UNIVERSITY OF TWENTE.

Turning data into value

Determining which Intelligent Process Automation technologies can be used to automate the process of ordering packaging at Company X.

Master thesis

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Preface

After nearly two years of studying at the University of Twente, it is coming to an end. During the (pre) master I learned a lot in the field of digital business and doing academic research. This master thesis is the final product for completing the master Business Administration with a specialization in Digital Business. While writing the master thesis, I had help from several people at different organizations. I would like to thank these people for all the help.

First of all, I would like to thank my supervisors Dr. A.B.J.M. Wijnhoven and Dr. M. de Visser from the University of Twente for the critical questions and feedback they provided. This has helped me tremendously with the writing of the master thesis.

Secondly, I am also grateful for the help of the employees of Company X, especially M. Korten (external supervisor) and M. Klanderman (problem owner), who helped me always with my questions about the process and the organization and giving me the opportunity to write the master thesis at Company X.

Finally, I would like to thank my family and friends who have supported me throughout my studies and also while writing this master thesis.

Thomas van der Holst

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Abstract

The process of ordering packaging at Company X is not automated and digitalized but consists of inspections and human actions (tacit knowledge). The number of to be ordered packaging is based on a daily physical check by one employee per production location. As a result, the entire packaging procurement policy depends on that one employee. Company X's wish is to have an automated process for data-driven order decisions to save time and to have the Purchasing Department take ownership of the process.

The literature study showed that Intelligent Process Automation (IPA) is increasingly used to automate processes. This research focuses on determining which IPA technologies could help Company X to automate their process of ordering packaging. The following research question is answered: *What Intelligent Process Automation technologies can be used to automate the process of ordering packaging at Company X?*

The research question is answered by a literature study, conducting interviews, and a focus group. A new process has been proposed and validated by the experts. The outcome of this research is that the proposed process can be carried out by the IPA technology Robotic Process Automation (RPA). This research shows that Company X saves more than two hours a day on ordering packaging when the proposed process is executed with RPA. This also reduces the costs of resources such as labour costs. Besides, since the proposed process is documented, the tacit knowledge of the process can be taken out and become explicit knowledge.

This research contributes both theoretically and practically. The theoretical contribution is that this research extends research on IPA because the potential of IPA is limited explained for the purchasing sector. In addition, the research also extends the research on the implementation of automation for procurement activities because the challenges are limited explained in the literature. This research also adds practical value. Namely, a proposed process together with recommendations on what Company X should do to keep the existing data reliable, allowing this data to be used in the proposed process.

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1. Introduction

This chapter contains a description of the company, the situation and complication, the goal and research questions, and the practical and theoretical contribution.

1.1. The company

Company X is a forerunner of smart industry in the sheet and tube steel processing industry. The company distinguishes itself from the traditional companies in the metal sector by using the Sophia® portal. Sophia stands for Sophisticated Intelligent Analyzer, a portal developed by Company X where customers make an order. The customer provides its own drawing showing how the sheets or tubes should be cut or bended. The customers are always companies, so Company X operates in the business-to-business market.

Currently, Company X has three production locations: one in the Netherlands (Varsseveld) and two in Germany (Oyten and Hilden). A total of approximately 500 employees work at Company X. The organizational structure can be found in the organizational chart (Appendix A).

Company X operates by the following six core values:

1. *Exact* – Working accurate, skilled, and certified.
2. *Smart* – Smart engineering, efficient, and error-free work by using intelligent software.
3. *In control* – Reliable processes, from the quote and order to production and delivery.
4. *Transparent* – The business processes are open, clear, and clean & lean.
5. *Sophisticated* – Company X benefits from the latest technologies. Innovation is the centre of Company X. Continue learning and developing is important.
6. *Customer-focused* – On demand. On Time. This is the slogan of Company X. Sophia® is 24 hours, 7 days per week available for customers. Quality customization is standard at Company X.

Table 1 shows a few key figures of Company X.

Table 1 Key figures of Company X

36,000	m² production area
500 +	Employees
37	Laser cut machines
20	ATC Bending machines
5	Deburring machines
130,000	Kilos sheet production per day*
2,000	Meters tube production per day*
50,000 to 70,000	Processed products per day*

* Average amount of cut metal per day in 2019 (only Varsseveld and Oyten)

1.2. Situation and complication

The situation and complication are based on the answers of an orienteering interview with the purchaser of Company X (also the problem owner). The interview can be found in Appendix C.

1.2.1. Situation

Almost everything at Company X is automated: ordering, nesting, production, and material supply. However, the process of ordering packaging is still completely manual. This process includes everything that is added to the product to transport it. For example, pallets, boxes, and everything that needs to be in and around the box to get the product safely to the customer (the different packaging products can be found in Appendix B). Because there is nothing automated in the process, the team leader of the incoming goods department creates an order list by inspection of the stock or receiving a request from the production department that there is almost no more packaging. Additionally, it often happens that there is too much or too less packaging. As a result, the truck drivers of Company X have to drive to the supplier of packaging because there is not enough for the next weekend. To conclude, the team leader of the incoming goods department has the responsibility to order the packaging.

There are several drawbacks to the current situation. Company X is now owned by an investment company that insists on a piece of Days Inventory Outstanding. In other words, how long something is in stock in the warehouse before the product is used. At the moment Company X does not have this insight. Moreover, the team leader of the incoming goods department in Varsseveld spends more than 45 minutes a day figuring out how much packaging to order, while 120 tonnes of raw materials are ordered within a few minutes because it is ordered via software. So the ordering of packaging takes a lot of time at the moment.

Because of the hustle and bustle, this has never been on the priority list. Additionally, the software development department has grown from six to eighteen people last year. This will go to twenty-four

people in 2021, so now the software development department has the opportunity to work on this. In addition, there is also support from management when it comes to working in a structured way and ordering materials based on data. Currently, when the supervisory board asks for packaging information, this is simply not possible because there is no reliable data about packaging at the moment.

To conclude, there is currently no automated process for ordering packaging. Ordering packaging is mainly based on experience and inspection while Company X wants to operate based on data and software. The current situation is therefore not in line with Company X's strategy. According to Nonaka (1994), this is called tacit knowledge, which means that all the information is in the minds of employees.

1.2.2. Complication

The biggest complication in the current process of ordering packaging is that there is no insight into how much packaging there is at present. Customers have the option of also having laser-cut products bent. As a result, the packaging allocated to the order may differ from the actual packaging used. This makes it difficult to buy based on the allocated packaging in existing orders. A physical check is done every day and purchases are made on that basis. Besides, although there is an agreement with the supplier of pallets to unload all returned packaging at the warehouse of the supplier of pallets, a part of the returned packaging is still unloaded at Company X's locations. Because of this, it is unclear how much packaging is in stock and it is difficult to estimate how much there has to be ordered.

1.3. Goal and research questions

The goal of this research is structured in Table 2.

Table 2 Template for formulating goals by Wieringa (2014).

Improve	the current manual process of ordering packaging at Company X
by	automating through Intelligent Process Automation technologies
That satisfies	the requirements of the purchasing and IT department of Company X
In order to	apply data-driven ordering of packaging and gain insights into the stock of packaging

The outcomes of the research are presented in this report and contain recommendations for an improved process of ordering packaging. For Company X it is especially important that the process will be automated. Therefore, the central research question is as follows:

What Intelligent Process Automation technologies can be used to automate the process of ordering packaging at Company X?

To gather more detailed information, the following sub-questions are given:

1. What is the current situation of the process of ordering packaging at Company X?
2. What are the alternatives to order packaging at Company X?
3. What are the requirements for the desired situation of the process of ordering packaging at Company X?
4. What data for ordering packaging is available at Company X?
5. To what extent does the proposed process meet the requirements?
6. What must Company X do to achieve the proposed process of ordering packaging?

2. Methodology

This chapter shows the methods that are used to answer the research question and sub-questions. The first part describes the research design. Then, the research type is described. The last section is about data collection and analysis.

2.1. Research design

Three phases are carried out in this research, namely problem investigation, treatment design, and treatment validation. These phases are defined by Wieringa (2014). Actually, there is another phase in Figure 1. The fourth phase, treatment implementation, is not involved in this research because it only examines which artifact is the best alternative to the process of ordering packaging. The three phases are called "the design cycle" (Wieringa, 2014). Figure 1 shows the design cycle. Phrases with a question mark behind them stand for knowledge questions, the phrases with an exclamation mark behind them stand for design problems.

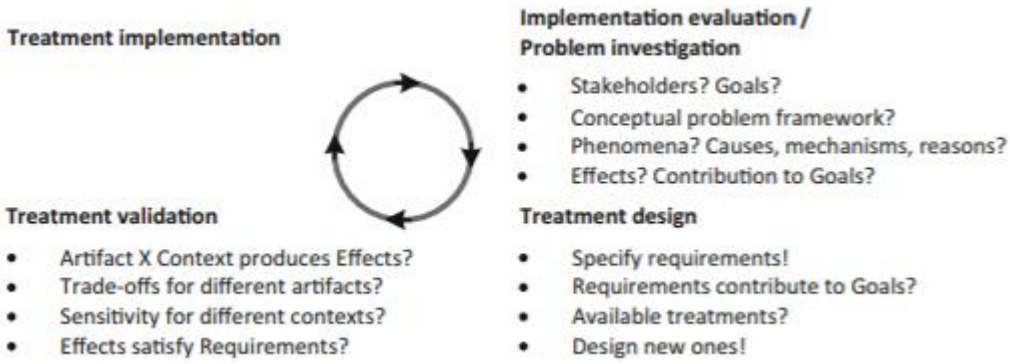

Figure 1 Design cycle (Wieringa, 2014)

Wieringa (2014) mentions multiple terms that are not often used by engineers. The first term is "artifact". Artifact is another word for "solution". Wieringa (2014) has chosen this word because a solution is often misinterpreted. For example, a solution will not solve all problems. Also, it can create new problems. Therefore, Wieringa (2014) prefers to use "artifact". In the context of information systems and software engineering, an artifact could be a technique, method, or framework that solves (multiple) problems. Additionally, another word that is unusual for design engineers is "treatment". Treatment is often used in health-care sciences. It suggests that a medicine (artifact) affects the human body to treat a problem. The interaction between the problem and the medicine is the treatment.

2.2. Research type

Babbie (2016) defines three purposes of research: exploration, description, and explanation. The purpose of this research is both exploratory and descriptive. According to Babbie (2016), a research is exploratory when the researcher explores a topic to familiarize with a specific topic. Babbie (2016) also mentions that exploratory research often has three purposes: 1) satisfy the researcher's interests and

motive for understanding the topic, 2) feasibility testing of undertaking a comprehensive research, and 3) create methods which can be used in future research. Therefore, this research can be considered as exploratory research because, in this master thesis, there is been searched for literature, such as Industry 4.0, data-driven decision making, and intelligent process automation to broadening the knowledge of the researcher. The second purpose is description. Babbie (2016) describes descriptive research as describing situations by observing the situations. The purpose of descriptive research is to examine why the recognized patterns happen and what they imply. Hence, this master thesis is also descriptive because the current situation is described in detail after investigating what the problem looks like.

2.3. Data collection and analysis

The data in this master thesis is collected by desk research, conducting interviews and a focus group. Therefore, this is qualitative research. Interviews were chosen because an interview is more likely to decrease the number of "do not know" and "no answers", which often happens when conducting surveys. Also, the interviewee can ask for clarifying the question when it is not entirely clear (Babbie, 2016). The units of analysis are employees of Company X. Each interview has a separate table with the units of analysis which can be found in the appendices. The topics chosen for the interview came from the literature review. Topics were asked about data-driven decision making, intelligent process automation, outsourcing, and the requirements for the artifact.

Three rounds of interviews were conducted, in the three different phases of the design cycle of Wieringa (2014). First, an interview with the problem owner in the problem investigation was conducted. Second, interviews with multiple employees in the treatment design phase were conducted to clarify the requirements of automation. Third, interviews with the same employees as in the second interviews were conducted to validate the treatment (treatment validation phase). Initially, the interviews were conducted face-to-face. However, some employees work at home due to the COVID-19 virus measures. Therefore, some interviews have been held online. Thus, interviews were held using face-to-face interviews and interviews via Microsoft Teams. Additionally, a focus group was held because new information came in after the validation interviews.

Kvale and Brinkmann (2009) identify seven phases of the interview process. Coding is not one of the seven phases but the coding phase is added to this research because coding transforms qualitative data into theoretical constructs (Strauss & Corbin, 1998). The eight phases are:

1. Thematizing: In this phase, the interviewer explains the goal of the interview to the interviewee. Also, concepts need to be explored.
2. Designing: The designing phase consists of explaining the way to the goal. For example, explaining which subjects are covered in the interview. Additionally, the ethical aspect is important, such as approval for recording the interview.
3. Interviewing: Conducting the interviews.

4. Transcribing: Writing a transcription of the interview.
5. Coding: Using open, axial, and selective coding.
6. Analyzing: Checking whether the coded results of the interviews relate to the purpose of the interview.
7. Verifying: Verifying the validity and reliability of the collected data.
8. Reporting: Writing down the results.

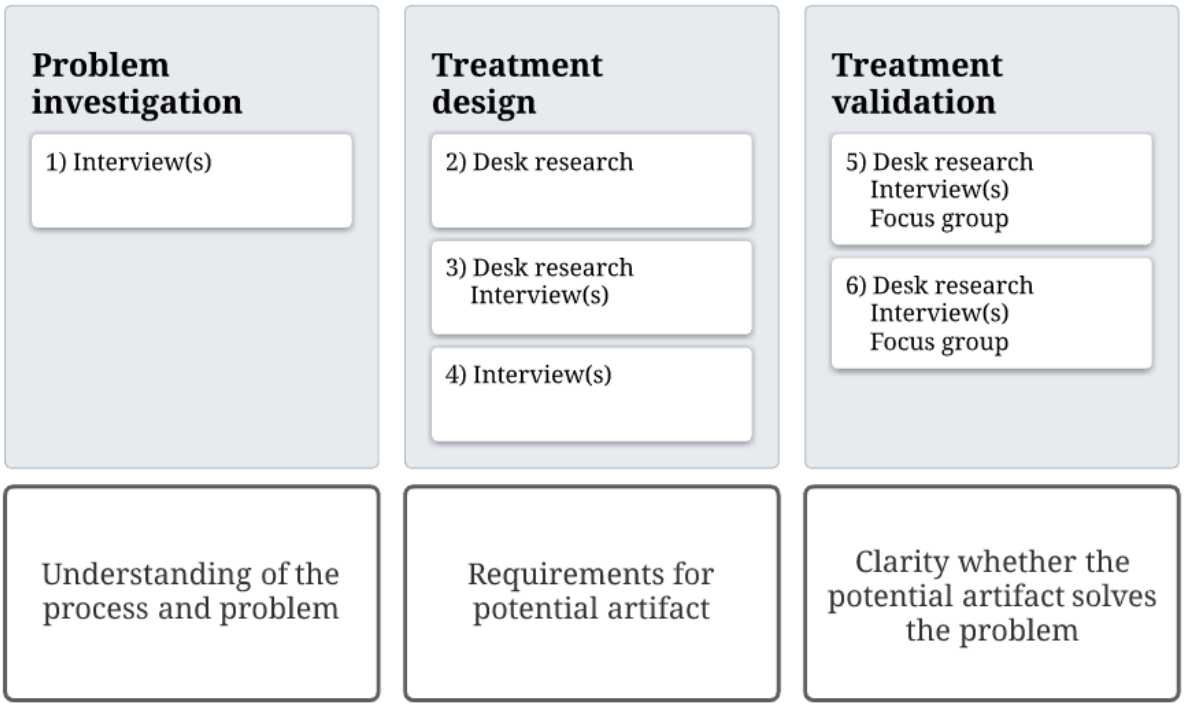

Figure 2 Phases, data collection methods and results

Figure 2 shows which research questions belong to which phase. The bottom blocks of the figure show the outcomes or the phases. The research questions are explained below.

Problem investigation

1. What is the current situation of the process of ordering packaging at Company X?

The first question is about identifying the process and its problems. This question was answered by conducting interviews with persons related to the process or order packaging. This has also made it clear who is involved in the process and where responsibility should lie.

Treatment design

2. What are the alternatives to order packaging at Company X?

To find out what alternatives are available to improve the process of ordering packaging, the literature was searched for alternatives. The second research question was answered by means of a literature search and interviews.

3. What are the requirements for the desired situation of the process of ordering packaging at Company X?

By means of literature research and interviews, the requirements to be met by the alternatives were sought.

4. What data for ordering packaging is available at Company X?

The problem investigation showed that Company X has a lot of data and stores everything. However, the data is not used. Therefore, by means of interviews and observations of quantitative data, we looked into which data can be used to automate the process of ordering packaging.

Treatment validation

5. To what extent does the alternative meet the requirements?

The fifth research question was answered by a combination of interviews, desk research and a focus group. It was checked whether the requirements resulting from the interviews and the literature matched the alternatives.

6. What must Company X do to achieve the proposed process of ordering packaging?

Desk research, interviews, and a focus group were used to answer the sixth research question. To automate the process of ordering packaging, recommendations have been given to achieve this.

3. Theory

After collecting data about the current and desired situation, it turned out that Company X has data about packaging that they can use for ordering packaging. For example, the amount of purchased packaging, shipped packaging, and actual used packaging. Currently, they do not use the data for ordering packaging. Therefore, an appropriate solution must be sought. Hence, a theoretical framework is conducted on the following key concepts: Industry 4.0, the purchasing department, data-driven decision making, intelligent process automation, and outsourcing. When there is better legitimization for the choices that the researcher has made during the theoretical framework, there will be a higher value of the theoretical chapter. Therefore, Wolfswinkel, Furtmueller, and Wilderom (2013) have developed "the grounded theory as a method for rigorously reviewing literature". By using this method, the theoretical framework becomes more useful to the field and will be more replicable. Also, when the literature is rigorous and well-explicated, the literature review will have a higher chance of getting published. Table 3 shows the process steps of the grounded theory.

Table 3 Grounded theory method stages (Wolfswinkel et al., 2013)

Number	**Task**	**This research**
1 DEFINE		
1.1	Define the criteria for inclusion/exclusion	Chapter 1
1.2	Identify the field of research	Digitalizing, automating, and outsourcing
1.3	Determine the appropriate sources	University of Twente Library, ScienceDirect, Scopus, and Google Scholar
1.4	Decide on the specific search terms	Industry 4.0, Smart Industry, Procurement 4.0, data-driven decision making, intelligent process automation, robotic process automation, artificial intelligence, and outsourcing
2 SEARCH		
2.1	Search	Searching for the literature
3 SELECT		
3.1	Refine the sample	Selecting articles that can be used
4 ANALYZE		
4.1	Coding	Literature review
5 PRESENT		
5.2	Structuring the article	Writing the theory chapter

The criteria for inclusion/exclusion (step 1.1) are defined according to Chapter 1, where the current problem and goal are described. Thereafter, the field of research is identified (step 1.2), this is also done based on Chapter 1, where the whole situation is described. The library of the University of Twente, ScienceDirect, Google Scholar, and Scopus are the appropriate sources to find literature (step 1.3).

Subsequently, search terms were drawn up (step 1.4). Then, there is searched for articles and literature reviews (step 2.1). Afterwards, the articles are filtered based on the abstracts and titles (step 3.1). Then, a literature review was done (step 4). Finally, the theory chapter is structured (step 5).

3.1. Industry 4.0

A new industrial revolution is currently taking place in the manufacturing industry. Namely, Industry 4.0. Liao, Deschamps, Loures, and Ramos (2017) argue that it is not yet generally known what Industry 4.0 means. The first three industrial revolutions took place in the previous two centuries. In the first industrial revolution, steam-powered machines were introduced. Human actions could now be done by machines. In the second industrial revolution, electricity and internal combustion engines allowed more mass production to take place. The computer became important in the third industrial revolution. Companies introduced CRM systems and e-mailing became increasingly important. In the fourth industrial revolution, there is a lot of attention to the Internet of Things (IoT). The fourth revolution focuses on being smart and creates interconnected industrial value (Liao et al., 2017). According to, smart manufacturing or Industry 4.0 is the fourth revolution. The fourth revolution contains manufacturing technologies and cutting-edge IT solutions. Industry 4.0 is the basis for making smarter and more accurate decisions (Kang et al., 2016). Schmidt, Möhring, Härting, Reichstein, Neumaier, and Jozinović (2015) agree with this but also mention that it contains digital and physical processes that interact with each other. In addition, both digital and physical processes cross the organizational and geographical borders. According to Müller, Buliga, and Voigt (2018), Industry 4.0 will also create value for partners and suppliers. For example, there will be higher inter-company connectivity, more innovative partnerships, higher transparent information, higher delivery reliability, more joint data analysis, more virtual contact, and more standardization. There are four stages of manufacturing in the context of Industry 4.0, namely craft manufacturers, preliminary stage planners, Industry 4.0 users, and full-scale adopters. Figure 3 shows the four stages and their motivation and roles towards Industry 4.0 (Müller et al., 2018). According to Porter and Heppelmann (2015), organizations that implement new software to become smarter will benefit most from shorter development cycles. This allows organizations to respond more quickly to customer needs. This is called Agile product development, where it is important that developers and marketers meet weekly to design a product. This is the best practice in software development (Porter & Heppelmann, 2015).

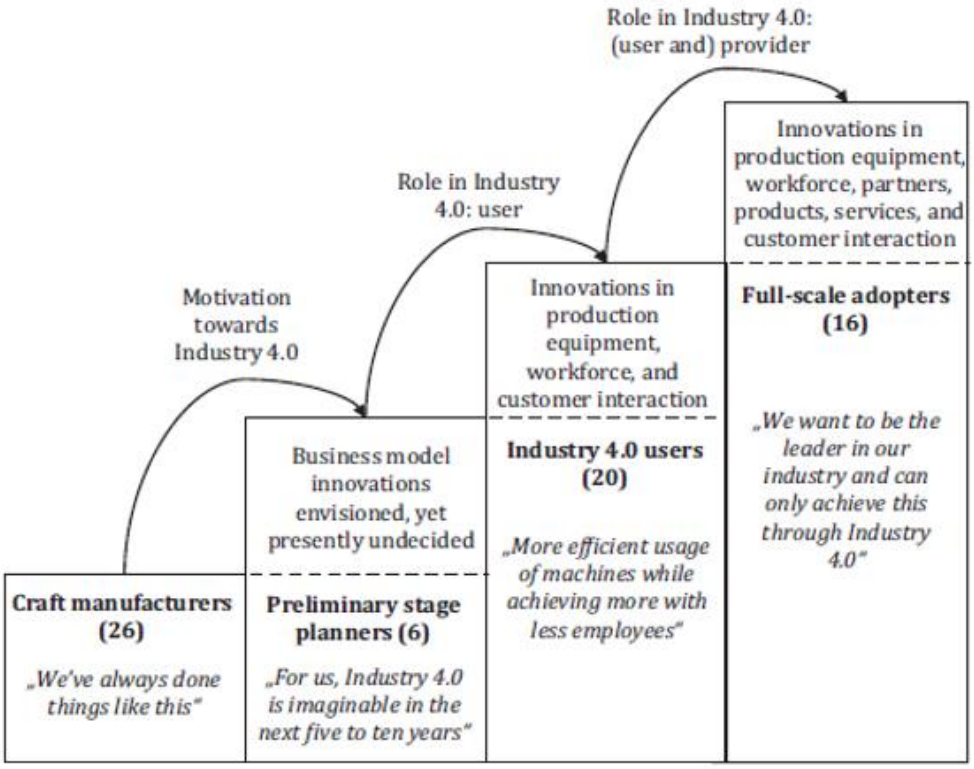

Figure 3 Four stages of manufacturing in context of Industry 4.0 (Müller, Buliga, & Voigt, 2018)

3.2. The changing purchasing department

Industry 4.0 also has an impact on the purchasing department. Nowadays a lot is automated and digitalized. In Purchasing & Supply Management too: competencies are changing and automation and digitalization are becoming increasingly important. According to Bals, Schulze, Kelly, and Stek (2019), Purchasing & Supply Management is an important aspect in the organization: 60 to 80 percent of the total costs are external. For example: paying the suppliers. Bals et al. (2019) describes what the current and future competencies of Purchasing & Supply Management professionals are and what competencies have changed over the last ten years. Bals et al. (2019) interviewed 46 Purchasing & Supply Management professionals from 16 companies to find out which competencies are important and what changed in the last ten years. Table 4 shows the top 10 of the most important competencies of a Purchasing and Supply Management professional. The grey colour means that the current and future competencies are the same. The current competencies come from a paper by Tassabehji and Moorhouse (2008). Just as in the study of Bals et al. (2019) purchasing directors and managers were interviewed about the current status of their job and the competencies that they need for their job. Although four out of the top ten competencies are the same, the differences are mainly related to technology, automation, and digitalization. Where communication, relations, and negotiation were important in 2008, the future competencies of a purchasing professional are related to data and technology. The future competencies are no substitute for current competencies, this is a list of the ten most important competencies. The

current competencies that are not included in the future competencies will still be important in the future, but the future competencies are more important.

Table 4 Current and future competencies top 10 in alphabetical order (Bals et al., 2019)

Current competencies	**Future competencies**
Analytical skills	Analytical skills
Basic knowledge of PSM role and processes	Automation
Communication skills	Big Data Analytics
Cross-functional abilities and knowledge	Computer Literacy
Interpersonal communication	eProcurement Technology
Negotiation	Holistic supply chain thinking
Stakeholder Relationship Management	Process optimization
Strategic sourcing	Strategic sourcing
Strategic thinking	Strategic thinking
Sustainability	Sustainability

Kosmol, Reimann, and Kaufmann (2019) state that leading organizations already use advanced digital technologies for purchasing. Examples of these technologies are the Internet of Things, additive manufacturing, big data analytics, and cloud computing. The use of these technologies will lead to cost savings and efficiency in processes. Bals et al. (2019) state that holistic supply chain thinking is a future competence of a purchasing professional. Müller et al. (2018) agree with this and state that inter-company connectivity will lead to value creation. Carter, Kosmol, & Kaufmann (2017) confirm this because, in the current digital transformation, it is important to have a theoretical scope across organizational boundaries. For that reason, Carter et al. (2017) introduced the supply chain practice view (SCPV). The SCPV is a holistic inter-organizational theoretical view that organizations can use to improve the supply chain.

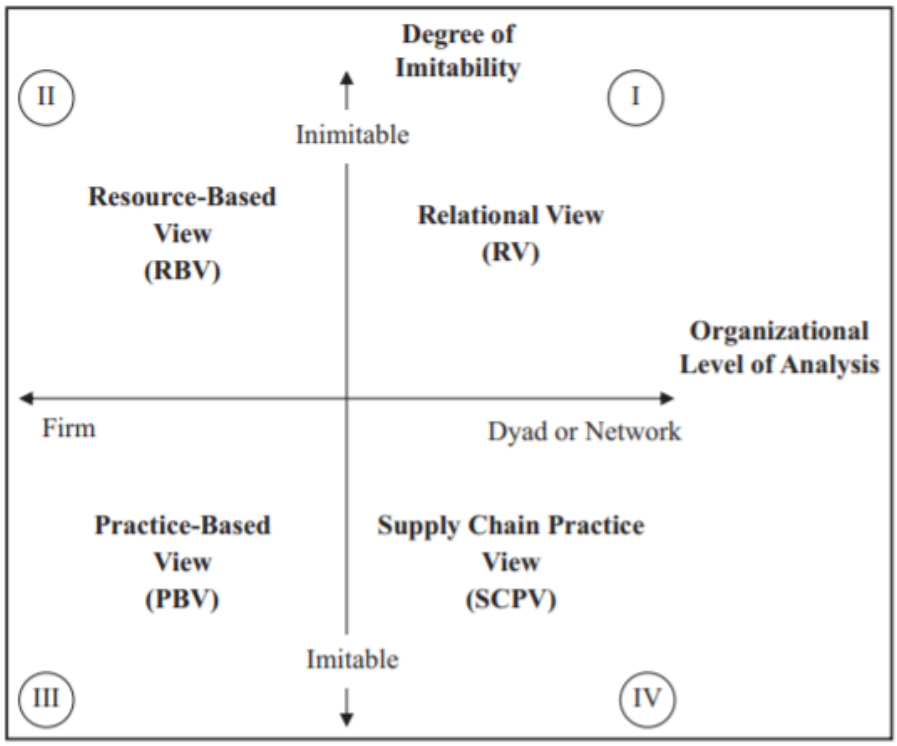

Figure 4 RBV, RV, PBV, and SCPV (Carter et al., 2017)

The resource-based view (RBV), Relational view (RV), and Practice-based view (PBV) were already known in the literature. Carter et al. (2017) has extended the RBV, RV, and PBV on an inter-organizational level. Figure 4 shows that RBV and RV are less imitable than PBV and SCPV. Additionally, the SCPV is more focused on a network instead of focused on a firm. According to Carter et al. (2017), the network represents more organisations, such as the supplier and the buyer. Moreover, the SCPV is an extension of the PBV to an inter-organizational level. Examples of inter-organizational supply chain management practices are supplier development for sustainability, product returns processing, joint product development with key customers, sharing knowledge between suppliers and buyers, and electronic data interchange. Figure 5 shows examples of how an organization can organize their purchasing department. The vertical axis shows how imitable the products are and the horizontal axis is representing the organizational level of analysis.

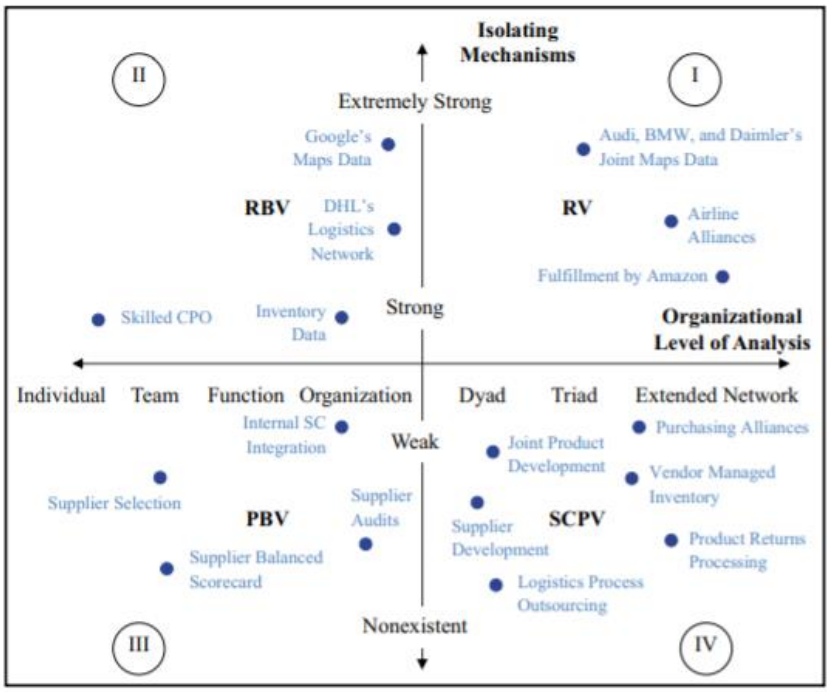

Figure 5 Isolating Mechanisms and Organizational Level of Analysis (Carter et al., 2017)

3.3. Data-driven decision making

One consequence of Industry 4.0 is that more strategic, tactical, and operational decisions can be made based on data because there is more data than before. Nowadays, companies are making more and more use of data. Moreover, also traditional companies are currently discovering the use of existing and new data to get a competitive advantage. However, using data is not only interesting for existing companies that have data, there are also companies that are developed with data mining and they use it as their key strategies. For many companies, it is critical to the business strategy (Provost & Fawcett, 2013). Provost and Fawcett (2013) also indicate that companies can create a professional advantage when they understand the fundamental concepts of data-analytic thinking. Provost and Fawcett (2013) translate data-driven decision making to: the practice of making decisions on the analysis of data, rather than completely on intuition. Additionally, data-analytic thinking will help to improve the data-driven decision making within a company. Iannone, Martino, Miranda, and Riemma (2015) state that a demand-driven supply chain must have real-time information on demand and inventory. Carvalho, Chaim, Cazarini, and Gerolamo (2018) agree with this and argue that real-time capability is one of the main principles of Industry 4.0. When this is the case, a company can react effectively and fast to unforeseen changes. Provost and Fawcett (2013) also state that if a company makes data-driven decisions, the company is also more productive. At one standard deviation higher on the data-driven decision-making scale, the productivity increases with 4 to 6%. Also return on equity, market value, asset utilization and return on assets are higher when a company makes its decisions based on data (Provost & Fawcett, 2013). Figure 6 shows that data-driven decision making is supported by data science and it is also

overlapping. This is because more and more decisions are made by computer-controlled systems (Provost & Fawcett, 2013).

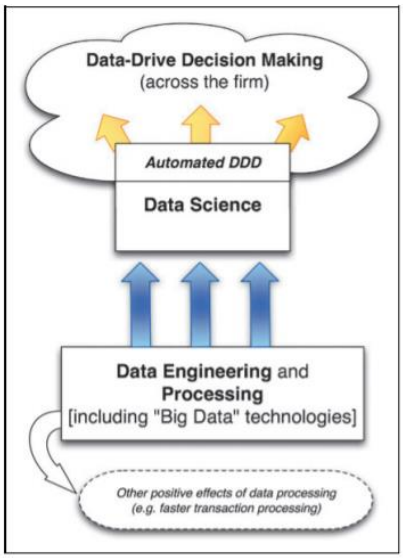

Figure 6 Data science in the context of related processes in an organization (Provost & Fawcett, 2013)

Not only the data scientist should know the aspects of data-analytic thinking. According to Provost and Fawcett (2013), also the managers and line staff should know the basics of the fundamental principles of data-analytic thinking. As a consequence, the managers and line staff will understand the consultants when they are talking about data science. Also, investors need to understand the fundamental principles of data-analytic thinking, because they have to review investment opportunities. Because companies are increasingly more busy with data, it is a benefit for the investors in being able to communicate about data-analytic-thinking and projects about data science. Besides, understanding data-analytic thinking will for prevention of competitive threats about data or to imagine potential opportunities for data-driven decision making. To conclude, nowadays are data and thinking about data important for companies.

Additionally, there are also risks in decision making. To improve the quality of the decision-making process, the effectiveness of the decision-making process has to be significantly increased by anticipating or correct the shortcomings that decision-makers may encounter (Cristofaro, 2017). Cristofaro (2017) argues that recognizing biases is the first step to improve the decision-making process. According to Raguseo (2018), privacy and security issues are the most common risks for organizations that use data. Because data can be used from different locations, it could lead to security vulnerabilities. Another risk is that it is not always clear who owns the data. As a consequence, organizations use data while they have not the legal rights to use the data and this leads to problems (Raguseo, 2018).

3.4. Intelligent process automation

One way to use data and make decisions based on data is Intelligent Process Automation (IPA), which mimics human action and learns from it. IPA is widely used by accounting firms. For example, for automating audits (Moffitt, Rozario, & Vasarhelyi, 2018; Zhang, 2019). However, Viale and Zouari (2020) argue that IPA technologies, such as Machine Learning, Blockchain, Artificial Intelligence, and RPA do not occur frequently in Purchase & Supply Management and are only used in large companies on a small scale. Ng, Chen, Lee, Jiao, and Yang (2021) mention that IPA research is a promising area and hope that more research about IPA practice and challenges among industries and organizations will be conducted. Bienhaus & Haddud (2018) state that the purchasing department could benefit from digitalization. For example, by supporting administrative and daily business tasks and supporting complex decision making. Also, the digitalization of the purchasing tasks will increase organizational effectiveness, efficiency, and profitability. The goal of automation is to let computers do monotonous tasks so that people can focus on more creative, complex, and emotional tasks (Wang & Siau, 2019). As mentioned before, there are several emerging technologies that are covered by IPA. Figure 7 shows examples of these emerging technologies. Because "Other technologies" are discussed in section 2.1, this section focuses on Robotic Process Automation (RPA) and Artificial Intelligence (AI). RPA is often seen as part of AI, but they are two different ways of automation. AI makes a process smarter by storing information and using it in the future, while RPA only executes a process. However, both ways of automation are part of IPA.

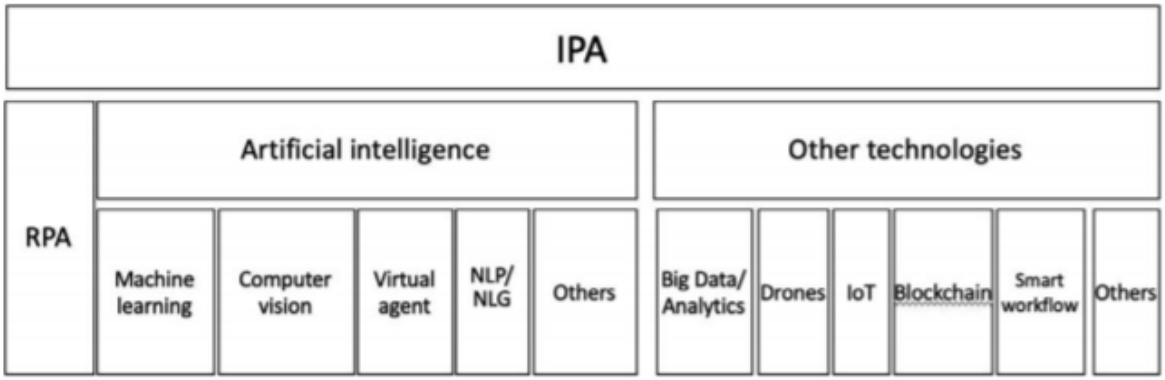

Figure 7 Examples of emerging technologies (Zhang, 2019)

Fung (2014) defined criteria for IT process automation which are also applicable to IPA:

- *The high volume of processes*

  Processes that are often carried out and are generally repetitive and routine, wherefore automating the tasks is a good choice. It is also simpler to justify automation of high frequently performed tasks because a lot of time is wasted on manual handlings.

- *The high value of processes*

  When the volume of a process is low, but the value is high, the process is still suitable for IT process automation. Usually, it is hard to justify low volume processes but when the costs of implementing automation are lower than the costs of the current process, automating the process is still suitable. For example, when the annual personnel costs ultimately exceed the investment of the automation.

- *Access to multiple systems*

  When employees need access to multiple systems for one process, it can lead to inconsistent performance, human errors, and high expenses for those impacts. IT process automation helps to reduce these problems.

- *Stable environment*

  It is hard to automate a process that is unstable, uncertain, and unpredictable. Therefore, a process that is not modified for a period of 12 to 18 months is a criterium for automating the process.

- *Limited exceptional cases*

  Software can handle exceptions. However, it takes more time to test and optimize the process automation when exceptions need to be dealt with. It is therefore recommended that as few exceptions as possible be included in the automation of processes.

- *Decompose the process*

  This criterium means that a process easily could be decomposed into sub-processes. When these sub-processes are clearly defined, it is easier to automate the process.

- *Understanding the costs*

  To justify the automation of the process, it is important to know the costs of the current process and the future costs. It is easier to convince the management when the future costs are lower than the current costs of the process.

- *Limited use of human brains*

  Processes with limited use of humans brains are a better candidate for an IT process automation solution such as RPA because it is easier for the IT department. Processes that need humans for judgement and thinking can be automated, but in this case, AI is a better solution.

In addition, Bienhaus & Haddud (2018) state that the digitalization of purchasing tasks requires a clear definition of the new roles, tasks, and responsibilities for the users in the process. Figure 8 shows which kind of IPA solutions are suitable for certain data (structured or unstructured), process (inference based or rule-based), and outcomes (single correct answer or set of likely answer).

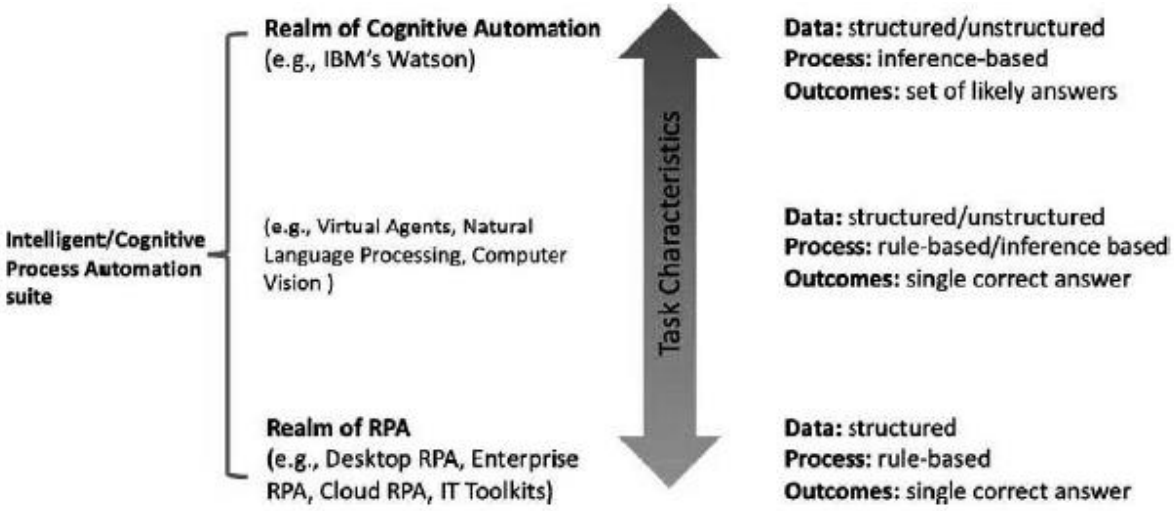

Figure 8 Tasks characteristics of automation solutions (Zhang, 2019)

3.4.1. Robotic Process Automation

Robotic Process Automation (RPA) is used for automating processes by taking over human tasks. IEEE Corporate Advisory Group (2017) defines RPA as "a preconfigured software that applies business rules and predefined action choreography to complete the autonomous execution of a combination of processes, transactions, activities, and tasks in one or more unrelated software systems to deliver a service or result with human exception management. Agostinelli, Marella, and Mecella (2019) define RPA as "a fast-emerging automation approach that uses software robots to mimic and replicate the execution of highly repetitive tasks performed by humans in their application's user interface.". Nowadays, RPA is mainly used in the automation of office tasks. For example, in the customer service and accountant sector. Extract semi-structured data from documents, copy and paste data across several columns and rows or spreadsheets, open and send e-mails, make calculations, and fill in forms are typical examples of tasks that can be carried out by RPA (Agostinelli, Marella, & Mecella, 2019).

3.4.2. Artificial Intelligence

As mentioned before, processes could also be automated by AI. AI goes one step further than RPA. Namely, AI ensures that computers behave with human-like intelligence. For example, AI solutions can produce analytics and insights that people are not capable of (Zhang, 2019). Besides, AI can solve problems faster than humans and do not have breaks, do not have diseases, and are not tired (Kumar, Kharkwal, Kohli, & Choudhary, 2016). According to Wang and Siau (2019), AI is an umbrella concept which is affected by multiple disciplines, such as engineering, psychology, mathematics, business, biology, logic, statistics, linguistics, philosophy, and computer science. Zhang (2019)mentions the most

common AI technologies: Natural Language Processing (NLP), Natural Language Generation (NLG), Computer Vision, Machine Learning, Virtual Agent, and Cognitive Computing. The descriptions of the most common AI technologies are given below.

Natural Language Processing/Generation

Natural Language Processing (NLP) consists of interpreting, understanding, and manipulating human language. It is used, among other things, for text-to-speech and speech-to-text conversion, translation for machines, contextual conversion, and content categorization (Zhang, 2019). Just as with NLP, Natural Language Generation (NLG) is all about analyzing textual documents. However, NLG is about numeric data converting to human language (Zhang, 2019). NLP and related topics are covered by the expression "Natural Language Understanding" (NLU) (Quarteroni, 2018). Quarteroni also mentions that NLU is based on three factors:

1. The use of innovative machine learning algorithms. These algorithms need a standardized language to work with. Therefore, NLU can translate it into the desired language.
2. The availability of large datasets is the second factor. For example, due to the presence of large datasets such as messages from social media platforms, there is a need to translate them.
3. The third factor is the availability of data centres to store data. Also, computers can run big and complex algorithms on big data sets.

Virtual Agent

A virtual agent is answering the questions of customers. This AI application can act as a customer service employee (Zhang, 2019). When the virtual agent is properly set up, it can hold adequate nonverbal behavioural conversations with customers. According to Quarteroni (2018), the virtual agent is part of NLU. Traditional chatbots respond to certain words to have a conversation with a person. Virtual agents go one step further. Namely, modern virtual agents have task-based communication with the customer and have a purpose. This purpose can be one or more tasks. Quarteroni (2018) defined four categories of task-oriented virtual agents. This can be an information-seeking task, where the virtual agent is seeking information for the customer after the customer asked a question. The purpose can also be transactional. This means that the task can change something in the system. For example, updating information in the company's system or transferring money to a supplier. The third category is a procedural task. A procedural task is a difficult and complex task that needs a design that Is computed by an (AI) system. An example of a procedural system is a system for technical troubleshooting. The fourth and last category of task-oriented systems is the persuasive system. This type of system has its own complex internal model made out of beliefs, purposes, and motives that wants to reach a goal in the conversation. For example, a virtual agent that helps with eating healthy and quitting smoking.

Computer Vision

According to Zhang (2019), Computer Vision allows computers to get detailed information out pictures, clips, or other multi-dimensional data. Leo, Medioni, Trivedi, Kanade, and Farinella (2017) mention eight classes of human needs: mental functions, personal mobility, sensory functions, daily living activities, orthotics and prosthetics, communication and skills training, recreation and sports, and housing, work and environmental improvement. Leo et al. (2017) argue that Computer Vision can support the first four classes. The other four classes have been otherwise addressed by scientific researches. For example, in research areas such as communication, medicine, robotics, and mechanics. Table 5 shows the relationships between Computer Vision tasks and the user's needs.

Table 5 Relationship between user's needs and Computer Vision tasks (Leo et al., 2017)

	Computer Vision tasks			
User's needs	Mental functions	Personal mobility	Sensory functions	Daily living activities
Localization	x	x	x	x
Self-localization and mapping	x	x	x	
Object detection	x	x	x	x
Object racking	x	x	x	x
Human activity recognition	x	x		
Biometric	x	x	x	
Head pose estimation	x	x		
Gaze estimation	x			x
Image retrieval	x			x
Optical character recognition			x	

Machine Learning

By programming computers, certain performance criteria can be improved by using data from the past (Zhang, 2019). Fernandes, Fitzgerald, Brown, and Borsato (2019) argue that many companies are optimizing processes in the traditional way, which consists of looking at workflows, mappings and documents, and comparing the obtained results in meetings. Moreover, the emergence of Artificial Intelligence ensures that computers can design and create solutions for human tasks. One branch of AI is called Machine Learning (ML). ML means that computers can learn from themselves. In contrast to RPA, the computer does not have to be programmed to learn to fix human problem-solving tasks (Fernandes et al., 2019). Wang and Siau (2019) define ML as an automated process with computers that analyzes big data sets, recognize patterns, and learn from it to support people in predicting and decision making. However, ML has also a drawback because how the self-learning computers work is a black box. Therefore, it is difficult to justify the recommendations of the computer because the algorithms are hard to understand (Wang & Siau, 2019)

Cognitive Computing

Zhang (2019) defines cognitive computing as "systems that communicate naturally to people and learn from it.". Cognitive science and computer science are combined to learn ant scale and reasoning with purpose. Sridharan, Tesauro, and Hendler (2017) add that cognitive computing systems understand language, expressions, and gestures. The fields of neuroscience and computer science are combined. Whereby, machines can have reasoning capabilities that people can understand (Lu & Li, 2020).

3.5. Outsourcing

If automation of a purchasing related process in-house is not the desired solution, the responsibility may be transferred to the supplier. Then, there is outsourcing the process. Figure 5 shows that outsourcing the purchasing department or creating purchasing alliances is a part of SCPV. As a company processing the data itself is not the only option to improve the process of ordering packaging. Another option is to give the supplier of the packaging products or a third party insight into the process and let them handle the purchases. Outsourcing the process of ordering packaging goes further than improving the current process, when the process is going to be outsourced, it is an organizational problem instead of a process problem. According to Leavy (2001), outsourcing allows organizations to focus on core competencies. Quinn and Hilmer (1994) note that many products that are non-core machined are outsourced and that organizations could outsource more activities if it is not a singular, world-class, or strategic product or process. Christiansen and Maltz (2002) state that modern organizations are often outsourcing the processes or functions that are not their core competencies and do their own processes and functions when it is creating a competitive advantage.

Many organizations want to have the purchasing department in-house. According to Parry, James-Moore, and Graves (2006) in a poll of Purchasing Magazine, eight of the ten purchasing professionals think it is not feasible to outsource the whole purchasing department. However, seven of the ten purchasing professionals say that it is no problem to outsource certain parts of the purchasing department. But, there are also examples of companies which does not have a purchasing department in-house. For example, the car producer Fiat has a partnership with GM that they make a unified worldwide purchasing company, and they both agreed to not use any other ways to purchase (Zirpoli & Caputo, 2002). Parry et al. (2006) also indicate when a part of work is not a core competence, the organization should not focus on this work. The organization should start a partnership with a company that has that specific part of work as a core competence. However, there are also disadvantages and risks. According to Parry et al. (2006), the biggest protest against outsourcing is that the organization has a feeling of losing control over supplier performance, legal issues, and costs. Leavy (2001) describes other risks, such as that the organization loses its opportunism because the supplier wants to abuse the situation by increasing the prices.

4. Problem investigation

This chapter consists of the following sections: the current situation, the stakeholders, the bottlenecks, the desired situation and the types of knowledge in the process.

4.1. The current situation

Currently, the packaging is purchased daily by the team leader of incoming goods. The team leader of incoming goods does a physical check every day to see how much packaging is still in stock. Then, the team leader of incoming goods creates an order list. Appendix D shows examples of (handwritten) order lists. The team leader of incoming goods creates a purchase order in the ERP system Navision. Navision generates an order list in pdf format and the team leader of incoming goods e-mails it to the supplier of packaging. The supplier returns an order confirmation and the team leader of incoming goods releases the purchase order in Navision. Subsequently, the supplier delivers packaging. Company X stores the packaging until it needs to be used. The packaging is purchased from two suppliers. The customer has the option to return pallets and pallet collars to Company X. For this Company X have agreed with the packaging supplier, that all returned packaging can be brought to the packaging supplier. However, it happens every day that returned packaging is unloaded at Company X, for example when the packaging supplier is already closed or it is on the route of the trucks. The process of ordering packaging is shown in Figure 9. Before this research, there was no current process documented. This is the first documented version of the current process and was created with the purchaser.

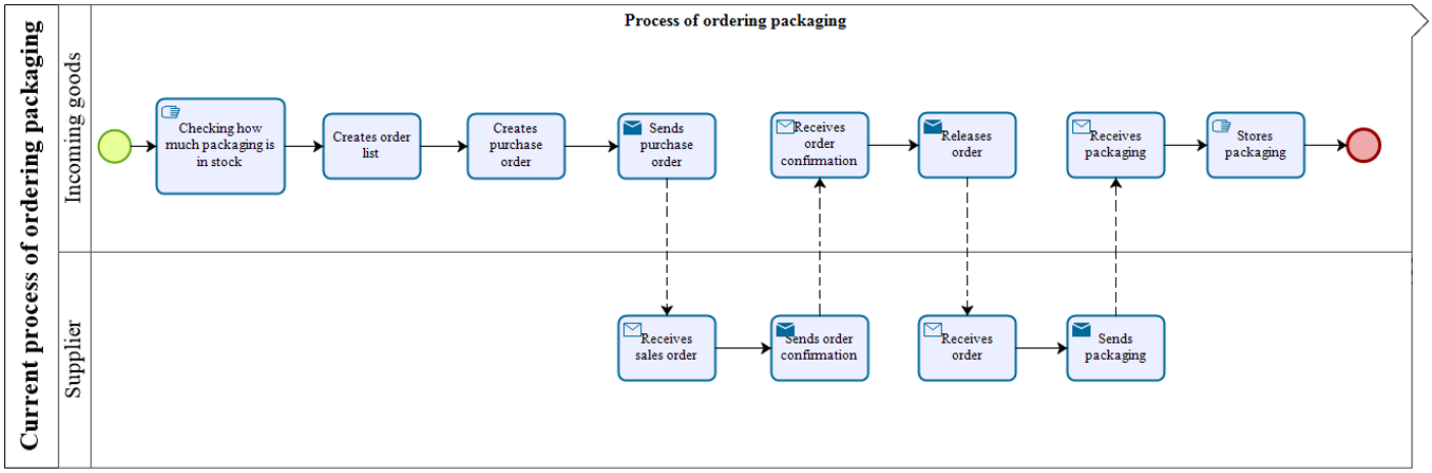

Figure 9 Current process of ordering packaging

4.2. Stakeholders

4.2.1. Current stakeholders

The stakeholders are categorized based on their direct or indirect involvement. It can also be a stakeholder if that person notices an effect of the process. Primary stakeholders are directly involved and affected by the process. Secondary stakeholders are indirectly involved and affected by the process. Key stakeholders are persons or groups that have the power to influence the process significantly. In the process of ordering packaging, the stakeholders as follows (see Table 6).

Table 6 Stakeholders in the process of ordering packaging

Type of stakeholder	**Function**	**Involvement**
Primary stakeholder	Purchaser	Responsible for organizing the process
	The team leader of incoming goods	Ordering packaging every day
Secondary stakeholder	Finance department	Handling of payments
	Supplier	Receiving purchase order and sending sales order
Key stakeholder	Board (CEO, COO)	Ability to approve or reject a project proposal

4.2.2. Future stakeholders

In the current process, the IT department is not involved. However, the IT department will be a stakeholder when the process is automated. The IT department must be involved in the implementation or development of any new software. Porter and Heppelmann (2015) describe that in a smart and connected environment there are changes that companies will face. One of these changes is that there will be a deep collaboration with IT teams and other departments. Especially the Research and Development department, which traditionally only create new products. This is similar to creating a new process, namely automating the process of ordering packaging. Therefore, the IT department will be a primary stakeholder when the process of ordering packaging is automated.

4.3. Bottlenecks

In the current process, several bottlenecks cause problems or ambiguities. This information comes from the interviews held with the experts. The bottlenecks in the current process are as follows:

1. Every day, the team leader of incoming goods looks at the number of pallets. This is a physical check, a walk through the storage area. Besides, the physical check depends on one person per location.

2. Ordering packaging is a procurement task, the responsibility should lie with the purchasing department. In the current process, it is a task for the team leader of the incoming goods.

3. There is no insight into how much packaging is present in the company. It is not recorded anywhere, except for the physical check by the team leader of incoming goods.

4. The packaging may change if bending is required after laser cutting of a plate. By bending the material, the product can get a different footprint, which causes the product to get different packaging than previously linked to the order.

5. Company X has no idea how much returned packaging they get back per day. It is also not clear whether the returnable packaging is still intact or broken.

4.4. The desired situation

The purchasing process of raw materials runs perfectly at Company X. Company X knows how much sheet material is needed and when it is needed. However, when it comes to ordering packaging, it is a process based on human actions. Company X also want to automate the process of ordering packaging. Moreover, the responsibility should lie with the purchasing department and not with the team leaders of the incoming goods/forwarding department. At the moment, the team leader of the incoming goods department has the ability to target financial transactions in the system, which is not desirable. In the future, these roles must be separated. Also, the team leaders of the forwarding department in Oyten and Hilden should no longer have to send an order list every time, but the purchasing department in Varsseveld should get a signal when something needs to be ordered. For example, via tooling or software. Somewhere there needs to be some forecasting so that the purchasing department gets a purchasing proposal. It does not matter if it is on a day or week basis. It is no longer meant to be order packaging by feeling and experience anymore but based on data-driven order decisions. Table 7 shows the drawbacks of the current situation versus the desired situation according to the orienteering interview with the purchaser of Company X (Appendix C).

Table 7 The current situation vs. the desired situation of the process of ordering packaging at Company X

Current situation	**Desired situation**
The process of ordering packaging is completely manual and purely based on inspection and experience.	An automated process of ordering packaging based on existing data.
Team leaders of incoming goods/forwarding departments are responsible for ordering packaging products.	The purchasing department is responsible for ordering packaging products.
The team leader of the incoming goods department has the ability to target financial transactions in the system.	Only the purchase department should have the ability to target financial transactions in the system.
There is no clear process for ordering packaging.	A clear process for ordering packaging.
Ordering packaging takes a lot of time and resources.	Spending less time on ordering packaging.
Lack of space for packaging products at Company X locations, because there is too much stock.	No more lack of space for packaging products at Company X locations.
No idea how much returned packaging comes back every day.	Understanding how much returned packaging comes back every day.

4.5. Types of knowledge

Currently, ordering packaging is based on inspection and experience and the process is only in the heads of a few people. In particular, the signal when to order is a human action. In addition, the process is not documented anywhere. This is a case of tacit knowledge. According to Nonaka (1994), tacit knowledge involves the skills and expertise of employees. Figure 10 shows the SECI-model, which shows four types of knowledge conversion: socialization, externalization, combination, and internalization. In the current process, there is socialization, where tacit knowledge is shared within individuals. The information about the current process then stays in the heads of employees. There are also different types of tacit knowledge because different locations use different ways of indicating whether to order packaging.

When a documented process is created, there is externalization. Explicit (or codified) knowledge is transmissible in a systemic and formal language (Nonaka, 1994). The desired situation of Company X is to have one clear process of ordering packaging with insight into stock and returned packaging. When creating a new process using automation, it is therefore important to document the entire process. Ultimately, employees learn from explicit knowledge and it becomes tacit knowledge. Through this cycle, the organization becomes smarter. However, Nonaka (1994) does not discuss change

management. Turning tacit knowledge into explicit knowledge brings changes with it. According to Benjamin & Levinson (1993), managing the change that comes by implementing new IT tools is important and employees need to be trained for this. For example, this can be done by creating work instructions for the employees who will have to deal with the new process. Employees then learn the new documented process and make it explicit knowledge instead of tacit knowledge.

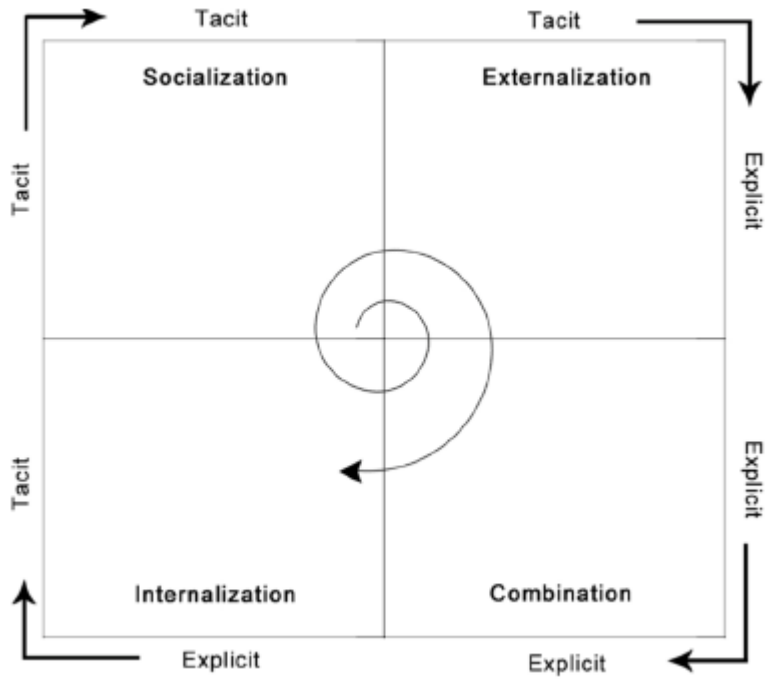

Figure 10 SECI-model (Nonaka, 1994)

4.6. Available packaging data

This section lists the available packaging data and the systems from which the data comes.

4.6.1. Navision

Currently, no data from systems is used to order new packaging. However, when a customer places an order in Sophia, data on the packaging is recorded in the sales order. This information is then stored in Microsoft Dynamics Navision, the ERP system of Company X. Customers also have the option of returning pallets and collars. The customer receives a credit note for this. This means that all the information needed to know how much packaging to buy is available in Navision. Namely, the sales order with the demand for packaging, the returned packaging, and the amount of shipped packaging. The date of the two variables is also known, so it is always known how much is in stock. However, the amount of shipped packaging in Navision does not always correspond to the amount of shipped packaging that is actually shipped. This is because when bending materials, the amount of packaging can change. Table 8 shows the parameters.

Table 8 Parameters in Navision

Parameters	Description	Source	Problem
Purchased	Amount of purchased packaging	Booked purchasing orders in Navision	
Returned	Amount of returned packaging	Booked returned packaging in Navision	Not always correct, because data is based on the returned packaging forms, not on the actual number of pallets coming into stock.
Shipped	Amount of packaging that is linked to an order	Booked sales orders in Navision	Not always corresponding with the actual amount of used packaging

4.6.2. Warehouse management system

Because the data from the booked sales orders in Navision does not always match the actual amount of shipped packaging, the data from the Warehouse Management System (WMS) can be used. The WMS registers when the packaging has been changed after bending products, which means that WMS enters the actual number of packages used. Table 9 shows the parameters in the WMS.

Table 9 Parameter in the WMS

Parameters	Description	Source	Problem
Actual packaging	The amount of packaging that is actually used	Warehouse Management System	This data is only available after cutting and bending the products

4.6.3. TS.Production

TS.Production is the online production environment of Company X. Because the packaging data is linked to an order, the moment when packaging is used is known. From this moment on, it is possible to reserve packaging for an order, so that it is in the system that the packaging is. At the moment, this is not registered. Reserving packaging provides insight into how much packaging can and cannot be used at the time. Table 10 shows the parameter in TS.Production.

Table 10 Parameter in TS.Production

Parameter	Description	Source	Comment
Order start time	The date and time when the laser cutting machine is going to cut an order	TS.Production	Data can be used to reserve packaging

4.6.4. Supplier agreements

Company X has contracts with the suppliers of packaging. In this, the suppliers are stockists and at the supplier of pallets they call per piece and at the supplier of other packaging (boxes, envelopes, etc.) per pallet. Prices of packaging are linked to wood and board indices, which means that they may change if the index changes. These agreements must be used in the calculation because the delivery times to the Netherlands and Germany differ. Company X has an agreement with the supplier of pallets that returned packaging may be unloaded at the supplier of pallets. The delivery times are shown in Table 11.

Table 11 Supplier agreements

Supplier	**Location**	**Delivery time**	**Comments**
Pallets	Varsseveld	Same day	Own trucks pick up packaging
Pallets	Oyten and Hilden	48 hours	Delivery costs for Oyten are €550 per transport
Other packaging	Varsseveld	24 hours	
Other packaging	Oyten and Hilden	48 hours	Delivery costs for Oyten are €550 per transport

5. Treatment design

This chapter gives the requirements for a new process, the available treatments, the proposed process design, and a comparison of the current and proposed design through simulation.

5.1. Requirements

The stakeholders of the process of ordering purchasing have requirements and desires that a new process must meet. According to Wieringa (2014), the requirement specifications contributes to helpful guidelines for searching for available treatments. In the interview "problem investigation and treatment design" (Appendix E), experts were asked what the requirements are for an automated process. The experts have mentioned many requirements, which are divided into process-related requirements and technical-related requirements. This is done because, in addition to creating a new process, it will be automated through the use of software or a tool. The problems arising from the current situation must also be eliminated, the experts have taken this into account when giving requirements for a new process. The requirements contribute to the goal formulated in Chapter 1, Table 2.

5.1.1. Process requirements

Below are the requirements that a new process must meet according to the experts.

- Use (reliable and structured) data

To achieve a well-functioning process, reliable data must be used. The experts all think it is important to make decisions and procure based on data. The use of real-time data leads to effective and rapid responses to unforeseen changes (Carvalho et al., 2018; Iannone et al., 2015; Provost & Fawcett, 2013).

- Order signal

The experts agree that there should be a moment in the process when there is a signal when the stock of packaging is almost finished. According to the experts, this can be done via a calculation or lean production techniques such as Kanban.

- Clear (role-based) ownership

A major problem with the current process is that there is no ownership in the process. The experts all agree that there should be clear ownership when a new process is created. An addition to ownership is that it is role-based. The current process depends on persons. When they are gone, there is a problem. The new process must be able to be carried out by everyone in a particular role. Actions should also be crossable, for example when someone is not available, the action can be done by another person.

- Defined process

According to the experts, a well-defined process is important. In the past, this has gone wrong by starting programming too early. The process could be decomposed into sub-processes to make automating easier (Fung, 2014).

- Scalability

Company X has several locations, currently in the Netherlands and Germany. The process must be scalable to the other and possibly new locations as well as to other products. The process must be performed in one way at all locations.

- Less human actions

The process should not be human dependent and should have as few human actions as possible to minimize the risk of errors. Processes with fewer human actions are better and easier to automate (Fung, 2014).

5.1.2. Technical requirements

To automate the process, software or tool is needed. Below are the requirements it must meet.

- Stable

It must be a stable system. According to the experts, an important aspect is up-time because it must not be down. Also, updates and maintenance must be guaranteed. Fung (2014) also claims that a stable environment is important for automating a process.

- Hosting

According to the experts, software should be self-hosted as much as possible. It must also be run on Windows as everything at Company X is run on Windows. Running in the cloud is not an option because Company X wants to be as independent as possible from third parties.

- Security

The software or tool must be secure. The information must only be accessible to authorized employees of Company X

- Learnable

According to the experts, new software or a tool must be learnable and multilingual.

- Integration

The experts agree that new software or a tool must integrate with the current architectural landscape. Fung (2014) notes that the integration of multiple systems leads to fewer problems. When employees need access to multiple systems, it can lead to human errors and inconsistent performance. Therefore, the presentation of the software or tool should be as minimalist as possible. It must be easy to understand. When software or a tool integrates with other systems, the employees no longer have to work with several systems at the same time.

- Costs

According to the experts, the costs must be kept within the limits. To justify automating the process, current and future costs have to be clear (Fung, 2014). The current costs of the process are not known, so this is based on assumptions. After that, the difference in costs with the proposed process is examined using time and resource simulation (section 5.4).

5.2. Available treatments

For each task in the process of ordering packaging, there has been looked at which IPA technology could replace the current process task. This is done based on the type of data used in the task and whether the data is structured or unstructured. Figure 8 shows the task characteristics and the best suitable solution (Zhang, 2019). The choice for an IPA technology is based on these task characteristics: type of data, type of task, and the outcome. Structured data is data with a certain length and format, simple to store, and has a high level of organization. Structured data can be used for queries, which are useful for organizational use. For example, Structured Query Language (SQL) (Eberendu, 2016). Unstructured data consists of data that has not a predefined data model and cannot be used in relational tables, for example, PDF, multimedia, and social media (Eberendu, 2016; Rusu et al., 2013). The task “Receiving order confirmation” is not included in the table because this task cannot be automated, it is only indicated in the process diagram so that it is known when the task "releases order" can start. Table 12 shows the tasks that can be automated.

Table 12 Tasks that can be automated

Task	**System**	**Type of data**	**Type of task**	**Outcome**	**IPA technology**
Calculates how much packaging is needed	Navision, WMS, TS.Production	Structured	Rule-based	Single answer	RPA
Creates purchase order	Navision	N/A	Rule-based	Single answer	RPA
Sends purchase order	Outlook	N/A	Rule-based	Single answer	RPA
Releases order	Navision	N/A	Rule-based	Single answer	RPA

5.3. Proposed process design

In order to save time and reduce human intervention, an automated process is designed (see Figure 11). The proposed process was designed together with the purchaser, who is also the problem owner in this research. Together with the purchaser, there is looked for a process that can replace the current process and also meets all the requirements. The conclusion is that a calculation can be made that calculates how much packaging must be ordered in the next days. Also the product owner, who is the link between IT and operations, confirmed that this calculation can be made. Below are the steps that can be automated explained. Only the tasks that are in the red box are automated because the other tasks are from the supplier or the actual moving of the packaging. They are all routine tasks, performed every day. Table 12 shows that this makes RPA the proposed automation technology for the tasks in the red box. At the moment, the order confirmations are trusted to be correct. When this is no longer the case, Natural Language Processing (NLP) could be used. This AI technique can extract unstructured data from the PDF file of the order confirmation into structured data, allowing the data to be compared with the purchase order. If this information corresponds, the order can be released. However, because the order confirmations are now trusted to be correct, this is not included in the proposed process and it will not be investigated further because RPA is sufficient for automating this process.

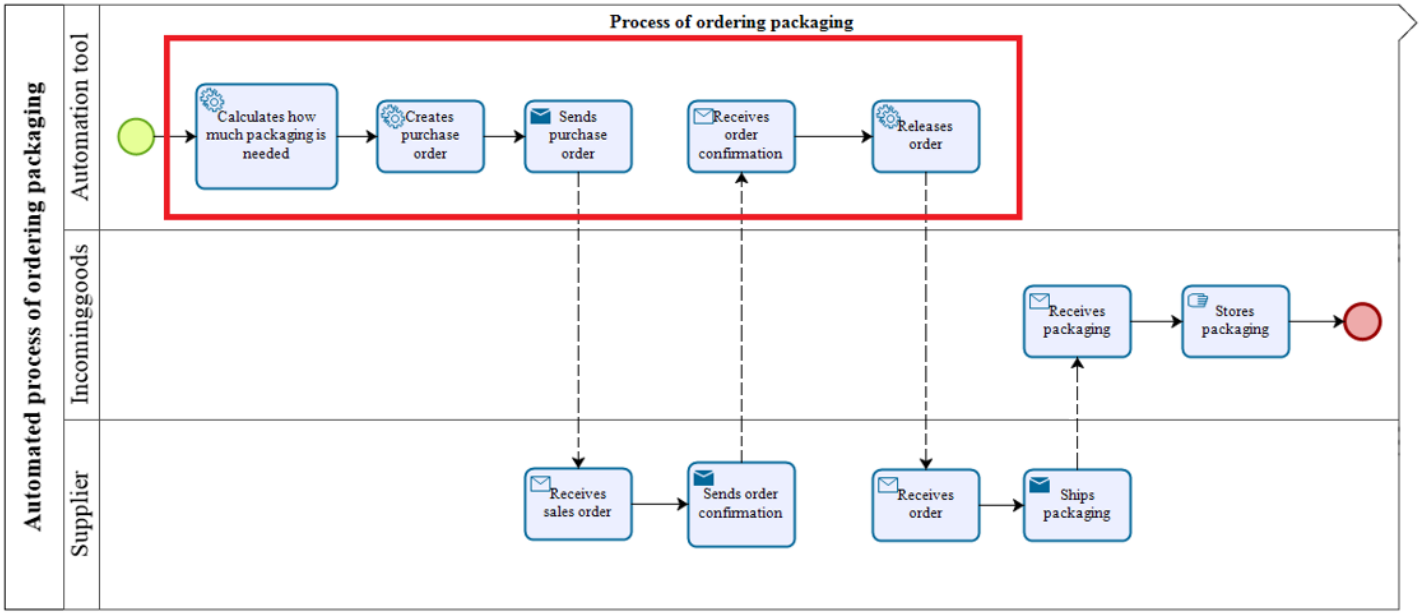

Figure 11 Proposed process design

- *Calculates how much packaging is needed*

In the current situation, this is a manual task, with the team leader of incoming goods doing a physical check to see if packaging needs to be ordered. In the proposed process design, this task is replaced by a calculation, which uses data from three systems. Because the data from Navision is not accurate enough because the amount of packaging can change in the production process, multiple measuring points have to be used to get real-time data. For this purpose, the "order start date" from TS.Production can be used

to reserve packaging so that it is known how much packaging is used at the moment. Also, the returned packaging can be included in the calculation. However, the returned packaging needs to be correct. Therefore, returned packaging should be entered correctly in the system. The ideal situation is to deliver all the returned packaging to the packaging supplier because then it is not necessary to book exceptions. This has been agreed with the supplier but in the current situation, a part of returned packaging is still unloaded at Company X instead of at the supplier's warehouse. In order to keep the data as clean as possible, unloading at the supplier's warehouse is preferred. If the choice is made to unload exceptions at Company X, the correct bookings must be made. As the amount of packaging can change after material bending, information from the WMS can be used to calculate the actual amount of packaging. By using these variables, a pre-calculation and post-calculation are made and it is clear how much packaging is actually used, so it is also clear how much has to be ordered for the coming days.

The calculation is as follows:

1. Order the predicted amount of packaging as indicated in Navision (pre-calculation).
2. When production order starts, the predicted packaging is reserved so that the system knows how much packaging can no longer be used for other orders.
3. When the cut and bent order is entered into the WMS, the difference is known to the predicted packaging. This difference must be corrected in the next day's order (post-calculation).

Because Company X also processes fast orders, a minimum stock must be used to accommodate large differences. By making these corrections through pre-calculation and post-calculation, the data remains clean and therefore it is always known how much is in stock. In addition, the delivery times of the supplier (Table 11) must be taken into account.

- *Creates purchase order*

When the calculation is made, the purchase order can be created in Navision based on the amount of packaging that results from the calculation. Navision will generate a PDF file with the required information.

- *Sends purchase order*

An e-mail is then prepared in Outlook with the PDF document attached. This is sent to the packaging supplier.

- *Receives purchases order & Releases purchase order*

The supplier sends an order confirmation. When this is received, the order can be released in Navision. The order is then confirmed.

5.4. Current versus proposed process

In order to demonstrate the differences compared to the current process of ordering packaging, both processes were simulated. Bizagi Modeler was used to mapping the process through Business Process Model and Notation (BPMN). Then Bizagi Studio was used to simulate the process.

5.4.1. Time analysis simulation

First, a time analysis simulation was done. The times per task in the current process are based on discussions with the team leader of incoming goods and the purchaser. The times per task in the proposed process are based on estimates. The results of the time analysis can be found in Appendix F and are summarized in Table 13. The biggest difference is in the first two tasks, where the team leader of incoming goods does a physical check of how much packaging is still in stock. Together with the preparation of an order list, this already takes 35 minutes per location. In the proposed process, this is done based on a calculation with the available packaging data. The estimated time is 30 seconds. There is also a big difference in the creation of a purchase order, as this is a manual task. In the proposed process, the quantities of packaging can be taken from the calculation and the creation of a purchase order is a ten-second task. Because the packaging for each location is now purchased separately, the times are multiplied by three. In the end, the current process of ordering packaging takes more than two hours per day for all locations.

Table 13 Time analysis simulation results

Task	Time per location	Time for 3 locations	Task	Time	Difference
Checking how much packaging is in stock	0:30:00	1:30:00	Calculates how much packaging is needed	0:00:30	
Creates order list	0:05:00	0:15:00			
Creates purchase order	0:10:00	0:30:00	Creates purchase order	0:00:10	
Sends purchase order	0:01:00	0:03:00	Sends purchase order	0:00:01	
Releases purchase order	0:00:01	0:00:03	Releases order	0:00:01	
Current process of ordering packaging	0:46:01	2:18:03	Automated process of ordering packaging	0:00:42	2:17:21

5.4.2. Resource analysis simulation

Additionally, a resource analysis simulation has been carried out. It has been assumed that Company X spends 50 euros per hour on an employee. This assumption is made by the purchaser. The simulation showed that ordering packaging per day costs €115.08 in personnel costs (for all three locations). As the order is made every working day (260 days), it costs €29,920.80 per year. The results of the resource analysis simulation can be found in Appendix F. According to Deloitte[1] and Blueprint[2], a single software robot costs between €4,000 and €12,000.

5.4.3. Simulation conclusion

The time simulation analysis and the resource simulation analysis show that the proposed automated process requires both less time and resources than the current process. The time simulation analysis shows that the proposed automated process can be carried out within one minute for all locations because the number of packages to be ordered is calculated based on data from systems, whereas it takes more than two hours in the current situation. Also the resources (in this case labour costs), are less in the automated process than in the current situation.

[1] https://deloitte.wsj.com/cio/2016/07/06/robotic-process-automation-slashes-it-costs-alleviates-complexity/
[2] https://www.blueprintsys.com/blog/rpa/how-much-does-robotic-process-automation-really-cost#:~:text=Determining%20an%20RPA%20solution's%20price,of%20the%20cost%20of%20RPA.

6. Treatment validation

This chapter consists of the following sections: meeting the requirements and the revised proposed process.

6.1. Meeting the requirements

A set of requirements has emerged from the interviews with the experts. For each requirement, it is described whether the new process meets it or not. The reasons are explained in Table 14.

Table 14 Meeting the requirements

Requirement	**Yes/no**	**Comment**
Use (reliable and structured) data	Yes	The data is structured and comes from existing systems. The data can also be reliable if Company X no longer unloads returned packaging at its locations but at the packaging supplier's warehouse.
Order signal	Yes	The first step in the proposed process, the calculation, is the signal to order.
Clear (role-based) ownership	Yes	Ownership of the proposed process lies with the purchasing department.
Defined process	Yes	The process is defined in BPMN.
Scalability	Yes	The process is scalable to other Company X production sites because the proposed process is sourced from existing data and executed by RPA making it location independent.
Less human actions	Yes	In the proposed process, the steps are carried out by RPA, so the process is no longer human-dependent. The purchasing department only has a controlling function.
Stable	Yes	As long as Company X's existing systems are running, the proposed process can be carried out by RPA.
Hosting	Yes	It is possible to host RPA in-house without having to go into the cloud. It can also run on Windows.
Security	Yes	Only authorized persons (purchasing department) can make changes.
Learnable	Yes	Because all steps are performed by RPA and are location-independent, there is no need to be learnable. Only the process owners need to know the process so that they can make adjustments when necessary.
Integration	Yes	All data can be retrieved from existing systems and RPA can integrate with multiple systems.
Costs	Yes	The resource analysis showed that having the process performed by an RPA tool costs less than the current process, where the (labour) costs are high because it takes a lot of time every day.

In Chapter 4, Problem Investigation, the current and desired situation are summarized in a table. Table 15 shows the same table, but now with the solutions from this research.

Table 15 The current situation, the desired situation and the solution

Current situation	**Desired situation**	**Solution**
The process of ordering packaging is completely manual and purely based on inspection and experience.	An automated process of ordering packaging based on existing data.	The proposed process carried out by RPA based on a calculation with existing data.
Team leaders of incoming goods/forwarding departments are responsible for ordering packaging products.	The purchasing department is responsible for ordering packaging products.	RPA tool is responsible for ordering packaging. The purchasing department has control over the RPA tool.
The team leader of the incoming goods department has the ability to target financial transactions in the system.	Only the purchase department should have the ability to target financial transactions in the system.	The purchasing department has control over the RPA tool.
There is no clear process for ordering packaging.	A clear process for ordering packaging.	The proposed process is defined in BPMN.
Ordering packaging takes a lot of time and resources.	Spending less time on ordering packaging.	Using the RPA tool, the proposed process can be carried out within one minute instead of several hours.
Lack of space for packaging products at Company X locations, because there is too much stock.	No more lack of space for packaging products at Company X locations.	More precise purchasing according to the proposed process ensures that smaller minimum stocks can be maintained.
No idea how much returned packaging comes back every day.	Understanding how much returned packaging comes back every day.	Unload all returned packaging at packaging supplier.

6.2. Revised proposed process

Expert validation was used to check whether the proposed process could be the right solution. In a demonstration interview (see Appendix G for the results) the proposed process was explained and the experts were asked if there are any comments and if the proposed process can be used in practice. Then, the feedback is processed. This resulted in a revised proposed process.

6.2.1. Comparing order confirmation and purchase order

The validation interviews also revealed that the order confirmation and purchase order must be checked by the purchasing department. Currently, this is not done because the team leader of incoming goods is ordering every day. Moreover, if the process is executed by software, the purchasing department wants to have a controlling function by manually checking the order confirmation and purchase order. Therefore, this manual task has been added to the revised proposed process (see Figure 12). The purchasing department must ensure that the prices are in line with the order. This has to be done to avoid invoice discrepancies. According to the purchaser, there should not be any difference in numbers because agreements have been made with the supplier. A difference of 1 to 2 percent is considered acceptable.

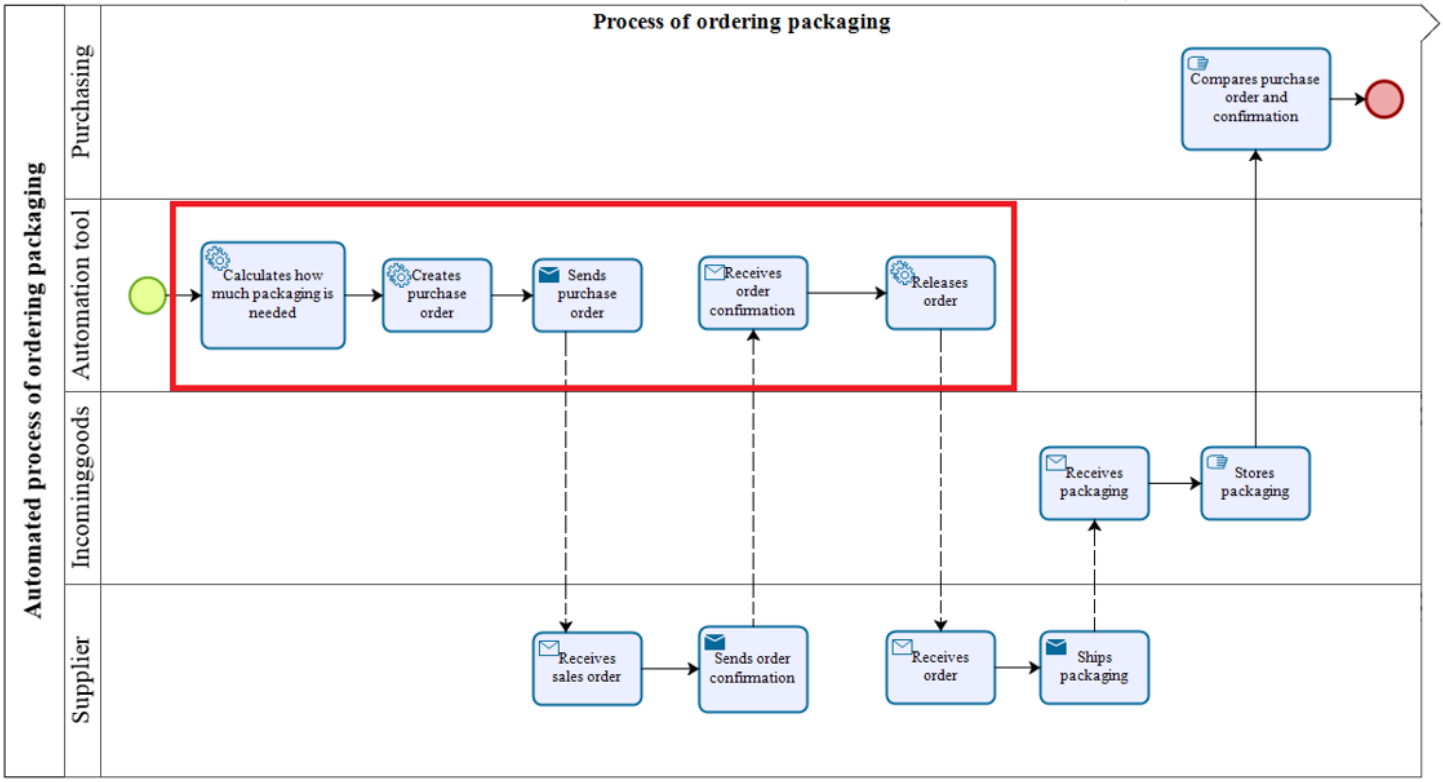

Figure 12 Revised process design

6.2.2. Unreliable data

The experts' reactions were varied about the data used in the proposed process. Initially, the experts were satisfied with a defined ordering process based on data. However, one of the three experts was uncertain about the quality of the predicted packaging data in Sophia. The amount of packaging that is calculated with the customer's order does not always correspond to the actual amount of packaging. An earlier study at Company X showed that there is a 30% increase in the packaging when an order is bent. It was already known that the allocated packaging with an order does not match the actual packaging used, but from previous discussions, it is known that it could be corrected in the calculation with the actual packaging data from the WMS. It can be concluded that the data is clean after the correction based on WMS data. Also, the possibility for customers to return pallets brings unreliable data with it. According to the experts, the customer's return forms are often incorrect because broken pallets or pallets that are not Company X's are included. This information is entered into Navision, which means that the amount of returned pallets does not match the reality and causes unclean data which is not desirable if orders are to be made based on data.

As a result of the fact that the data turned out to be unreliable, a focus group was held to see how this could be dealt with the unclean data (summary of the focus group can be found in Appendix H). The following conditions were set by the focus group:

- All packaging data movements must be registered correctly.
- Unload all returned packaging at the packaging supplier.

When these conditions are met, the experts think that the proposed process can work in practice. By using data from Navision, TS.Production, and the WMS, all packaging data movements are known, so the right amount of packaging can be ordered. The agreement on unloading the returned packaging at the packaging supplier is an example of using the supply chain practice view of Carter et al. (2017), which is discussed in the literature study.

7. Conclusion and recommendations

This chapter consists of the following sections: answering the research questions, the recommendations, contributions, and limitations and future research.

7.1. Research questions

To answer the main research question "*What Intelligent Process Automation technologies can be used to automate the process of ordering packaging at Company X?*", sub-questions have been formulated. In this section, the sub-questions are answered first and then the main research question.

1. What is the current situation of the process of ordering packaging at Company X?

Currently, the process of ordering packaging is completely manual and purely on inspection (tacit knowledge). Besides, there is no clear process that is carried out at the various production sites. The responsibility for ordering does not currently lie with the purchasing department, but with an employee who works near the packaging storage. It takes a lot of time every day to see how much packaging needs to be ordered and there is no idea how much packaging comes back from the customers every day.

2. What are the alternatives to order packaging at Company X?

In the literature, different ways of ordering packaging have been searched for. One alternative is to involve the supplier by outsourcing the process. However, the interviews showed that Company X does not want to be too dependent on other parties. Because Company X wanted to order based on existing data, there is looked at which IPA technologies fit the process of ordering packaging. Because this process only involves structured data and rule-based tasks, AI is a less suitable IPA solution and it was decided to carry out the future process using RPA.

3. What are the requirements for the desired situation of the process of ordering packaging at Company X?

From interviews, a set of requirements was compiled that a new process must meet. This set can be found in chapter 5, the treatment design.

4. What data for ordering packaging is available at Company X?

At Company X packaging, data is available in different systems. Namely in Navision, TS.Production, and the WMS. By making a calculation before and after, it is possible to know how much packaging has to be ordered in the future. During this research, the data seemed reliable enough to make the calculation.

5. To what extent does the proposed process meet the requirements?

The proposed process, where orders are placed based on a calculation of parameters from different systems, seemed to meet all the requirements. In the last phase, treatment validation, it turned out that

the data in Navision, coming from Sophia (the portal where customers order), was not reliable enough to be used in the proposed process. There was some discussion about whether the data was reliable enough. The unreliable data calculated by Sophia (pre-calculation) can be corrected by the data from the WMS (post-calculation) so that it can be used to order the right amount of packaging. There was also a discussion about the returned packaging. There is an agreement with the supplier to return returned packaging to the supplier's warehouse. This is not always used and therefore returned packaging is still being registered at Company X. Because employees do not always book this correctly, this gives unclean data and makes it difficult to order the right amount of new packaging because it is never sure how much packaging is returned by the customer. In the next sub-question, it will be discussed how Company X should deal with returned packaging.

6. What must Company X do to achieve the proposed process of ordering packaging?

The biggest challenge is to keep the data clean. The pre-calculation and post-calculation ensure that the data that has been calculated by Sophia is corrected. The other factor that can cause unclean data is returned packaging. By unloading all returned packaging at the supplier, Company X does not need to book returned packaging anymore. This agreement is already made. However, drivers keep making exceptions by unloading at Company X. Therefore, Company X has to choose to unload all returned packaging at the supplier or to book all returned packaging correctly. Book the returned packaging correctly remains a human action as a result of which mistakes can be made and the data will no longer be correct. Therefore, the preference is to unload the returned packaging at the supplier. A vendor offering RPA solutions will also have to be found. By taking these steps, the process of ordering packaging becomes more based on explicit knowledge, rather than tacit knowledge so that the process is no longer dependent on a few individuals. To ensure there is explicit knowledge, work instructions must be made of the proposed process and how employees should handle data. This ensures that all stakeholders are working in the right way and the date remains clean.

After answering the sub-questions, the main research question "***What Intelligent Process Automation technologies can be used to automate the process of ordering packaging at Company X?***" can be answered. In the literature chapter, several IPA technologies have been discussed that have the potential to be used in procurement processes. Also, outsourcing was one of the alternatives. However, the interviews showed that Company X wants to keep control of the process. As there is no unstructured data involved, only the use of RPA satisfies the process, which is the answer to the main research question. In the future, AI technologies such as NLP could be used if, for example, when unstructured data such as a purchase order and order confirmation need to be compared. However, the purchasing department still wants to do this comparison manually so that there is still some human control in the process. This research also proposed a process, how Company X can organize the future process. This proposed process can be found in section 6.2.

7.2. Recommendations

This research delivered a new process (Figure 12) with an IPA technology that will save time and resources. It also takes out the tacit knowledge and turns it into explicit knowledge that benefits all of Company X's locations. If Company X want to implement the proposed process based on RPA, it is important that the data on which the order size is based is correct. The following recommendations will help:

Firstly, keep the data reliable. By having as few human actions as possible in the process, the chance of the data becoming unclean is small. Therefore, it is recommended to unload all the returned packaging at the packaging supplier. If this is the case, returned packaging no longer needs to be booked by employees of Company X. As a result, returned packaging does not need to be included in the calculation because Company X can focus on ordering new packaging instead of taking care of returned packaging.

Secondly, make sure the employees at Company X understand why clean data is important. The data in the WMS must be correct. Because the booking of packaging in the WMS is a human activity, it is important that the employees do this correctly. Also, when packaging is not usable, this has to be registered in the system. All movements of packaging have to be registered. When this is not done, the data is no longer clean. To get commitment from the warehouse employees, work instructions can be created that explains how important it is to keep data clean.

Thirdly, now that Company X has been introduced to IPA and RPA, Company X can look at other repetitive processes that take a lot of time because of manual handling. An example is the purchase of raw materials. This is already done via a system and rationalized. RPA can help to fulfil these repetitive tasks, allowing Company X employees to focus on innovation and growth instead of repetitive tasks.

7.3. Contributions

This research contributes to the research on Intelligent Process Automation and digitalization of certain processes in organizations and helps the employees and stakeholders understand how to deal with a process such as a process of ordering packaging at Company X. This research is academically relevant, as it combines several research topics such as Industry 4.0, procurement, data-driven decision making, and Intelligent Process Automation. The theoretical chapter focuses on these topics so that it becomes clear what different solutions exist for automating a process. Notably, there is currently limited literature on IPA in buyers' practices. Viale and Zouari (2020) mention that the potential of IPA is limited explained in the purchasing sector. This is particularly true for conventional and traditional sectors such as the steel industry. On the contrary, Bals et al. (2019) mention that automation and process optimization are very important in today's purchasing sector. Ng, Chen, Lee, Jiao, and Yang (2021) state that IPA research is a promising area and hope that more research about implementation and challenges among industries and companies will be held. Therefore, this research will extend the literature on IPA in procurement organizations and purchasing departments and that can help organizations where the use

of intelligent software is not yet the norm. From this research, it can be learned that it is essential to have reliable data before IPA technologies can be implemented. This research is focused on packaging: at Company X it is not clear at an early stage how much packaging is involved in an order because the amount of packaging can change at any moment because Company X never has the same orders, but tailor-made products. This makes IPA more suitable for processes with reliable data, for example, an order process where hardly any changes in packaging occur during the production process and where it is always clear how much packaging a product needs. This research can be an eye-opener for individuals or organizations wishing to implement IPA technologies, that clean and reliable data is one of the most important aspects when implementing solutions based on processing data.

In terms of practical contributions, this research gives the employees and stakeholders of Company X (particularly the purchasing department and IT department) the knowledge about how they can automate the process of ordering packaging at Company X. Recommendations are given in the previous section, which will help when Company X is going to implement the proposed process and keep the data reliable. This master thesis could also be useful to other procurement organizations or purchasing departments of companies who want to automate their processes. In addition, this master thesis started with the intention from Company X that something should be done with the data, for example, prediction. However, there was no clear process and the data is not immediately usable. From this master thesis, other companies can learn to rationalize their processes first and only then look at what kind of automation solution fits.

7.4. Limitations and future research

The first limitation is about the literature. Many articles about IPA are restricted so it is not possible to read them. Besides, there was little literature focused on a procurement organization or department and especially not about ordering packaging. Most of the articles were about the financial audit industry so not much of the literature can be directly applied to a company in the metal sector. The second limitation is that the research is done at a single organization which may limit the applicability for other organizations. Other organizations can learn from it, but it is not directly applicable. Because there is not much known about IPA in the procurement sector, future research can be about applying IPA in the procurement sector that applies to specific industries or organization types.

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Appendices

Appendix A – Organizational chart

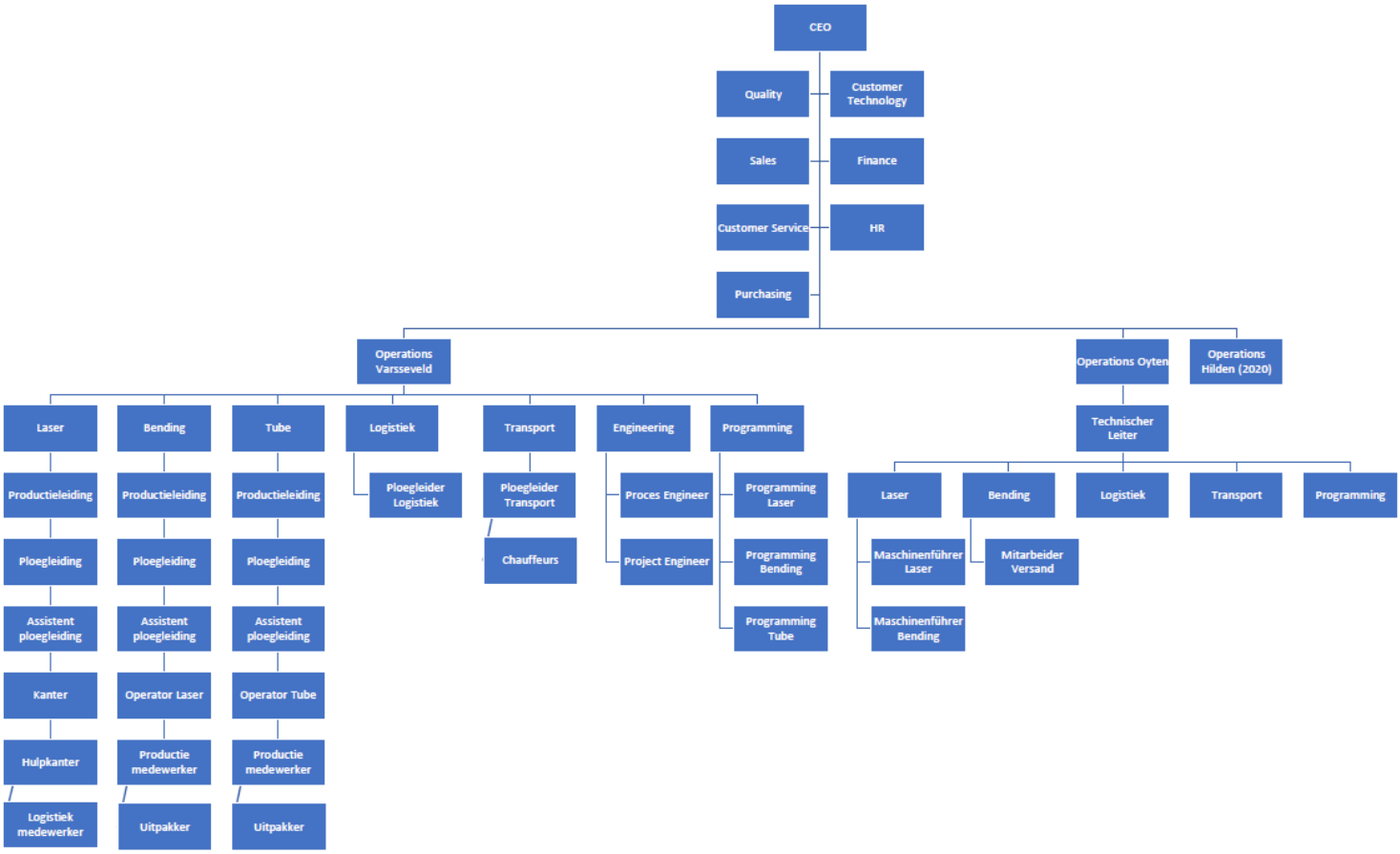

Figure 13 Organizational chart of Company X

Appendix B – Packaging products

Table 16 All packaging products

Supplier	**Product number**	**Description**
PACKAGING SUPPLIER 1	0030300	Doos 600x400x100 Transparant
PACKAGING SUPPLIER 1	0030400	Doos 310x220x100 EXACT
PACKAGING SUPPLIER 1	0030600	Doos 800x600x100 CUSTOMER-FOCUSED
PACKAGING SUPPLIER 1	0040100	Foam Enveloppe 362x478 (max)
PACKAGING SUPPLIER 1	0040200	Foam Enveloppe 216x338 (A4)
PACKAGING SUPPLIER 1	0050010	Palletdeksel 800x600x50 SOPHISTICATED
PACKAGING SUPPLIER 1	0050020	Palletdeksel 1200x800x50 IN CONTROL
PACKAGING SUPPLIER 1	0050102	Kanaalplaat Wit 780x590
PACKAGING SUPPLIER 1	0050103	Kanaalplaat Wit 1180x780
PACKAGING SUPPLIER 1	0050104	Kanaalplaat Wit 1780x380
PACKAGING SUPPLIER 1	0050105	Kanaalplaat Wit 1780x580
PACKAGING SUPPLIER 1	0050106	Kanaalplaat Wit 1780x770
PACKAGING SUPPLIER 1	0050107	Kanaalplaat Wit 1780x1170
PACKAGING SUPPLIER 1	0050108	Kanaalplaat Wit 1780x1490
PACKAGING SUPPLIER 1	0050109	Kanaalplaat Wit 2380x380
PACKAGING SUPPLIER 1	0050110	Kanaalplaat Wit 2380x580
PACKAGING SUPPLIER 1	0050111	Kanaalplaat Wit 2380x770
PACKAGING SUPPLIER 1	0050112	Kanaalplaat Wit 2380x1170
PACKAGING SUPPLIER 1	0050113	Kanaalplaat Wit 2380x1490
PACKAGING SUPPLIER 1	0050114	Kanaalplaat Wit 2980x380
PACKAGING SUPPLIER 1	0050115	Kanaalplaat Wit 2980x580
PACKAGING SUPPLIER 1	0050116	Kanaalplaat Wit 2980x770
PACKAGING SUPPLIER 1	0050117	Kanaalplaat Wit 2980x1170
PACKAGING SUPPLIER 1	0050118	Kanaalplaat Wit 2980x1490
PACKAGING SUPPLIER 1	0050250	Kunststofhoekbeschermers 60252
PACKAGING SUPPLIER 1	0050330	PET Band 12,5x1700x0,9 WIT
PACKAGING SUPPLIER 1	0050450	Tape Kleeffix 70g/m2, Wit onbedrukt
PACKAGING SUPPLIER 1	0050600	Rekfolie 35um (500x200)
PACKAGING SUPPLIER 1	0050650	Handrollen minirekwikkelfolie 10x150

PACKAGING SUPPLIER 1	0050900	Plakzak 225x115
PACKAGING SUPPLIER 1	0051051	Papierplus GE fanfold R 06.02.0056
PACKAGING SUPPLIER 1	0051150	AR Schrenzpapier Grijs 50cm-70gr
PACKAGING SUPPLIER 1	0051300	Golfkarton 120cmx100mtr
PACKAGING SUPPLIER 1	0051401	Polystyreen Stroken 40x60x1200
PACKAGING SUPPLIER 2	0010040	Pallet 1800x390, Type A - 15.01.01
PACKAGING SUPPLIER 2	0010041	Pallet 1800x590, Type B - 15.01.02
PACKAGING SUPPLIER 2	0010042	Pallet 1800x780, Type C - 15.01.03
PACKAGING SUPPLIER 2	0010043	Pallet 1800x1180, Type D - 15.01.04
PACKAGING SUPPLIER 2	0010044	Pallet 1800x1500, Type E - 15.01.05
PACKAGING SUPPLIER 2	0010050	Pallet 2400x390, Type F - 15.01.06
PACKAGING SUPPLIER 2	0010051	Pallet 2400x590, Type G - 15.01.07
PACKAGING SUPPLIER 2	0010052	Pallet 2400x780, Type H - 15.01.08
PACKAGING SUPPLIER 2	0010053	Pallet 2400x1180 4-weg, Type I - 15.01.09
PACKAGING SUPPLIER 2	0010054	Pallet 2400x1500 4-weg, Type J - 15.01.10
PACKAGING SUPPLIER 2	0010060	Pallet 3000x390, Type K - 15.01.11
PACKAGING SUPPLIER 2	0010061	Pallet 3000x590, Type L - 15.01.12
PACKAGING SUPPLIER 2	0010062	Pallet 3000x780, Type M - 15.01.13
PACKAGING SUPPLIER 2	0010063	Pallet 3000x1180 4-weg, Type N - 15.01.14
PACKAGING SUPPLIER 2	0010100	Pallet 3000x1500 4-weg, Type O - 15.01.15
PACKAGING SUPPLIER 2	0010400	Pallet 1200x800 - 20.03.04
PACKAGING SUPPLIER 2	0010500	Pallet 800x600 - 10.01.00
PACKAGING SUPPLIER 2	0010600	Pallet 600x400 - 20.06.01
PACKAGING SUPPLIER 2	0020100	Opzetrand 800x1200 - 21.01.01
PACKAGING SUPPLIER 2	0020200	Opzetrand 800x600 - 21.00.01

Appendix C – Orienteering interview

This interview with the problem owner was conducted at the beginning of the study to get acquainted with the current situation.

Interviewer: T. van der Holst

Interviewee: Purchaser

What is your position at Company X and what are you responsible for?

I am a purchaser and logistic manager, so I am responsible for all purchasing activities. Actually from raw materials to toilet paper I always say, and in addition I am responsible for the logistics processes, such as incoming goods, forwarding, the packaging department where all goods are prepared for shipment and for transport planning. So everything that needs to be transported within and around the company.

And do you do all this yourself?

For the most part, yes. We have one operational buyer in purchasing. And that's more of a call-out function. We all do the controlling through the software. So as long as the software's right, it's a call-out function. When it comes to the logistics part, there are three divisions. That's forwarding, logistics and transportation. Expedition is done by the team leader of incoming goods, who's under me. In logistics that is the team leader of expedition, who is responsible for our own planning of our own trucks and external transport. And then there is the team leader of the drivers. We have 15 own trucks, a BE combination and a Mercedes sprinter. So there are a number of regular drivers and raid forces etcetera.

Clearly. Now we are going to talk about the current situation regarding the graduation assignment. What does the ordering process look like from packaging from A to Z?

That is actually entirely manual work. The team leader of incoming goods is down here in his office. The way it is done now is purely by eye. So we have standardized pallets of 20 different sizes. We use those standardized pallets as dimensions even at the quotation stage of Sophia. That is standardized, but we have no idea how much we need. So every day we check whether we still have enough stock in the system, standing on the floor. We don't get too short, but in the end the process operator at the machine always has to assume that what's on his production form on pallets is there. So it is the team leader of incoming goods' job to make sure that he orders on time, but that is purely by feeling. After approximately 13 years he knows how much he has to order every day. It also happens regularly that we have to rush to the packaging supplier on Friday afternoons with our own trucks because we are already almost through the pallets and we still have 2 days left in the weekend. So that's the current way it happens, purely by eye. We even had the team leader of incoming goods on vacation without making a transfer to a colleague. Monday morning all pallets were gone and the team leader of incoming goods had not arranged anything.

So if he dropped out, there'd be a problem?

Then someone else would have to take over that manual task. Of course the team leader of incoming goods has a lot to do here, but in the end we are no longer a small organization and we expect the team leaders to lead us to a higher level. That's where the function of walking across the floor fits in and you no longer have to check how many pallets to order. We also have another issue, and that is returned packaging. We have no idea how much returned packaging we will get back. In addition, we have no idea what is still whole or broken. So the team leader of incoming goods ordered, because on that snapshot he sees that he has to order pallets of a certain size, but it is only possible that 15 trucks will return this afternoon with pallets in about the same numbers as what he ordered. Then you already have twice as many pallets lying around as you would normally use. That is not desirable either. So it always comes down to the fact that when it comes to stock, there is either too little or too much. So it's never good. While we actually do it exactly right with sheet material. We know exactly how much we need and when we need it. That is actually where we want to go with the packaging and pallets.

And you can't just do that just like with sheet metal?

No, because there is a piece of returned packaging in there. That has so much influence that you can't take it for granted.

And what is your role in the process?

I am responsible for the entire packaging process. As a buyer and logistics manager, I am responsible for ensuring that these processes run smoothly. However, there isn't really a process when it comes to packaging. At least, I find a manual process and we only do what we do and it goes well nine times out of ten and it's wet finger work. I don't really call that a process. And certainly not at Company X’s level. You know how we fly things here and that piece of packaging just doesn't fit.

And how are decisions being made at the moment regarding the purchase of packaging?

For Varsseveld we actually have the team leader of incoming goods who buys the pallets, who also does his own orders. When it comes to Oyten and Hilden, we basically work with the expedition manager sending an e-mail once or twice a week to the operational buyer, with an order list of what needs to be ordered. And then the operational purchaser orders those products. Actually, it is not desirable that someone from incoming goods or an expedition manager also has a buyer's role. It is not his primary task, he does have the ability to direct financial transactions in the system, and that is not desirable. So if we have a good system, and I think Hilden can be a good test for that. That we can retroactively roll that out to Varsseveld. That we say: team leader of incoming goods, thank you for the way you have always done it, but we're going to do it now with a bit of tooling. And that has to be in the area of purchasing as well. It's a purchasing activity. And maybe a team leader should send out a signal that the buyer has to buy something. But you want to keep those roles separate.

And do you also want to involve the pallet supplier?

We have been ordering everything from the packaging supplier since 1 July. Also for Oyten and later for Hilden. So we have one central partner where we order. That also gives us the opportunity to think further about a piece of stock management and that sort of thing. We really do have a contract with the supplier, which makes it easier for him to make things from scratch. In the past it was: here you have a price list, I'll see if I ever get an order. And if he gets an order then sometimes he has to make something quickly.

Who are all the people involved in the process?

The team leader of incoming goods in Varsseveld, the expedition leader in Oyten and in Hilden it is still unknown. However, they have more of a forwarding role because we are not there as purchasing agents. We have to get something from a trigger that we have to order something. If we have a piece of software for that, we don't need that forwarding role anymore.

Okay, and the current situation is in line with Company X's strategy?

No. Because it's gambling. And if there's anything we hate about this company, it's gambling. If it doesn't fit in with the software and the planning, then it could go very, very wrong. That's what you want to avoid. Actually, we don't do anything else with pallets. How often I hear when I walk in the expedition: "The stock of this type pallet is small, but the driver from truck 1 always takes Euro pallets with him because he always does. So that will be alright". That is how they steer in stock, and that is of course very dangerous.

And does the current situation have any advantages?

Well, when it comes to data: you don't have to keep track of anything, because it doesn't matter, we just do something and we just buy in. A pallet more or less doesn't matter because you don't have to register it. So it might make you more flexible, but I don't know if that's an advantage.

And the disadvantages?

Everything that's in stock here has to be paid for. We are now in the hands of an investment company, they are also very keen on a piece of Days Inventory Outstanding. That means, how long is something in stock in the warehouse before you start using it. With those pallets, we have no idea. Sometimes we buy a hundred pieces and suddenly a hundred come back. And the other time we buy two hundred and nothing comes back. So we don't even know how many of those two hundred pieces we'll need in the next few days, while those dates are wandering around somewhere in Sophia. Because somewhere the customer gets a piece of packaging costs calculated, so that should be in it. We know how many pallets we need on the basis of a SV number, so we can perhaps already plan more according to consumption, so you also know how much you need. When it comes to drawbacks, it's all wet finger work. It can all

go well, but it can also go wrong. If someone spends 2/3 hours a day ordering pallets then believe it will work out. But if we make purchases based on software, just like the raw materials, we can order in less time.

And what goes with packaging?

We have two different components in our system, packaging and packaging. Actually, it's all packaging. You do have the pallets, everything made of wood. And then you have the boxes. These are all items we use to ship. A carrier for the product.

And does everything we just discussed about pallets also apply to the boxes?

Yes, ditto. In the end, it's also bought by feeling. That's not just the boxes but the corrugated cardboard, the PET tape, that sort of thing. When there are two rolls left, the team leader of incoming goods has to be told that he has to order something. And then they don't have that in stock at the supplier, so they send another kind of PET-band. Then you get some ugly alternative PET-band. That makes it difficult for a supplier to manage his stock. After all, the team leader of incoming goods buys on the basis of the input he gets from the floor, and he puts everything through without a hitch. Then, if it's no good, it comes to me that the supplier doesn't have it in stock. Look at that process before, there is 0.0 process and line in it. Then I understand that it's difficult to control it.

So it's not really a big problem, but it's mainly that you don't want to work that way?

After all, all those packaging are product carriers or means of transport. If we don't have a PET belt, you can't actually pack a lot of products. In any case not in the way that it arrives at a customer undamaged. So it can be very dangerous. The other day we had a problem, a standard box of ours was out of stock, then the team leader of incoming goods took another alternative temporarily, of thin wave quality. We had a lot of transport damage problems with that, because that box was just a lot thinner. That's just very dangerous. While a supplier also says: if we have more insight into our stock management because you also have, then such things don't have to happen. Packaging is one of the easiest things there is, it's inventory management. If stock management fluctuates from nothing to everything, you can expect things to go wrong one day.

And what does the desired situation look like?

What I ultimately hope is that we get some tooling. A bit the same as with the raw materials, that we get a purchase proposal. Whether that's on a day or week basis, it doesn't matter. But somewhere we have to get a bit of forecasting. That is the desired situation, that we buy on the basis of a system, and not on the basis of feeling. And what that system looks like, that doesn't matter to me. As long as there is a system. We are a webshop, we are digital and we work from systems, so you want to be able to order a

correct number of pallets at any time you want, based on data. That whole feeling aspect has to come out.

And who is to buy in the end?

Actually, in the end we want to get a piece of software/tooling that you call off. In the end, we want the following division of roles: I am the controlling function, I look at data and input from systems. And operational purchaser who calls it off. That's putting orders through. If the input is correct, then calling it off is pure order-pushing. That input is actually missing now, we have to get it.

Then some general questions about the research. Has anyone been working on it?

No, actually, not yet. Always because of crowds, it's never been on the prio list. Also because there's a piece of software involved from software development. That department's grown from 6 to 18 people in a year. That goes to 24 next year. Then there is much more chance of success, it never happened. They can really help to make a piece of software.

Is there also support from the management?

Yes, there is always support when it comes to working in a structured way and purchasing according to statistics. That we can substantiate why we did something. That substantiation now interrupts. If we receive questions from the supervisory board, that they see that something is very long or that a lot of money has been spent on it, we don't know. So there's always support.

What data can be used for the research?

You can of course analyze on historical data, we have all the pallets used and purchased in recent years in our system, you can see what structures are in it on a daily basis, so you can determine something on a historical basis. It also contains a piece of returned packaging, so which returned packaging has been returned. What you can also do is based on what is calculated in Sophia. That is a lot more accurate than looking at the past. So there are several possibilities. Maybe it's a good idea to start comparing the two. We have all the quotations so you can see them. Basically everything is in Navision, behind every order there is a piece of packaging.

What other important aspects can I look out for?

The hardest part is the returned packaging. Consumption comes from Sophia, those orders that are in there you can just order pallets for it. But we don't know how many pallets come back. Maybe you should say structurally: we are going to calculate this way, but on a historical basis we subtract the returned packaging, because we always see that on average this returned packaging returns. So at the bottom of the line you're left with that. That returned packaging is a kind of maximum stock level. But then you also use a minimum stock level in order not to miss out.

But that is not known, what comes back, so there is no one who keeps track of that.

No, we do have that the returned packaging has to be registered via the website, that is done via forms. But you also see that drivers take returned packaging back from goodwill to the customer. Because they are there anyway, so they take it with them. Maybe there should also be structure in that, that they have to register it via an app, so that we know what is coming back. That's it. It's completely finished. Maybe we can do it on a historical basis. Because we know exactly from all bookings what a return package booking has been. Because it has a certain coding, a credit has been sent to the customer, so that is a returned packaging. So we can see if there's a pattern in there. If it's pretty much the same over the last 13 years, then we know it's a structured way that drivers always take the same, or that it's always with the same customers. There's also a big chance that on Mondays and Tuesdays more will be taken with them than on Fridays, because on Fridays everyone wants to go home on time. I'm sure you'll see all that again. So it is also good to talk to the guys from incoming goods, they always unload that and figure it out. It is also good to talk to the packaging supplier because they also receive returned packaging because we don't have the space for it now because of the renovation. The returned packaging is sorted and processed there, for which we receive a credit. At least, that's the idea and we want to start with that test. I think it's a good idea to take that with us. There is no process at all right now, it's a little bit of tying together and if the picture is kind of round then it's good. There are no flowcharts of this process.

Is there anything else you want to say about this?

There is one thing that is certain, and that is that it can only get better. It started out as some sort of necessary addition, but now we buy in pallets for 150,000 euros a year, it's become a bit more than a necessary addition and we still do it the same way, so something has to change.

I think I know enough for now. Thank you very much for your time.

Appendix D – Examples of handwritten order lists

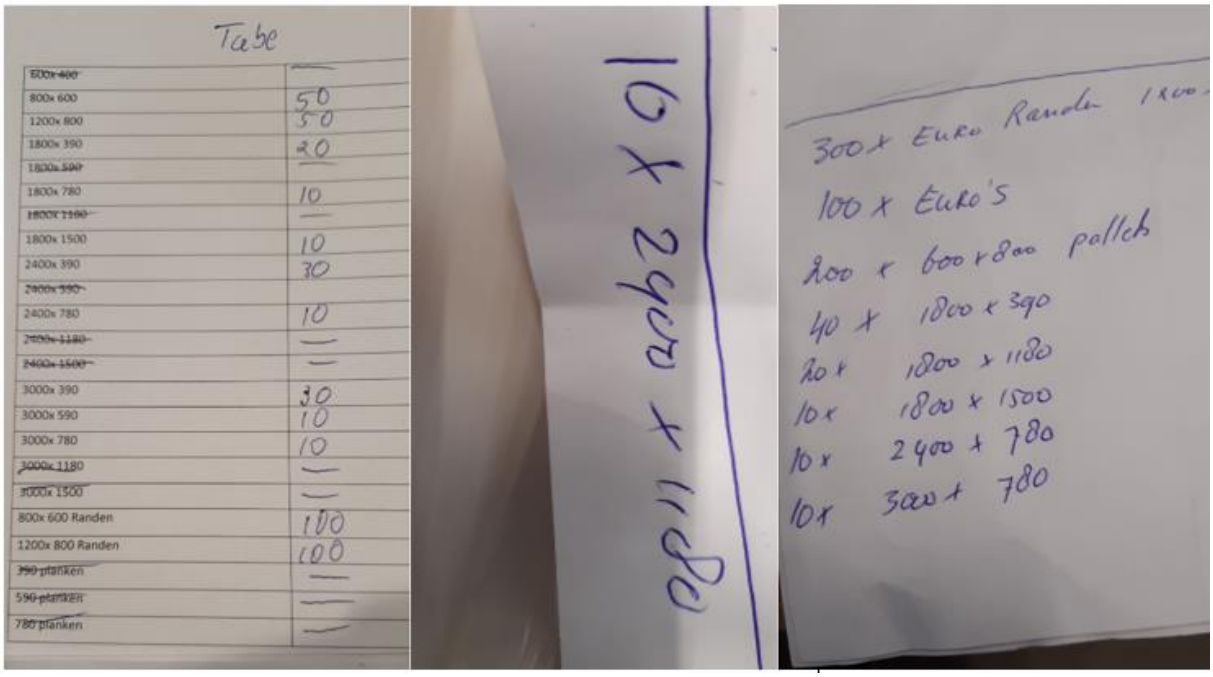

Figure 14 Handwritten order lists

Appendix E – Interview problem investigation and treatment design

To find out exactly what the problem is and what the requirements are for a new process, interviews were held with the relevant experts in various fields, such as procurement, operations, and IT. The background of the experts can be found in Table 17. Through these interviews, chapters 4 and 5, namely the problem investigation phase and the treatment design phase, were shaped (Wieringa, 2014). During this interview, the eight stages described in Chapter 2 Methodology were followed (Kvale & Brinkmann, 2009; Strauss & Corbin, 1998).

Table 17 Background of the experts

Expert	**Job**	**Expertise**	**Experience**
1	Purchaser	Purchasing and logistics	6 years
2	COO	Operations	14 years
3	Product Manager	Automation, IT	20 years
4	Team leader of Software Development	Computer Science, programming, Data Science, Software Development, IT	15 years

Introduction

1. What is your current position within Company X and what are you responsible for?
2. How long do you have working experience in your current and/or similar functions?

Problem situation

3. Are you familiar with the current situation of the process of ordering packaging?
4. What do you think are the biggest problems in the current process?
5. What do you think could be improved in the current process?
6. Do you think the ordering process of packaging can be automated?
    a. If so, in what way?
7. To what extent do you support the idea of automating the process of ordering packaging?

Decision-making

8. How important is it to you that decisions are made based on data?
9. Do you prefer to make decisions based on intuition/expertise or on data?

Automate

10. In your career, have you had any experience with automating business processes?
    a. If yes, please tell me in what way?
11. In what ways is there automation within Company X?
12. What do you think are the biggest challenges in automating business processes?

Intelligent Process Automation

13. Do you think Intelligent Process Automation is a good solution to automate process of ordering packaging?
14. To what extent does Intelligent Process Automation fit the vision of Company X?

Other possible solutions

15. How do you feel about shifting the responsibility of the process of ordering packaging to the supplier?
16. What do you think of outsourcing the process of ordering packaging?

New system requirements

17. What are the requirements for a new system/tool/process?
18. What should be taken into account when implementing a new system/tool?

Closing

19. Which persons within Company X can help me further with automating process of ordering packaging by means of Intelligent Process Automation?
20. Do you have any other comments or questions about the survey?

Table 18 Interview results

Question	Expert 1	Expert 2	Expert 3	Expert 4
1	Purchaser. Purchasing and logistics.	COO. Operations.	Product Manager. Industrial Automation, ICT.	Team leader of Software Development. Computer Science, programming, Data Science, Software Development, ICT.
2	6 years	14 years	20 years	15 years
3	Yes	Yes, with lists and notes. In Varsseveld with a lot of experience, other locations large stocks. No stock system. Supporter of lean, the less the better.	On a global level, I know there are lists being kept. It is a manual process and there is little automation. Rough estimates are made.	No
		Manual process. Intuition. Stocks. Lean.	*Manual process. Little automation. Intuition.*	
4	Time consuming. Hard to calculate. No control. Ordering on gut feeling. Depends on one person.	It takes space. No insight. Returned pallets causes poor insight. Shortage of packaging, people start looking and this takes time.	There is a lack of rationalisation. There is no transparency. There is no overview. There is a high risk of errors. There is no ownership at the moment.	-

	Time. Calculation. Control. Gut feeling. Person-dependent.	*Space. Insight. Errors. Time.*	*Insight. Transparency. Errors. Ownership.*	
5	Using data we already have. Driving by facts.	Kanban or two bin system. Automatic purchasing.	Define what the process is: ownership, organizing, controlling on parameters. There must be a signal when we fall below the minimum stock.	-
	Use data. Data driven decision-making	*Signal.*	*Ownership. Use data. Signal.*	
6	Yes, of course.	Yes, but I don't know if that requires AI. RPA could be something. Working with sensors and reflectors to see if packaging is present. Organising the process is important. The process must be scalable; it will not work if it remains manual.	Yes, everything can be automated. The question is to what extent: integrate it with multiple systems or in a tool. That is a trade-off in what the costs and benefits are.	If you want to scale that up to other people, which is sensible and essential, you will have to do it based on more data and facts.
		Signal. Define process.	*Integration. Tool.*	*Use data. Data driven decision-making.*
7	Yes, it can be automated. We are		I fully support that. Priority and	Yes, of course

	able to extract parameters from the system. Enough data to automate it. The supplier side is not automated. Our side can be automated.		importance should be considered, but this has to happen sometime. I think this can be done in a tool that is not very advanced, and we can gain from this.	
	Use data.		*Tool.*	
8	100% important. 100% Control by data, hard concrete work: no data, no action.	Very important, because scalability and traceability.	I personally find that very important because you are talking about rationality instead of gut feelings.	I think that is essential. Decisions based on data are becoming increasingly essential.
	Use data.	*Scalability. Insight. Transparency.*	*Insight. Gut feeling.*	*Data driven decision-making.*
9	Data based. Process of ordering packaging is on intuition.	Both. Some choices needs expertise, can be based on data too.	I fully support data-driven decision making. Within Company X, there is little evidence of this. There is a lot of data, but it is not managed in an unambiguous way and little analysis is done on it. Most of it is gut feeling. In all cases, I am convinced that choices based on data are always better.	Data. Ultimately all data, but it depends on the decision. A lot of intuition is often also based on a piece of data through experience.

	Data driven decision-making. Intuition.	*Data driven decision-making. Intuition.*	*Data driven decision-making. Intuition. Use data. Gut feeling.*	*Data driven decision-making. Intuition.*
10	Yes. Complete digital process set up based on own parameters and own software. Purchasing is a side issue, digitizing processes is my job. Process of ordering packaging is not automated because data is not reliable. Only a minimum safety stock is not necessary because it can be done faster, better and smarter.	Much in the way of quality, where making mistakes is prohibited. Pick-by-light, sensoring. Fool-proof.	Yes, that is my job. I dictate to ICT how the process can be automated, what we are going to automate and what it should look like. Where a business is distinctive, you have to do things yourself.	Yes, that is my whole career so far. I have done a lot when it comes to automatic planning of business processes; which things to do first, which to do next, what are the constraints and exceptions
	Reliable data.	*Signal.*	*Automation.*	*Automation.*
11	The current procurement system was conceived, rolled out and developed by the company itself.	Only at the front end of the process, at the back it is still a matter of searching for boxes. It is important to record everything, this went wrong at the WMS.	At Company X, we have gone too far in doing things ourselves. Where you are not distinctive, you have to standardise. Every respectable ERP package has an environment where you can control production and purchasing.	The intake of orders is automated, including cutting and bending.

	Software development.	*Software development.*	*Software development. Standardizing.*	*Software development.*
12	Generation of reliable data. Making the system smart. Getting people to follow the suggested advice. How to make it reliable and scalable. The source of the data.	Mapping the whole process before programming it.	There is a lack of a broadly supported vision on the automation of business processes. The distance from ICT to the rest of the organisation is too big; we have to start working together. Change management is a major challenge: the change from a manual process to a digitalised process.	Divided knowledge, no overview. Dealing with exceptions.
	Reliable data. Scalability. Use data.	*Define process.*	*Vision. Organizational problem. Change management.*	*Data source. Insight. Use data.*
13	I think so, yes. The ultimate goal is to apply AI so that everything is automated and can be taken care of.	I don't know. A simulation or digital twin would help us to shorten the learning curve. I don't know if Big Data could help. It must become a learning process that is done every day or week.	Yes, of course. Structured data must be present, what is not the case now. The data is also in different sources.	It is difficult to say because I do not know the process. There is a lack of overview, so people cannot make good decisions. A support system is missing. This can be first a simple system like Excel, and later a decent system with

				integrations with other systems.
	Automation.	*Simulation.*	*Structuring data. Data source.*	*Insight. Decision-making. Tool. Integration.*
14	One on one. Need for a tool that can grow along with wishes and needs.	It must add value.	It fits in completely. There is not really an established vision yet, but we do want to be at the forefront of automation and industry 4.0. Robotisation, automation and artificial intelligence are aspects that go with that. Use of Business Intelligence stems from ICT, I think it sounds good but the connection to the business is missing.	That certainly fits. A few aspects of IPA we are already using. Future projects will certainly follow suit.
	Tool	*Value.*	*Vision. Organizational problem.*	
15	Not a supporter. Conventional and traditional market where people still think in days. Purchasing department is responsible for sales order with supplier. Direction must lie	It is possible, but it requires a process that we do not have. Supplier must do it smartly.	I know of examples where it works well, but it also works badly: that has to do with the extent to which you are reliable in your consumption. I don't expect that would go well for us if we	

	with the purchasing department. Supplier does not know the process. We need flexibility.		switched to that now.	
	Outsourcing. Ownership. Flexibility.	*Outsourcing. Define process.*	*Outsourcing.*	
16	That is possible, a tool that you do not develop yourself. Purely on digitalisation, no human actions. Not being dependent on other parties.	Other alternatives may be better.	Everything can be outsourced, we have to see if we are going to buy standard software or if we are going to do it with customisation. I see no obstacle to doing this externally.	If we use an excisting system, it must meet security requirements. It must be stable. Updates must be guaranteed in the future. It must run on Windows. Self-host as much as possible. The up-time is important, so the system must be in good order. Not in the cloud, because if the connection is not in order somewhere, it will be down immediately.
	Tool. Independency.	*Tool.*	*Tool.*	*Tool. Requirements*
17	Presentation must be as minimalist as possible. It must be crossable.	It must not disrupt the main process. It must be scalable to the other locations.	It must be solid. It must be scalable. It must be flexible.	It must fit within the company's vision. It must meet security

		it must be learnable. It must be standardised. Multilingual. It must be able to connect to Navision.	Maintenance must lie with the owners.	requirements. It must be stable. Updates must be guaranteed in the future. It must run on Windows. Self-host as much as possible. The up-time is important, so the system must be in good order. Not in the cloud, because if the connection is not in order somewhere, it will be down immediately. The documentation must be in order. The costs must be kept within limits.
	Requirements	*Implementing. Requirements*	*Requirements*	*Implementing. Requirements*
18	Scalability to other products. Apply roles so that several people can order.	Implement in phases, first with 1 or 2 types of pallets at one location. Involvement of concerned persons. Looking at the whole chain of the process.	Maintenance must be transferable to the support organisation within ICT and the business that has to work with it. It must be scalable so that it can be rolled out to other locations. The technical side must integrate with the landscape, so	The technical and business requirements must be clear. Current employees must be able to work with it. My thinking is that you can implement 80% in 20% of the time, and 20% of the

			architects must help with integration. The process must be role-based, not human-dependent.	exceptions cost 80% of the time in the project, so make sure you implement the 80% because then a lot is already gained. The other 20% could still be a manual process.
	Implementing. Requirements.	*Implementing. Requirements.*	*Implementing. Requirements.*	*Implementing. Requirements.*
19	-	-	-	-
20	-	-	-	-

Appendix F – Simulation results

Table 19 Time analysis simulation results for one location (Current process)

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time
Current process of ordering packaging	Process	1	1	46m 2s	46m 2s	46m 2s
Checking how much packaging is in stock	Task	1	1	30m	30m	30m
Creates purchase order	Task	1	1	10m	10m	10m
Creates order list	Task	1	1	5m	5m	5m
Sends purchase order	Task	1	1	1m	1m	1m
Releases order	Task	1	1	1s	1s	1s

Table 20 Resource costs for one location

Resource	Utilization	Total fixed cost	Total unit cost	Total cost
Incoming goods	100,00 %	0	38,36	38,36
	Total	0	38,36	38,36

Table 21 Resource costs for three locations

Resource	Utilization	Total fixed cost	Total unit cost	Total cost
Incoming goods	100,00 %	0	115,08	115,08
	Total	0	115,08	115,08

Table 22 Time analysis simulation results (Proposed process)

Name	Type	Instances completed	Instances started	Min. time	Max. time	Avg. time
Automated process of ordering packaging	Process	1	1	42s	42s	42s
Calculates how much packaging is needed	Task	1	1	30s	30s	30s
Creates purchase order	Task	1	1	10s	10s	10s
Sends purchase order	Task	1	1	1s	1s	1s
Releases order	Task	1	1	1s	1s	1s

Appendix G – Interview treatment validation

Expert validation was used to find out whether the new process meets the requirements of the experts. Interviews were held with the relevant experts in various fields, such as procurement, operations, and IT. The background of the experts can be found in Table 23. Through these interviews, chapter 6, namely the treatment validation phase, was shaped (Wieringa, 2014). During this interview, the eight stages described in Chapter 2 Methodology were followed (Kvale & Brinkmann, 2009; Strauss & Corbin, 1998).

Table 23 Background of the experts

Expert	**Job**	**Expertise**	**Experience**
1	Purchaser	Purchasing and logistics	6 years
2	COO	Operations	14 years
3	Product Manager	Automation, IT	20 years

1. Do you think this calculation is a better alternative than a physical check how much packaging is present? Why?
2. Do you think RPA is a good solution to handle repetitive tasks? Why?
3. Do you think there is any information missing from the process? What kind of information?
4. Do you think the proposed process can work in practice?

Table 24 Interview results

Question	**Expert 1**	**Expert 2**	**Expert 3**
1	Yes, of course. At the moment, it is just a matter of guessing how much will be ordered. I think any alternative based on parameters is better. However, the data may be unreliable due to the returned packaging that is still unloaded at our location.	I am afraid that there are too many corrections because the amount of packaging after the bending orders is no longer correct. I don't think our data is pure enough because of the returned packaging and the corrections. A recount should then be	Of course. Yes, of course, you are no longer dependent on people, accuracy increases and time is saved.

		done every 2/3 weeks, just like with sheet material. This also takes time.	
2	I think so. Anything that is repetitive, you want to link to software.	I do not think this tool is suitable for this process, although it may have seemed that way at first.	Yes, I think so. However, the implementation must consider whether robotics is immediately necessary.
3	I do not think so. I think it is complete.	I think the data is too unclean.	I think you have to look very carefully at what the possibilities are in relation to the costs. And whether there are alternatives. Because I think that if you start looking at robotics, you get into a considerable investment phase. So you have to look very carefully at costs and benefits.
4	Of course it can work. But it does require some change management because for 13 years there has been no change at all. The biggest challenge is keeping track of parameters	It can work, but then you have to correct a lot. This will take more time than the current process. I think such a tool could be better applied to other processes, where we have clean data.	I have my doubts, because in this organization I often see that people work around the process. You have to come up with something that cannot be worked around. It is also about the reliability of the data, which has to be kept up to date. The system itself will work, but it's important to take the people with you.

Appendix H – Focus group summary

Table 25 Background of the experts

Expert	Job	Expertise	Experience
1	COO	Operations	14 years
2	Product Manager	Automation, IT	20 years
3	Researcher		

Unclean data:

- Sophia does not take bending into account. After bending cut products, the amount of packaging can triple or quadruple.
- Pallets can break down, this is not recorded anywhere so the data can be unclean.
- Data from WMS is clean. Actual use of packaging is known. However, the prediction of packaging in Sophia is inaccurate.
- Returned packaging also gives uncleaned data. Data must be pure by recording every movement of an item. It is not done now. Another option is to deliver all the returned packaging at the suppliers warehouse.

Potential improvements:

- Using RPA for processes with clean data.
- Using RPA for the process of ordering packaging with conditions.
- Using other technologies to measure whether we have passed through the minimum stock.
    - Scales, sensors