it may be relevant to clarify in what direction the AI solutions strive towards. This may not be practically achievable, but an exemplary "ideal" situation may give a nuanced understanding of the subject.

Total process automation
Human intuition in order creation and processing is replaced by a neural network that can process greater information at higher speeds. The operational purchasing process is fully automated, and no human involvement is needed because of the AI solution continuously evaluating itself.

Automated value creation
Decision-making for creating value and taking actions on savings is made without the need for a human validation before proceeding.

Full spend transparency
With full digitalization, all numbers and spend analytics can be leveraged and available whenever key stakeholders need it.

Agile supplier ecosystems
The horizon for information that is provided in decision-making will not only be within the firm of the software solution. It will extend to strategic supplier relationships and measurements made within this area. Consequently, AI will make decisions based on the ecosystem of suppliers that are involved, and not only on data of a specific supplier. This can be compared to a purchaser making strategic decisions based on intuition about the supplier ecosystem.

3.3.5 Identification of data

Questions that are described by Sammalkorpi et al. (2019) to be relevant when starting to use AI include the identification of what information is available, which is the described definition of *digitalization* in this thesis.

Do we have enough right kind of data?
Dark data is described as information that is not used in decision-making processes of purchasing. This includes:

Contract metadata
Cui et al. (2021), in their research paper about document scanning with artificial intelligence, talk about how implementing automatic information processing within structured documents such as sales contracts is essential for a digital transformation. In the paper, it is mentioned how the used AI solutions are not able to process bigger chunks of information effectively, which is a limitation for

automatic document processing practices. With the release of LLM's such as GPT-4, these limitations may have been mitigated.

Data stored across disconnected ERPs or other databases
This is defined in this research paper as information that is not available for all parties in the supply chain to include in their decision-making process.

In addition to the above-mentioned types of dark data, there is also *general ledger information,* and *external unstructured data available over the internet.*
These will not be included in the thesis due to it not being deemed relevant to the findings or the research paper scope of *supplying*.

3.4 Digitalization and turbulence within the supply chain

3.4.1 Co-evolution of digitalization

A procurement process is a process with two parties involved, this is the buyer and the supplier. As Kosmol et al. states (2019), when assessing the digitalization degree of only one actor such as the buyer, it might not reflect if the digitalization project is successfully implemented because of the involvement of the supplier in the process which is not included. *"IndustryCo is not independent from its environment, from the city in which it is located, from China. You cannot be ten years ahead of others; then you could not integrate with suppliers. I think the best companies are three or five years ahead; then you can get the most advantages. But you cannot be successful if you are too quick. (Head of Strategic Procurement, IndustryCo)."* The compatibility of a buyer and supplier was measured through digital readiness.

Kosmol et al. (2019) defines Digital readiness as the degree to which a firm's supplier side is ready to embrace digitalization technologies. This encompasses the two main dimensions of *technological readiness* and *organizational readiness*. *Technological readiness* has the subdimensions of *IT infrastructure* and *IT human resources*. *Organizational readiness* has the subdimensions *Top management support, financial resources*, and *organizational structure*. Digital readiness is defined as the *potential* of digitalization within a buyer-supplier relationship, these described subdimensions may also be used to describe the current digitalization degree as previously described in this thesis. With the subdimensions of *IT infrastructure*, *IT human resources* and *top management support* being the most relevant subdimensions for the description of current digitalization cases of this thesis. Interestingly, characteristics below seemingly correspond to our chosen digitalization characteristics previously described.
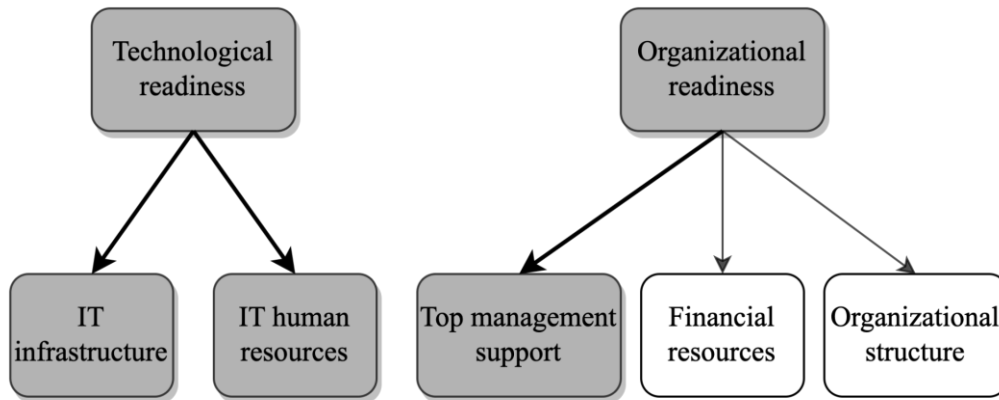
Figure 12. Diagram of the different dimensions of digital readiness relevant for this thesis. (Kosmol et al., 2019)

Below is a figure visualizing the digital readiness of the buyer/supplier and the respective successful implementation of digitalization technologies.
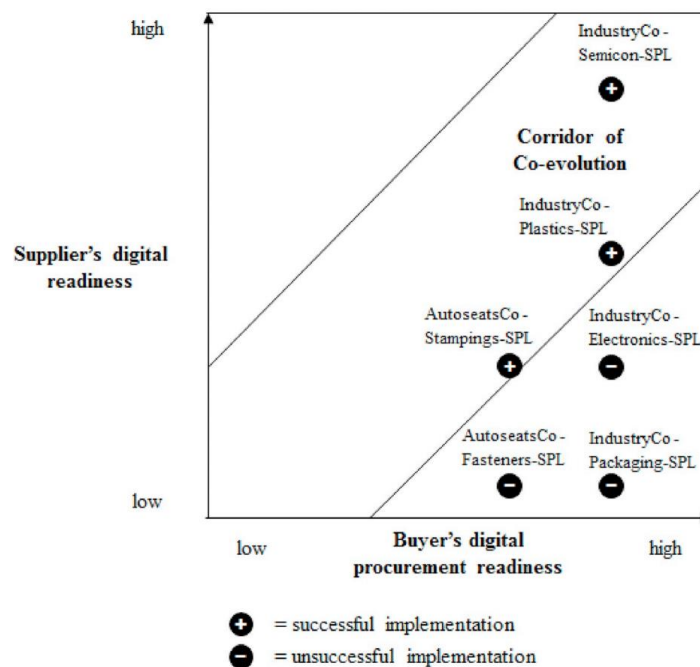
Figure 13. Graph of successful digitalization implementation depending on supplier and buyers digital readiness. Kosmol et al. (2019)

3.4.2 Turbulence within the supply chain

Trkman et al. (2009) defines Turbulence within a supply chain as the likelihood of disruption of Supply Chain processes. This is divided into two types of turbulence. *Endogenous turbulence* and *exogenous turbulence*. Endogenous is defined as turbulence within the specified supply chain borders, respectively, and in terms of SPM is a more viable area for risk management because of the

relative control of the supply chain. Examples of endogenous turbulence include fluctuations in demand and unreliable suppliers, this type of turbulence is often the result of poor supply chain coordination.

Comparatively, exogenous turbulence is defined as turbulence that occurs outside of the supply chain borders. Because of the origin of the turbulence, possibilities to resolve the turbulence at its core is reduced. And what is possible is mostly preparing and mitigation effects of exogenous turbulence within the company. Examples of exogenous turbulence include terrorist attacks, natural disasters, or changes in government regulation.

Factors within a company that affect the impact of turbulence include financial performance, human resource and operational factors. In this thesis, it is the operational factor that is to be studied. More specifically, the aspect of digitalization on the operational process and its relationship to turbulence. Lastly, a supplier's current performance in a stable environment does not reflect its performance in a turbulent environment. To evaluate the risk of non-conformance. An in-depth analysis of the operational processes and performance in previous turbulent events is to be made.
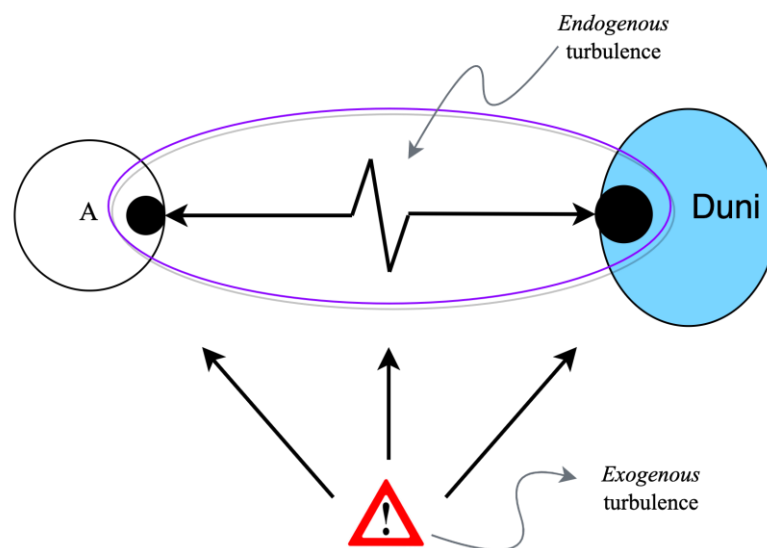
Figure 14. Visualization of endogenous and exogenous turbulence. Created by authors.

Interchangeability of Turbulence and risk

Van der vorst et al. (2002) describes uncertainty as follows: "*uncertainty will result if decision makers are unable to accurately determine the impact of control mechanisms on supply chain behavior*". While the two concepts of turbulence and uncertainty are similar, they are not the same. Turbulence, as mentioned previously, is defined as the likelihood of disruption of supply chain practices. While uncertainty can magnify the impact of turbulence because of the lack of knowledge and mitigating actions for the turbulent events that will affect the supply chain. In this thesis, similarly to *digitalization* and *automation*, the terms *turbulence* and *uncertainty* are used interchangeably with some adherence to their original definitions.
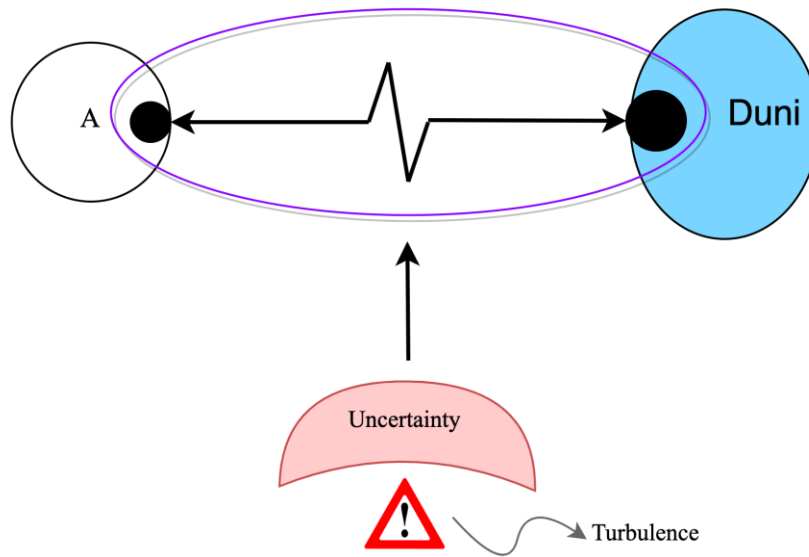
Figure 15. Visualization of uncertainty magnifying the impact of turbulence. Created by authors.

Turbulence factors impact on supply chain

As mentioned in the chapter "*General trends of digital transformation within procurement*" Global disasters such as the previously mentioned COVID-19 pandemic, has put digital transformation at a much higher level on the corporate agenda. Before the specific case of COVID-19, companies treated digital tools mainly as tools for information management, including communication and data sharing (Ye et al., 2022; Bonnet & Westerman, 2021). For companies to be able to mitigate turbulence that may affect their processes, they need to start treating technology as not only a tool for communication or data sharing but also as a tool for proactive management of their purchasing processes, which has been further proven by the consequences experienced by the COVID-19 pandemic (Ye et al., 2022; Bonnet & Westerman, 2021; Loonam et al., 2018).

Alok et al. (2022) conducted a quantitative study to evaluate the impact and prominence of the most relevant turbulence factors that affect the supply chain. In their research they identified the 10 most important factors for this purpose, as visualized in the table below. The identification was done through reading relevant literature within the SCOPUS database search engine. Common challenges were subsequently identified and complemented by being presented to fifteen experts to assess their relevance and uniqueness. The experts contributed input to the challenges with changing of wording and meaning.

Supply chain challenges.

Sr. No.	Key challenges	Code	Implied Meaning
1	Uncertainty of Demand	PLD	Irregularity and inconsistency in orders received from customers due to shifts in buying behaviour, including decline in consumption of high-value commodities, lack of awareness regarding COVID-19, and non-consumption of certain food items causing demand disruption.
2	Inconsistency of supply	PIS	Constraints and uncertainty at the vendor's end coupled with volatility in price and quantity of essential raw material leading to the barrier of inconsistent supply.
3	Scarcity of Material	SSM	Scarcity of material in the market due to surges in demand caused by hoarding and panic buying, coupled with questionable continuity of operations at supplier's end, including unavailability of imported goods owing to nationwide lockdown situation.
4	Delay in Delivery	SDD	Restrictions on imports as well as local transport, coupled with certain routes involving detours due to restricted zones, slower movement of goods, higher lead times, thus leading to delay in delivery as a supply chain barrier.
5	Suboptimal Substitute Adoption	SSA	Closure of operations of existing critical suppliers, coupled with the availability of suboptimal alternatives/substitutes in the market, leading organizations to procure such alternatives, causing poor quality, rework, and other supply chain issues.
6	Scarcity of Labour	PSL	Imposed lockdown restrictions leading to a reduction in wages, lack of employment and sustenance issues, causing skilled migrant workers to move back to their respective states, leading to scarcity of workforce and a major barrier to efficient supply chain operations in an emerging economy like India.
7	Suboptimal Manufacturing	PSM	The majority of manufacturing hubs across India being located in regions that were categorized as red (restricted) zones, with complete closure leading to limited manufacturing activity. Further, uncertain demand and inconsistent supply led to the manufacturing of a suboptimal product portfolio mix further contributing as a barrier to the supply chain.
8	Constraint in Capacity (Storage)	SCC	Declining consumer optimism and lack of demand for high-value non-essential commodities leading to the stocking of products in warehouses and distribution hubs, causing working capital blockage and liquidity issues
9	Vehicle Unavailability and Delays	DVU	Lack of commercial trucks travelling between key routes, severe restrictions on exports, and local transport coupled with delivery routes in restricted zones leading to vehicle unavailability and delays in delivery as a supply chain barrier.
10	Last-Mile Delivery Challenges	DLM	Most urban areas, which contain the majority of the population, being categorized as a restricted zone. Switching routes to bypass these zones leading to in-transit delays. Local and state-level regulations and delays associated with electronic pass issuance, compliance, and validity contributing to last-mile delivery challenges.

Figure 16. Supply Chain Challenges. (Alok et al., 2022).

The purpose of the study was to evaluate the relationship between the supply challenges, and subsequently rank them in terms of importance. The results of the study showed that the four main supply chain challenges were ranked in the following order, from highest, in terms of importance: Inconsistency of supply (PIS), Suboptimal Manufacturing (PSM), Vehicle Unavailability and Delays (DVU), Delay in Delivery(SDD). These challenges and their ranking is used when evaluating possible improvements or specific challenges of the Duni supply chain of this Master Thesis.

Use of agility mitigation of turbulence

As discussed before in literature review (Trkman et al., 2009), the different case studies did confirm the presence of both exogenous and endogenous turbulence. Endogenous turbulence is the turbulence which occurs inside the supply chain well within the borders. Exogenous turbulence occurs outside the supply chain borders. The nature of endogenous turbulence is continuous with low intensity whereas the nature of exogenous turbulence is high in intensity and occurs for a shorter period of time. From the case studies, it became evident that all multiple stages of the purchasing process get affected due to the presence of both endogenous and exogenous turbulence. Normal working scenario suits the best when it comes to digitalization and automation tools and the efficiency of both could not be on the same level when the rate of turbulence gets higher. For the foil supplier, turbulence does not seem to have created much impact and they feel that the turbulence in general is not a huge problem. Extended material stocks effectively mitigate the problem of stock outs and related issues during the period of turbulence. The FS feels that the design acceptance is much of a bottleneck overall. Whenever there is a need for a new design, the circulation of proposed new designs to get approval with different teams consumes a longer time. Since the approval time gets longer, it directly impacts on the overall processing time and delivery time. the IS, the ink supplier feels that they have both endogenous and exogenous turbulence impacting them equally. It is also noteworthy to mention that these turbulences did not impact the tools of digitalization. Digitalization tools were acting as usual even during the turbulent times because of which the turbulence is mitigated. When it comes to the buyers in Bramsche, endogenous turbulence is well monitored and mitigated but when it comes to exogenous turbulence like the covid pandemic and the war situation in Ukraine, the impact was larger, and it was hard to mitigate.

Fresh challenges (Eubusinessnews, 2022) and constant need for evolving is nothing new when it comes to the supply chain which is expected to be responsible, responsive, sustainable, fast, resilient, and also cost effective. The approach which could balance out all and benefit an organization could be 'agile'. Achieving agility could be differentiated by five different steps which are as follows,

Customer Agility : Every organization's primary concern must not just understand their customer's preferences in purchasing but also know and completely understanding them. It could help for an organization to find the factors which could potentially turn a preference into a purchase. Agile helps to make some strong decisions as agile responses have costs and the responses which could generate profit in a sustainable way is found. Mass advertising is becoming a thing of the past. Mass advertising has the potential to direct customers towards more profitable and favored ways. The scenario with the competition in price is also changing in the age of ecommerce as the products being purchased are chosen more on the foundation of service and delivery, the options that are usually free when it comes to the customer. 'Agility' plays a crucial role in avoiding high-cost and low-return scenarios which helps to mitigate the uncertainty.

Direction Agility : Wide parameters and flexibility to a certain degree must be allowed when it comes to agile strategy. Agility is a journey which focuses on consistent refinement and improvement. Agility allows the chances to have a plethora of appropriate responses by building flexible platforms, processes, technology, physical assets, competencies, and people. But at the same time, taking away the responses from agile which doesn't provide added value and keeping it lean is also crucial. Logistics and Warehousing along with providing fulfillment are one agile response's single component but a very crucial one as the organization can make most of their calls relying on them.

Solutions Agility : When it comes to addressing existing issues and also aligning with an organization's strategy for the betterment of their future, the functionality of agile solutions must be taken into consideration carefully. Key Performance Indicators (KPIs) must be redefined to make sure they are appropriate and applicable to the agile world. Agile is a mixture of mechanized, manual and automated processes and never just highly automated which results in focusing better on separate parts of the operations. Simple adaptive nature, easier alignment with change or growth and faster deployment makes modular solutions the right choice when it comes to finance and operations. The responses from agile calls for initiative and creativity, operating in new ways, various ways of revenue streams development by using various assets.

Technology Agility : The key component of agile is end-to-end visibility. The organization must be able to identify the problem whenever it happens and also wherever it happens. Different issues like new trends in demand due to consumer preferences, fulfillment delays in warehouses caused by order spikes or delayed supplier inbound must be found and be able to plan it again or at minimum, communicate around it. In previous years, data sharing and connected systems were not predominant but now due to the reducing cost of technologies along with rapid pace in advancement, things are moving forward with important technologies such as artificial intelligence, cloud computing, internet of things and robotics. Especially with artificial intelligence, agile responses could be effectively organized around current data which makes it convenient for any organization that uses it. More varied agile responses in real time according to the needs of the customer are possible with the help of artificial intelligence, predictive analytics and machine learning.

Organization and People Agility : Effective communication and collaboration along with building the sense on what exactly is required for an organization must be cultivated with all employees in an organization and not only with logistics and supply chain managers. The collaboration may go so far that it may require collaboration with competitors in future which calls for building a fresh mindset. A culture which does not resist changes but rather welcomes it will lead to a clear and simple decision-making process. Strategic supply chain partners who bring empowering structure with their proactiveness, flexibility and innovation can help to make this mindset shift happen. Supply chains must not be shackled but they should be empowered with the help of contracts and a collaborative approach to solve major problems by finding solutions.

4. Empirical data

The chapter of Empirical Data will follow a structure of first explaining the sources from which the research material has been collected from. Thereafter, the written individual report of the four cases within this study are presented, following the subjects described in the literature review and interview guide. Thereafter, a holistic cross-case examination is done of the individual cases for finding similarities and differences in regards to the aforementioned sub-topics of this Master Thesis. Lastly, a summary of the main findings of the research collection is concluded.

The main research material that was collected and used in this thesis consists of four 90-minute semi-structured interview sessions, with subsequent complementary questions for the interviewees in email. Below is a table describing the practical cases of analysis, interviewees, and their different roles. Due to limitations of informational availability about suppliers, the interviewees were selected by the contact at Duni, according to who would be most available for this research paper. In the case studies, the two suppliers will be anonymized and named IS (Ink Supplier) and FS (Foil Supplier).

Table 3. The cases, members of the units and type of research collection. Created by authors.

Duni Contact	Interviewee responsibility	Type of research collection
Duni Group - General input	**Director of sourcing** Wilbert Baerwaldt	Continuous contact through interviews and Email during research collection.
Case Studies	**Interviewee responsibility**	**Type of research collection**
Duni Buyer - Bramsche Factory	**Raw material planning Order creation**	One Interview (1 Hour)
Duni Buyer - Poznan Factory	**Purchasing**	One Interview (1 Hour) One Complementary Email
Ink Supplier	**In-house Logistics Order processing**	One Interview (1 Hour)
Foil Supplier	**Printing house Delivery responsible Operations assistant**	One Interview (1 Hour)

Note: Although purchasing has been generally described as one department. The organization structures of different companies vary, consequently, the assignment of responsibilities and names of different roles vary, as can be seen in the previous table.

4.1 General information about the Supply Chain of Duni

This chapter will cover a general description of the multiple cases, and an explanation of the used Jaggaer solution within all these cases.

4.1.1 The multiple cases and their relation

The cases that are to be studied in this master thesis consist of two suppliers and two factories. One of the suppliers is the supplier of foils for manufacturing in the Duni factories, similarly, the other supplier is supplying the inks used in manufacturing of Duni products. The two Duni factories that are included in the study use both ink and foils in their production, meaning that both Duni factories have a purchasing relationship with both suppliers.

Furthermore, this means that there are hypothetically 4 different specific purchasing relationships to be studied, with each interviewee having a purchasing relationship with two entities that are also included in the master thesis, e.g., a supplier supplying to the two factories or a factory procuring from the two suppliers. When conducting the interviews with the suppliers and purchasers, the possibility of describing their two different relationships was explained in the introduction of the interview. Below is a visual representation of the cases and their inter-relationships.
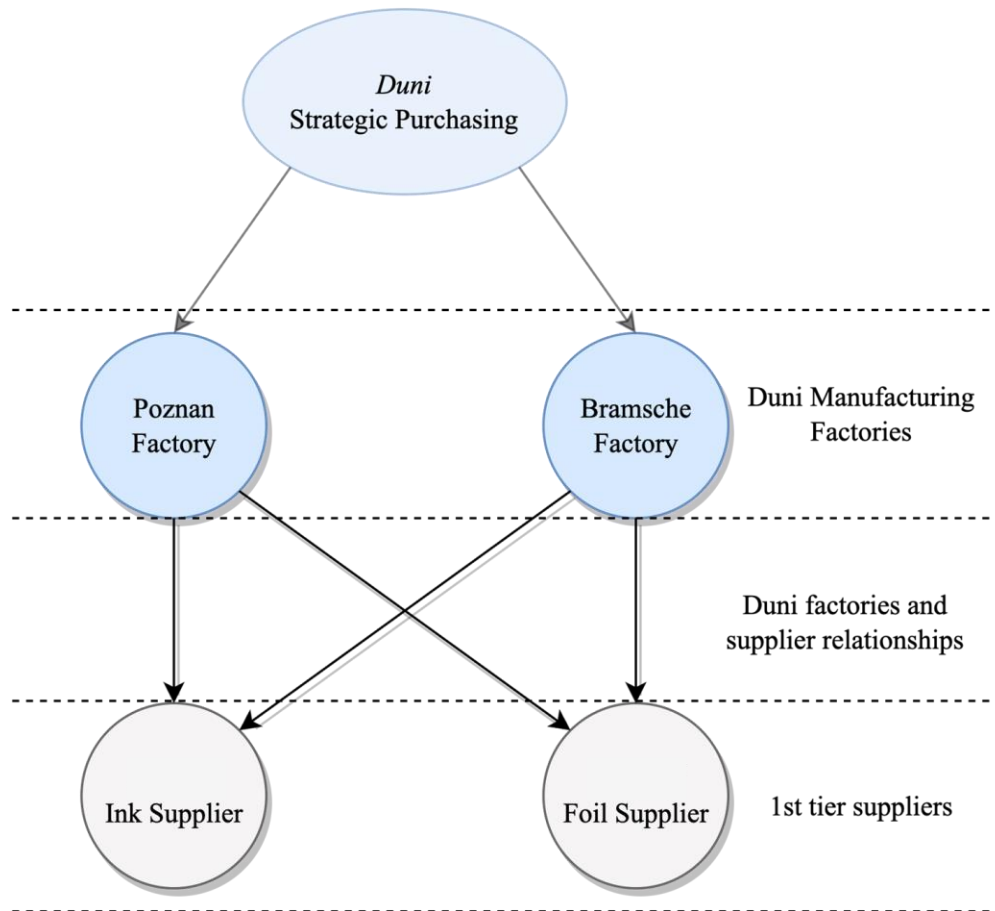
Figure 17. Diagram of the supply chain relationships of Duni and its 1st tier suppliers in this study. Created by authors.

4.1.2 Information management system (Jaggaer)

The information management system used in the studied cases within Duni's supply chain are provided by the solution named Jaggaer. This is a form of cloud-based all-in-one software solution that provides the customer with all necessary functions for procurement functions.

It is listed that the Jaggaer All-in-one solution provides functions within the following areas: Spend analytics, Category management, Supplier management, sourcing, contracts, Eprocurement, Invoicing, Inventory Management, Supply chain collaboration, Quality management.

Gartner rates the Jaggaer software solution as one of the top competitors in the market of procurement software solutions, rivaling softwares such as Gartner's "Customers' Choice 2022 - Coupa BSM Platform."

4.1.2 System Applications and Products system (SAP)

Another software solution that supports the information management system of Jaggaer is Systems Applications and Products widely known as SAP. It (SAP, 2023) is one of the leading software that

has been used by many companies across the world to come up with solutions to handle huge scales of data, to supervise different processes within the business and assist in seamless flow of information between different organizations. SAP connects all parts of a business such as Production Planning, Materials Management, Sales and Distribution to name a few. This allows organizations to create an intelligent suite where the whole platform is digitalized which could replace the legacy platform which is driven by process. The centralization of data management of SAP paves way for functions of different businesses with a single view of truth. This will help organizations to manage business processes which are difficult in nature by providing the employees from various departments an uncomplicated access to insights across the enterprise which are real-time. This will result in being able to facilitate workflows, operational efficiency improvement, customer experiences enhancement, productivity increase which finally results in the increase of profits for an organization.

4.2 Case 1 - The Foil Supplier

The FS is currently one of the longest operating flexographic printing houses and factories of flexible heat-sealable packaging in Poland. At present, apart from printing and laminating, they also produce single- and multi-layer foil bags.

4.2.1 Operational process and digitalization tools

The results of the operational process are primarily compared to the conventional Van Weele procurement process (Van Weele, 2014), where the *supplying* part of the process is divided into the contract framework, ordering, expediting, and lastly, long-term evaluation.

Contracting and ordering
In the simplest of purchasing relationships that the FS has, the act of creating contracts and ordering with suppliers is combined into one process. This means that the scope of the contract is only to include the specific order that is currently placed. This type of contracting combined with ordering is used when the order quantity is not high enough to warrant a long-term contract.
The usage of long-term contracts is implemented when order quantities are high enough and where the deliveries are split up over a longer period of time. The FS explains that the longer-term contracts are up to 3 months long. Similarly, to the single-order contracts, there is a specified order quantity that is to be delivered with the long-term contract. With the long-term contract, Duni now has available flexibility of choosing when the smaller deliveries of the total long-term order quantity may be delivered, reducing the logistical challenge for Duni of ordering a too large quantity of product for Duni storage, while simultaneously giving the FS supplier the ability to plan production and subsequent storage for the fulfillment of the long-term contract. Regarding the production planning, the FS mentioned that their production planning usually consisted of producing the entirety of the long-term contract order quantity and storing it for delivery. This is in order to reduce set-up cost of production facilities and further improve the lead time for deliveries towards Duni. Furthermore, even when orders were not formally placed, and no contract was in place to predict

this, purchasers of the FS would plan ahead for the future placement of orders because buyers such as Duni may follow a relatively predictable pattern of order placement. This prediction of future orders that are to be placed is explained to be based on human intuition. The majority of orders were of the single short-term type, the FS mentioned that it was possible to progress from single order short-term contracts to long-term contracts when trust has been established.

Expediting and follow-up
The FS mentions that the ensuring of order fulfillment is done with the help of production planning and logistical choices, with both being equally impactful to the delivery performance. The delivery choices that the FS has available when planning an order fulfillment is between two 3rd party providers of delivery solutions. These two providers are the companies Raben and Polbus. Raben is used for large order quantities where volume is prioritized over delivery speed. In contrast, Polbus is used when speed is prioritized over volume. This gives the FS the ability to adjust delivery specifications to Duni's specific needs. The ability to track the progress of deliveries was also mentioned as being available from both Raben and Polbus, although it was not mentioned as being essential for delivery performance. Aside from the ability to choose between Raben and Polbus for their deliveries, the FS does not have a further ability to impact the delivery solution. This is because the FS has used the mentioned delivery solutions for a long period of time and therefore has developed a trusting relationship with the providers to ensure delivery performance of the provided solutions. The FS also mentions that a follow-up evaluation is done with their buyers every year to ensure long-term quality of relationship.

Digitalization tools
The digitalization tools that the FS uses are three different platforms that combine to support the operational processes of purchasing. These different tools and their functions are: The *information Management System* of the *Jaggaer* software solution, used as the main formal communication channel between Duni and the FS for placing and accepting orders. The complementary communication channel using Email between the FS and Duni for discussing the details and creation of orders. And lastly, the FS's internal system of storing information where all logistical information is put into the system, such as raw material availability for production facilities and delivery date possibilities for an order. It is with the help of the FS's internal system that orders are evaluated for acceptance.

4.2.2 Delivery performance

An order placement with its delivery information consists of three main information points: The article number of the ordered product, the order quantity, and lastly, the delivery date.

The main parameters that are used when measuring the results of delivery performance is the amount of deliveries fulfilled within the agreed delivery date, and by how many days a delivery is late if this delivery date requirement is not fulfilled. The FS mentions that tracking of orders is possible, but

puts emphasis on that proactive planning of orders is of more importance when ensuring delivery date performance, and that tracking of orders is a complementary tool.

4.2.3 Turbulence and risk

When discussing the turbulence and possible issues of the purchasing operations towards Duni, the FS mentions the COVID-19 pandemic as *exogenous turbulence* that affected them. Although it was impactful on the FS operations, it is explained that they mitigated the risk relatively effectively with the help of multiple layers of buffer material in their production facilities. Instead, it is suggested that the design acceptance of new products that are to be produced is the biggest factor of turbulence, which is defined as *endogenous turbulence*. This is deemed most impactful because there may occur situations where production facilities and delivery solutions are ready to fulfill orders but are waiting on the acceptance of new designs, creating a bottleneck in the supply operations. The reason for this is that the designs look different to the human eye depending on what computer screen it is displayed on, with examples of varying parameters such as screen density, color coding program and shadow processing. In earlier times, the buyer of a certain product was at the production facilities where the first prints of the new design were made, in order to ensure and validate that the expected design was made. In modern times, this is replaced by two different methods. The first is to send a physical proof of the product with a courier to the buyer for confirmation of the expected design. Compared to the digital processes of placing orders and communicating, this is a slow process, hence the previously mentioned bottleneck. The other method is comparatively faster and is the act of sending the product design with a PDF to the buyer for confirmation. This method introduces the issues of displaying designs on different monitors, as previously described. It is with the choice between these two methods that the bottleneck of design acceptance is mitigated. Lastly, although the FS describes this bottleneck as the most impactful turbulent factor on operations. They emphasize that in a holistic sense, this is normal in their industry and is described more as an annoyance than a greater problem.

4.2.4 Further complementary information

When the FS issues an order to be produced at their production facilities, a *production envelope* is sent. This is a lengthy and detailed description of all the necessary specifications that are needed for the production of a product.

The FS has a supplier relationship with several factories of Duni that they supply to. In this thesis, the factories are specifically the Duni factories situated in Bramsche and Poznan. When asked if there was a difference between these two relationships in terms of purchasing processes and delivery performance, the FS described that there was no bigger difference between the two, and that they follow the general pattern previously described.

Below is the visual representation of the purchasing relationship between Duni and the FS, and the operations of the purchasing department within Duni. The green lines represent the digitalization

tools used. In this case, Duni's internal system is purposely slightly out of the figure because the focus of the figure is on the specific case of the foil supplier.
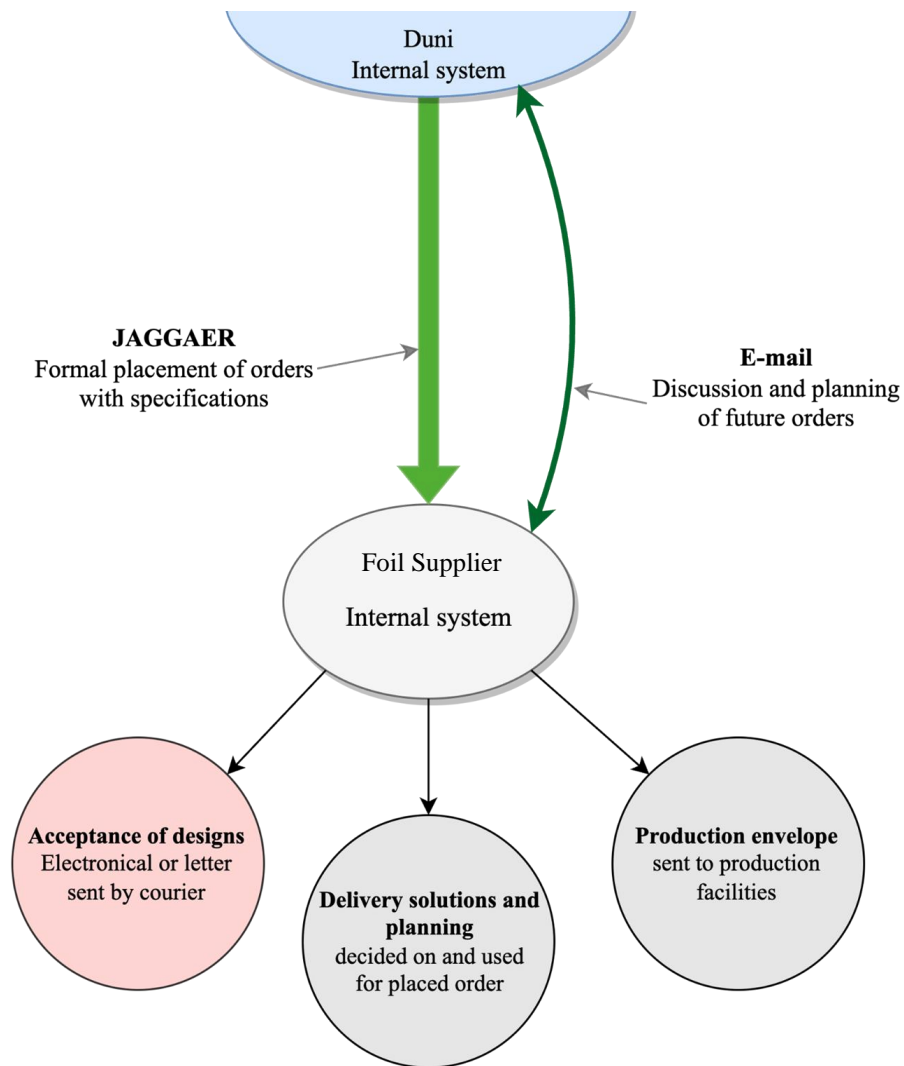
Figure 18. The operational processes and digitalization tools of the FS's purchasing department. Created by authors.

4.3 Case 2 - Poznan - Duni Purchaser

The procurement process in Duni from their suppliers are divided and taken care of by three teams. They are the Planning, Quality and Procurement team. The interview was done with the person responsible for the planning of the procurement process. The operational processes, constraints, proactive and reactive measures during uncertain times from a planning point of view is explained here. The planning team works with quality and purchasing of the continuous supply of products of already established suppliers. The orders to the suppliers vary in a wider range as per the production

needs. For example, the case company orders fifty to sixty different components from one of their suppliers. Contracts are used with suppliers for the materials which are ordered quite often.

4.3.1 Operational process and digitalization tools

The various results of the operational process are compared to the procurement process of Van Weele.

Contracting and ordering
Poznan uses majorly single order contracts where in rare occasions, they use long-term contracts. The role of digital tools is well established in the process of contracting and ordering. The team uses three softwares for different purposes and the integration of information and communication between them are quite seamless. The three softwares used for the procurement process are Jaggaer, SAP and APO. The process of production planning is taken care of by the ERP SAP (Systems Applications and Products). Article and article number within SAP plays a crucial role as it consists of all the necessary information of the orders. APO is an application module from SAP which is used to manage the supply chain process. The production planning for Duni machines is planned with the help of APO. There are multiple components like lead time, total capacity used as parameters to try to make the plan the orders in an efficient manner. Delivery date and Delivery quantity plays an important role as an essential component of an order. APO acts as an optimizing tool that optimizes the production planning process and runs during the weekend. It needs approximately ten to twelve hours to run and to be processed completely. SAP is used to place orders and once the orders are placed, the information is transferred to Jaggaer. An automatic mail is triggered to notify the information and the supplier needs to confirm the order placement through Jaggaer. If the supplier feels that there are some changes that need to be made in the proposed order, they can change which will generate an email back to Duni informing about the changes with a link from Jaggaer which redirects to the ongoing order. Duni has to confirm it to proceed further. There is no problem found between the integration of information and softwares. The softwares appears to be completely utilized as Information management systems and provide great value in helping the overall procurement process. There are no differences in the digital processes between different suppliers of Duni and it is safe to say that the overall utilization of digitalized tools is optimizing the procurement process.

Expediting and follow-up
When it comes to expediting and follow-up, Duni mentions that delays in orders are manually informed and reactively mitigated. In general. Delays are routinely checked for in advance. There is no continuous monitoring as the process usually is to confirm the order and waiting for the confirmation of the delivery from the supplier end. Even though there is no continuous information about the delivery once the order has been placed, Duni feels that the tracking of orders is not critical when it comes to improving the current expediting process.

Digitalization tools

The digitalization tools used by Duni for the procurement process are the software Jaggaer which acts as the *information Management System*, SAP as an ERP and APO which is a module in SAP mainly used as an optimizer tool which optimizes all the orders being placed (Knudsen et al., 2021). The digital flow starts with SAP where the orders for the procurement process are made. The production planning is made with the help of SAP. The data after creating purchase orders is transferred to Jaggaer. Automatic mail is generated from Jaggaer with the details and if there are any changes in the order from the supplier end, it will again be notified with an email. The interviewed Duni purchasing department mentions that Jaggaer works efficiently with information management when it comes to exchanging information across the platforms. Complementary information from the Poznan factory explains how they also utilize the "proposed ideal order" function to have a baseline of order proposals to adjust from.

4.3.2 Delivery performance

For the planning team, delivery performance is defined by the fact of having components on time before the production starts. The planning team finds the article number, delivery date and delivery quantity as important factors when it comes to assuring the delivery performance. There is no tracking involved once the order is placed until its delivery. Mostly the entire process till the delivery is about the trust with the suppliers. The interviewees did clearly mention that the delivery performance of the suppliers to Duni progressed much better after the introduction of the information management system Jaggaer as the data tracking became much easier. Before the introduction of Jaggaer, it was just emails all along to follow up on any order which made it hard to effectively handle.

Supplier Rating:
The yearly evaluation of the suppliers is the total result from the combined group of four topics which are commercial aspects, compliance, quality, and delivery rating. Commercial aspects, compliance and quality contributes to 60% of the total score of the vendor rating and delivery rating contributes to the remaining 40% which completes the supplier rating evaluation. The department and the people who are responsible and cooperating with the supplier on a daily basis will fill the questionnaire circulated within the company which has a plethora of questions which covers the topics of commercial aspects, compliance and quality. The result of which will contribute to the 60% of the total rating score. The remaining 40% is measured from delivery rating as mentioned before and the results are derived directly from the system results where On Time Delivery Performance (OTD) and Quantity Reliability (QR) are measured. The Delivery rating is explained in detail below.

On Time Delivery Performance (OTD):
The number of deviation days between the first expected delivery date on the Purchase order and the last date of the Goods Receipt booking calculated to express the result of OTD. The absolute figure of the value is being used.

The amount of deviation between the Purchase order quantity and the quantity that is booked in Goods receipt will provide the value of QR.

The performance score is calculated as the total of OTD and QR in absolute figure. Figure 19 below provides the detailed rating measurement of the delivery performance.

Figure 19. Rules of Delivery Performance measurement

The example for delivery performance measurement can be seen below in Figure 20.

Figure 20 : Example of Delivery Performance measurement

In the above example, the OTD of the supplier is taken on average and the delivery is 2,69 days per point. The QR of the same supplier delivered in agreed tolerances earns them one point. When combined together, the total score will turn out to be 3,69 points and when evaluated yearly will give 80 points to the whole rating. In the same figure 20, when we see below, the OTD of the supplier delivered on average will be 3,6 days per point. The agreed tolerances with respect to supplier delivery in this case will earn no points. The Total score is 3,6 points and as mentioned, the lower the deviation the better when it comes to quarterly evaluation.

4.3.3 Turbulence and risk

The discussion about the turbulence and the associated risks helped to get an overview in terms of focusing on acquiring right information. During one of the recent turbulent periods, the lead time for the ink components from the suppliers were drastically increased. Duni also found it hard to get paper from the suppliers for their products during the uncertain time. The lead time increased from three to eight weeks for ordering boxes. Ordering boxes were fully manual and Duni had to work proactively to make sure they were ordering keeping the increased lead time in mind. Orders for napkins dropped low when the pandemic hit. Additionally, storage costs were also high during the same time which made things even more difficult for Duni. Along with storage cost, storage validity also plays a crucial role when it comes to managing inventory and handling production. For example, inks for the prints have a limited period of six weeks validity before which it must be used in the production. Other proactive measures such as changing the orders as most important machines have some capacity to shift. Most of their components are not only used for one but many articles. Hence, proactively trying to switch the production will mitigate the risk of machine shortage. There were various types of endogenous turbulence faced by Duni within their supply chain. Some of them are technology turbulence when trying to implement new technologies to support the procurement process and reåplace outdated technologies. Changes in management and the decision-making process like conflicting decisions and bottlenecks along with the changes in internal policies. Another endogenous turbulence occurs with the planning of production and also with changing forecasts, a classic example of production failure that leads to bottlenecks.
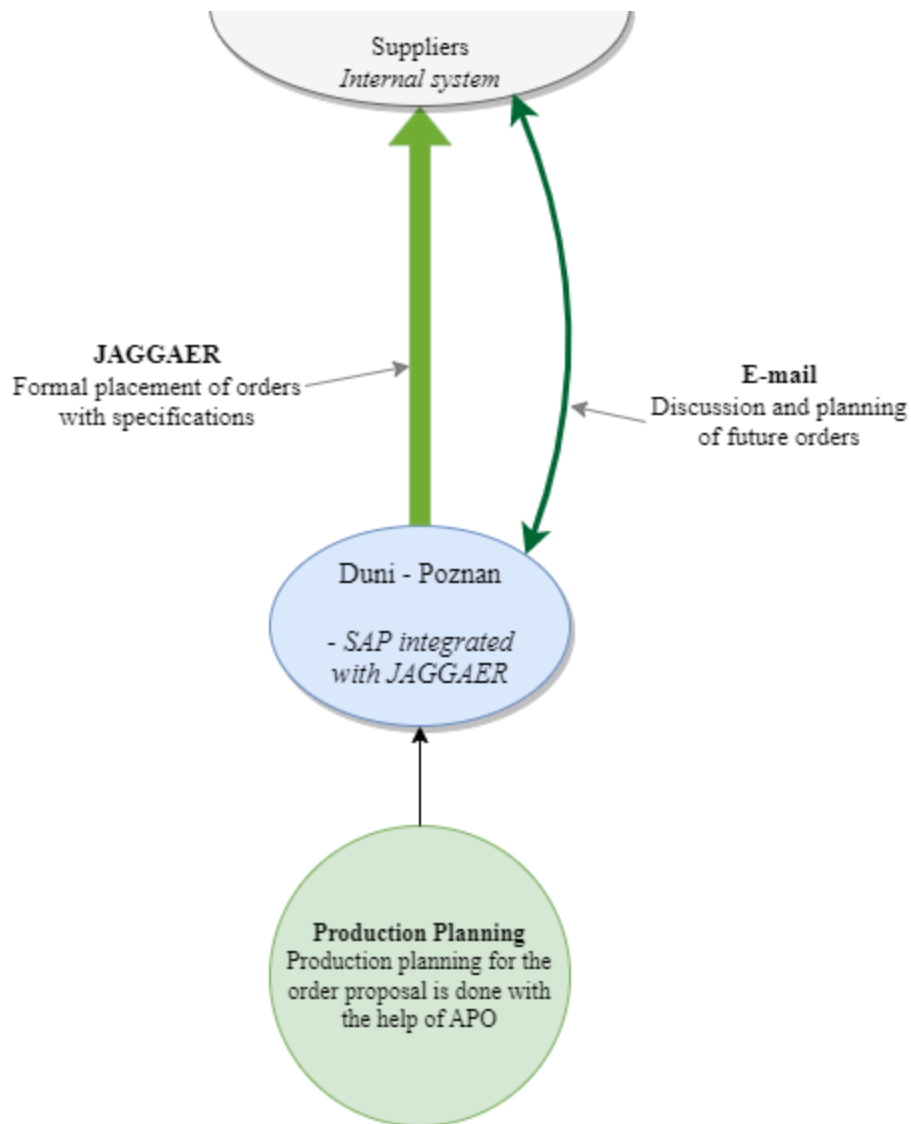
Figure 21. Visualization of the operational and digital processes of the Poznan factory. Created by authors.

4.4 Case 3 - The Ink Supplier

Duni needs ink to create different coloured napkins and the IS is one of their suppliers who produce, and supply inks headquartered in Luxembourg. Both production and logistics is taken care of in the headquarters. The interviewees take care of various activities within the company from order registration, inhouse logistics management, outgoing freight ordering to delivery management.

4.4.1 Operational process and digitalization

Contracting and Ordering
The IS majorly uses a single contract but uses long term contracts with partners where the order sizes are bigger and predictable consistently. The ordering finalization process starts with an email sent with a link to Jaggaer where all the details can be seen. Inside the Jaggaer software, all the order details could be checked and also be saved in the form of PDF which might come in handy in future to cross check the order details. The IS uses their own software called Farben which takes care of the process from ordering confirmation to invoicing. This software plays a vital role, and it could be one of the main reasons for their overall good delivery performance. The IT (Information Technology) team of the IS is also located at headquarters, which makes the communication process much simpler. The continuous collaboration with the IT department enables an effective use of the Farben software. Whenever there is a need for new options to be added in the software or change some existing features, it could be done with the help of the IT department. This is one of the main reasons which enhances the overall process and effectiveness of the IS as a company. The article name, delivery date, order quantity and place of delivery are the essential details of an order as these are used as inputs to process the order.

Expediting and follow up
The IS mentions that there are few possibilities to track the order. The position of the trucks could be tracked. There is no possibility for live tracking of the trucks, but it can be tracked whenever they reach different checkpoints before reaching the destination. The IS could email to get details of the order whenever it feels necessary. The IS feels that the current tracking system is not producing any major problems and also thinks that it is not a crucial process in their overall supply chain process as they feel the follow-up process is functioning smoothly without any major problems. Order delays are manually informed and reactively mitigated. Delays are routinely checked for in advance.

4.3.3 Digitalization Tools:
The IS uses Farben, Jaggaer and emails as their main tools of digitalization to manage the overall procurement process. The interesting finding here is the use of the software Farben which is very much customized as per the requirements of the IS which would be one of the main factors for their overall good performance (Knudsen et al., 2021). Farben (Farben, 2021) is a software providing global solutions which helps to stabilize the business process of a company with their experienced quality control and process implementation procedures. Farben could compare delivery options extensively. The software could be able to compare twenty different delivery options at a time. One of the best parts about Farben for the IS is that the IS is updating and modifying the software as per the business requirements. The IT team of the IS could modify and create customized options in the software as per the varied set of needs. This could allow the IS to have a streamlined flow of their supply chain operations. Emails are mainly used for communication and could play an important role in case of delays to find out more information to resolve it. During the ordering process, the

email is shared with a link to access the order in Jaggaer. All the order details are stored in Jaggaer which acts mainly as the information systems. The details of the order can be checked in Jaggaer with the help of the link shared and would be stored as PDF for future reference.

4.4.2 Delivery Performance

The IS usually has yearly contracts with bigger business partners. Most of the time, it is single order. When it comes to the volume, 15% of total orders are one-year contracts and the rest are single order contracts. When it comes to transport, 25% of the orders are sent by their own fleet. The IS sends those orders in their own trucks and the rest of the 75% orders are sent through third party providers. Price is always discussed and fixed before the delivery. The IS also gets next day deliveries where the orders are supposed to be delivered the very next day. These deliveries are a bit pricier to the normal cost of delivery. The IS as an organization feels that long term planning and bigger orders would be helpful. The relationship with the buyers is maintained and remains the same irrespective of the number of orders. For the IS, it is more important that the delivery date is matching the order delivery as it shapes the whole business relationship and growth.

4.4.3 Turbulence and Risk

In terms of turbulence, the IS feels that they are exposed to both exogenous and endogenous turbulence.

Endogenous Turbulence
Endogenous turbulence like a machine breakdown has a minor impact on the delivery performance. The order is delayed, and it may harm the trust and relationship between the IS and its customers. The availability of machines can be crucial when it comes to overall performance and delivery as it directly impacts the production planning. Employee illness is a minor factor for risk as it may lead to non-operation of alloted machines on time if there is no alternate employee available. The IS may also face issues with their suppliers in terms of receiving the raw materials. The software Farben is used in a proactive manner when it comes to checking the availability of the raw materials. If there is no raw material available, the system provides a warning which could lead to active measures to solve the problem. The software will also give the equivalent raw material that can be used as an alternative when the desired raw material is not available. This would make the operation process simpler and also make sure that production is not being halted due to the unavailability of any raw material. When it comes to tracking the transportation process, there are no proactive measures being taken as the IS feels that the operations are almost always smoother. But in case, if there is any problem with the transport, it is communicated and let know through emails.

4.3.7 Exogenous Turbulence
Due to the location of the company, the weather would also play a major role in the exogenous turbulence. Weather conditions like heavy snow might affect the machines and cause breakdowns which will delay and affect the delivery performance. During the covid pandemic, production did

not stop but the work shifts were reduced. Due to restrictions in gathering more employees together at the workplace, there were a limited number of employees working on the production.

The IS still got orders as usual during the pandemic which did not differ much. Farben did not have any special impact during the pandemic as the tasks completed through the software were fine like usual. Covid did not have an impact on the digital tools and the operations were run smoothly.
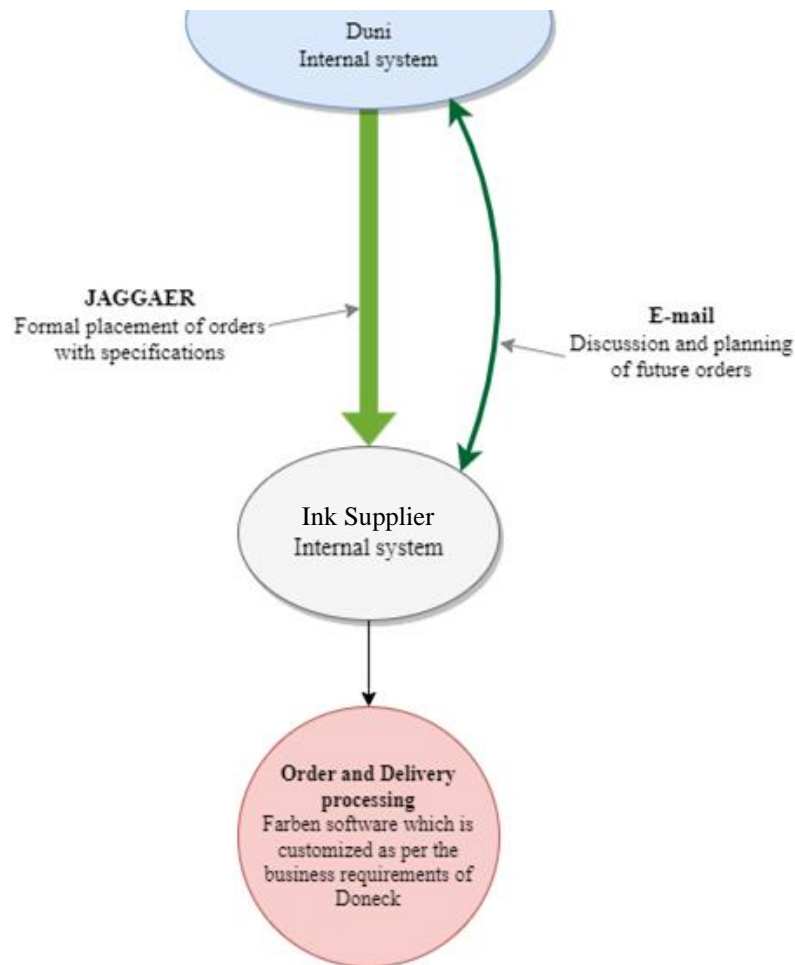
Figure 22. The operational processes and digitalization tools of the IS's purchasing department. Created by authors.

4.5 Case 4 - Bramsche - Duni Purchaser

The Duni factory in Bramsche is one of the two Duni factories studied in this Master Thesis, they are responsible for the procurement and production of napkins, tablecloths and similar products. They have local owned storage facilities combined with rented storage facilities for their products.

The two interviewees were responsible for the production planning and raw material order processing of the Duni factory.

The interviewees in the Bramsche factory did not have direct contact with the IS, the supplier of inks. The purchasing department that is higher upstream in the supply chain were responsible for the procurement of the inks in Duni. Therefore, no comparisons were made between the supply differences of the two suppliers, the FS and the IS, in this specific case.

4.5.1 Operational process and digitalization tools

Contracting and ordering
The fixed-price contract is the main form of contracting used in the contracting process. The details for the contracting and essential order details towards the Bramsche factory are done in the same document. The upstream purchasing department sends a general framework of an order, including terms of payment, assignment of responsibilities, to the supplying department of the Bramsche factory. The interviewees explain how long-term contracts are not being handled by them, but instead decided by the upstream purchasing department, with the interviewees being responsible for planning and order processing, regardless of if the contract is a single-order contract or the order is a part of a longer contract.

The internal SAP system that is used, automatically evaluates four different basic parameters to produce a purchase order proposal. The parameters used by the SAP system when producing these orders include:
The demand being the first parameter which is the calculated demand provided to the Bramsche factory by the upstream purchasing department. The lead time, the second parameter described as the time needed for an order to be fulfilled by the specific supplier that it is directed towards. The third parameter is described as the specific minimum order quantity that a supplier has defined for a product, the minimum order quantity being the lower limit for order quantities. The fourth parameter is the amount of safety days that is included in the lead time, and subsequently the whole ordering process. This is a manual input decided by Duni on the basis of general intuition and pattern recognition. The last parameter is the requirement of a specific material to be active in the SAP system, meaning available for purchasing.

The essential details of an order are the three values of Order quantity, Article number, and delivery date. These are the outputs of the SAP system after evaluating the input parameters previously described. It is then possible to change the details of the proposed order to account for specific variables that the SAP does not account for. The interviewees explain that the proposed order by the system is seen as what is possible if the circumstances were optimal, or "perfect". Subsequently meaning that the adjustments done on the proposed order by the system deviates from the hypothetical optimal. Because the adjustments done, account for turbulence details that are not included in the systems evaluation. An example of this was provided by the interviewee, if the

forecasted demand for a specific week is 500 products, but the actual demand turns out to be 100 products because of e.g., exogenous factors such as natural disasters, the adjustment to include exogenous turbulence in its calculation is then manually done by the employees placing the orders. If then the next week has a forecasted demand of 1000 products, then the proposed order is adjusted to a "real" demand of 200 products, meaning that a form of intuitive identification of pattern in the order history is done by the order processor employee and raw material planner. The interviewees might also get a warning from the upstream purchasing department if one of the suppliers is involved in a long-term contract and will therefore have procurement of large quantities of product.

The information channel used by the suppliers is the Jaggaer all-in-one solution web software, this is integrated with the SAP system, automatically sending orders through the Jaggaer system when a purchase order is created and confirmed by the order processing employee. Email and phone calls are used as a complementary communication channel to discuss details and changes of order placements.

Expediting and follow-up
When an order is placed, the delivery of the order is the responsibility of the supplier with all the essential details of the order: article number, order quantity and delivery date. There is no continuous/live expediting of orders. Instead, a delivery of a purchase order has different stages in the process: "Waiting for confirmation of order", and "order delivered", with any changes that have been done in between these two stages included.

Follow-up with suppliers is done regularly once a year, in the form of informal discussions about the experiences with specific suppliers and their perceived delivery performance. The follow-up discussions are described more as based on human intuition than on quantitative data. During these supplier follow-up evaluations, qualitative ratings are done.

Digitalization tools
The digitalization tools used by the Bramsche factory is as described: Jaggaer for the communication channel with suppliers, where orders are sent and information about changes is transmitted through. The SAP is used as the internal system for planning, proposal of orders and subsequently creation of orders that are to be sent with Jaggaer to the supplier. As mentioned, Phone calls and Emails are used as complementary communication tools for discussing orders.

4.5.2 Delivery performance

In the interview, two types of delivery performance are described. One is the easily measurable delivery performance that is easy to measure and evaluate, the other is a more abstract criteria of delivery performance that may need more complex measurement systems and is therefore instead evaluated by human intuition. Below are examples of both described.

Measured delivery performance parameters
The measured delivery performance parameters are closely related to the essential details of an order placement. Namely, the order quantity, article number, and delivery date. More specifically, the order quantity and delivery date are the two main criterias of delivery performance measurement and make up the majority of information that is used when evaluating delivery performance.

Non-measured delivery performance parameters
During the interview, all possible non-measured delivery performance parameters were explored and discussed. The first was the flexibility of suppliers to adapt to changing circumstances. E.g. if the forecasted demand was to change drastically, the measurement of how effective suppliers are in adapting to the changed demand and still perform in the aspect of delivery performance.

The second subject was the timing of order cancellations done by the suppliers. The interviewees explained that the SAP system does not differentiate between how late a supplier cancels orders, even though the consequences of this may drastically differ. If a supplier cancels an order two weeks before the delivery date or one day before the delivery date is the difference between simply creating a new purchase order to replace an early cancellation, compared to needing a complete remake of order schedules to accommodate the late cancellation. The interviewees mentioned that there is information about these late cancellations stored in the order history of suppliers, and may be used for manual evaluation, but it is currently not used by the system to evaluate cancellation times of orders.

The third subject was that the time units in the digital systems were of a wide margin. This meaning, that if a delivery was to be delivered in the morning of a date but was instead delivered in the afternoon. Technically, it is defined as late, but because the system does not differentiate between different times of a day, it is still seen as a correct delivery.

Improvement possibilities
When asked about the main area of improvement for their supplier relationships, they emphasize that their current supplier relationships are of good quality and display an understanding for potential lacking delivery performance with suppliers because of turbulent reasons. But if they were to pick one area of improvement, it would be the long-term trust and reliability between them and their suppliers.

4.5.3 Turbulence and risk

Exogenous turbulence
Examples of exogenous turbulence include the pandemic of 2020 where they described how the pandemic had a deep impact on supplying processes, with no specific area that was affected, but a general impact that affected the whole supply chain. Similarly with the Ukraine war, the balance of

the supply chain was distorted because every activity is connected with the activity before and activity after. This distortion travels throughout the supply chain and affects all parameters.

Endogenous turbulence
The endogenous turbulence is described in the form of specific events happening in an area of the supply chain. This may be the failure of a machine, changing demands or traffic jams. No one specific event was described as most impactful.

Comparison
When discussing the turbulence factors that affect the delivery performance of their orders. The interviewees of Bramsche give examples of turbulent factors but do not put a major emphasis on any one factor being the main reason for impacting delivery performance, instead, it is described as many factors having some impact on the delivery performance. The interviewees explained that if they were to choose between exogenous and endogenous turbulence regarding which one is the most impactful, they would choose exogenous turbulence because of the difficulty of mitigating these drastic and general turbulent events. This was described to be because of the fact that the magnitude of endogenous turbulence, even though continuous, was usually small and could easily be mitigated, e.g., if a supplier has issues with production, the problem is specific and may be resolved e.g., with the replacement of the supplier with another one, capable of producing the order quantity. Compared to the events of exogenous turbulence, the capabilities of the automation of order proposals within the SAP system is not able to accommodate the general variables of drastic global turbulence, leading the employees needing to make more complex adjustments of the proposed orders and relying less on the automatic functions of the SAP system. An example of the variables not accounted for by the system is the closing of restaurants as a consequence of the COVID-19 Pandemic. Because of the restaurants having a demand for Duni products, this decrease in demand had to be manually accounted for.

4.5.4 Further complementary information

The Duni factory in Bramsche has a bottleneck in the form of a small internal warehouse that is not able to accommodate large volumes of product. This leads to a smaller safety stock being available and subsequently putting pressure on the purchasing and supplying departments to accommodate this by more accurate delivery dates and better delivery performance to ensure that the described small warehouse is not over encumbered or understored.
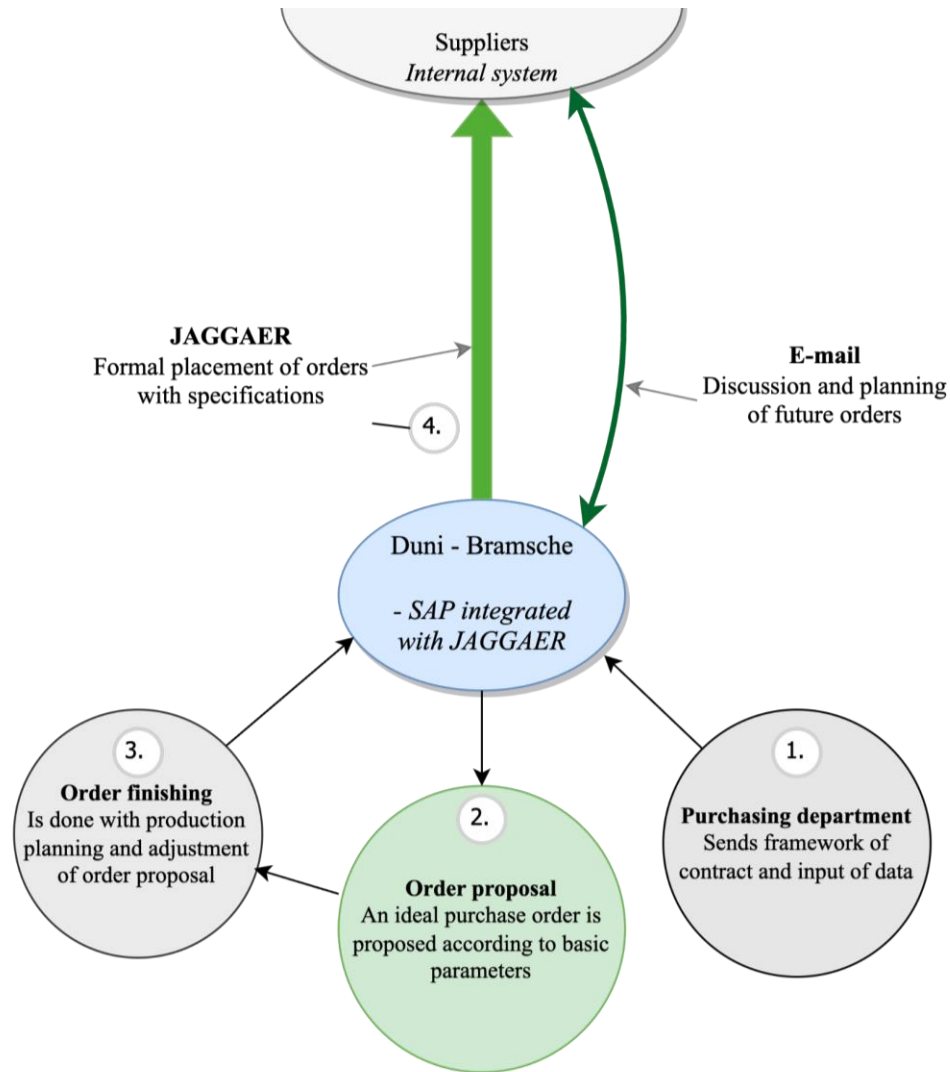
Figure 23. Visualization of the operational and digital processes of the Bramsche factory. Created by authors.

4.6 Cross-case examination

After the written individual case report describing the findings of the specific cases within the supply chain of Duni, a cross-case examination is conducted to describe the similarities and differences of these cases. This is done by inter-case pattern matching as described in the methodology, by utilizing this concept of pattern-matching, the differences can also be clearly described and analyzed. Tables are used as a tool to clearly show the differences and similarities between cases.

The first detail that is noticed between the studied cases is the differences of organizational structure, job titles and department responsibilities. Example, the Bramsche factory interviewees responsible for the raw material planning and order creating were not part of their organizations purchasing department, but still conduct parts of the purchasing process that is defined by our literature e.g.,

order creation. Instead, the purchasing department's responsibility in this specific case was to calculate demand and provide a framework of a contract. In comparison to the purchaser interviewee at the Poznan factory who had a more all-around responsibility for the processes.

4.6.1 Operational process

In the aspect of operational processes in the studied cases, it includes contracting, ordering, expediting and follow-up, as described in our literature review and limitations to the *supplying* part of purchasing. A pattern in contracting and ordering was noted, in the manner that the order and contract details were often in the same document, described as a single-order document with one article number and quantity. The contracts were all in the form of fixed-price contracts, where the four essential details were the *Article number, order quantity, delivery date, material availability*. The single-order documents included a general framework describing the terms of payment and delivery which was generally used by the purchasers for orders. The Single-order type was the most prevalent form of ordering between cases but could be complemented by a long-term contract of 3-6 months. Similarly, to the single-order, the long-term contract was a fixed-price contract where the order quantity for the whole period was determined, with the purchaser having the ability to split up the total order quantity to several sub-deliveries to reduce warehouse costs while increasing the demand forecast stability.

In terms of follow-up and evaluation, there was a difference in the approach of long-term evaluation of supplier-purchaser relationship. This long-term evaluation of purchasing relationships was heavier on the purchasing side in comparison to the supplier side.
Lastly, the interviewees of Bramshce did not have a direct relationship with the IS, this relationship was handled by another team.

Table 4. Table showing difference and similarities between cases regarding operational process. Created by authors.

Operational process (Contracting - Ordering - Expediting and Follow-up)			
Similar inter-case pattern Mostly single-order contracting with order details and contract framework in the same document. Expediting was in the form of checkpoints for the current delivery and live-tracking was not deemed important. EXPLAIN DIFFERENCE IN OPINION (delivery performance)			
Case differences			
Foil Supplier	Ink Supplier	Factory buyer *Bramsche*	Factory buyer *Poznan*
Complementary long-term contracting (up to 3 months).	Complementary long-term contracting (1 year with bigger partners).	Complementary long-term contracting (up to 3 months), done by the separate purchasing department.	No long-term contracting.
No mention of long-term followup.	Follow-up on a yearly basis of faulty events and implementing measures to prevent future faults.	A qualitative long-term evaluation in the form of an informal discussion based on intuition about supplier quality.	A quantitative long-term evaluation in the form of a questionnaire with a methodology of measuring and rating supplier performance.
Two available delivery options to choose from. One cheap, one fast.	20 different delivery options to compare and choose from with their customized internal software solution Farben.	Delivery not the purchaser's responsibility.	Delivery not the purchaser's responsibility.
		The interviewees did not have direct supply with the IS.	

4.6.2 Digitalization tools

A pattern studied between the cases was the usage of Jaggaer as a formal communication channel regarding order sending, accepting, and tracking. All cases used this software solution for their formal agreements and terms. Similarly, all cases used Email as a complementary tool when discussing potential order details and the change/cancellation of already placed orders.

The main difference was in the internal systems that were used for production planning and order creation and processing, e.g., the IS had a specially customized software for order creation with their own software developer department to provide live updating. Comparatively, the Poznan and Bramsche factories used the two-software solutions SAP and APO as their internal systems.

The internal systems differ from the Jaggaer communication channel in the form that the internal systems are used for order *creation* and *processing*. While Jaggaer is used for order *sending* and *accepting*, meaning that the internal systems integrated orders into the rest of the sending and receiving company departments and processes while Jaggaer was used for the communication between suppliers and purchasers. Furthermore, an interesting detail to note is the proposed order system used by the Bramsche and Poznan factories. There, their SAP systems takes into account basic parameters and proposes an "ideal" order proposal that would theoretically be acceptable if there was no turbulence and only perfect conditions. These basic parameters being Because this is not realistic, the interviewees have a manual input and adjustment of the order proposal to take into account the turbulence that is not measured by the internal system.

In the literature review of this Thesis, different digitalization examples were defined for a potential use in describing the digitalization aspects of suppliers and purchasers. In regard to that framework, the digitalization tool "Supplier relationship management" tool is the most prevalent in the studied cases, being the software solution of Jaggaer and the internal systems of Farben, SAP and APO. No specific mention of Big Data (Bhatt, 2022), Crowdsourcing (Sooran, 2019), Blockchain (GEP, 2023) or artificial intelligence (Sammalkorpi & Teppala, 2022) was made in the findings of the cases.

Table 5. Table showing difference and similarities between cases regarding digitalization tools. Created by authors.

Digitalization tools			
Similar inter-case pattern Jaggaer is used as a formal order placement, acceptance and tracking tool. Email used as a complementary informal discussion about order details. Internal systems of studied cases were different.			
Case differences			
Foil Supplier	Ink Supplier	Factory buyer *Bramsche*	Factory buyer *Poznan*
Internal systems not discussed	Specifically created software (Farben) used as an internal system with live support and customization.	Uses a combination of SAP and APO as an internal system. Automatically proposes "ideal" orders according to basic parameters that are manually adjusted.	Uses a combination of SAP and APO as an internal system. Automatically proposes "ideal" orders according to basic parameters that are manually adjusted.

4.6.3 Delivery performance

When studying the delivery performance parameters, the findings showed that the parameters closely correlated with the *essential details* of an order placement, more specifically, the delivery date, order quantity, and availability of material. The first two order details were of more significance compared to the last one. The usage of order quantity deviation and delivery date deviation can be described as the two main staples of delivery performance, uniformly used between all suppliers and purchasers to evaluate delivery performance. These parameters are clearly defined, easily measurable and comparable between several actors. In one of the last interviews, with the Bramsche purchasing department, non-measured delivery performance parameters were explored more in-depth. The findings described supplier order cancellation time and supplier flexibility as two non-measured delivery performance parameters. The order cancellation time is described as the amount of time difference from the order cancellation date to the original delivery date that was canceled. This is important because an order that is canceled one day before the delivery date compared to two weeks before the delivery date introduces different magnitudes of consequences to the supply process. Similarly, the flexibility of suppliers to adapt to changing circumstances such as the change

of essential order details, or replacing another unavailable supplier, is a non-measured delivery performance. The current evaluation of the two mentioned non-measured delivery performance parameters is based on human intuition, although Bramsche mentions that information about order cancellation and delivery dates are stored within the system and can therefore be used to manually calculate order cancellation time. Lastly, an extra detail was mentioned. If an order is placed for the morning of a delivery date, but is instead received in the evening, Jaggaer does not measure this as a late delivery because of the order being received at the correct date, although at the incorrect time, this being an issue with JaggaerS time units being "days" and not e.g., "hours".

Table 6. Table showing difference and similarities between cases regarding delivery performance. Created by authors.

Delivery performance
Similar inter-case pattern Material availability a requirement for delivery. Order compliance in regards to order quantity deviation and delivery date deviation used across all cases as the two main measurable staples of delivery performance. Non-measured delivery performance includes order cancellation time, supplier flexibility, and Jaggaers time measurement not differentiating between different times of a day.
Case differences No differences were studied between the cases on the subject of delivery performance.

4.6.4 Turbulence and risk

The subject of turbulence was a more open-ended discussion compared to the previous subjects of delivery performance, operational process and digitalization tools. The discussion was started with an explanation of the definitions of exogenous turbulence and endogenous turbulence, followed by examples of both. All interviewees mentioned that both endogenous and exogenous turbulence had an impact on the purchasing processes of their departments. The difference was in the examples given by the interviewees and the perceived relative impact of endogenous and exogenous turbulence compared to each other. A pattern noticed is that the automation and digitalization tools work most effectively when the turbulence is minimal. When turbulence is introduced, a manual input has to be used for adjusting the supply process in accordance with the non-measurable turbulence factors.

Table 7. Table showing differences and similarities between cases regarding Turbulence and risk. Created by authors.

Turbulence and risk			
Similar inter-case pattern The purchasing processes of the interviewees were impacted by both endogenous and exogenous turbulence. Digitalization and automation tools work most effectively when there is minimal turbulence.			
Case differences			
Foil Supplier	Ink Supplier	Factory buyer *Bramsche*	Factory buyer *Poznan*
Turbulence is generally not a big problem. Mitigated by three more extended material stocks. Design acceptance is the most impactful bottleneck in the process.	Equal impact from endogenous and exogenous. Did not impact the digitalization tools. Turbulence is mitigated.	The Ukraine war and pandemic had a big impact. Endogenous turbulence is easily mitigated.	Not mentioned

4.6.5 Complementary inter-case findings

An interesting detail that is to be mentioned is the different perceived supplier quality of the two purchaser interviewees in this thesis. When asked about a specific supplier, one purchaser interviewee described their relationship as "room for a lot of improvement, with improvements already tried to be implemented unsuccessfully" while another interviewee described their relationship with the same supplier as "equally as good as the other suppliers". When the purchaser of a lesser opinion about the purchasing relationship was asked what they believe is the reason for this, they mention that it may be because of the supplier not having adequate production planning processes for their orders. Just-In-Time is mentioned to be defined as if the delivery comes within a margin of 1 day from the decided delivery date. E.g., if a delivery date is decided to be on a Wednesday, it is still defined as a Just-In-Time delivery if it is received on Tuesday or Thursday

4.6.6 Conclusion of main findings

Lastly, as a summary of the main findings between the different cases. A table is concluded below showing the similarities and differences of all cases regarding all aspects of this study e.g., operational process, digitalization tools, delivery performance, turbulence, and risk.

Table 8. Table showing main findings of the different cases. Created by authors.

Main findings of the different cases

General similarities between cases

- The essential details of the placed orders, with mainly short-term single-order contracting.

- Usage of Jagger, SAP, APO and Email as formal and informal communication channels, the main tools used in the supplying of material and product.

- The measurable criteria of delivery performance

- The continuous and low-intensity impact of endogenous turbulence, short and intense impact of exogenous turbulence. The manual adjustment when mitigating turbulence.

Main differences between cases

Foil Supplier	Ink Supplier
- The perceived supplier quality by the different purchasers - Their industry-specific bottleneck of design acceptance	- Their customized "Farben" software solution is used as an internal system. - The IT-department closely works with the interviewees and develops specific requests for improving the "Farben" software solution.
Factory buyer *Bramsche* - Their qualitative and informal discussions about supplier relationships.	Factory buyer *Poznan* - Their quantitative rating process of rating long-term supplier relationships.

5. Analysis

The different sub-chapters of the "Analysis" chapter of this master thesis will follow the structure of first tying together the objective empirical findings, with the different aspects and perspectives presented in the literature review. As a complement, if further research is found on the identified patterns within the findings of this thesis, it will also be included for a further nuanced analysis on the subject.

5.1 Operational process

As discussed in Literature review (Jenkins, 2021) under the section of the scope - supplying and its subparts, contracting will be discussed within the scope of the thesis and in all different cases, single-order contracting was prevalent where the details of the order and the contract framework were present in the same document. As explained in the Van Weele procurement process (Van Weele, 2014), expediting plays a crucial role and it is similar among the studied cases. Expediting was missing the part of live tracking and it was done by checking at different checkpoints for the current delivery. When it comes to the FS, the foil supplier for the case company, along with single order contracting, long-term contracting is used, and the time duration is of three months. When it comes to delivery, the FS has two types of delivery options, and they vary from each other. One delivery option would provide cheaper delivery and the other one would provide a faster delivery. Faster delivery would be a bit expensive when compared to the other option. When it comes to the IS, the contracting is done for one year with reliable partners. In terms of follow-up, it is done on a yearly basis for faulty events and also implements new measures to prevent such faulty events from occurring in future. Their internal software Farben plays a major role when it comes to day-to-day activities of the IS and it is no different when it comes to choosing the right delivery option. Farben provides twenty different types of delivery options to compare and choose from, which increases the efficiency of each and every delivery as the best possible option is being chosen. As the process (TFIG, 2012) of purchasing has two sides involving suppliers and buyers and also involving two types of materials in direct and indirect materials (ControlHub, 2023), the buying process involves the Duni factory buyers who are located in two different locations in Bramsche and Poznan. When considering the buyers in Bramsche, the contracting process is taken care of by the purchasing department and the long-term contracting with suppliers is to be done up to three months. Purchasers in both Bramsche and Poznan do not hold any responsibility when it comes to delivery. It is worth also mentioning that the interviewees from Bramsche did not have direct supply with the suppliers from the IS. When it comes to buying in Duni's factory located in Poznan, there is no long-term contracting involved. When it comes to follow-up, a quantitative long-term evaluation is done with the help of a questionnaire. This questionnaire helps to measure the performance of the suppliers which eventually helps Duni to rate them.

5.2 Digitalization tools

Digital readiness (Kosmol et al., 2019) defines the readiness of an organization to adapt to digital technologies. Digital readiness leads to adapting to use digital technologies *(Reis et al., 2020)* to generate profit by making digital information as the core which transfers the manual process to automation from technical systems (Makeitfuture, 2020) As discussed in Literature review (Deloitte, 2017) describing the different technologies, various digital technologies have different purposes from contract management, eprocurement and contract management to name a few. From all the cases we interviewed, it's been understood that everyone uses Jaggaer, the information management system. All the needed procurement functions are provided by Jaggaer, and it is designed to be an all-in-one solution software which is also cloud-based. Jaggaer is used to make sure that there is no miscommunication between Duni and the suppliers and information is properly managed and transferred.

As discussed in Literature review (Deloitte, 2017) describing the spectrum of digitalization, the degree of digitalization are equal in all the cases since the digitalization tools used are similar in Jaggaer and SAP. Among the three different degrees of digitalization in Basic, Intermediate and Advanced tiers, we think that Duni as an organization belongs to the Intermediate tier when it comes to the degree of digitalization for themselves and with their suppliers. The reason being is the supply chain management process is more cross functional and more efforts are put in to optimize the supplier network. There are still manual activities being involved and it is not completely digitalized yet which makes Duni not move to the advanced tier category when it comes to the degree of digitalization. But we believe that fully digitalized, zero manual process for the entire procurement process is possible in future which will make them move to the advanced tier.

The characteristics of digitalization in the procuring process chapter in literature review explains the three different types of digital characteristics. The first digitalization characteristic explains the extent to which the software of digitalization is used in the operational process steps. When it comes to all the cases studied in this thesis, the extent of digitalization tools used are similar. The process and the digitalization tools used are the same across all the cases. The second digital characteristic talks about the amount of manpower in the division of purchasing related to the purchasing scale. This thesis did not have the resources to explore this topic. The third digital characteristic is the supplier's leadership perception with respect to digitalization and the impact of turbulence. The order automation and its reliance is the main difference across the different cases.

Duni as an organization can be put in the category of Network organizations (Knudsen et al., 2021). This is because the installed user base of Duni enhances the overall process and also enhances the product's value. In the future, the pace of digitalization increases and also reduces the work done by the users and also the size of digitalized products and services increase. The network effects are not easy to replicate by the competitors and the competitive advantage is sustainable. Whenever new users enter into the market, superior value is offered, and the speed of digitalization is increased. As

the speed of digitalization increases, the superiority over the competitors in the market will also increase as it is hard for the competitors to catch up. Due to the well-organized nature of network organizations, Duni could be able to raise the standards of competition well above their competitors.

5.3 Delivery performance

As Bienhaus and Haddud (2018) mentioned, increased openness and traceability can benefit businesses and strengthen buyer–supplier relationships and the level of confidence between them, which will make procurement functions more strategic, support overall organization goals and help (Erp-information, 2023) them to measure their own standards expected from the customers. As mentioned in the literature review under Delivery performance chapter, there are several factors (Elogii, 2020) that contribute to the performance of delivery of an organization. On time delivery along with order quantity from the supplier plays a crucial role for Duni as it helps to measure the quality of service of the delivery and also the suppliers. Duni will evaluate the suppliers' performance with the help of on-time delivery and order quantity as it helps for the future relationships with that particular supplier and benefits Duni as an organization in the long run. Duni can build trust and relationships with the suppliers who are performing good when it comes to timely delivery and also can check with the suppliers who are not performing good and try to find a solution. The calculation can be done monthly, quarterly or yearly. The number of deliveries and the fulfillment of it is crucial for Duni as they cannot compromise on the shortage of deliveries as the production and the whole process of gaining upper hand in the market against the competitors and also gaining profit as an organization depends on it. As mentioned in literature review (Elogii, 2020) under the topic on number of completed deliveries of section delivery performance, the whole operational efficiency is measured by delivery quantity and delivery date. The future growth potential of an organization is calculated by taking the average number of deliveries with respect to operational capacities and for Duni, it is important to get the deliveries completely on time from the suppliers as it will help to utilize the operational facilities to the fullest and help them stand out in the competitive market.

5.4 Turbulence and risk

Uncertainty can magnify the turbulence impact as uncertainty happens if the impact of supply chain behavior on control mechanisms cannot be determined in an accurate way. (Van der vorst et al., 2002) In general, we noticed that endogenous turbulence (Trkman et al., 2009) is of low impact and continuous in nature whereas exogenous turbulence generates high impact and is rare. As discussed in the literature review chapter explaining turbulence factors impact on supply chain by Alok et al. (2022), Duni as an organization faces some key challenges with their supply chain. New challenges (Eubusinessnews, 2022) and constant improvement are a part of the supply chain. For example, the Duni buyers in Poznan faced inconsistent supply from their suppliers during the time of uncertainty. The uncertain time created volatility of the raw material's quantity which led to inconsistency. The Poznan factory also experienced delays in deliveries for the ordered boxes. The lead time drastically

went to eight weeks from the usual three weeks. Local transport restriction during the uncertain time along with movements of goods which became slower led to this delivery delay. The IS as an ink supplier to Duni faced turbulence when it came to unavailability of machines as it was crucial when it comes to on-time production and delivery. The IS also faced a minor risk when it comes to scarcity of labor which may happen for a plethora of reasons from employee sickness to restrictions imposed during lockdowns which ultimately delays the production and on-time delivery.

Duni as a company has a growing agility when it comes to technology. Especially with the use of their information system Jaggaer (Jaggaer, 2023), all inputs and updates can be identified and communicated across different streams of suppliers and buyers. Whenever there is an order, it is transferred and gets informed across different levels and also when there is a modification in orders, it is notified with the help of email and also changes can be seen in the software Jaggaer. Data sharing and connected systems are given priority but there is still a scope to implement advanced technologies like Artificial Intelligence (Sammalkorpi & Teppala, 2022), Robotics (Comtecinfo, 2023) which enhances the current level of performance to the next level. Once the technology agility is achieved completely, organization and people agility can be implemented as it is possible to have communication and collaboration that are efficient and an effort together including all employees of an organization could be possible and not just with higher level of management in logistics and supply chain managers. In future, the organization's mindset has to be adapted where there would be a need to collaborate with competitors like mentioned above in organization and people agility for the betterment of the organization.

5.5 Assessment from an AI-perspective

This chapter will cover the findings of the study from the perspective and space of automation and artificial intelligence. First, the potential availability of information for future usage in automation is assessed. Thereafter, the relationship between the decision-making processes of humans and systems is studied. Note: in this chapter, because of the increased informational availability and the fact that the purchasing side is more relevant compared to supplier side, the Poznan and Bramsche factories are focused on.

5.6.1 What information is available?

In this thesis, the *contract metadata* and *data stored across ERPs* is covered, as mentioned by Sammalkorpi & Teppala (2019). Their availability and potential is analyzed. An important note is that there is an immense potential for in-depth research in the area of AI within this study. AI (Sammalkorpi & Teppala, 2022) which uses algorithms of smart computers provides efficient solutions for all procurement problem solving. Because of the limitations of this study, the analysis of this area is mainly focused on a general qualitative mapping of the information landscape within the studied cases.

Before the unused sources of information are studied, current usage of information sources is concluded. The findings show that, in their current automation of *"proposed ideal orders"*, these proposals arise from four different basic parameters used in this process. The demand of a product, the lead time of an order, the specific minimum order quantity, and the amount of safety days determined by the purchasers. This function then proposes an order with the essential order details of article number, order quantity, and delivery date that may be manually adjusted by the purchaser for turbulence not taken into account. Below, unused potential sources of information for automation is listed.

Data stored across or within ERPs
Data stored across or within ERPs, in practical terms, is defined as information that is not generally available to several different decision-makers in the Duni supply chain, in this category, *contract metadata* is described as a sub-category.

The first source of information that is relevant is the PDF document that, in this case, contains the single-order details of product specifications and delivery date, combined with the general contract framework. This type of data can be categorized as the other type of data that is included in this chapter, namely *contract metadata*. Cui et al. (2021) explains in their research paper how document processing is one of the essential processes to collect information that will consequently be available for automating and increasing information visibility. With the release of powerful LLM's such as GPT, Longyue et al. (2023) explores the use of these powerful LLM in document processing and came to the following conclusions:
"1) leveraging their powerful long-text modeling capabilities, ChatGPT outperforms commercial MT systems in terms of human evaluation.
2) GPT-4 demonstrates a strong ability to explain discourse knowledge, even though it may select incorrect translation candidates in contrastive testing.
3) ChatGPT and GPT-4 have demonstrated superior performance and show potential to become a new and promising paradigm for document-level translation."
This shows a promising and relevant potential for automation for document processing with Duni, especially with both contract details and order information being in the same document file.

Another example of a disconnected information source may be the quantitative rating used by the Poznan factory. It was not mentioned that this quantitative supplier evaluation was used outside the internal systems of the Poznan factory. This information source is another potential for future automation implementation, with Cui et al. (2021) explaining how quantifying information for decision-making processes is the first step in automation. Drawing the parallel to Bramsche, it is necessary to first have a quantitative rating process implemented to then be able to integrate it into automated decision-making, which is why it seems more relevant to the poznan factory.

A small detail that has potential for automation are the non-measured delivery performance parameters such as cancellation time and cancellation rate. This information is already stored in the order history of the studied cases but is not used in producing a formal and systematic assessment of supplier performance in the software solutions. These two parameters of cancellation time and cancellation rate can be combined with the metric of *time from order placement until delivery date* to give a holistic view of a certain supplier's flexibility.

Lastly, a long-term solution would be to start vertically integrating information technology, sharing information such as forecasted demand for certain products for effectivizing purchasing practices. As included in the literature review Kosmol et.al (2019), states that when assessing the digitalization degree of only one actor such as the buyer, it might not reflect if the digitalization project is successfully implemented because of the involvement of the supplier in the process which is not included.

5.6.2 The relationship between digitalization processes and human intuition

As mentioned in the literature review, the problem formulation of implementing digitalization tools is how it is to ensure that there are minimal errors in the operational purchasing process of an organization. This includes automating the process to some degree, to ensure right levels of supply, with the right cost, at the right location, to a more efficient process with the digital tools compared to the human process counterpart (Khan & Khan et al., 2022; Khan & Parvaiz, 2022).

When discussing the relationship between digitalization processes and human intuition, the most relevant area of the thesis findings are the results within the *turbulence* chapter of the empirical results. The findings show that there already exists a primitive automation solution from which the operational department uses as a crucial function in serving supply chains (Sousa-Zomer et al., 2020; Seyedghorban, 2020; Koh et al., 2019; Tortorella et al., 2019; Schrauf & Berttram, 2016; Rubbio et al., 2019; Hastig & Sodhi, 2020; Martinez et al., 2019). This makes the human operational process work from a more slightly more *strategic* perspective, taking into account abstract turbulence factors that the system does not. Karmehag and Löfnertz (2018) similarly describe how a full process automation in purchasing leads to the operational purchasing process, specifically placing manual orders, is slowly phased out and replaced by AI automation. The more advanced the AI solution is, the more strategic factors it includes. Below is a figure describing the current relationship between system automation and human intuition within the Duni purchasing practices of the Poznan and Bramsche Factories. An increased automation of operational processes leads to a bigger area of factors taken into account by the automated system, and a decreasing area of factors taken into account by human intuition. Van Duin & Bakshi (2018) describe the four main characteristics of AI solutions in procurement operations. These include processing massive amounts of data, context driven awareness, ability to learn based on historical patterns, and solving complex problems. These are the different areas of automation implementation that automate the procurement operational practices.
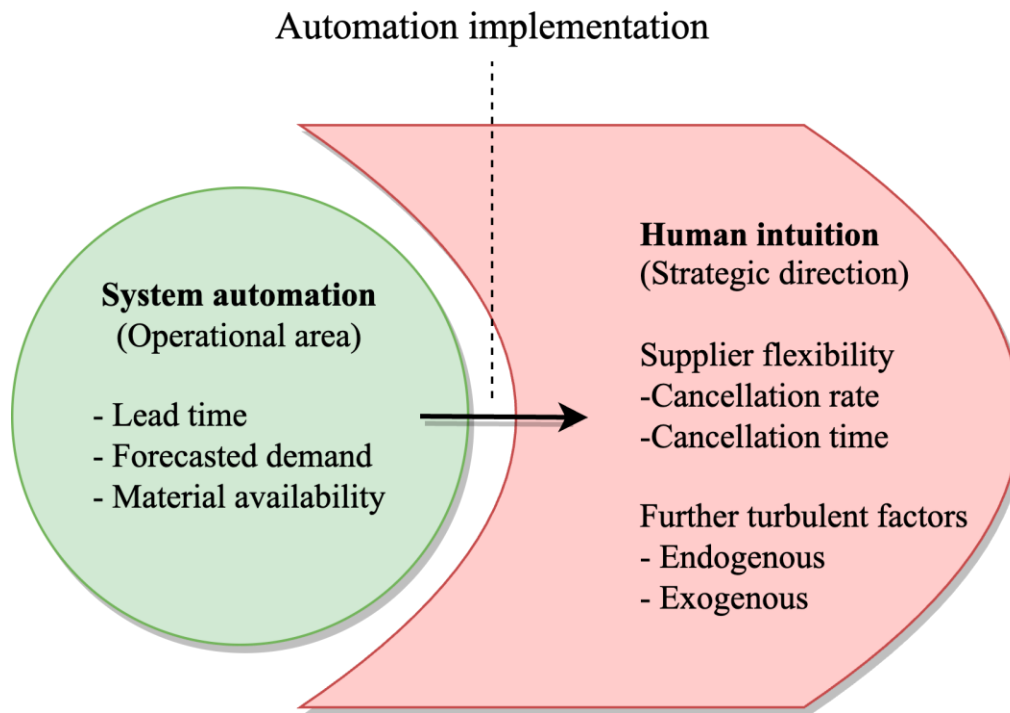
Figure 24. Factors taken into account by system automation and human intuition of Duni purchasing practices. Created by authors.

On a last note in this chapter, there is a prioritization done in terms of what is most relevant to automate in the purchasing practices of the Duni supply chain. This is based on what the interviewees have described as the system being the most important and effective in, and comparatively least effective in. The most relevant area for automation is the quantitative analysis and measuring of supplier performance, this leads to increased data-driven decision-making which is a relevant implementation for moving a network firm into a data-driven network firm, increasing the competitive advantage (Knudsen et al., 2021). This means using both measured and non-measured delivery performance parameters as input in an automated system to produce ratings of supplier performance. Thereafter, the next step is the continuous endogenous turbulence of the supply chain. Deloitte (2018) explains how AI solutions may be used for On-time delivery, planning and time-estimation that may be used by logistics companies through their track-and-trace system. Because of the interviewees describing the endogenous turbulence and continuous, low-impact, and reasonably predictable, this is seen as the second area relevant for automation. Lastly, it is the area of exogenous turbulence. This is described by interviewees as being a high-impact low-probability area that is hard to predict, leading to this being last in the priority. These areas of automation drive the purchasing processes to be more information based, leading it to become a data-driven network having the most stable competitive advantage (Knudsen et al., 2019). Below is a figure visualizing the different possible areas for automation.

High priority   Increasing complexity, decreasing priority   Low priority

Delivery performance rating

Implementing a quantitative system for measuring supplier performance with the usage of currently measured and non-measured delivery performance variables

Endogenous turbulences

Further extending the automation capabilities by including the low-impact continuous endogenous turbulence such as changing forecasts and order placements.

Exogenous turbulence and strategic decision-making

Further extending automation scope to global trends and events to process massive amounts of information and predict relevant trends.
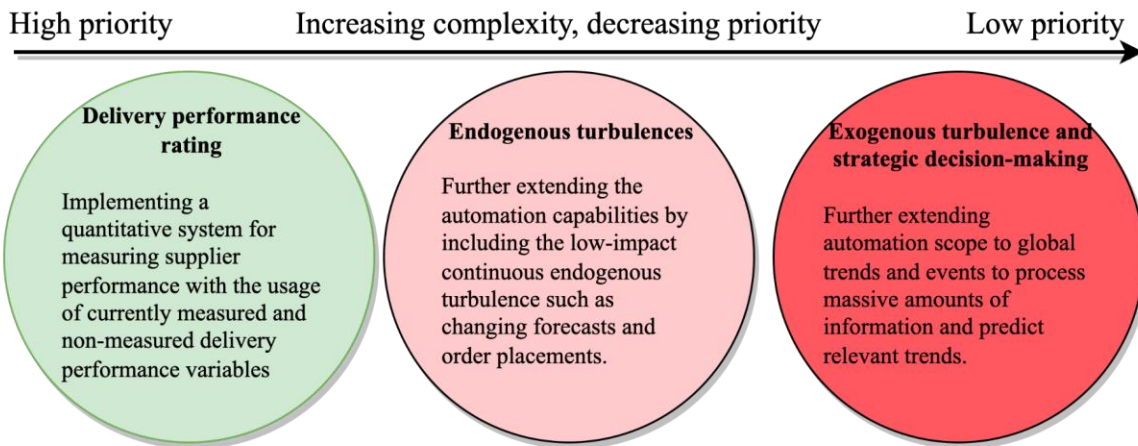
Figure 25. Prioritization of different areas of potential automation. Created by authors.

6. Discussion

In contrast to the objective and factual nature of the "Analysis" chapter, the "Discussion" chapter will follow a more subjective approach from the perspective of the authors and interviewees of this research study. The different sub-aspects of the study that may need a more informal approach to be explained and explored, is covered. The findings used in this chapter are the findings from the interviews that are of an informal and general nature.

6.1 Complementary discussion of subtopics

This chapter will cover general discussion of subtopics and details that are not included in the *analysis* chapter.

6.1.1 Operational process

One unexplored area, that was not included in this paper because of time constraints, is the possibility to measure the effectiveness of order automation with the help of quantitative data. Suggestion for this would be of using a specific metric for this, e.g., the amount of orders placed in comparison to the amount of employees responsible for order processing in the specific company. Logically, the more a process is automated, the higher the number of orders placed would be in comparison to the employee amount. This is a simplification that could be extensively studied, with several quantitative metrics, and its own research purpose. In chapter 3.2.4, *Characteristics of digitalization in the procurement process*, this is described as the digitalization characteristic "*The amount of manpower in the purchasing department relative to the purchasing scale.*"

6.1.2 Digitalization tools

When discussing the Jaggaer and SAP digitalization tools with Baerwaldt, several nuances were uncovered that are not previously known. These are shortly mentioned as follows.
Even though the programs used by the purchasing departments of the Bramsche and Poznan factories are the same, there is a possibility of difference in the functions within the programs that are used. An example of this would be the proposed ideal orders by the system. Baerwaldt mentions that this function is available to all users of the Jaggaer program, but the reliance on the proposed ideal order by the system may be different between departments. The reason for these differences is discussed as a consequence of company culture differences between departments. This means that the management within a company that has the values of trusting human intuition over system automation will not be equally as trustful of the system proposed ideal orders compared to the management of a company that has a positive perception of automation. This phenomenon has also been mentioned in chapter 3.2.4, *Characteristics of digitalization in the procuring process*, described

as the digitalization characteristic "*The perception of the leadership in terms of digitalization and turbulence impact.*" The fact that this has been brought up as a point of discussion proves the relevancy of this characteristic. Regarding the digitalization spectrum described in the literature, during the interviews with the interviewees, the digitalization assessment of an organization proved to be too complex to be put on one axis.

Lastly, the customized Farben software is an interesting area, in how it produces optimal delivery solutions and order processing. Further study of this specific program may be difficult, because of wanted secrecy by the supplier using this program.

6.1.3 Delivery Performance

As previously mentioned, the number of created orders in comparison to the purchasing process is an important piece of information that is not included. From the perspective of delivery performance, a quantitative metric would be essential for the quality of this research. As mentioned in *assessment from an AI perspective*, and its first step of implementation. The measurement of performance, specifically delivery performance, is critical for future research in any of the potential subjects within this paper. All interviewees see the two metrics of delivery date fulfillment and order quantity fulfillment as the two staples of delivery performance, while simultaneously no general system for general evaluation and rating of suppliers and their delivery performance is in place. This is the biggest potential for improvement, a groundwork of performance measurement essential for general future development within digitalization.

6.1.4 Turbulence and uncertainty

What has been noticed in the chapter of turbulence and uncertainty is the abstract nature of it. When constructing the research methodology of this chapter, there was an expectation of turbulence factors being concrete and direct, with the interviewees clearly explaining what specific problems contribute to the biggest impact on delivery performance. Instead, we discovered that turbulence is more of an abstract concept that needs situational consideration on how to solve it. Situational awareness and the approach to decision-making was seems more important, in comparison to the previously believed importance of studying in-depth reasons for turbulent events.

6.1.5 Assessment from an AI perspective

In continuation of turbulence and uncertainty, the most interesting aspect of this chapter within this paper, is the inter-play between human intuition and system automation. This is a subject that is immensely more important in the future and is only touched upon in this paper. Still, the simple recognition and general mapping of the specific inter-play of automation and manual processes within the operational procurement process of Duni is one of the important contributions of this work.

6.2 Factors affecting quality of empirical data

In *Factors affecting research quality* we will discuss the different obstacles presented to us when writing this research paper and how it affected our research process, and consequently the research results. This is to further nuance the findings and bring to light the affecting variables that may otherwise unknowingly affect the results.

6.2.1 Interview obstacles

When conducting the first interview with the FS, the process was slightly chaotic because of the unfamiliarity with their operational processes, and the general operational processes of the supply chain. Comparatively, the last interview with Bramsche went effectively enough that time was left over in the end for general questions and deeper examination. This was because the familiarity of operational processes was further developed after every interview, leading to a difference in depth of interviews. From the perspective of the research questions: in the first two interviews, there was a heavier emphasis on RQ 1 about mapping operational purchasing processes. Comparatively, in the last two interviews, there was a heavier emphasis on RQ 2, and 3 regarding digitalization tools and turbulence factors.

Similarly, the interviews were conducted with 1-3 interviewees per unit of analysis. Specifically in the case of 1 interviewee, there exists a risk that the interviewee has specific personality traits and experiences that colors their judgment and subsequently their answers to the asked questions. This is especially true regarding the questions about turbulence factors, because of their purposefully multi-faceted and open-ended nature. Because the interviewees were situated in Germany and Poland, there was a slight language barrier that presented an obstacle when collecting the data.

Lastly, when we prepared the interview methodology for this master thesis, there was an expectation of using the "Transcribe" function within the Microsoft Teams meeting. Meaning that all the spoken words within the Microsoft Teams meeting where the interviews were conducted would be automatically transcribed to a text format, with a possibility to download this document and thus be able to search for specific subjects with the CTRL-F function. The function would significantly improve the research collection process and would be possible to include the transcription in the appendix. This proved to not be possible, furthermore, it was not possible to host any of the interview meetings from the authors own Lund University accounts on Microsoft Teams. After several hours of trying to find the underlying reasons for this, a conclusion was inductively formulated. The conclusion being that Microsoft Teams accounts which are tied to the Lund University school are prohibited from booking and hosting meetings, and consequently, transcribing these meetings. The question of why this function is disabled for LU students is unknown, and no reason or explanation of this can be found online, even with several frustrating hours of research done on this problem. Attachments in the *appendix* of this paper with the whole interview transcribed would be immensely valuable but is now not possible. This might be relevant for future research done by students who

expect to use this simple and helpful function to be pleasantly surprised that it is disabled, with no explanation of how or for what reason.

Note: The solution of creating a new independent Microsoft Teams account for booking meetings was tried, but this did not work either due to several different complications of product purchasing and availability. The reasons for these complications being a mystery, an enigma whose depths know no bounds, that we hope may be solved sometime in the future of our global technological advancements.

6.2.1 Different cases, organizational structure and competitiveness

As the research proceeded, the results found that even though the four cases were within the Duni supply chain, they were in different countries (Germany, Poland), had different managements, and had different organizational structures. This leads to some obstacles when comparing the UOA's with eg. the interviewees having different areas of responsibility within their respective departments purchasing process. As an example, from the *Empirical Data* of this paper; the interviewees of Bramsche factory and Poznan factory. In Bramsche, the interviewees' roles were "order creation" and "raw material planning" while at the Poznan factory, the interviewees' role was named "Purchasing". Furthermore, Bramsche mentioned that they were not included in their organizations specifically defined *purchasing* department. This leads to a slightly unclear comparison between the different UOA's organizational structure. Since the scope of this paper does not include a study of the organizational structures within a company, the responsibilities of the interviewees were simply identified by their words and named.

A possibility to explore the complexity of each organizational structure and process of the UOA's would be to increase *time spent on collecting data*. E.g., more interviews with several different actors within the studied department. This introduced the obstacle of several different transactional relationships; since our research paper studies a transactional relationship between a buyer and a supplier, and our main entrance into the supply chain was through the company of Duni, the conducting of data collection with actors within the Duni supply chain is made possible with the good-will of the interviewees. When *competitiveness* is also introduced in the mix because of the competitive supplier market that the suppliers and purchasers operate in, an increase in data collection time may expose unwanted weaknesses and strain the relationship between Duni and their suppliers. In summary, the complexity of the different organizational structures is difficult to mitigate with an increased time spent on collecting data, because of the vastly different backgrounds of the interviewees and the competitive nature of the purchasing relationship.

7. Conclusion

The purpose of the thesis has been to analyze and map several different areas within the supply chain of Duni Group in. The opportunities for future automation and digitalization have also been analyzed. Finding these results has been accomplished by using three research questions as guidelines for what information is relevant. These research questions are answered below.

7.1 Research questions

As mentioned in chapter 1.4, the purpose of this Master Thesis is to explore and map the purchasing practices of Duni through the following four lenses of; the operational process, the role of the digitalization tools used, the impact of turbulence, and lastly, possibilities of AI automation. This has been divided into the research questions described in chapter. 1.5. Below, the research questions and their answers will be answered.

Research Question 1

How does the operational procurement process work at Duni and its first-tier suppliers?
The operational procurement processes within Duni's factories mirror a standard theoretical model, going through stages from need recognition to supplier evaluation. The process is managed using two Enterprise Resource Planning (ERP) systems that differ in functionalities, particularly between the Poznan and Bramsche factories. These systems feature an automation tool, "proposed orders," suggesting order quantities and delivery dates, but the operational purchasers manually approve these due to unpredictable variables the system can't account for. The frequency of orders placed varies between the Poznan and Bramsche factories due to different production structures.

As a default, a form of short-term ordering is utilized where both the order details and contract/payment framework is included in the same document. When deemed necessary, the contract length of specific product orders may be extended to ensure stability in the orderings process, while still dividing the total order quantity into several delivery periods. Expediting is a simple system in terms of following checkpoints of a placed order, such as "currently in delivery" and "delivered". Follow-up and evaluation is mostly done on a qualitative and informal basis through informal yearly discussions and reflection on supplier performance. The findings of these informal supplier evaluations are not found to be formally shared within the supply chain.

Research Question 2

How is delivery performance evaluated in the Duni supply chain?

The most relevant metrics when measuring and evaluating delivery performance are the two staples of delivery performance, delivery date compliance and order quantity compliance.

Complementarily, non-measured delivery performance parameters such as cancellation time, cancellation rate, supplier flexibility, are also evaluated, although this is done informally through human intuition. Evaluating delivery performance is mainly done from the purchasing side of the studied cases. One of the main areas of improvements that have been identified is the implementation of a general quantitative supplier delivery performance rating system within the Duni supply chain. A potential version of this is already in use in the case of the Poznan factory purchasing department. Having a formal system of rating suppliers will also lay the foundation of measured performance that is essential in future automation of operational processes.

Research Question 3
How does the digitalization of the operational procurement process ensure adequate delivery performance with mitigation of risk, and what are the possible automation opportunities?

Ensuring the optimal delivery performance results is a balance between the use of system automation to effectivize primitive operational processes, and the use of human intuition to adjust the ordering process to more abstract turbulent factors. Jaggaer for communication and SAP for production planning are the main solutions used in the studied cases of the research paper. These systems utilize an automation of order creation which takes into account basic parameters such as lead time, safety days, demand, and material availability. With the input of these basic parameters and the output of the automatic order proposal, the employees then manually adjust the proposed order to take into account more abstract turbulent events e.g., fluctuations in demand, weather changes which affect transportation time, or temporary production failure. These turbulent events have been divided into exogenous turbulence and endogenous turbulence. Endogenous turbulence such as production failure has been found to be of a continuous low-impact nature, being easily mitigated by the manual adjustments. Exogenous turbulence was found to be of a sporadic nature, with the consequences of these events being abstract and needing a lot of manual adjustment to be mitigated. Similarly, in the case of future automation, the most relevant area of automation is the measurement and rating of supplier delivery performance. Having a formal system of rating suppliers will lay the foundation of measuring essential variables that opens up the possibilities for future automation of operational processes. After the measurement of performance is set in place, endogenous with its low-impact and continuous nature is most relevant to mitigate with automation. Lastly, exogenous turbulence with its high-impact and low-turbulence has the least priority of automation due to its abstract and complex nature.

7.2 Contribution

7.2.1 Theoretical

When discussing the general qualities of our master thesis, the subject of how the different perspectives and areas of this research correlate to each other, was touched upon. The first subject, which is also discussed in *Different cases, organizational structure and competitiveness*; is the

differences in how responsibilities are divided and assigned between the different departments of the interviewees. This, in itself, is a possibility for further research. Similarly, all the different subjects of this research study present interesting potential for more in-depth research. Examples of this include the information availability within the used digitalization tools; another example is how turbulence and uncertainty affect the reliance of automation and decision-making. These are just some examples of potential research directions. In summary, even though it was a priority to make a strict and narrow scope for this research study, the different subjects and perspectives that are included unlock several future possibilities for research.

7.2.2 Practical

With the previously mentioned mapping of processes, this research will provide Duni Group a general assessment of their Operational processes, Delivery Performance parameters, and Turbulence mitigation practices, which may be relevant in future strategic decisions and implementations by Duni Group within these areas.

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Resources

The main resources used in this research paper can be divided into two categories: the interviews of the specific case studies within the research paper (the suppliers and purchasers), with the follow-up Emails. These interviews laid the foundation for the findings of this research paper by which the analysis and discussion is built upon.

The other category is the continuous contact through interviews and Email with Wilbert Baerwaldt, the Director of Sourcing at Duni Group. This has allowed us to receive continuous feedback and reflection from an experienced professional in the field of purchasing and has greatly improved the quality of our work. With his genuine interest of the studied subjects, the writing of this paper has been a cooperation between the writers and Baerwaldt.

Appendix

Appendix A - Interview guide, questions

Color code for **Interview guide**.

Interview guide

1. Interview introduction

A short introduction detailing the purpose, research questions and scope of the thesis. Thereafter, the questionnaire used for the interview is detailed. A confidentiality agreement has been signed. This has been done so that you may feel free to discuss all relevant information in this interview.

1.1 Purpose

The purpose of this Master Thesis is to compare operational procurement processes with varying degrees of digitalization and delivery performance, how they correlate, and if a certain degree of digitalization ensures higher delivery performance in uncertain times.

1.2 Research Questions

- RQ1: How does the operational procurement process work?

- RQ2: What are the most relevant factors of turbulence when ensuring delivery performance?

- RQ3: How does the digitalization of the operational procurement process ensure adequate delivery performance with mitigation of risk?

1.3 Scope and limitations

Suppliers that is included in the case study is limited to first tier suppliers to Duni. In the procurement process, only the continuous supplying process of an already established supplier is studied, excluding the supplier selection and sourcing process. In terms of material, the scope is narrowed to only include direct material that Duni Purchases. This will not include indirect material that is for the supportive functions of procurement. In terms of delivery performance, the limit of the scope is to only include delivery of goods and the aspects that are included in this, specifically excluding the payment terms and invoicing of said deliveries. With respect to contracting, the specific contract of a case is only used as an already established framework by which the supplying adheres to, this means not including the negotiation and determining of said agreements in a contract.
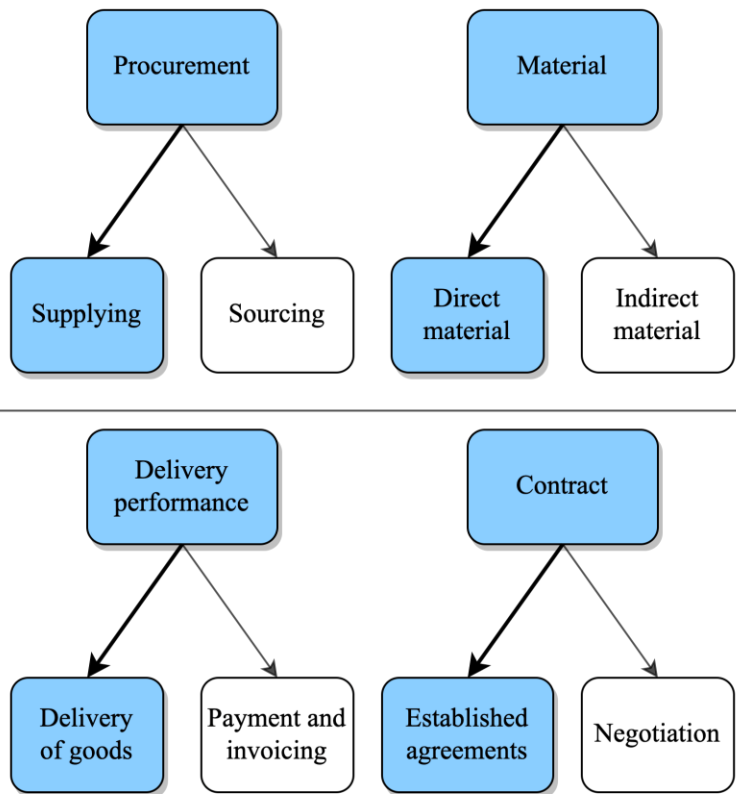
Figure 1. Visualization of the thesis scope with first tier suppliers.

2. Questionnaire

This is a semi-structured interview. Meaning that the questions presented form a common thread which the interview will follow, with a possibility to go deeper into subjects with follow-up questions after the interviewee has answered. This interview will cover this specific relationship between one supplier and one buyer.

The interview guide is structured in such a way that the operational processes and digitalization tools are represented in contrast to the turbulence and risk of the supply process. The delivery performance results can be seen as the results of the interaction between the operational (with digitalization) process and turbulence, with the operational process striving for certain positive results on the delivery performance while turbulence risks the possibility of having a negative impact on the delivery performance.
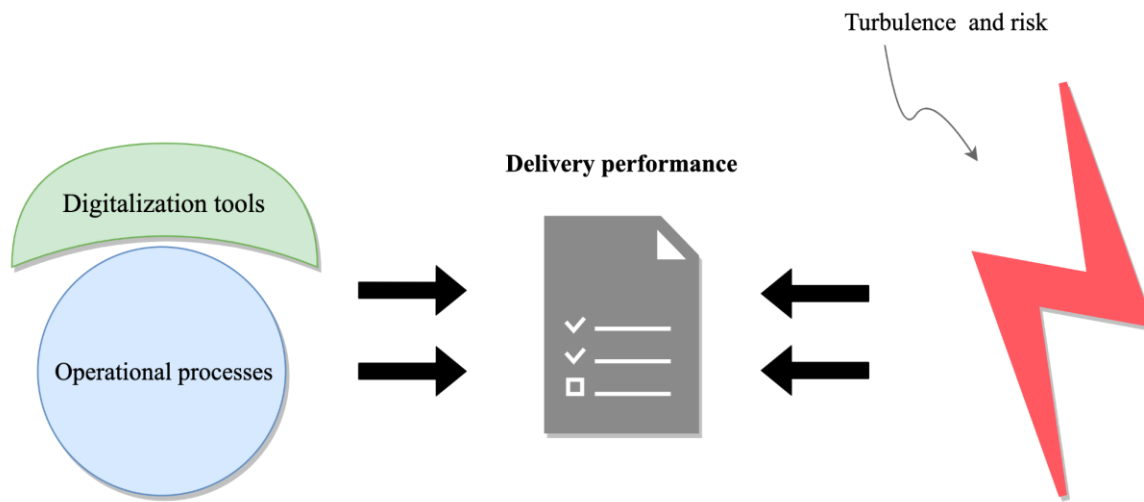
Figure 2. Operational processes and digitalization tools opposing turbulence in impact on delivery performance.

X. Question that can be answered by both interviewees.
Xb. Question that is formulated for the buyer.
Xs. Question that is formulated for the supplier.

2.1 General overview of department

1. Can you please give us a brief description of your organization?

2. What is your role in the company? Briefly describe.

3. What are your department's responsibilities that you are to fulfill within the organization?

2.2 Identification of operational processes and the digitalization degree.
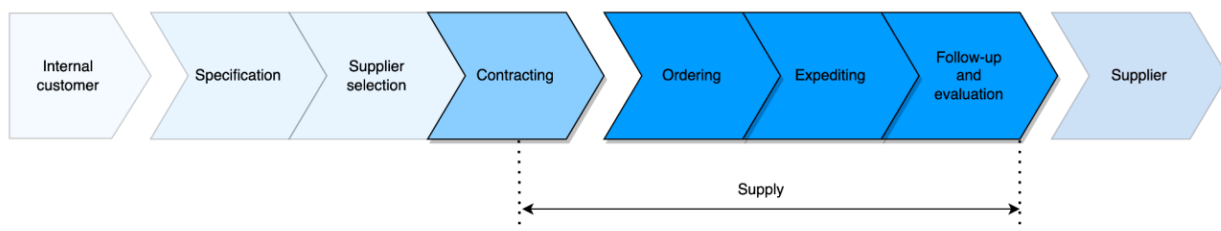

Figure 3. Visualization of the scope in Van Weele procurement process that is to be considered in this thesis

Concept	Definition
Contract	The formal agreement that is agreed upon by both parties when an order is placed.
Delivery Performance	The specific indicators that are measured to evaluate the delivery process.
Ordering	The process of creating an order and sending it to the supplier recipient.
Expediting	The subsequent planning (such as production planning) and tracking of a processed order for the purpose of ensuring a successful delivery to the buyer.
Follow-up and evaluation	The evaluation of delivery performance indicators.

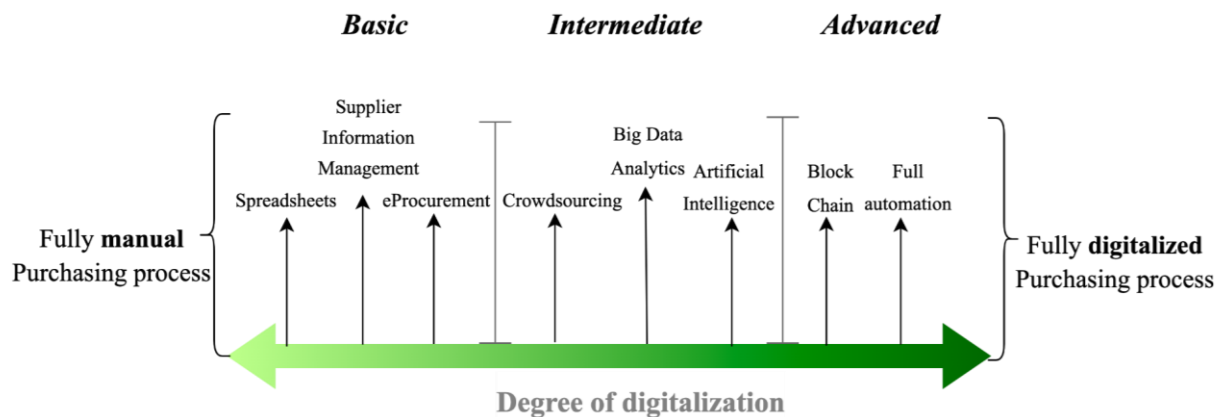Table 1. Definitions of the concepts included in this interview guide

Figure 4. Examples of digitalization tools regarding operational procurement process

Ordering
4b. Could you please explain the process of orders being created in your system?
5b. What types of digital tools are being used for this?
6b. What are the essential components of an order?

4s. Could you please explain how purchase orders are being received and entered into your system?
5s. What are the essential details of an order when it is received?
6s. What types of systems and tools do you use when working with new orders?

Expediting (Production Planning - Delivering)

7. How is the delivery of a made order monitored?
Examples: delays are manually informed and reactively mitigated. Delays are routinely checked for in advance.

8. What information about the delivery is available?

9. Is there some critical information that is needed for an improved expediting process?

2.3 Delivery performance and its criteria

10. What type of contracts/purchase orders are established with your partner? Examples: *fixed-price with incentive fee contract, cost-reimbursable contract.*

11b. What are the delivery performance criteria that measure the success of a delivery? Is everything part of the contract?
Examples:
- Compliance rate
- Supplier lead time
- Flexibility in turbulence

11s. What do you need from the buyer to be able to ensure that deliveries may be fulfilled per the performance criteria? How would this help you?
Examples:
- Incentive fees
- Long-term planning and forecasts
- Information availability

12. Is there some delivery performance criteria that is not formally included in the contract/ purchase order? How is it best described?

13. What is the most significant improvement you think can be made on the subject of delivery performance in this relation?
(would you value a long-term contract more than a purchase order?)

Follow-up and evaluation

14. Is a long-term follow-up and evaluation done in this purchasing relationship? If so, how is this process structured?

15b. What are the information sources when following up with long-term suppliers?

16b. Is this evaluation digitally stored or automated for future use? Example: rating in a program for selecting suppliers.

2.4 Turbulence, its impact and mitigation.

17. Comparing different factors of exogenous and endogenous turbulence, which has the most negative impact on delivery performance? Examples:

Exogenous turbulence (outside the supply chain)
- Economic turbulence, recessions, availability of resources
- Natural disasters, earthquakes

Endogenous turbulence (within the supply chain)
- Technology turbulence, implementation of new technologies, outdated technologies currently used
- Changes in management, decision-making processes (conflicting decisions, bottlenecks), internal policies
- Production planning, changing forecasts

18. Is there any example that you can share, regarding the mentioned turbulence factors?

19. Are there turbulent factors that significantly impact the delivery performance?

20. Do you have any process to deal with changes in the procurement process? Either proactively or reactively? Is this a manual process?

21. In an ideal scenario, how would the procurement process between you and the supplier look like? What role would a digital solution play in this?