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Designing a Point-of-Sale System to Decrease Refunded Orders at E-Commerce Platform

Applying the Requirements Engineering Process to Provide Insights into Retailers' Preferences

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Management Summary

Introduction

Company X operates an electronic marketplace which gives local retailers in different locations in the Netherlands the opportunity to sell their products online as an addition to their physical store. The idea behind the operation of this electronic marketplace is the desire of meeting local demand with local supply. It shall give the customers an alternative to traditional delivery services which create a big competition for local retailers.

This research is conducted as part of Company X's business development and process optimization for the operations team. The information that is used to operate Company X's web shop comes from an inventory repository which is fed by information retrieved from the retailers. As the retailers operate their businesses in different ways, they also use different point of sale (POS) and information systems. While Company X can establish a live connection with some of these systems and gets daily updates on the retailers' inventories and stock levels, some retailers do not have POS systems which can be connected to Company X's inventory repository. This leads to frequent refunds. Refunded orders are orders that are placed but cannot be completed in their entirety due to insufficient inventory at the retailers' locations. In that case the amount of money paid for the unavailable items is refunded to the customer. Consequently, the customers do not get their entire order delivered, but only receive the products that are available at the stores. Company X is already looking at different ways to decrease the number of these refunds. While some potential solutions have been explored in previous research, introducing new POS systems at the retailers, who do not have a live connection with Company X, was identified as another potential solution.

This research aims at getting insights into the retailers' requirements for a new POS system and at understanding, how successful an introduction of this POS system would be. This will give Company X valuable information to make further decisions on how to decrease the number of refunds.

Research methodology

The requirements for a new POS system are established based on the requirements engineering process, which is a common practice in software systems development. Initially, potential requirements are determined based on observational research, semi-structured interviews, and literature search. These requirements are validated using a survey. The survey is shared with the research population of retailers who currently have no systems allowing for a live connection with Company X's inventory repository. Next to validating the requirements, the survey is used to assess the likelihood of a successful introduction of the new POS systems at the retailers. Eventually, the requirements are prioritized using the MoSCoW rule. Afterwards the requirements are modelled and recommendations for further action are given.

Main findings

63.33 % of all participating retailers indicated that they either have a neutral or a positive attitude towards the introduction of the new POS system. An introduction of the new POS system at these retailers can help to decrease the number of refunds from currently 11.66 % to 4.28 % in the best case. Next to that, the workload of both the retailers as well as Company X's employees can be decreased significantly through automation of the inventory updating process.

The functional requirements that should be included in the design of the POS system were identified to be a payment processing function. Further, an inventory management function that allows for continuously updated stock levels which can also be manually adjusted in case errors in the data are identified, and in which bulk updates of the inventory can be performed for

larger numbers of products was identified as useful. Next to that, an analysis and reporting function which should be able to keep track of customers' purchases and preferences was selected. Finally, a connectivity that can be established between the retailers and Company X's web shop as well as their own web shop was identified to be of high importance. Further functionalities were identified and can be included. However, Company X is advised to focus on the most important requirements and to keep the complexity of the system to a minimum.
The non-functional requirements of a good usability, deployability and security were identified to be of high importance. Weights have been assigned to the specific requirements to allow for an easy assessment of their performance that considers the retailers' opinions. A well-functioning POS system with few key functions is identified to be more important to the retailers than a POS system with many features.

Conclusions

The overall interest in the POS system is a good motivation for introducing the POS system to an initial group of retailers. This group should be the 63.33 % of retailers who have shown a neutral or positive attitude towards the new POS system. The interested retailers have given multiple reasons for switching POS systems and are interested in a variety of features. This makes convincing the interested retailers to use the new POS system much easier compared to the less interested retailers.
Nevertheless, the less interested retailers are still of importance to Company X, since refunds also occur in the orders placed at their locations. Thus, special focus in the design should also be placed on the features that are important to retailers with a negative attitude towards the new POS system. This potentially makes them more likely to switch to the new POS system. A successful introduction of the POS system at the retailers who showed interest in it could be used as an additional motivation for others to integrate the system as well.

Table of Contents

List of tables

List of figures

1 Introduction

1.1 Company X

Company X is a relatively young start-up company that was founded four years ago. They provide an online marketplace for its customers in the locations Amsterdam, Rotterdam, Utrecht, Den Haag, and Groningen. On their website, customers can purchase not only foods and drinks, but they can choose from a wide range of products including books, fashion items, and do-it-yourself products. To provide these for their customers, Company X works in cooperation with the residual retailers at each of their locations. Thus, the customer can order something from a local store, and it will be delivered within a few hours, or even faster if the situation allows it. Deliveries are completed using electric cargo bikes.

Delivering products directly from the stores makes it possible for Company X to not be reliant on an own warehouse from which the orders are packed. Instead, the delivery drivers simply drive to the retailers and pick up the products right from the store. This way Company X can save costs that would otherwise be incurred for renting and operating warehouses. This is one big advantage that Company X has over their competitors in the e-commerce industry. However, this practice also makes Company X dependent on the retailers to be able to provide the requested products at the time of the orders.

1.2 Problem identification

The data necessary for operating the online marketplace of Company X comes from an inventory repository. This data includes inventory levels, prices, the products' bar codes, and images. The retailers can update these data variables through a merchant portal on the website.

The merchant portal is the back end of Company X's website which can be used by the different retailers for managing how their store is represented on the website. Inside the merchant portal the retailers can make manual changes to the inventory levels of the products as well as to the prices of their products and how they are organized within the store's categories. However, new products cannot be added here, and the products can also not be enriched with new images or descriptions.

For their marketplace to run smoothly and to make sure that the products are available for delivery, Company X depends highly on the data to be accurate and up to date. This is currently one of the biggest bottlenecks Company X is facing as the updating process is not always automated for every retailer and is time intensive for the retailers. The consequences are frequent orders which need to be refunded. This means, a retailer needs to issue a refund and the customer will be notified that a product is not available. It was found in Company X's database that over the period of the last three years the average number of orders including a refund lay between 4.6875 – 14.6875 % of all orders. After that, the amount of money that was paid for the missing product is transferred back to the customer's account and only the available products are delivered. The issue of refunds is explained further in Chapter 2.2.2.

1.3 Previous research within Company X

In previous research, Sara Lute (2021) has already explored different options of improving the situation regarding the inventory updating and the number of refunds that are connected to this. Next to the proposed solution, another promising way of updating the inventory data in a regular and reliable fashion has been identified by Lute. However, it has not been explored as a part of their research, as it was too extensive to be included. The potential solution for this issue is the introduction of Company X's own POS system enabling a live connection of

information between a retailer and Company X. In her conclusions, Lute has recommended to conduct an additional research project which investigates this topic in more detail.
A point-of-sale system provides hardware and software that is needed to conduct transactions at the check-out (Johnson, 2022). Traditionally, point-of-sale systems include hardware such as barcode scanners, cash registers and recipe printers which enable the retailers to perform the tasks that are necessary whenever a customer wants to purchase a product or a service. However, modern POS systems can perform more tasks, than simply helping the retailer to check out a customer. For instance, they can give them the opportunity to keep track of their inventory or get more insights into their sales via an accounting or reporting function. As it is a POS system's core function to enable the retailers to process payments, this requirement will be a must-have functionality and will not be researched further into in the context of this work. The focus will be mainly on features, that add to this payment processing function.

1.4 Research motivation and aim

This work connects directly to Lute's research. The aim of this research is to provide insights into the needs and requirements for a new POS system that will allow for a live connection with Company X's inventory repository. Figure 1 represents the problem cluster that was used to identify the core problem of this research. The problem identified by Company X is the large number of refunds due to insufficient stock at the retailers. This was identified to be the consequence of data inaccuracies in the inventory repositories. The inventory repositories need to be updated manually if a retailer does not use a POS system allowing for a live connection between the two parties. This has two underlying roots. On one hand, some retailers do not fully understand the benefits of a POS system. On the other hand, the retailers are missing a system on the market that is based on their needs. Company X does not fully understand the retailers' needs and requirements as well and thus, they cannot provide the retailers with a fitting solution yet. This lacking insight into the retailers' requirements was identified as the core problem. By understanding the retailers' needs and requirements, Company X can make a well-founded decision what a potential POS system should look like. In addition to that, this information will add to the results from previous research, so that the management can choose which potential solutions will be applied to get rid of the large number of refunds.
The new POS system should ideally be introduced to a broad range of retailers who currently do not have a running live connection with Company X. Thus, it will be of high importance to take these retailers' opinions into account when designing the new system. The main goal of this research is to give Company X insights into the requirements and opinions of the retailers who currently do not have a live connection to Company X's inventory repository. In addition to the retailers' interests, the ideas of Company X's employees will also be captured via qualitative interviews. They will not work with the POS system eventually, but they will still be directly affected by the information that is gathered and updated via the POS systems.
Within this research it will also be assessed how likely the retailers are to introduce the new POS system. This will provide valuable information helping Company X's management to make decision on whether to continue with such a project. It is important to conduct this research early on, to prevent the spending of valuable resources on a project which will not give Company X any value in the end because the retailers refuse to make use of the system.

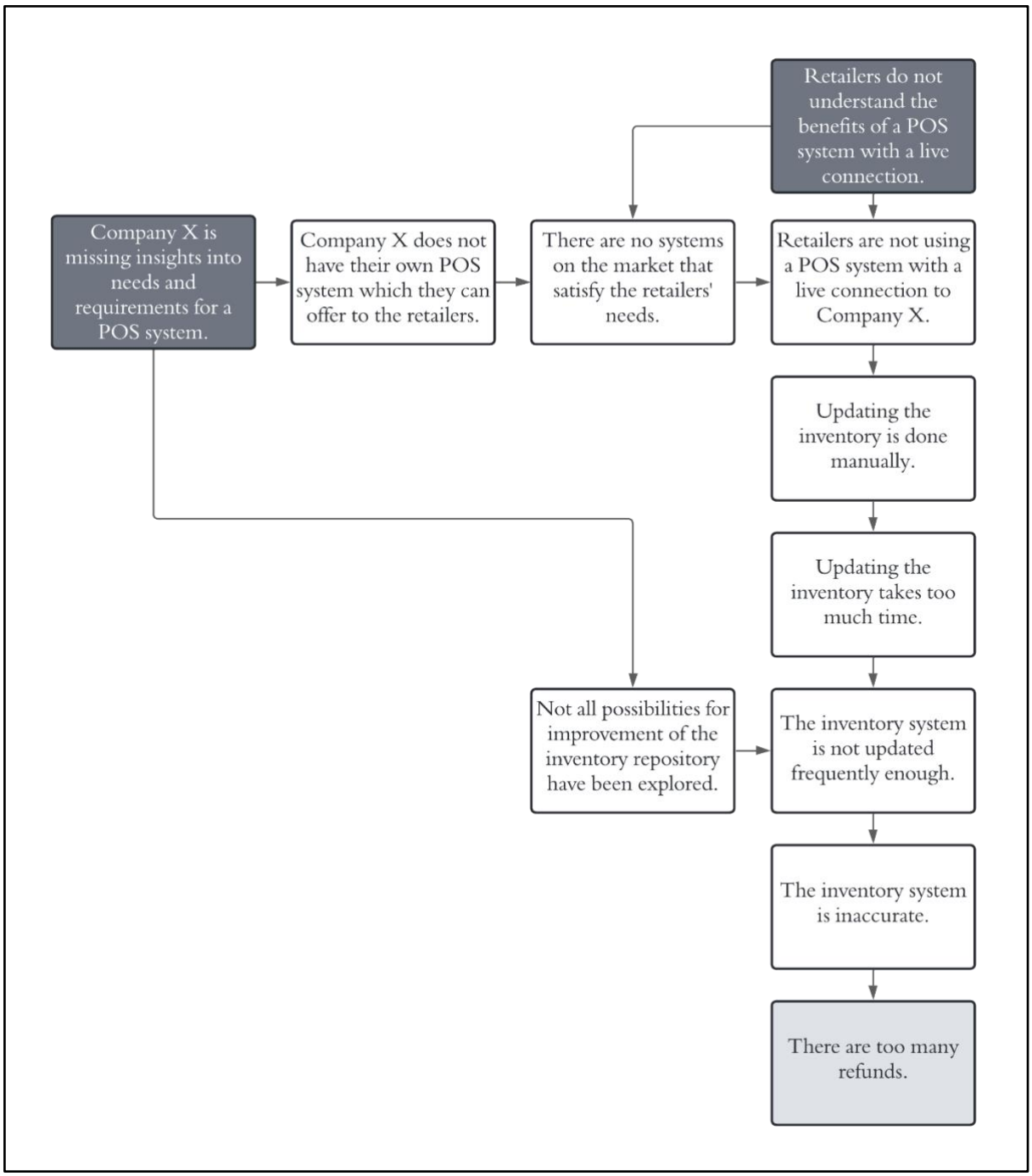


Figure 1: Problem cluster

1.5 Method

In software and systems engineering, requirements engineering (RE) plays a central role. P. Zave, who is an American computer scientist at the Princeton university, has defined it as the "the branch of software engineering concerned with the real-world goals for functions of, and constraints on software systems" (1997). This definition fits this research well, as it puts emphasis on the real-world goals that are the basis for the software development. In this research the stakeholders' real-world goals are derived.

Rudeck (2013) explained how requirements errors are responsible for roughly 20 % of development costs and that some companies can manage to increase their profits by 15 %

through addressing the challenges of changing requirements more effectively. This motivates the use of requirements engineering from an economical point of view.
Furthermore, Nuseibeh & Easterbrook (2000) explain that the success of a software can best measured by how well it meets its intended purpose. In case the entire design process is based on the stakeholder's requirements, the greatest success of a software system can be guaranteed.
In their roadmap for Requirements Engineering, Nuseibeh & Easterbrook (2000) explain the different steps of Requirements Engineering. This chapter will present the most important steps of Requirements Engineering and explain, how it relates to this research. The activities can be intertwined and even later, during the design phase, there can be changes to the initially chosen requirements as they develop throughout the process. Rudeck (2013) also emphasizes the importance of managing the requirements over time as poor management of requirements could potentially also lead to a delayed time to market, an unpredictable and inconsistent delivery and poor customer satisfaction.
The first step that is identified in their report is the "elicitation of requirements" (Nuseibeh & Easterbrook, 2000). They further explain that the information collected needs to be interpreted, analysed, modelled, and validated. Only if these steps have been completed, a complete enough list of requirements for a system or software has been established.
The main goal of elicitation is figuring out what the underlying problems are that need to be solved. Another important task of the elicitation is the identification of stakeholders. These can include clients, developers, and users. In the elicitation process it is also important to identify the needs of different user classes. This means that different users could potentially have different requirements for the system. According to Nuseibeh & Easterbrook (2000) eliciting the main goals of the software early is fundamental. This shows the importance of the elicitation process. They also explain that the requirements elicitation continues throughout the development process and that high-level goals are refined into lower-level goals later. The elicitation process puts the focus on the stakeholders' needs, rather than the potential end product.
The next step in the RE process following Nuseibeh & Easterbrook (2000) is the modelling and analysis of requirements. The main goal of this step is to enable better communication with the stakeholders, who might not have a technical background. With a model, it can be easier to see the positive and negative aspects of a proposed solution. This makes the models also a valuable tool for the further elicitation process. Based on the models, new information from the stakeholders can be gathered, which will help to fit the software developed even better to the stakeholders' requirements.
The communication of requirements is the next step and is about the documentation of the requirements. In this step, the requirements should be documented in a way that ensures that they can be read and understood easily and be validated by additional stakeholders (Nuseibeh & Easterbrook, 2000). As it was explained above, the requirements can evolve throughout the entire development process, and to make sure that no information is lost in this evolution, the documentation is very important.
During the entire development process, it is important that the stakeholders agree on the requirements that were set for the product. It is important to continuously check whether the goals of the stakeholders are met with the proposed requirements for the system. This should not only be done by comparing the software to the initially set requirements, but the stakeholders should get an active role in the development process and should continuously be asked for their approval. Like this it can be avoided that the solution is refused in the end of the development process and that valuable resources are wasted. One major difficulty in this part can be the agreement of the different types of stakeholders. Different types of stakeholders can have different interests and requirements for the new system. Thus, it can be a challenge to simultaneously satisfy all their needs. To facilitate with this, the win-win approach was

introduced (Nuseibeh & Easterbrook, 2000). The various stakeholders shall be asked for their conditions under which they would be satisfied with the solution and the software development process should be managed in a way that meets all these conditions. Sometimes negotiation among the stakeholders is necessary to find an agreement.
The last activity in the requirements engineering process that is pointed out by Nuseibeh & Easterbrook (2000) is the management of change. As explained earlier, it happens throughout the entire development process, that changes to the requirements need to be made. These can include adding or deleting entire requirements or simply adjusting them a little to better fit the needs of the stakeholders. Thus, it is important not only to document these changes, but also to measure the effect of these changes before they are made. The software needs to be evaluated frequently and as mentioned above the stakeholders need to be involved in this evaluation process. The trade-off between cost and benefit of a change must be assessed every time a change to the existing software is made.
Nuseibeh & Easterbrook (2000) explain that the development of software system product families is of high importance for the development activity. Software system product families are a range of products which share core requirements. However, the products can differ slightly in case the fulfilment of one stakeholder's requirements hinders another stakeholder's satisfaction. This could come in especially handy in case retailers that operate in different industries have very different requirements for the final product. In that case different versions can be offered to different retailers to make sure that their needs can be fulfilled.
This research corresponds greatly to the requirements engineering process. The objectives of the various stakeholders are identified through interviews. A validation of these requirements is made through a survey to make sure, that the actual needs of the various stakeholders are represented in the requirements for the POS system. Next, a visualization of the requirement is given. By performing these steps, Company X gets a first impression of their stakeholders' needs and can make further decisions, about what actions they are to take next. The visualization of the requirements helps them to communicate the requirements within the own operation and with potential external stakeholders, such as potential future investors or retailers that consider implementing the POS system.
Various elicitation techniques exist. In the context of this work, the focus will be on the so-called "traditional elicitation techniques" (Nuseibeh & Easterbrook, 2000). These include the use of questionnaires, surveys, interviews, and findings from previous research.

1.6 Research design

Figure 2 visualizes the research process. Initially, the current situation is explored through observational research at Company X and through interviews with five retailers and five employees representing the group of stakeholders. In addition to that, the interviews are used to elicit potential requirements. The potential requirements are validated within a survey that is shared with all retailers who currently do not have a live connection with Company X's inventory repository through e-mail. In the survey the retailers' likelihood to introduce a new POS system is also assessed giving Company X an idea of how well the new POS system will be accepted by the retailers. After assessing the different requirements' importance, the most important requirements are chosen and modelled to enable communication among stakeholders. Finally, conclusions are drawn and recommendations for Company X's management are given.

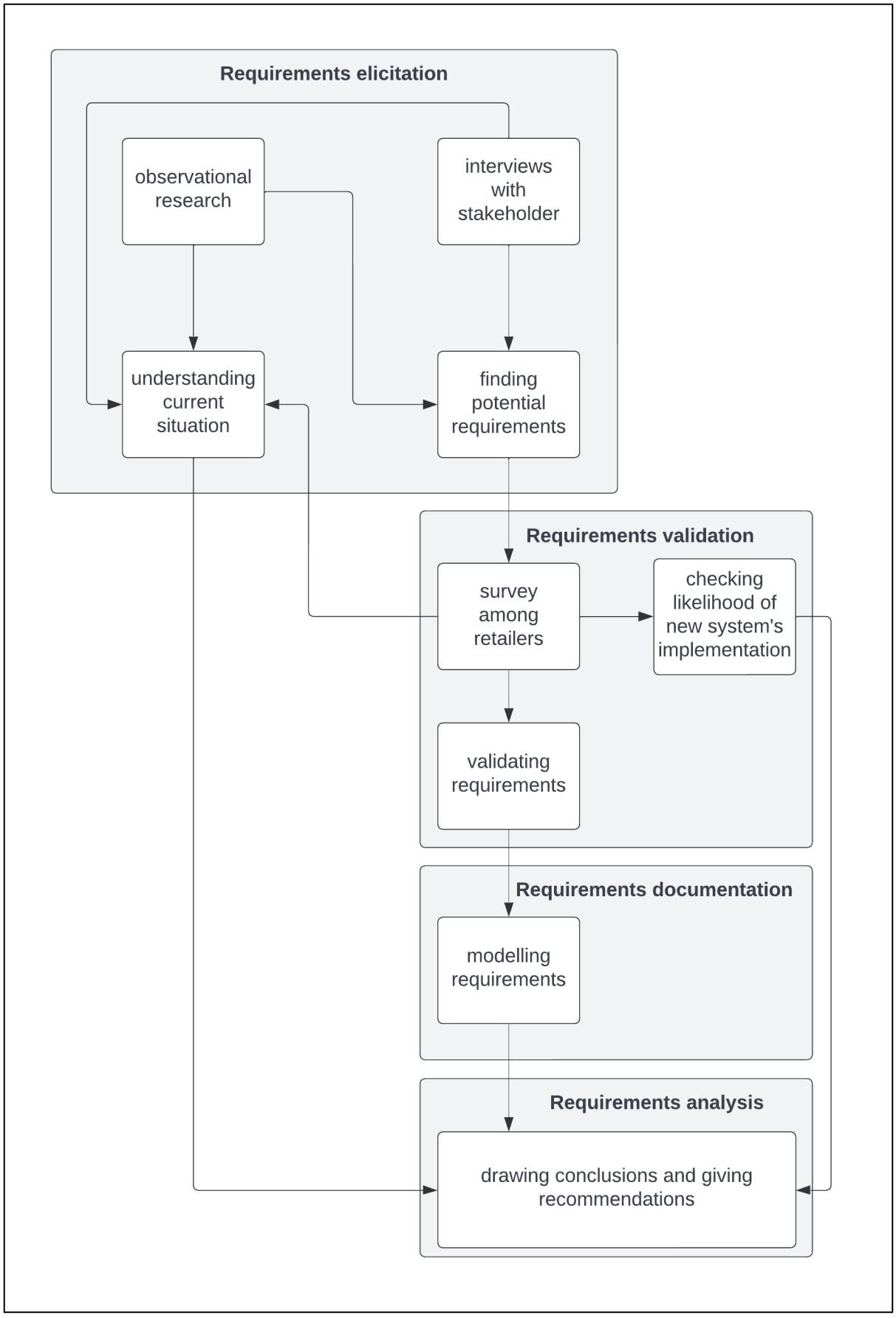


Figure 2: Conceptual model of research design

1.7 Research questions

The main research question for this research and for solving the core problem is as follows:

What requirements should a POS system's design satisfy to decrease the number of refunds at Company X while making it attractive for retailers to implement it at their stores?

To give this research more structure, the main research question is broken down into multiple smaller research questions which are answered throughout this research. Below, these research questions are explained and motivated and it is shown in which part of this work the research questions are answered.

To find a suitable solution that can give value to Company X, it is important to establish the current situation and to explain, how a potential solution can improve this. To do so, the data that is available on refunds at Company X is used. In addition to that, the retailers and the employees at Company X were asked about their perspective on the current situation. This question is answered in Chapter 2. Even though this is not part of the requirements engineering process, it is vital to this research as it will show where the problem is located.

Research question 1: What is the current situation regarding refunds at Company X?			
Key variables: percentage of orders with refunds	**Research population:** retailers, Company X's employees	**Research method:** observational research, interviews, survey	**Phase in Requirements Engineering process:** none

The retailers are the users and main stakeholders of the POS systems. Thus, it is crucial to integrate their requirements into the design of a POS system. Without taking these into consideration, the POS systems might not satisfy the needs and will not be accepted by the retailers which can lead to the POS system being of little use for Company X in the end. The potential requirements will be identified through interviews that are conducted with a small sample of retailers.

Next to the retailers, the employees are also affected by the introduction of the POS system. Their requirements should be considered as well. They also have insights into the retailers' way of conducting business which is why they might have additional information on the retailers' requirements.

Finally, potential requirements from literature are added to make the list of potential requirements more comprehensive. The potential requirements are explained in Chapter 3.

Research question 2: What potential requirements exist among the stakeholders and in literature?			
Key variables: retailers' and employees' potential requirements; potential requirements from literature	**Research population:** retailers without a live connection; Company X's employees; literature on POS system design	**Research method:** interviews; observational research; literature search; survey	**Phase in Requirements Engineering process:** Requirements elicitation

It is unlikely that each requirement is equally important to the users. To decide which requirements to include in the final design, it is important to assess the requirements'

importance. The importance of the requirements is assessed via an online survey that was shared with the retailers who have not yet established a live connection with Company X's inventory repository. This topic is addressed in Chapter 4.

Research question 3: How important are the potential requirements for the relevant retailers?			
Key variables: importance of potential requirements	**Research population:** retailers without a live connection	**Research method:** online survey	**Phase in Requirements Engineering process:** Requirements validation

After checking how important the various requirements are for the retailers and understanding what the driving reasons for switching POS systems are, a set of requirements to be implemented in the design phase is generated based on this information. Chapter 5 discusses this research question.

Research question 4: What requirements should be considered with priority in the design of a new POS system?			
Key variables: importance of requirements, likelihood for a switch	**Research population:** results from online survey	**Research method:** data analysis	**Phase in Requirements Engineering process:** Requirements validation/analysis

Company X is not only interested in what requirements matter for the retailers, but also, how likely they are to make use of the new POS system eventually. If the retailers do not show a high interest in the new system, there is no reason for designing and programming it. The retailers' interest in the new POS system is also assessed through the answers to the online survey. In addition to the overall likelihood of a store to eventually implement the new system, the retailers will also be asked about what the main reasons for switching to the new POS system are. This is relevant to Company X as it helps them to set the right focus in the design phase of the POS system. This research question is the topic of Chapter 6.

Research question 5: How likely are the retailers to introduce the new POS system?			
Key variables: likelihood of an introduction of new POS systems	**Research population:** retailers without a live connection	**Research method:** online survey	**Phase in Requirements Engineering process:** Requirements validation/analysis

Next to getting an understanding for the most important requirements, that the different retailers have for the new POS system overall, Company X is also interested in the identification of sub-groups of retailers and the differences that can be found among them. This is also of interest for Company X as it can help them to identify groups that have requirements or needs that are different from the remainder of the group. This matter is discussed in Chapter 7.

Research question 6: What sub-groups can be identified based on the results of the online survey?			
Key variables: importance of requirements, likelihood for a switch	**Research population:** results from online survey	**Research method:** statistical comparison, tests	**Phase in Requirements Engineering process:** Requirements analysis

1.8 Limitations and scope

The main limitation of this research is the fact that it relies on the participation of an external group of retailers who do not gain a direct advantage by participating in it. This could lead to the participation rates to be low and the effort that is required to get the retailers to participate to be high. In addition to that the results come solely from the population of retailers that currently work with Company X. Thus, they cannot be used to make assumptions for the overall population of all retailers who operate in the Netherlands.

Another limitation is the time that will pass until the information gathered in this research is applied. As Company X is currently looking for investments that help them to finance projects like this, it will take some time until resources for such a project are available. In this time the circumstances can change which means that it will need to be checked whether the findings from this research are still relevant.

The scope of the research is limited to retailers that operate in the five locations in which Company X operates. Namely these locations are Amsterdam, Den Haag, Utrecht, Groningen, and Rotterdam.

Next to that, only retailers without a current live connection to Company X's inventory repository are part of this research. No assumptions for the overall group of retailers working together with Company X can be made based on the results of this research.

2 Current situation

In this chapter the first research question is answered by looking at the current order data at Company X. This is done to understand the underlying problem and to give the reader an idea of why it is relevant for Company X to address the problem of having too many refunds. In Chapter 2.1 it is shown how the data is currently updated using the different connections that retailers can have with Company X. The problems that result from this way of operating are highlighted. In Chapter 2.2 the refunds are explained and quantified. In addition to that, potential consequences of having too many refunds are given to show the importance of reducing the number of refunds.

2.1 Data updates

Company X offers a wide product selection on their marketplace. Thus, they work together with a wide variety of retailers who all handle their operations differently. While there are retailers who do their business without much support of technology and might only use some offline product lists, other retailers even manage their own web shop including accurate inventory counts. The retailers can be split into two different categories based on the type of connection between the stores and Company X's website.

Some stores have a live connection with Company X's website. In this case the retailer usually also has their own web shop, and they can provide Company X with so called keys. These keys enable Company X to retrieve all the information that exist on the products and update the information on Company X's website daily. Usually in the early morning of each day the data is synchronized with the retailer's own information system meaning that in the beginning of a day the data is most accurate. However, as the retailers do not have an option to add new products themselves, they need to request a Company X employee to add products. The employee in turn enriches the product data with images and descriptions and finally adds it to the web shop. Figure 2 shows the process of updating the information in case a live connection exists. Problems only arise from the time between updates. That is because during this time the recorded stock levels and the actual stock levels in the store can differ due to physical sales in the store that are not recorded in the inventory repository until the next morning. This potential cause for inaccuracies is depicted by a flash symbol and the waiting time is depicted by the clock symbol. Another potential problem could arise from the fact that retailers always need to ask a Company X employee for changing the product list they are offering on Company X's website. This leaves a greater workload for Company X' employees while the retailers are left with little autonomy for arranging their products on Company X's website. However, this problem is not related to the large number of refunds and is not part of this research.

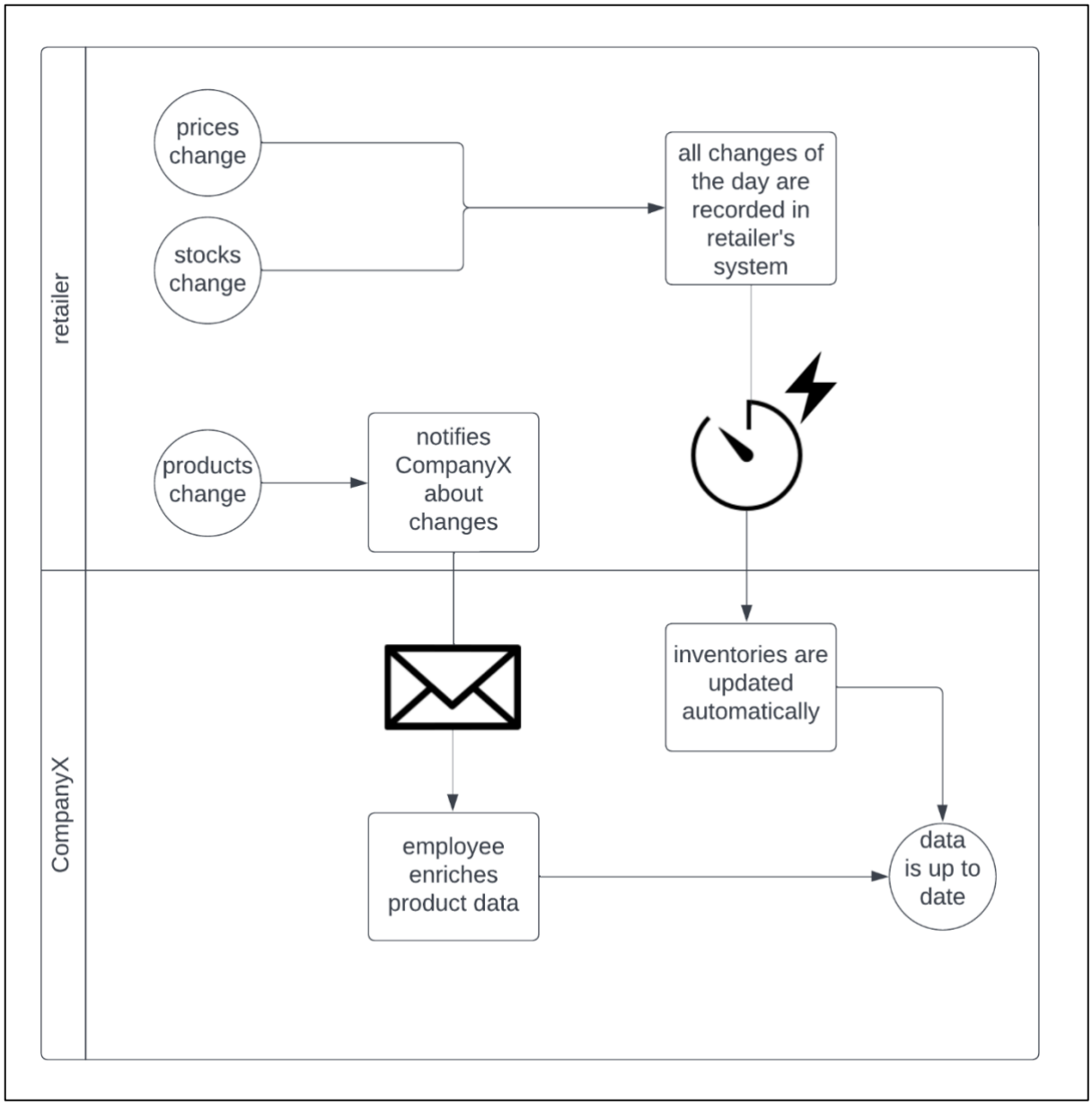


Figure 3: BPM of data updates with an existing live connection

When a store does not have a system in which the inventory information can be updated automatically, it is said that there is no live connection between the retailer and Company X. At the time of this research this was the case for 66 retailers throughout the different locations. This usually means that the retailers must manually make changes to the information shown on Company X's website through the merchant portal. Alternatively, they can make a data export of their information system or of their product list. This list is imported to Company X's data repository by one of Company X's employees. The export needs to be manually checked by the employee for errors or inaccuracies. In the interviews an employee mentioned that it can take a couple of minutes or up to a few hours until the new data is integrated. However, if new products are added to the retailers' web shop it can take longer as the data needs to be enriched to give the product a nice appearance on Company X's web shop. To do so, product images or descriptions must be added.

Both options are not ideal, as they leave a high risk for human errors and are inefficient when compared to the automated updates. Either the retailer or the Company X employee needs to perform tasks manually. This risk for human errors was also identified to be an existing

problem by some of the interviewed employees. Figure 4 shows the updating process if no live connection between the retailer and Company X is established. Compared to Figure 3, there is more room for error which is again represented by the flash signs in the figure. Problems within the process can arise if the retailer does not send updated lists of the stock by themselves meaning that a long time can pass before the system is updated. This results in a larger number of inaccuracies between the stock in the physical store and the recorded online inventory. Next to that, it was mentioned that it can take up to several days until a retailer sends the requested updates. This again increases the number of inaccuracies due to longer waiting times. Last, the exports need to be made manually by the retailers. Consequently, there is always a chance that errors happen in this step as Company X's employees have explained that many retailers are not very proficient with digital systems and handling computers. The exports could, for example, be incomplete which again leads to more workload for Company X's employees and increases the amount of time that passes until the information is eventually updated.

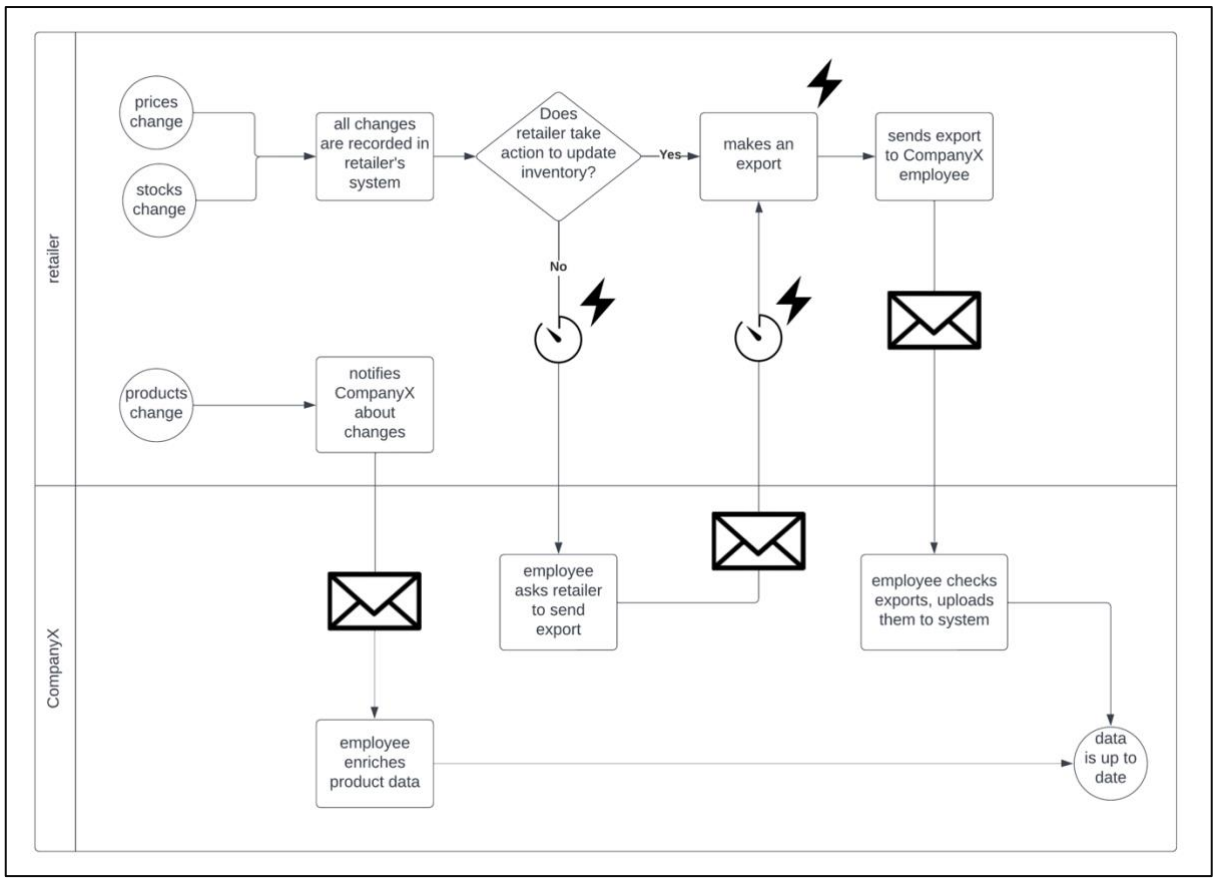


Figure 4: BPM of data updates with no existing live connection

The idea of introducing a new POS system aims at improving the situation of those retailers who do not use POS systems enabling automated updating and therefore do not have a live connection with Company X. The problem of data inaccuracies is the biggest in this case due to the large amounts of time between updates of the inventory information and the larger number of tasks that need to be performed manually. The more time passes between two data updates the bigger become the data inaccuracies between the physical inventory at the retailer and the recorded inventory online. Besides, more manual work leaves more room for human error on both the retailers' and the employees' side.

2.2 Refunds

2.2.1 Explanation of refunds

The issue of lacking data accuracy is best shown in the number of refunds which are orders that cannot be fulfilled by the retailers in case there is no sufficient inventory at hand. Such a refund can be partially in case only a part of the order placed is not available in the shop. Alternatively, entire orders can be refunded if none of the requested items are available.

To prevent refunds, ideally only products should be shown on Company X's marketplace that are available at the retailer offering this product. Whenever a product is currently not available, the product should be clearly marked as such on the website. On Company X's web shop, products that are currently not available are shown without colour and there is a red caption on the product image saying, "Back soon". Figure 5 shows the difference between items that are available and those that are currently marked to be out of stock. Furthermore, customers cannot add these items to their basket anymore, so the retailer does not have to cancel the purchase later. This is the optimal case and happens only if the information on the products' stock is updated accordingly.

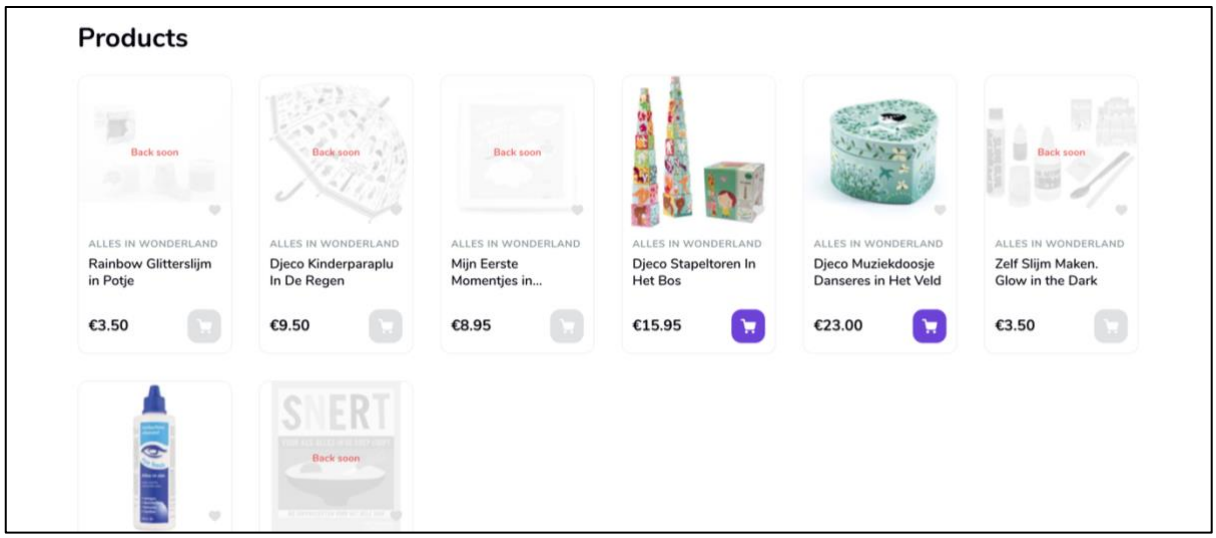


Figure 5: Available and unavailable items on Company X's website

To mark a product as not available, the retailer must go to the merchant portal on the website's back end and select the item to be disabled or they need to put the item's inventory level to zero. This is done automatically if the inventory updates regularly through a live connection between the retailer's systems and Company X's inventory repository. If such a connection is not available and the recorded stock does not change with the sales made, it needs to be done manually. In the interviews however, all five retailers explained that they do not make any manual changes to the stock levels and only barely disable them on Company X's web shop. They explained that this was too time-consuming for them as they all sell a large variety of products with constantly changing stock levels. All the five interviewed retailers use an option allowing them to set the inventory of their products to an infinite amount. In this case, the products are always shown as available on the web shop. The fact that retailers do not take time to adjust the stock on the merchant portal is a major problem that can potentially be resolved by taking away the need for manual adjustments in the merchant portal through introducing automation within this process.

Before requesting a refund, the retailers are encouraged to contact the customers and ask them whether they would like a substitute product if there are similar products in store. This is done to make sure that the customer does not feel the dissatisfaction of an incomplete order. Only if the customer does not like the proposed substitute product or they cannot be reached, the order

needs to be fully or partially refunded. In either case, this increases the amount of work for the retailer. In the interviews four out of five retailers said that they use this option and try to contact the customer whenever an order cannot be packed completely. According to the interviewees, the customers' responses vary a lot. Some retailers explained that customers are happy to take a substitute product while others respond very rudely and do not want to take substitutes. Another downside of this option mentioned in the interviews is that it can take a considerate amount of time to contact the customers. This decreases the motivation to avoid refunds by offering substitute products.

According to Company X's order data, the number of refunds makes up 8.52% of all the orders that have been going in since the data gathering started in July 2020. When looking at the years separately, an upward trend can be identified. While in 2020 only 4.84 % of orders where refunded, this number has increased to 7.11 % in 2021. In May 2022 the current percentage of refunded orders is 11.66 %.

When refunding an order, the retailers also can give the reason for the refund. Not every time the order is refunded, it is because the requested item is out of stock. Based on Company X's data, overall, 62.60 % of the retailers gave the reason that there was insufficient inventory to complete the order. 13.90 % of the orders were refunded due to a customer request and 11.67 % of them gave the reason "other". This leaves 11.83 % of orders for which no reason for the refund was indicated by the retailers. This could either be due to the lack of time or the lack of training. However, if we assume that the proportions of reasons for the refunds behaves similar as in the remaining population, the number of refunds due to insufficient inventory amounts up to 71 %, while customer requests are responsible for 15.76 % of refunded orders and "other" makes up 13.24 %. This is shown in Figure 6.

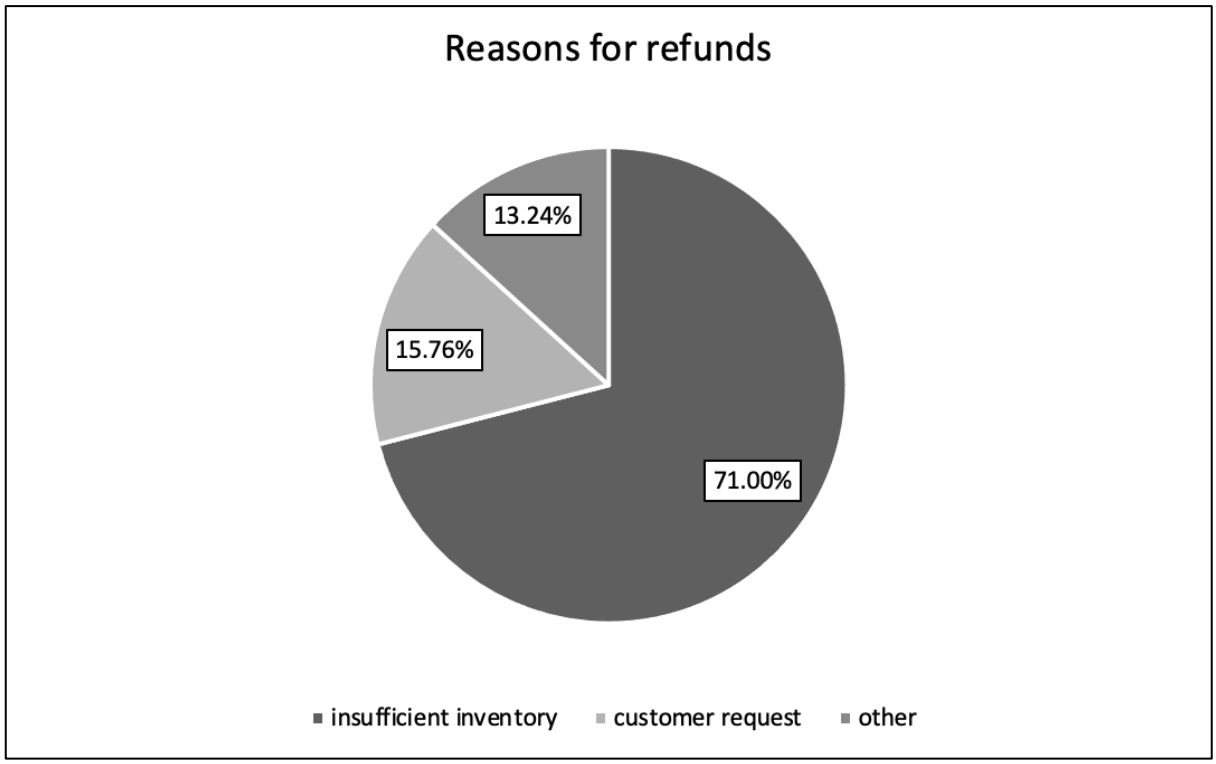


Figure 6: Reasons for refunds

The percentages of refunded orders due to insufficient inventory compared to total refunds grouped in years are depicted in Figure 7. It also shows the clear upward trend of refunded orders throughout the years. This means that the problem of refunds due to insufficient

inventory can be expected to grow further in the future in case no action to resolve it is taken. This trend underlines the importance of taking action regarding this matter.

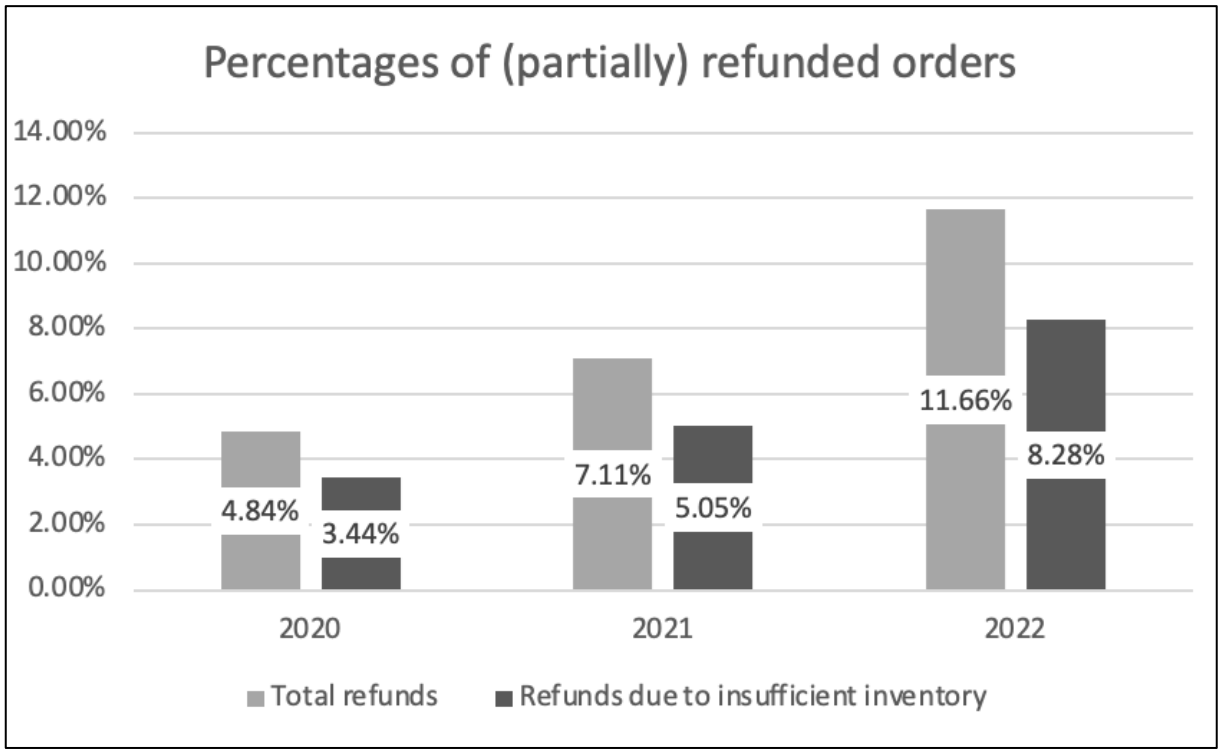


Figure 7: Total refunds and refunds due to insufficient inventory in percent of total orders

In the survey, the largest group of participants indicated that between 0-10 % of their orders cannot be completed due to insufficient inventory. The average percentage of the incomplete orders, as indicated by the retailers, lays between 4.6875 % and 14.6875 %. This is calculated based on the answers that were given by the retailers and could vary slightly from reality for reasons such as personal perception. It should be noted that the margin of error was not included in this calculation yet, which means that the real average values that are true for the entire research population can vary further from this. However, the values seem to comply with Company X's data. Figure 8 visualizes the percentages of refunded orders due to the insufficient inventory as indicated by the retailers. Very striking are the two participants that have indicated to have either 31-40 % or 41-50 % of orders refunded which means that there are few cases where the situation is much worse than the rest. Company X is advised to investigate further what the reasons for these extreme cases are.

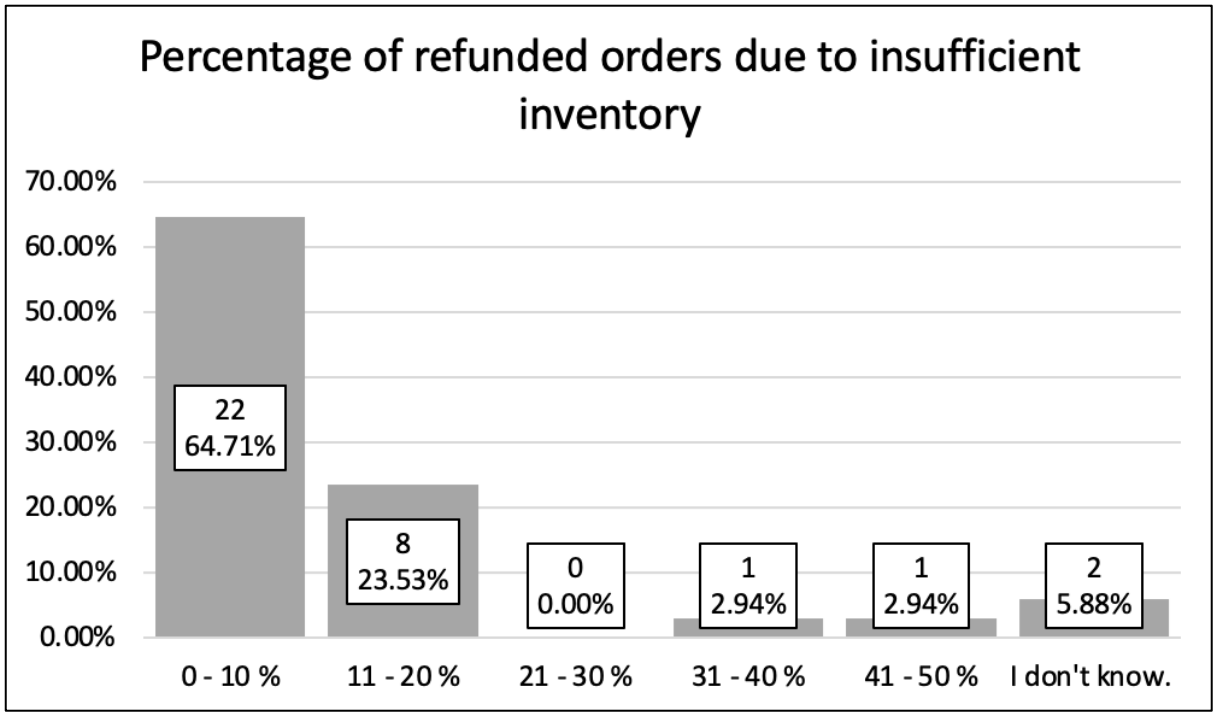


Figure 8: Percentage of refunded orders due to insufficient inventory

2.2.2 Consequences of refunds

Refunds or cancelled orders should be avoided or at least kept to a minimum for different reasons. Firstly, refunds can have a negative impact on the customer experience. If a customer experiences a refund, this "leads to frustrated and angry customers and creates a very negative shopping experience." (L. Mulder, 2021). The best scenario for Company X in case of a refunded order would be if a customer was either willing to wait for the product to be restocked or if they purchased a substitute product from the retailer. For Company X this would mean that no sales are lost. However, the customer will most likely still feel a certain dissatisfaction as their needs cannot be fulfilled entirely. If this would only happen once, this might not be a big problem for the customer. However, if they continue to have these negative shopping experiences, it can also lead to customers not returning at all or negative word-of-mouth among the customers (cf. UKEssays, 2019). This can give Company X a bad reputation within the market. In turn, this might slow down Company X's growth opportunities as new customers will be more hesitant to try out Company X's service if they have the reputation that orders are often cancelled. This potential threat was also identified during the interviews conducted with the employees. If the customer does not want to wait for their product to be restocked or does not want to choose a substitute product, there is the chance that a customer will go to a competitor in the market and simply purchase the desired products there. This means lost profits for Company X, and it is possible that the customer will not return at all. In the interview with an employee, it was mentioned, that attracting new customers is very expensive now, as marketing activities cost a lot of money. If the new customer does not have a good experience on their first purchase through Company X and does not return, the money that was spent on attracting them is wasted.

Secondly, the refunds can also have a bad impact on the relationship between the retailer and Company X. Refunds can lead to customers trying out different stores instead (L. Mulder, 2021). If they believe that the other store can satisfy their needs in a better way, then they might not return to a store that they have had a bad experience with even if it is only through Company X's web shop. In turn, this will decrease the number of sales that a store generates through Company X, and this will leave a bad experience for the retailer. Retailers join Company X's

platform with the objective to reach more potential customers and therefore also increasing their sales. If the retailers have the feeling that the partnership with Company X does not help them enough and they need to put in more effort than they get value out of the cooperation, they will perhaps be dissatisfied. A consequence of this can be a termination of the cooperation. One of Company X's employees explained that the retailers are just as important to Company X as their customers. Since without them Company X would not be able to conduct any business at all. Thus, negative experiences for the retailers are another negative impact of the refund and should not be ignored.
Lastly, one of Company X's employees believed, it also conveyed a bad image for potential investors, as it came off as unprofessional to have large numbers of refunded orders. Now, Company X is in a position, where they try to find investors and then it became especially important to be able to convince the potential investors with convincing numbers.
In the interviews, all five of the retailers said that they take no measures to avoid orders from being incomplete in the first place such as keeping an extra stock that is reserved for orders through Company X. As a reason for this, it was mentioned that the orders through Company X's web shop do not follow a clear pattern, as they do for customers walking into the physical store. This makes it hard to anticipate sales. Therefore, increasing the stock levels in anticipation of larger sales numbers is risky as it can increase the costs incurred if the unsold products go obsolete. However, all the five retailers do not see a big problem with the large numbers of incomplete orders. They explained that they do not depend too much on the customers that order through Company X. Their focus are the customers that walk into the physical store. One of the retailers said that Company X is merely a nice addition to their sales, but that they are not very dependent on their sales through Company X.

2.3 Summary of the current situation faced by Company X

In this chapter the current situation at Company X has been explained. The most important retailers for the problem faced in this research were identified to be the retailers that do not have any systems supporting a live connection between their store and Company X. This is due to the large amounts of time that pass between two consequent updates of the inventory repository. These are caused by the need for manual adjustments in the merchant portal that are too time consuming and are rarely done by the retailers. In case the live connection can be established, the time that elapses between two updates is much shorter which leaves less room for data inaccuracies. That is why this research focusses on retailers that currently do not have a live connection with Company X yet.
Over the last three years, the percentage of orders that had to be refunded due to insufficient inventories at the retailers has been increasing constantly. So far 8.68 % of orders had to be refunded because at least one of the ordered products within an order was not available at the store. As refunds can have various negative effects for Company X, this increasing number calls for action to stop it from rising further and to prevent the negative effects associated with this. Potential negative impacts are dissatisfied customers and retailers who are the base of Company X's business model.

3 Potential requirements

In this chapter the potential requirements for the new POS system are established. This step corresponds to the requirements elicitation process of the requirements engineering process. As explained above, the traditional elicitation techniques including interviews and literature search are used. The interviews were conducted with five Company X's employees as well as five retailers. As both parties are affected by the implementation of the new POS system, they were both included in the elicitation process. The interviews were conducted using closed ended as well as open ended questions to understand the retailers' needs in the best possible way and to give them room for explanations.
In addition to that, some papers on the design of POS systems have been taken into consideration to get a more comprehensive list of potential features that have been implemented in other cases of POS system design before. The papers that were considered consist of an evaluation model for point-of-sale systems (Kabir & Han, 2016), a report on the deployment of a bitcoin point-of-sale system (Eskandari et al., 2016) as well as a report on a protection profile for point-of sales systems (Lee et al., 2014). To understand the requirements' importance for this specific case, the retailers were asked about their importance in the survey. The respective requirements' importance is explained in Chapter 4.
Below, the potential requirements for a new POS system are listed including a short explanation and motivation. Some objectives or requirements were expressed directly either by the employees or by the retailers. Others need to be derived from the other statements that were made. The potential requirements can be divided into the functional requirements and the non-functional requirements. Functional requirements express the tasks that the system should be capable of performing and are listed in Chapter 3.1. Non-functional requirements represent the characteristics of the system that are not helping the retailers to perform any tasks in their stores. These are listed in Chapter 3.2.

3.1 Potential functional requirements

During the interviews with Company X's employees and the retailers and during observational research at Company X, potential requirements were identified that might be selected to be part of the final design. Table 1 lists the functional requirements including a description and a motivation why the requirement might be relevant. The requirements can be grouped based on their functionality. The four functionality groups are inventory management, analysis and reporting, connectivity, and customer relationship management.

	Potential requirement	**Description**	**Motivation**
Inventory management	Track keeping of stock levels	The system keeps track of changes in stock through both, replenishment, and sales.	This is the main function of interest for Company X and has been identified by multiple stakeholders.
	Inventory information can be read by other platforms	The inventory information can be read by other platforms, such as Company X's website.	This is one of the features, that is necessary for Company X, to improve the current situation regarding the many refunds. Only if a connection can be established, Company X can

			make use of the automated updates.
	Automation of order process	The system places an order for products that are out of stock or low on stock automatically.	Some stakeholders have explained that the retailers spend much time with the order process and that they would expect a new POS system to facilitate this process.
	Semi-automation of order process	The system places an order for products that are out of stock or low on stock semi-automatically. This lets the retailer make changes to the order.	Some stakeholders have explained in the interviews, that they would not want to the system to order fully automatically. This could be a suitable solution.
	Possibility to enrich product data for external platforms	Next to stock levels and prices, the retailers can add descriptions or product images within the POS system. This will allow them to decide, what the product will look like on other platforms, such as Company X's website.	Some stakeholders at Company X have explained, that they spend too much time on enriching the product information. They would like to give the retailers the opportunity to add information by themselves. Like this, they hope to lower the workload of Company X's employees.
	Various ways of stock keeping	Next to units, the POS system can use multiple ways, such as weight, to keep track of stock levels.	Especially the interviewed retailers from the Food & Drinks industry expressed concerns about the systems usefulness, if fresh products, for which the price is calculated on the weight, cannot be included in the system's inventory.
	Automatic price changes based on suppliers	The POS system updates prices based on suppliers' prices and selected margins.	Due to frequent changes in the prices, the retailers often must adjust the prices for their products within their system. As this takes up a considerate amount of time, some of the retailers expresses the wish for automatic changes in prices based on the suppliers' prices.
	Bulk updates for inventory	Instead of manually inserting replenished products into the POS system, bulk updates can	Various stakeholders have explained that they believe the time it takes to get the inventory up to date is not

		update stocks for entire deliveries.	worth the effort. This could be avoided, if entire deliveries could be added to the systems within one large update. An employee suggested the use of bar code scanners.
	Manual adjustments to the system	The stock levels can be adjusted manually for reasons such as theft or damage.	Some retailers were afraid, that the system would be useless as sometimes things break or get stolen and then, the system is not accurate anymore. Manual adjustments to the stock could avoid this problem.
	Random inventory counts	The system urges the retailers to perform random stock counts, to account errors in the inventory data due to reasons such as theft.	Some retailers explained that they are worried about long inventory counts to check the inventory data's accuracy. To prevent large data inaccuracies and time-consuming inventory counts to verify the accuracy, random inventory counts can give a good idea about the overall accuracy.
Analysis and reporting function	Analysis function for sales data	The retailers can get insights into their sales data and store performance through an analysis and reporting function.	Few of the interviewed retailers already have an external function to get insights into their sales and the overall performance, while others get no insights at all. Also, stakeholders of Company X expect high value of an analysis and reporting function.
Connectivity	Connection with Company X	The POS system can be connected to Company X's inventory repository.	This requirement is necessary to improve the data inaccuracies between the retailers and Company X.
	Connection with own web shop	The POS system can be connected to the retailers' own web shop.	As some retailers already have their own web shop, it is likely that also the retailers that do not have one yet might introduce one soon. Some stakeholders explained that the POS system should also be linked to a retailers' own web shop.

	Connection with other external platforms	The POS system can be connected to any other external platform, such as additional service providers.	Some of the interviewed retailers expressed the desire to link the POS system to external platforms. For example, one retailer uses and external program to get insights into the sales data. Some stakeholders also mentioned that further service providers could be linked to the system.
	Connection with other retailers	The POS systems of similar retailers can be connected to generate larger order quantities which can potentially drive down the purchasing costs.	One employee explained that he could imagine that some retailers might be interested in combining their orders to drive down the purchasing cost through economies of sales. In that case, Company X could link similar retailers.
Customer relationship management	Tracking customer's purchases and preferences	All purchases can be connected to individual customers with customer accounts, to better understand their purchasing behaviour.	A retailer expressed the desire to be able to track customers' purchases to better understand their preferences.
	Individual promotions for customers	Based on the information gathered on customers' purchasing behaviour, individual promotions are offered to them.	The same retailer said that this knowledge could be used for individual promotions or discounts that are only available to selected customers.

Table 1: Potential functional requirements

3.2 Potential non-functional requirements

While the list of potential functional requirements gathered from the interviews and observational research was already comprehensive, the list of non-functional requirements that could be gathered from the explorative interviews and the observational research was very short. This list was expanded by requirements found in the literature. The articles that were used to gather potential non-functional requirements also focus on the design of POS systems. Therefore, they relate to a similar problem. The articles in which the potential requirements were found are given in the "Motivation" column. Table 2 lists the potential non-functional requirements that could be part of the final design. The requirements are grouped into the categories of usability, deployability and security.

	Potential requirement	Description	Motivation
Usability	User-friendliness	The POS system should be user-friendly and intuitive. This means that the users should have no difficulties understanding, what to do and how to do it.	This requirement was expressed by multiple stakeholders and was also be found in the literature search (Eskandari et al., 2016).
	Customer service	The users should be able to easily get help, whenever needed to perform a task.	Stakeholders at Company X explained that they have experienced many retailers complaining about bad customer service with their current service providers and that they value personal contact.
	(Time) efficiency	The tasks that need to be performed with the POS system should ideally take a minimal amount of time.	This requirement was found in the literature search (Eskandari et al., 2016).
	Availability	The POS system should be available to enough employees in a store to enable a smooth processing of customers.	This requirement was found in the literature search (Eskandari et al., 2016).
	Operability	The POS system should work properly and without errors in its entirety and its users can control it properly.	This requirement was found in the literature search (Kabir & Han, 2016).
	Effectiveness	The tasks that need to be performed with the POS system should ideally be done with a minimum of steps.	This requirement was found in the literature search (Kabir & Han, 2016).
	Compliance to industry standards	The POS system should meet common practices and standards.	This requirement was found in the literature search (Kabir & Han, 2016).
Deployability	Affordability	The POS system should be affordable for the retailers.	The cost of a new POS system was identified multiple times to be a potential bottleneck for a successful implementation. Therefore, a good affordability of the system should be guaranteed. This requirement was also found in the literature search (Eskandari et al., 2016).
	Quick installation	The initial installation of the POS system should not take much time.	The effort of making a switch was identified as a potential problem by both retailers and Company X employees.

			Providing a quick installation process could therefore be very important.
	Support during installation	The retailers should get appropriate support during the installation process.	Like the overall customer service, it was expected by some of the Company X employees, that retailers would need support during the installation process. Also, some retailers explained, that they would not have much time or human resources to spend on the installation process.
	Expandability	The POS system should be expanded to new locations easily or new units should be added easily if necessary.	This requirement was found in the literature search (Eskandari et al., 2016).
Security	Compliance with security standards	The POS system should adhere to all Common Criteria for software systems and ensure the users' data security and privacy.	This requirement was found in the literature search (Lee et al., 2014). While the retailers could be asked about the importance of each of these Common Criteria, this would only make the survey more complicated. So, to keep it simple, but still make it possible to capture the stakeholders' opinion on the overall importance of security in their POS system, they are simply asked about how important they consider the security in the system to be.

Table 2: Potential non-functional requirements

3.3 Potential requirements identified through interviews and literature search

Through the interviews with the different stakeholders and observational research, a comprehensive list of potential functional requirements for the new POS system is established. The potential functional requirements can be grouped into four broad categories, that help the retailers with a specific function. These categories are the inventory management function, the analysis and reporting function, the connectivity of the system and the customer relationship management function.

Next to that, potential non-functional requirements were identified in the interviews. However, the stakeholders focused mostly on functional requirements when explaining what matters most to them in a POS system. From literature this list of non-functional requirements is expanded. The non-functional requirements can be grouped into the categories of usability, deployability and security.

In this chapter the potential requirements that could be implemented by Company X in the final design of a POS system were merely identified. However, not all requirements are equally

important and will need to be given the same amount of attention in the design phase. Thus, in Chapter 4 the measurement of the different potential requirements' importance is explained and in Chapter 6 the requirements are given priorities with which they should be handled to allow for the greatest acceptance among the retailers.

4 Measuring the importance of the potential requirements

In Chapter 3 a list of potential requirements is given based on the input from the interviews, observational research, and literature search. In Chapter 4.1 it is first explained, how a survey is designed to understand how important the retailers believe the various requirements to be. Also, the conduction of the survey is shortly explained. Secondly, the results from this survey are presented in Chapter 4.2.

4.1 Survey design and conduction

The survey is designed in a very straight forward way to make it easy for the retailers to participate. After some demographic questions first, the questions are rather repetitive afterwards. This keeps it simple to guarantee that the retailers understand what to do and to make sure that the questions are understood correctly. In the following paragraphs, the various questions are explained in more detail. The complete survey can be found in Appendix A.

4.1.1 Demographic questions

The demographic questions at the beginning of the survey are helpful for Company X to understand the different retailers better. Opposing to the more common demographic questions in surveys which ask for the age of the gender of the participants (Jovancic, 2021), the demographic questions for this survey focus more on the properties of the store rather than the properties of the person filling out the survey. Like this, the stores can be grouped and responses such as the importance of requirements can be linked to the different groups of retailers. It will enrich the insights that are gathered in the research as it helps Company X to better understand the needs of each of these groups of retailers. For instance, if a certain group showed particular interest in a functionality that other groups show less or no interest in, this need could be satisfied individually by offering them another final product or by making different versions for different groups.

The respondents are asked about the following characteristics of their store: (1) industry the store operates in, (2) whether they use a POS system or not, (3) time they have been using the current POS system, (4) time of working with Company X, (5) what percentage of orders cannot be completed due to insufficient stock of one or more of the requested articles, (6) how many potential users the store has. In all these questions the respondents must choose from a predefined set of potential answers to keep the number of different responses to a minimum and to allow for better statistical analysis (Farrell, 2016).

4.1.2 Assessing the importance of functional requirements

In this section of the survey the importance of the different potential functional requirements as mentioned in the interviews either by the retailers or the employees is validated. This section is divided into the four categories of functional requirements that were identified in Chapter 3. These are the inventory management function, the analysis and reporting function, the connectivity of the system and the customer relationship management function.

At the beginning of each category, the overall importance of the respective category is assessed using a Likert scale in which the participants can choose from five different levels of importance. The Likert Scale ranges from “not at all important” to “extremely important”. Next to that the respondents always have the option to choose “I don’t know” in case they are unsure what to answer. This Likert scale is used to assess the importance of all four categories.

After that, the importance of the more specific functionalities is assessed. The participants are asked, which functionalities of a category they could imagine to be useful in the final product. To do so, they can choose from the list of potential functionalities of certain category. Multiple

selections of requirements can be made, so that retailers can select as many requirements as they would like to use in a POS system. This will enable a quick overview of what percentage of retailers wants to include the different functionalities in the final product.
In case retailers would like to see another functionality that is related to a certain category, but not included in the list, the participants can enter more functionalities in a text field at the end of each category block. These functionalities' importance cannot be assessed in this survey yet, however further research on them needs to be performed to understand whether there is a common interest in the functionality. However, as explained above, requirements engineering is a continuous process, and it needs multiple iterations to capture a holistic list of requirements.

4.1.3 Assessing the importance of non-functional requirements

As it is the case with the functional requirements, the non-functional requirements are split into their respective categories. In this case there are three categories, namely usability, deployability and security. Again, the overall category's importance is measured using the same Likert Scale as explained in Chapter 4.1.2.
The questions regarding the specific criteria's importance are asked using the same Likert scale. It was decided to use a Likert scale, because in this case, the retailers cannot really decide whether a requirement should be included or not as it is the case with a functional requirement. Instead, they should simply decide how important such a criterion is for them, in the evaluation of a POS system.

4.1.4 Assessing the likelihood of an introduction of a new POS system

In the last section of the survey, the participants are asked, how likely it is that they would be to introduce a new POS system, assuming it would fulfil their requirements as they have indicated it in the survey. Again, the participants can choose from a Likert scale with five levels. In this case the Likert scale ranges from "extremely unlikely" to "extremely likely". Again, there is an additional option of "I don't know" in case the respondent does not know what to answer. This question aims at capturing the retailers' overall demand for a new POS system. This will be a good estimation for Company X's management to decide whether it will be worth continuing with the project of designing a POS system, or whether there will not be a high level of acceptance among the retailers.
The second question in this section is a multiple-choice question. Here the different categories that were included throughout the survey are listed again, and the participants are asked to select the categories that would make them choose for a new system. This question was included to understand which requirements are the driving forces for a switch from one POS system to another. The requirements that are listed with the highest frequency can be understood as the most important requirements in terms of motivating retailers to change their POS systems. The information gathered from this question helps to set the right focus in the design phase. The retailers can choose from a list of potential reasons for a switch. It is possible to make multiple selections in case that more than one requirement needs to be fulfilled. In case the respondent does not find the right choice in the list, they can choose to answer, "None of the above". The results from this set of questions are explained in Chapter 6.

4.1.5 Conduction of the survey

The survey was conducted as an online survey. The link to the survey was first shared with the selected 66 retailers via email. It had shown in previous research by Lute, but also in observing the retailers' behaviour by doing everyday tasks for Company X, that the retailers are usually busy with the tasks they need to do within their stores. Thus, they sometimes forget about emails or the tasks they were asked to do for Company X. Therefore, the retailers were called within a couple of days after sharing the survey link with them. In the call, they were kindly

asked to participate in the survey as soon as possible. This was intended to get the results faster and to make sure that the retailers do not forget about participating. Next to that, multiple reminder emails were sent to the retailers to guarantee a better participation rate.
The survey was active for two weeks and in total 38 retailers participated which is more than half of the research population of 66 retailers. From the 38 responses 34 responses can be used for further research. From the remaining four responses, two participants indicated they do not want their answers to be recorded or used for further research. The other two participants' answers were not processed properly by the system and their response could not be saved. Figure 9 shows the process of conducting the survey.
Summing up, the survey is designed in a way to allow the participants to easily answer the questions without having to enter a lot of text manually. This aims at capturing more responses by keeping the participants motivated. Thus, the questions are mostly closed ended questions. In addition to that, this choice of question allows for a better statistical analysis afterwards, as the number of different answers is kept to a minimum and the responses are given using the same scale. To increase the participation rate, the retailers were contacted multiple times through various forms of communication.

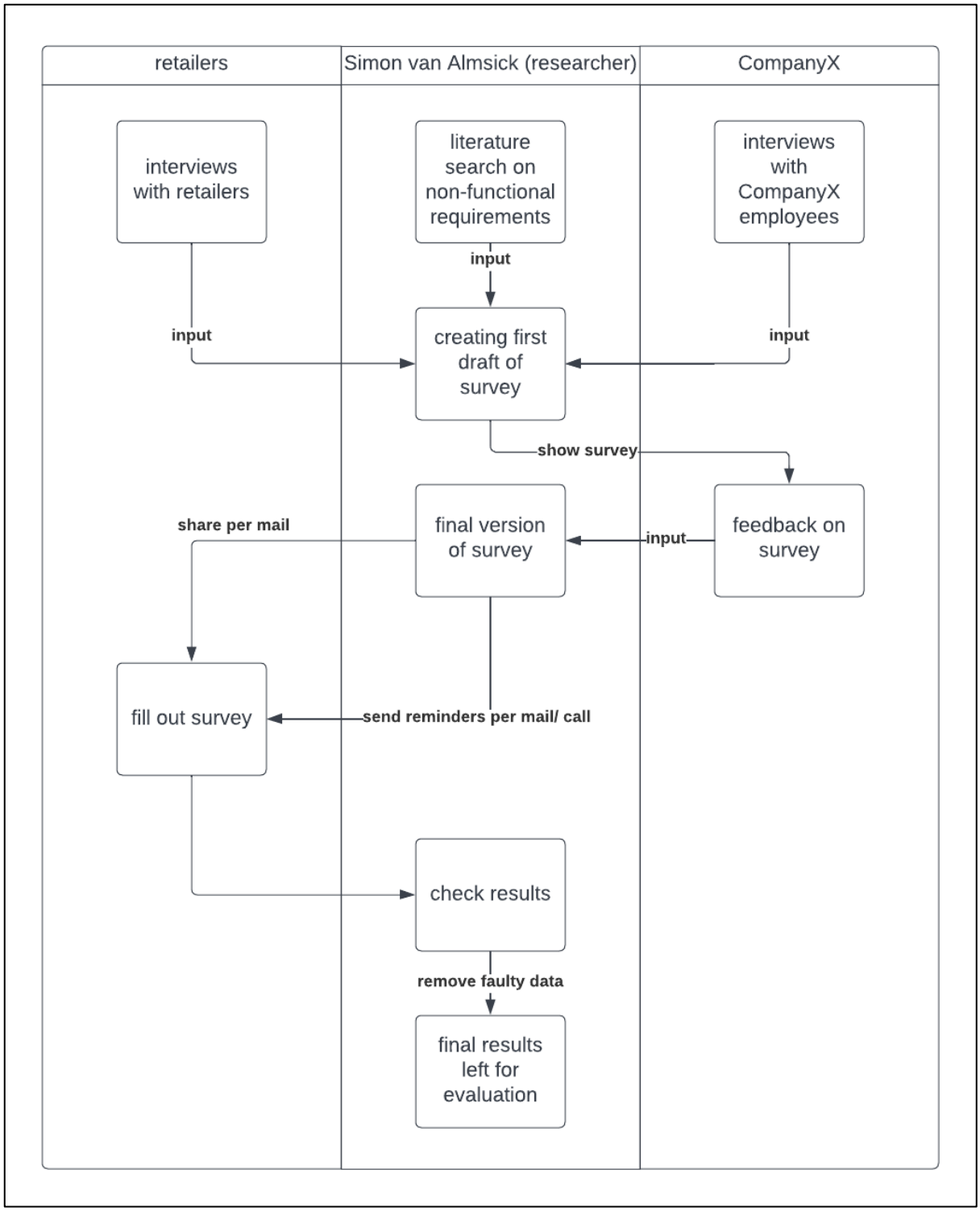


Figure 9: Process of conducting the survey

4.2 Survey results

In this chapter the respondents' answers to the survey are presented. In Chapter 5 and Chapter 6 these answers are analysed further to give Company X a better understanding of what requirements are of importance for the retailers and how likely the retailers believe their stores to be to change to the new POS system. The importance of each requirement is presented in a histogram representing the percentages as well as the absolute numbers of participants that have selected a certain value from the Likert scales. This allows for an easy understanding of the retailers' needs.

4.2.1 Demographic information from the survey

Demographic information on the retailers' stores were collected at the beginning of the survey to allow for an easy start into the survey. This information is used Chapter 7 to detect potential trends among the retailers. Figure 10 shows how the participating retailers are distributed among different industries of operation. The largest fraction of retailers focuses on the sales of food and drinks.

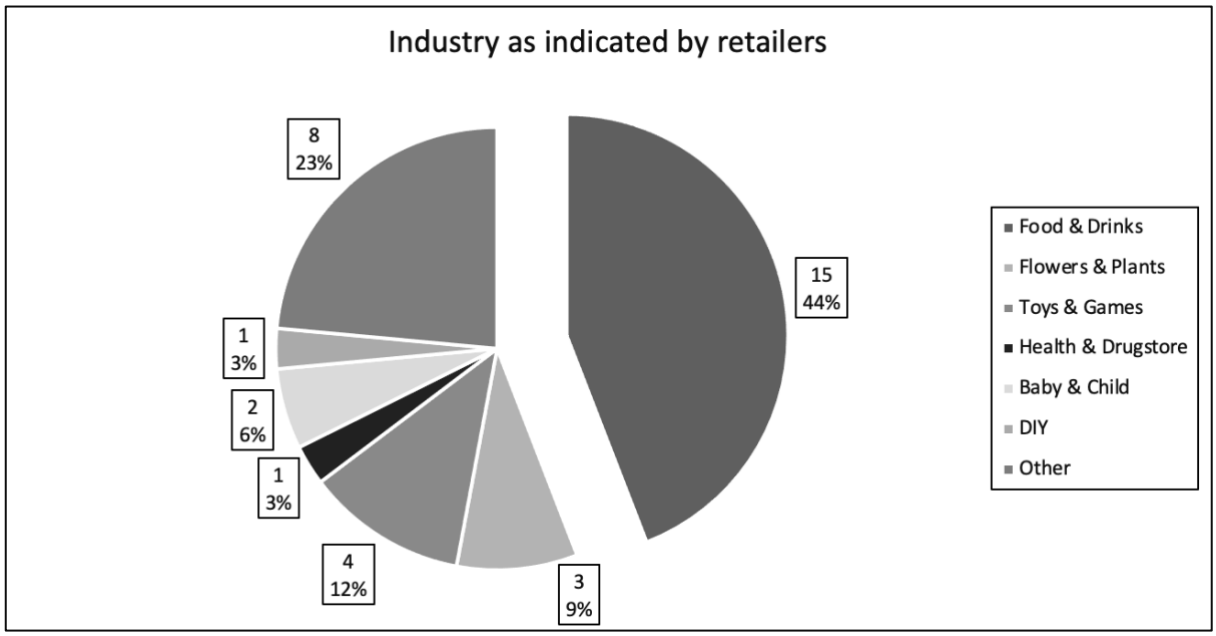


Figure 10: Industries as indicated by retailers

Figure 11 shows what percentage of retailers is currently using a POS system. In this question, there was no distinction made between the types of POS system that are in use. It can be seen easily that the larger share of participating retailers uses a POS system.

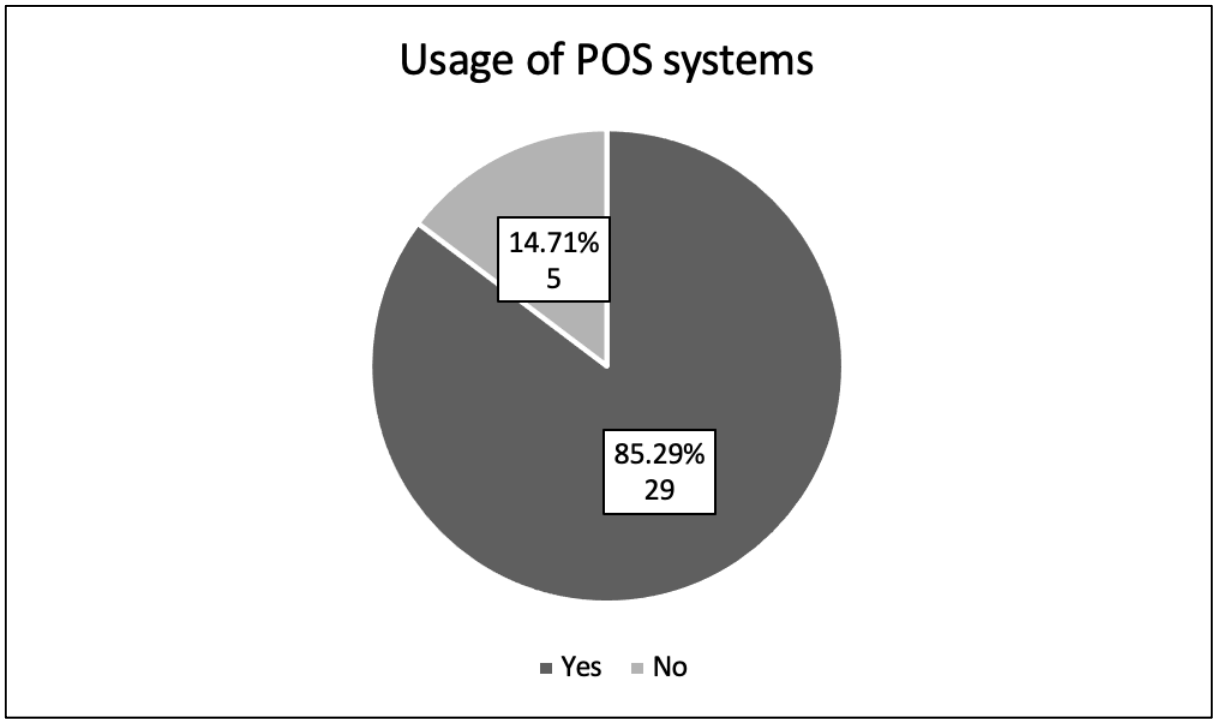


Figure 11: Percentages of retailers using and not using a POS system

In Figure 12 it can be seen how long the current POS system has been used by the retailers. The different time frames are distributed quite evenly, however a large share of retailers has used their POS system for more than ten years.

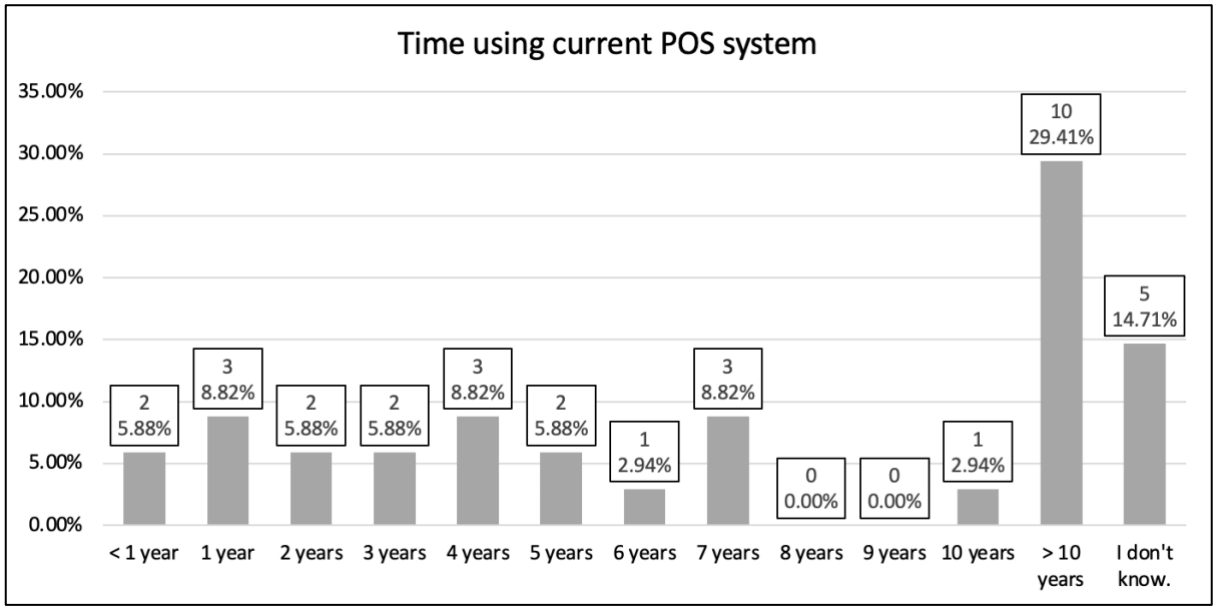


Figure 12: Time of using current POS systems

Figure 13 represents the time each retailer has worked together with Company X already. Since Company X has started operating in the first half of 2020, no older time frames can be selected by the retailers.

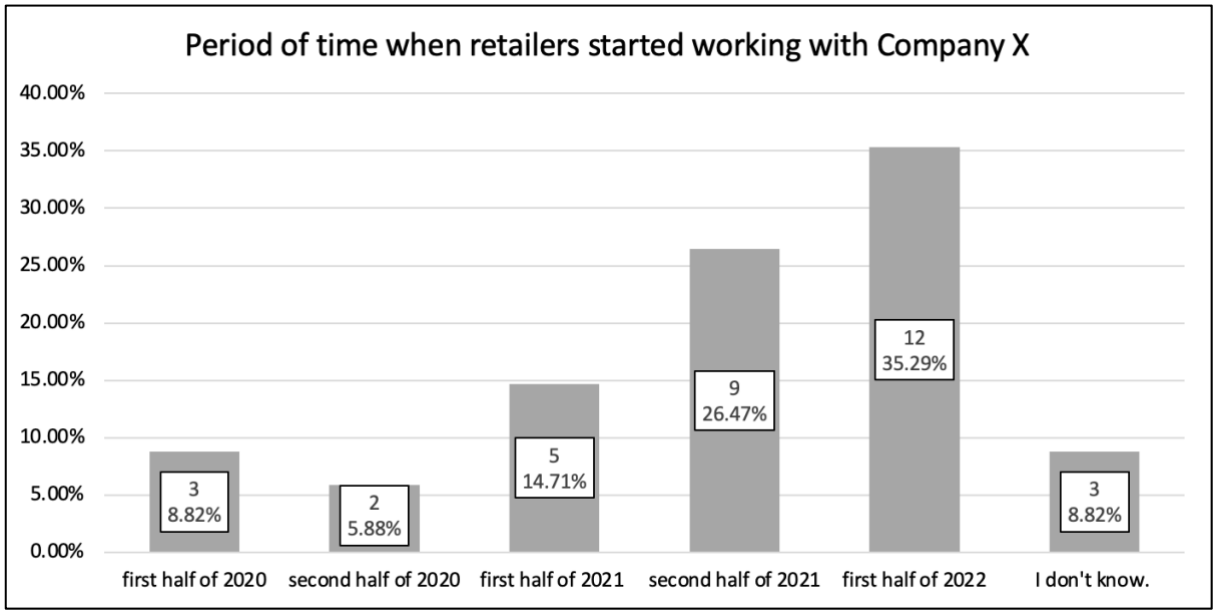


Figure 13: Time retailers started working with Company X

Figure 14 shows what percentage of orders must be refunded at the different retailers. The largest share of retailers does not have to refund more than 20 % of their orders. However, two extreme cases exist where more than a third of all orders are refunded.

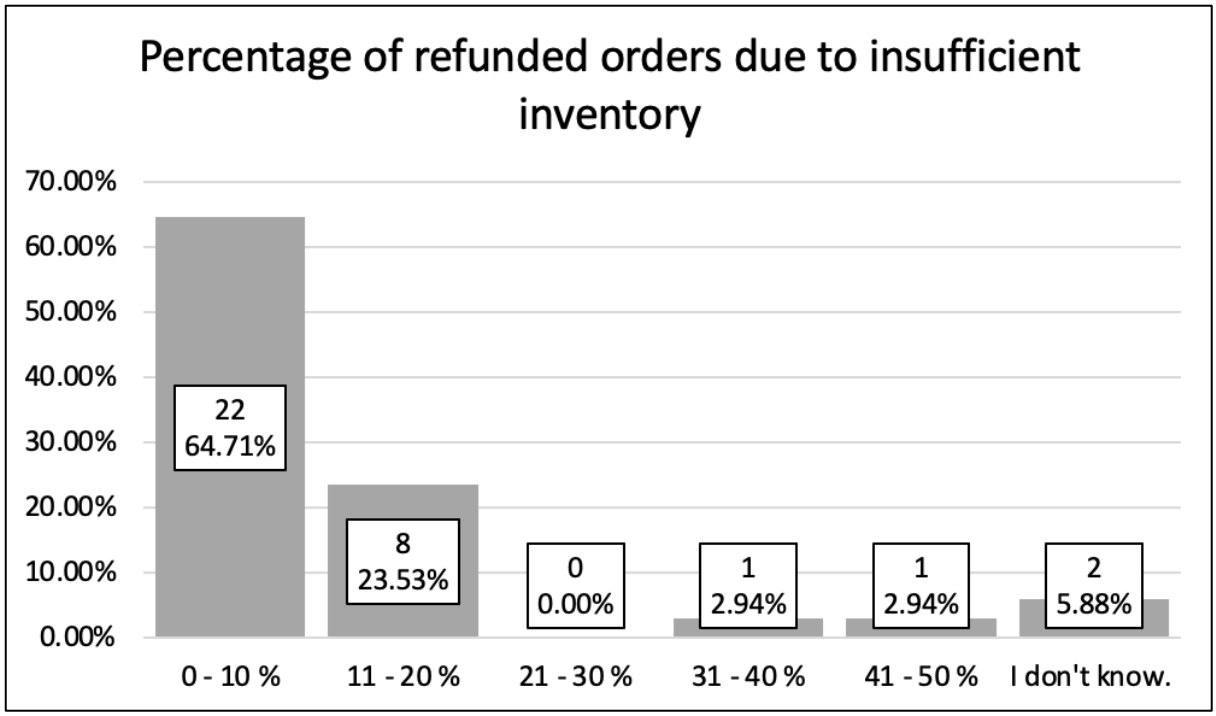


Figure 14: Percentage of refunded orders due to insufficient inventory

Figure 15 shows the number of employees that would potentially be using the POS system in the different retailers' stores. Usually only a small number of users are given for the stores.

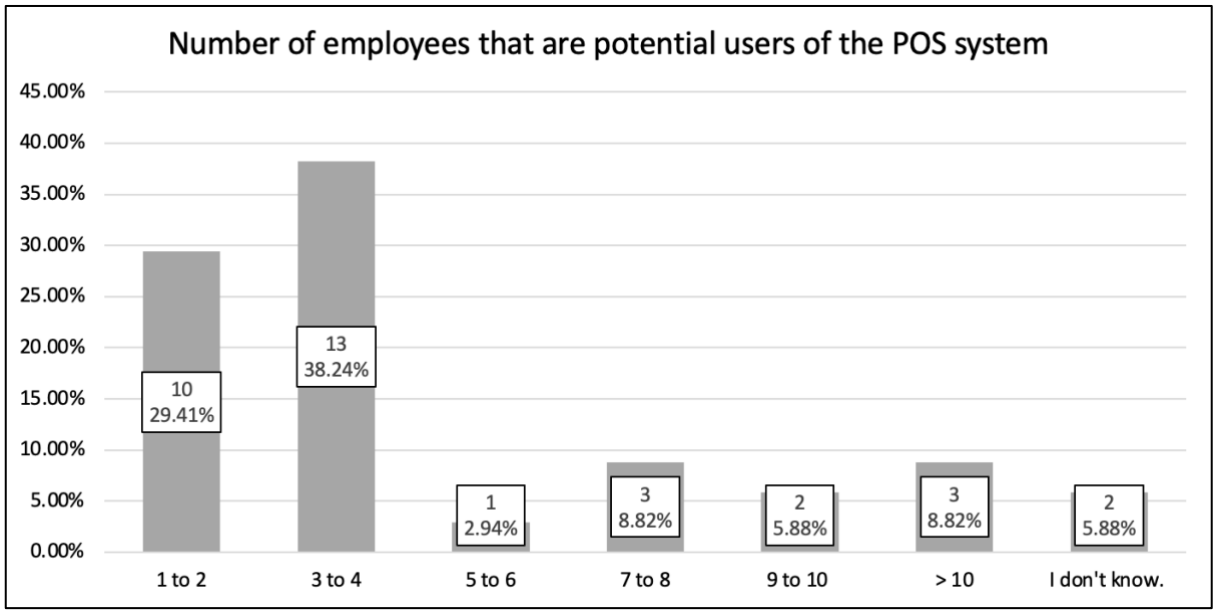


Figure 15: Number of employees

4.2.2 Importance of the functional requirements

Figure 16 shows what importance the retailers assign overall to the functionality of inventory management. The average importance is 2.91 with a standard deviation of 1.35. Next to that, it can be seen from Figure 17 that the potential features of the inventory management function were evaluated very differently. What is surprising and does not comply with the expectations of Company X, is that even simple features like continuously updating stock levels are not even considered important to be included in a system by around half of the research population. It is also surprising that features like bulk updates are only considered important by seven

participants. Especially functions like this that would save the retailers time and effort were expected by Company X's employees to get a high score.

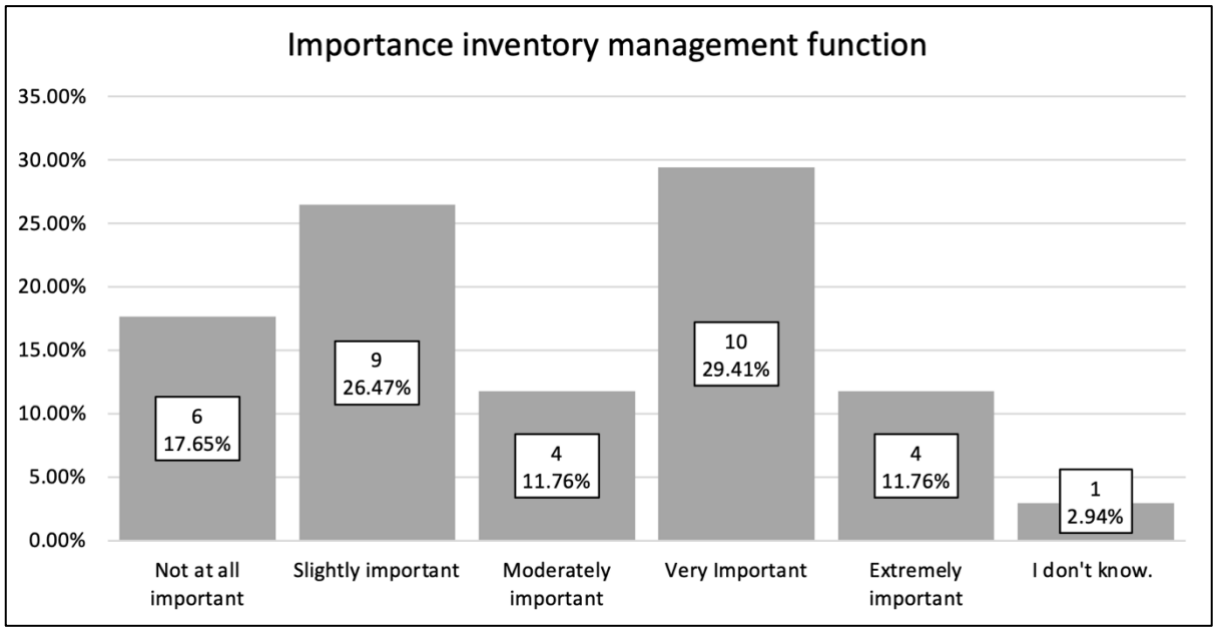


Figure 16: Importance of the inventory management function

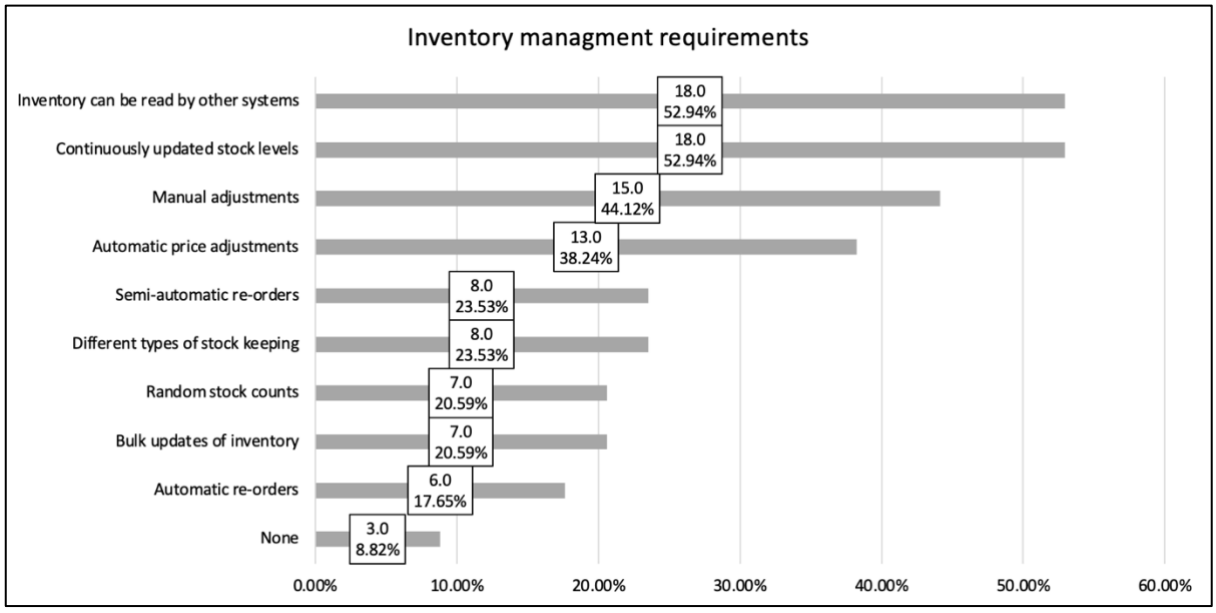


Figure 17: Selections of inventory management requirements

Figure 18 represents how important the retailers believe the analysis and reporting function to be. The average importance is 3.5 and the standard deviation is 1.22. Among all functional requirements this is the functionality with the highest assigned importance.

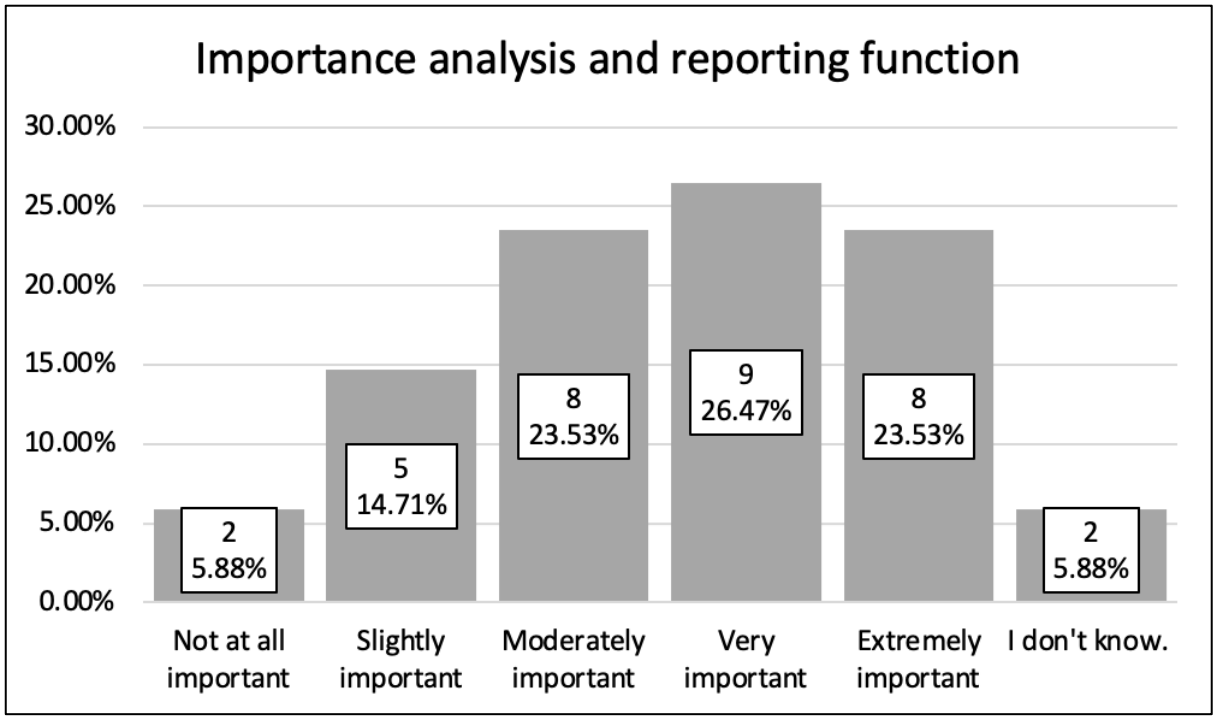


Figure 18: Importance of the analysis and reporting function

Figure 19 shows the importance the retailers assigned to the connectivity features. The average importance is 3.23 and the standard deviation is 1.28. Figure 20 shows the importance of the specific functionalities from the connectivity group. From the specific connectivity features identified as potential requirements the possibility for a connection with Company X got the highest score. This is surprising, as this means that participants found this connection more important than a potential connection with an own web shop. This is a good sign for Company X, as it shows that the number of retailers that value their online marketplace is high. The desire to connect the system to other platforms is rather low which is also a good sign as the external platforms include Company X's potential competitors that offer a similar service.

For Company X it is a good sign that around half of the participants see a value in including product descriptions, product images, and other information about their products. This makes it easier to quickly connect the store's products to an online marketplace which requires this information. As explained above, it takes up a large amount of time whenever new products need to be put online on Company X's online marketplace. It could also help to integrate new stores faster. In addition to that, this will give more power to the retailers who can manage the descriptions themselves to match their expectations. However, in the interviews with the employees of Company X it was already explained that there is need for some kind of check to make sure the data is up to Company X's standards.

One of Company X's employees expected that a connection among retailers to streamline their purchases and thus, drive down the purchasing costs would be valued by a lot of retailers. However, it turned out that only three of the participants could imagine implementing such a connection which means that currently there seems to be no interest in such a feature.

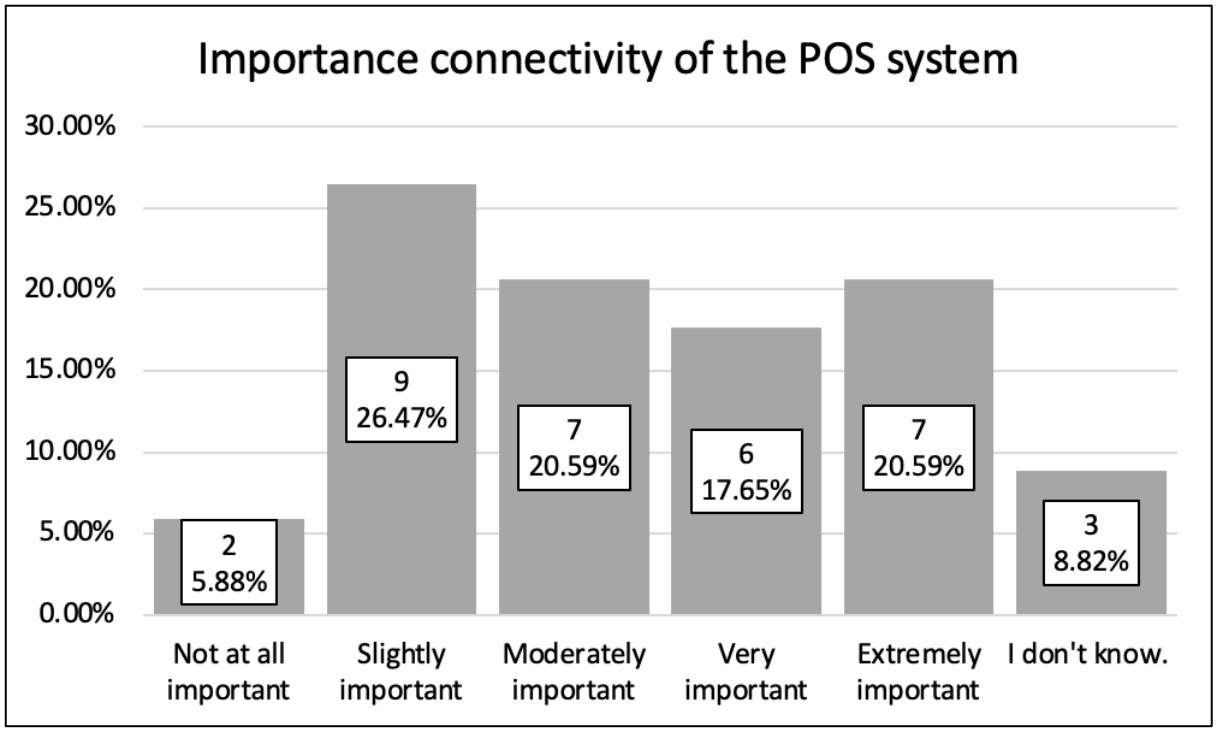


Figure 19: Importance of the POS system's connectivity

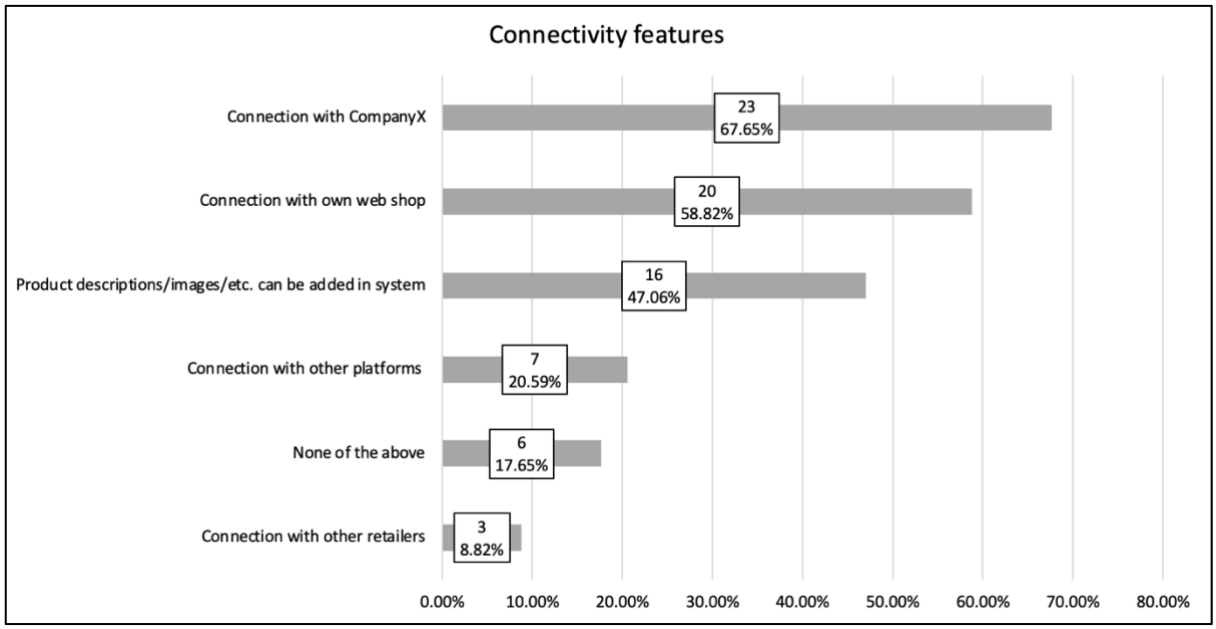


Figure 20: Selections of connectivity requirements

Figure 21 shows the importance that is assigned to the customer relationship management function. The average importance is 2.3 and the standard deviation is 1.21. It was assigned the lowest importance among the four requirement categories. Figure 22 shows that despite the comparatively low average importance of the CRM functionalities, there is still a respectable number of them who could imagine implementing either a function to keep track of various customers' purchases or introducing individual promotions for their customers. It, however, needs to be said, that individual promotions are only possible if the system also tracks the customers' purchases as this would be the underlying data for the individual promotions. Nevertheless, the group of participants who does not want either one of the two functionalities is still of considerable size as it makes up 38.24 % of the participants.

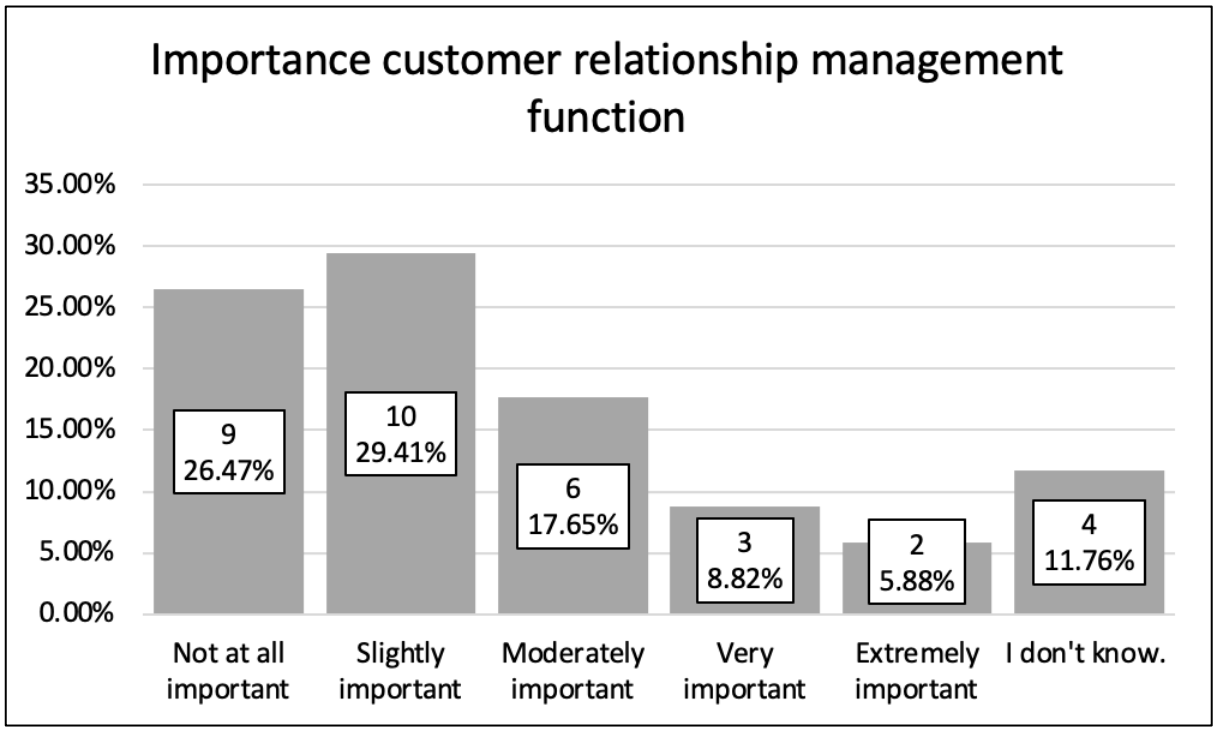


Figure 21: Importance of the CRM function

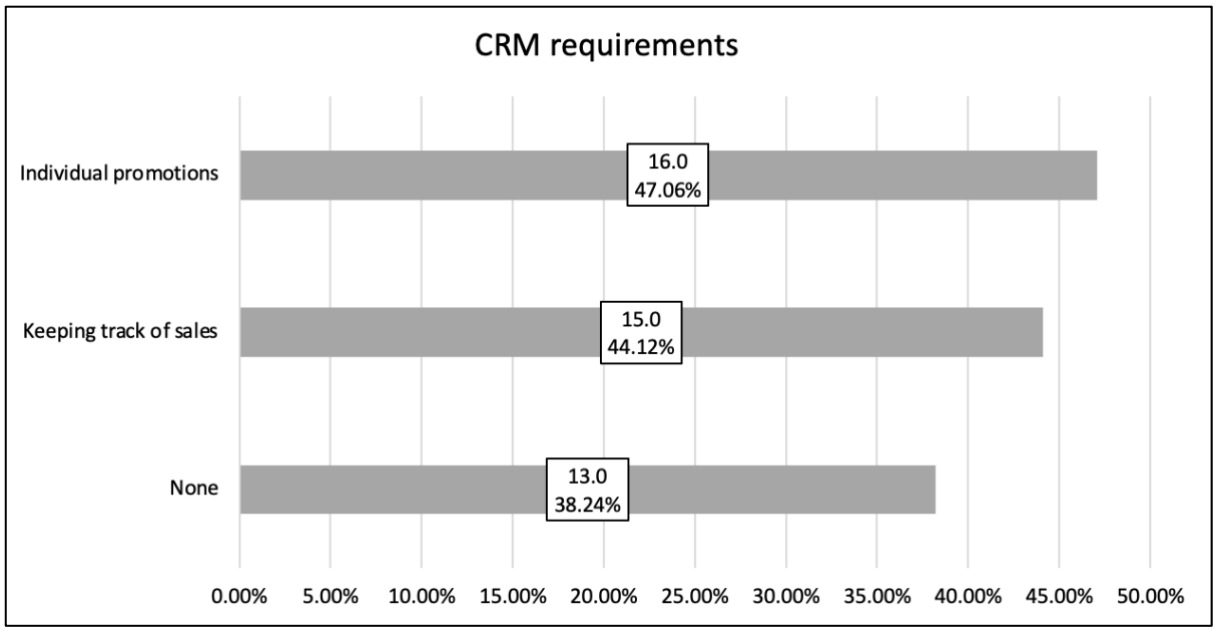


Figure 22: Selection of CRM requirements

Next to assessing the importance of the potential requirements that were found in the elicitation process, the retailers were also asked to add additional requirements that they find important in a POS system. In Table 3 the potential additional requirements that were mentioned by the participants are summarized. These need to be verified again before they are implemented in the POS system. This guarantees that they add value to the POS system and that they are important to many retailers. As explained above, requirements engineering is a continuous process and new requirements can be added during the process but should also be validated before implementation.

	Potential additional requirement
Inventory management function	Within the POS system, retailers can select the products, they want to sell through Company X, without having to access the website first.
	Products should be identified in the system as variations. For example, if the product is available in different sizes or colours.
Analysis and reporting function	Comparison between sales in various time intervals such as days, weeks, months, or years.
	A function to analyse the products' shelf life and how long it takes, until they are sold.
	A function to individually choose, which features to include in the analysis and reporting function.
Connectivity	Connection to the retailer's accounting system.
	Connection to external business intelligence systems, such as "Qlik".
Customer relationship management function	Easily accessible customer lists.

Table 3: Additional potential functional requirements

4.2.3 Importance of the non-functional requirements

Figure 23 shows the importance assigned to the usability of the system. Usability was overall considered to be very important and got an average score of 4.13 with a low standard deviation of 0.87. It should also be highlighted that none of the participants finds the usability of the system "not important at all". This was also expected by Company X's employees as derived from the interviews. It emphasizes the value of a system that is intuitive and easy to use.

The importance of the usability of the system is also reflected in the overall high scores of the different aspects of usability. These are shown in Figure 24. Every score is higher than 3. This means that for every aspect there are more participants who find it important than there are participants who do not find it important.

As expected by the employees, user-friendliness was identified as the most important aspect by the participants. This supports the expectations from the management who said that many retailers are complaining about their systems not being handy enough and having many problems with them in general. These results show that it will be of high importance to make sure these requirements are satisfied to a great extent. A detailed overview over the distribution of the indicated importance of the different requirements can be found in Appendix B.

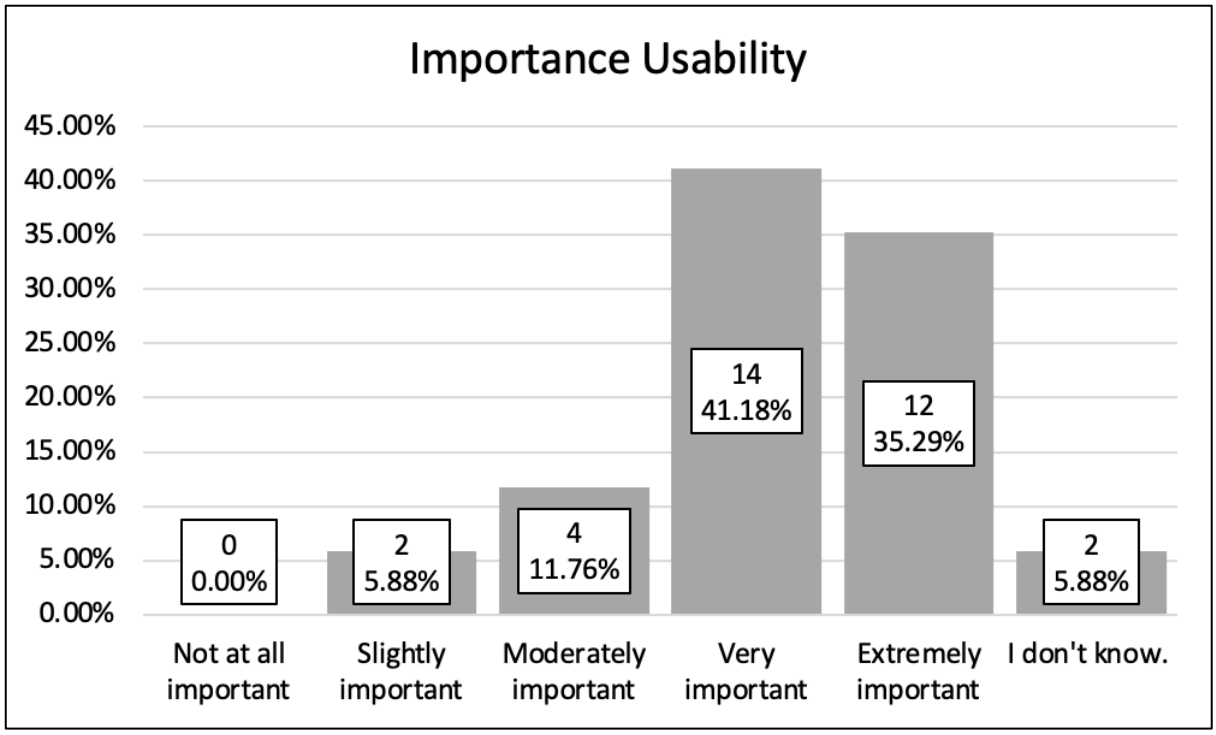


Figure 23: Importance of usability

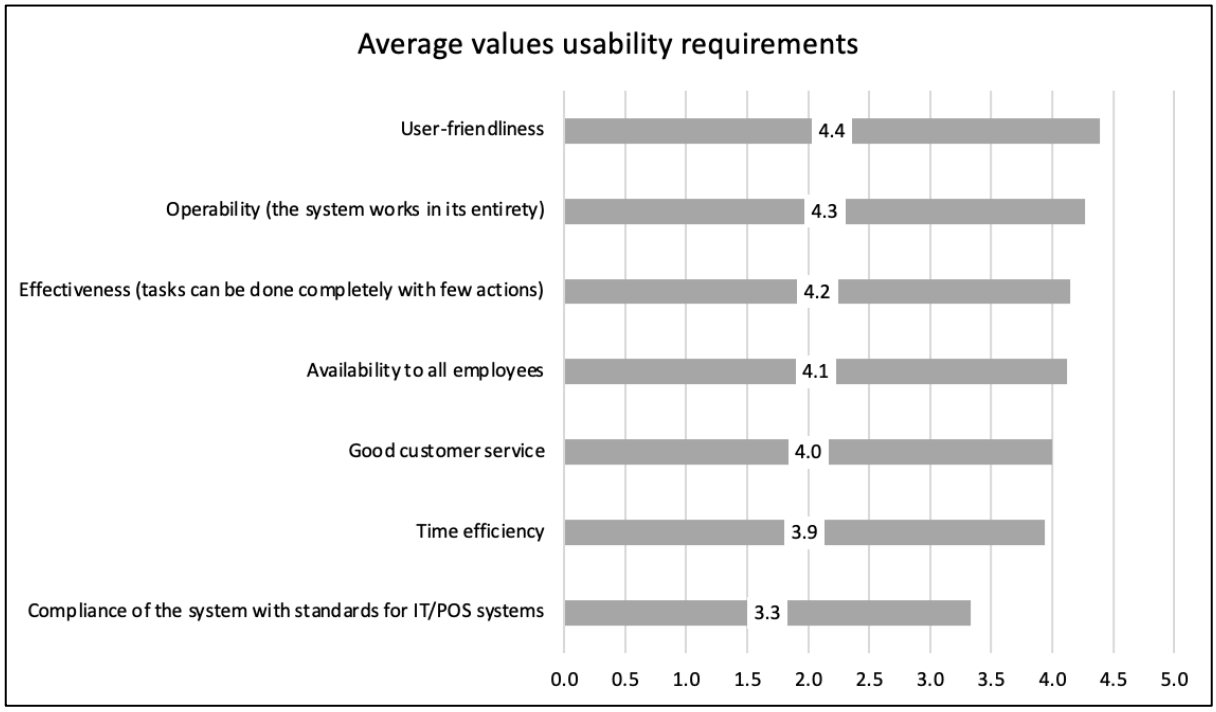


Figure 24: Mean usability requirements' importance

Figure 25 represents the importance that was assigned to the system's deployability. The average importance of the system's deployability requirements is 3.71 with a standard deviation of 1.06. Figure 26 shows the importance of the respective aspects of deployability. Again, there was no participant who gave it the lowest score possible.
Overall, the different aspects of the system's deployability got relatively high scores. Only the expandability scored just slightly above 3 which could be explained by many of the stores not looking to expand to new locations soon.

By the employees' experiences, many of the stores usually do not want to spend much time on tasks they need to do for Company X. Therefore, it is quite surprising that the score of a quick installation process is somewhat lower than the other aspects. The high scores of the importance of support and affordability were expected by the employees as well. In the interviews the main reasons that were given on why some retailers would not have more advanced systems were lacking knowledge, the effort to install new systems, and high costs. A more detailed overview of the distribution of the importance of the deployability requirements can be found in Appendix C.

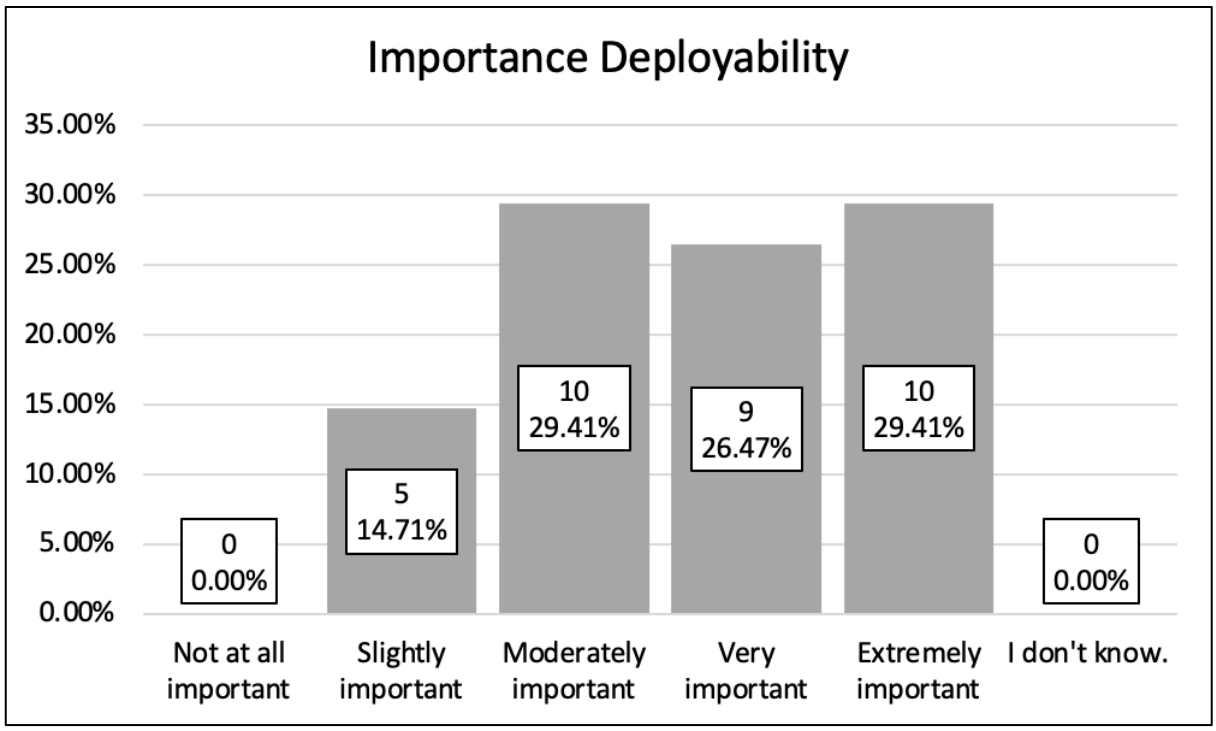


Figure 25: Importance of deployability

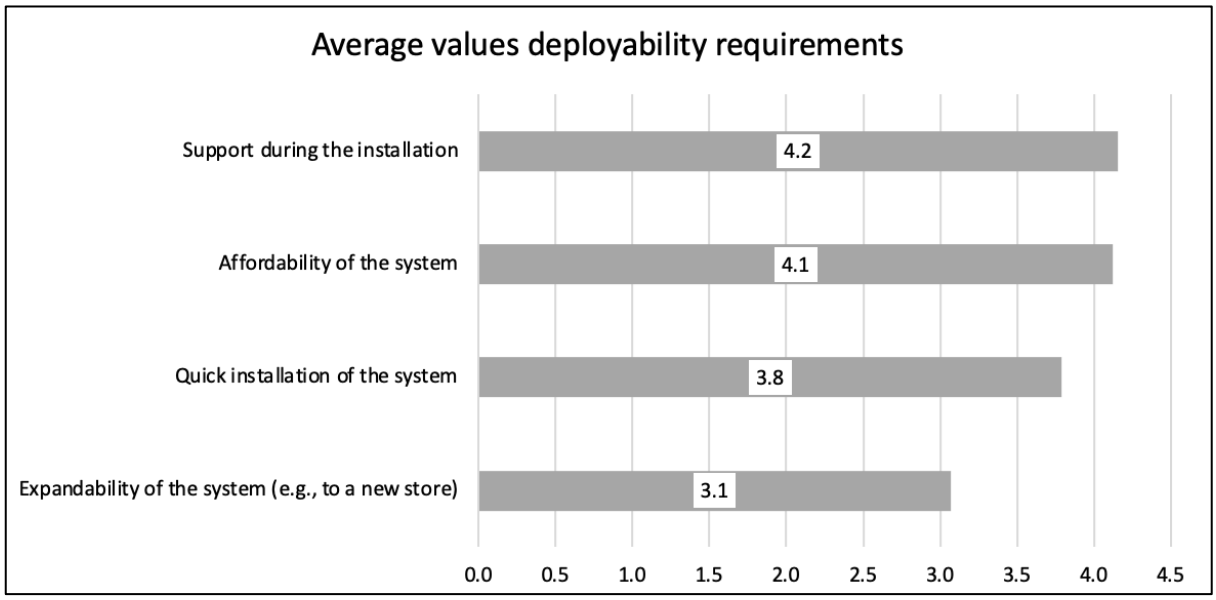


Figure 26: Mean deployability requirements' importance

The system's security's importance got the highest score from the three non-functional requirement groups. The distribution of answers given by the participating retailers can be seen

in Figure 27. The average importance is 4.15 and the standard deviation is 0.83. This makes sense, as the stores are very dependent on the systems to be safe and secure as they need to ensure a safe payment process for them and their customers. If the system was not safe from threats such as hacker attacks, the store's reputation could be seriously harmed, and large fines or reparations could be incurred.
The best way to ensure a secure system would be to follow common practices and to adhere to security standards that are already in place in the markets where the system will be introduced. As explained above, there are Common Criteria for IT systems, which serve as a good guideline for the security standards.

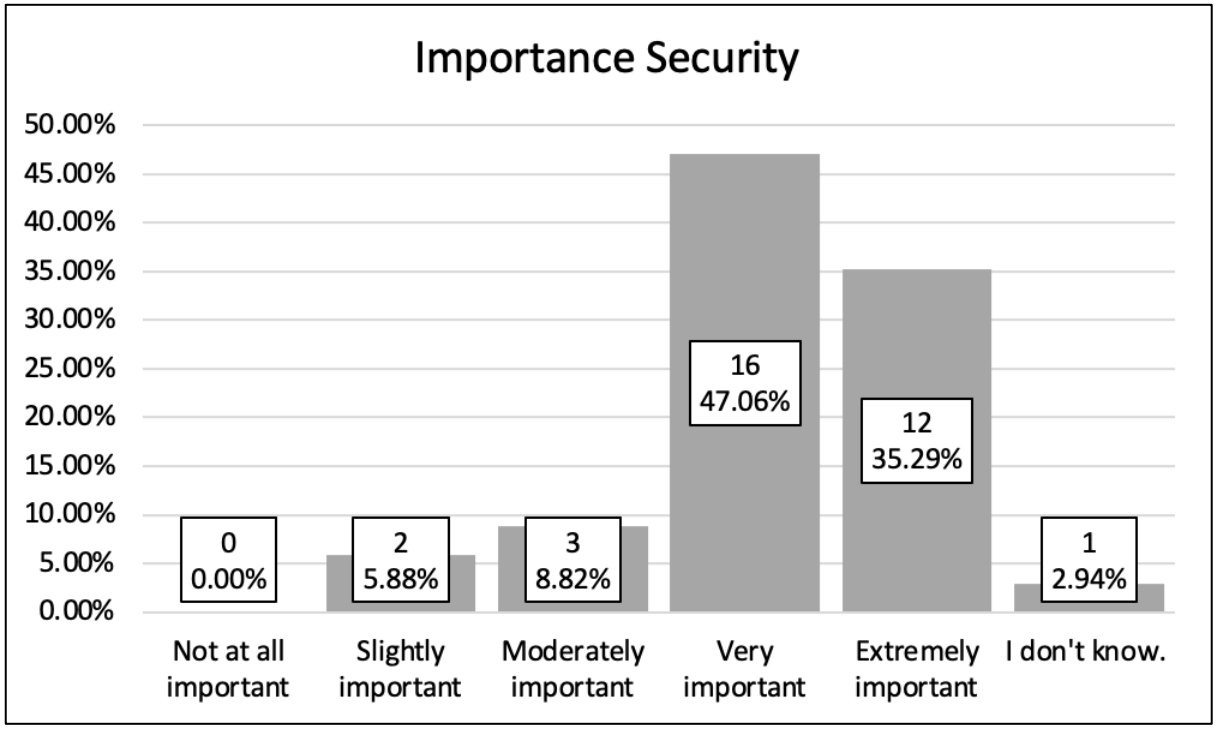


Figure 27: Importance of security

4.3 Potential requirements' importance as indicated in the survey

This chapter has shown the various results for the demographic information and the importance of the various requirements as assessed by the retailers. Table 4 below sums up the average importance and the standard deviation of each requirement category. The results presented in this chapter constitute the answer to research question 3. It is interesting to see how the non-functional requirements are more important to the retailers than functional requirements. Thus, it seems to be more important to them to have a well running system than a system with many different functionalities. Also, the non-functional requirements' standard deviation is lower which shows a higher amount of agreement on their importance.
In Chapter 5 this information is used to give priorities to the various requirements and to give recommendations for Company X what requirements and functionalities to focus on in the design of the POS system. The information of the demographic questions is taken into consideration in Chapter 7. There the information is analysed to detect trends among the different sub-groups of retailers.

	Requirement category	Average importance	Standard deviation
Functional requirements	Inventory management	2.91	1.35
	Analysis and reporting	3.5	1.22
	Connectivity	3.23	1.28
	Customer relationship management	2.3	1.21
Non-functional requirements	Usability	4.13	0.87
	Deployability	3.71	1.06
	Security	4.15	0.83

Table 4: Mean and standard deviation of the requirement categories

5 Validation of requirements

In this chapter the data collected on the requirements' importance is assessed. Based on this data and the data on the reasons that motivate retailers to switch to a new POS system, a selection of requirements is made. This selection should be included in the design of the POS system. From the list of functional requirements only the most important requirements shall be included for the final design of the POS system. Since non-functional requirements cannot be included or not included in the design, the non-functional requirements are only assigned weights that help Company X to set the right focus in the design phase of a new POS system. Alternatively, the weights can guide Company X when assessing the performance of POS systems offered by external providers that are considered instead of designing an own POS system.

5.1 Selecting functional requirements

In their book "Solving Managerial Problems Systematically", Heerkens & Winden (2017) propose the MoSCoW rule. Using this rule the various potential requirements are put in categories based on their importance for the end user. The requirements categories that are used are the "Must have" requirements, "Should have" requirements, "Could have" requirements, and "Want to have but will not have this time around" (Heerkens & Winden, 2017). This procedure helps deciding what requirements might be included in a final design. In this section the various requirements are put into these categories and the decision is motivated briefly. The decisions are made based on the overall importance the retailers put on the requirements category, such as the overall average importance of the requirement categories, the number of retailers that has chosen a certain requirement to be included in the POS system, as well as the value the requirement would bring to the system. Table 5 shows both the average importance and the standard deviation of the various functional requirement categories.

Requirement category	Average importance	Standard deviation
Inventory management	2.91	1.35
Analysis and reporting	3.5	1.22
Connectivity	3.23	1.28
Customer relationship management	2.3	1.21

Table 5: Mean and standard deviation of the functional requirements' importance

5.1.1 Must-have requirements

First, must-have functionalities are identified. Without including the must-have requirements, the system would either not work at all (Heerkens & Winden, 2017) or it would not help Company X to decrease the number of refunds. The first must-have functionality is the payment processing function which was identified as a must-have function in Chapter 1 but left out from further research as this is the core function of a POS system.

The second function the POS system must have, is a function allowing for continuously updated stock levels whenever a sale is made, or a new incoming order is registered at the retailers. Otherwise, the system's underlying data would be wrong and the information that is sent to Company X would also be incorrect leading to more errors in the inventory repository.

The third must-have function of the POS system is a connection between the retailer's POS system and Company X's inventory repository which updates the data used to operate Company X's web shop. This should ideally be done whenever the inventory changes at the retailer. To make this possible, the POS system must be able to build a connection with an external platform such as Company X's web shop.

The last must-have function that must be emphasized is the function to make manual changes to the inventory. In case a product breaks or the inventory is incorrect for other reasons, the inventory could otherwise not be adapted and thus would convey wrong information to Company X's inventory repository.

5.1.2 Should-have requirements

Should-have requirements are not essential for the system to work, but the desire for them is significantly high among the retailers (Heerkens & Winden, 2017). To make this decision, the number of selections made by the participants of the survey as well as the average importance of the requirements' categories are used.

Based on this information the most important category among the retailers is the analysis and reporting function that has an average importance of 3.5 and the second lowest standard deviation of 1.22. This shows that this function is overall regarded to be of high importance with rather low fluctuation within the sample as the standard deviation is comparably small. Tied with the inventory management function, this was also the functional requirement category that was selected most frequently to be a driving factor for switching POS systems (38.24 % each). As this is the most important functional requirement, this should be included in the final design of the POS system.

One potential sub-functionality of the analysis and reporting function could be the functionality that tracks customer purchases which has been selected by 44.12 % of the retailers. Even though this requirement was grouped in the customer relationship management function, it could also be put in the analysis function. As there were no more specific requirements mentioned in the elicitation phase, the most common analysis and reporting functions should be identified and their importance among the retailers should be assessed to make sure that the retailers' needs are respected. A starting point for this is the list of additional requirements that were mentioned by the participants in Chapter 4.

The second most important requirement category is the connectivity of the system which got an overall importance of 3.23 with a standard deviation of 1.28. Thus, it is of similar importance as the analysis and reporting function. Next to the connection with Company X's web shop, two more requirements were selected by a respectable number of retailers. The first connectivity functionality that was selected by more than half of the retailers is the connection with an own web shop. 58.82 % of the retailers indicated that they could imagine using such a function. Even though many retailers might currently not have their own web shop yet, it could happen that they want to establish one later. In case the POS system would not allow for such a function, there is a considerable risk that the retailers switch to another POS system that has this possibility.

The ability to enrich the product data in the system with additional information such as a product description or product images was also selected by almost half of the participants (47.06 %). Next to that, this function can also add great value for Company X as it can help shifting some of the workload from Company X's employees to the retailers. Furthermore, this gives the retailers some more autonomy which in turn gives them more control over how their products are presented on Company X's web shop. However, it is important to note that some sort of checking mechanism is needed to make sure that the product images and descriptions are up to Company X's standards.

The last requirement of the group of should-have requirements is the function to make bulk updates of inventory. Even though this requirement was only selected by 20.59 % of the participants, this requirement should be included in the system. The reason for that is that observations by Company X's employees have shown that retailers tend to be very busy during their regular work already. In case the retailers had to add large deliveries to the inventory system manually, this would only add more workload. An option for bulk updates would allow

them for example to upload entire delivery lists to the inventory, so that this task can be performed in a shorter time. It should however be investigated why retailers have not selected this requirement in larger quantities. Potentially, the benefits of such a function have not been conveyed convincingly.

5.1.3 Could-have requirements

The could-have requirements are requirements that do not have to be included in the system (Heerkens & Winden, 2017) as they are not very important to the end user. In this case, these are requirements that only have a rather low number of selections as indicated by the retailers. The first could-have requirement are orders which can be manually adjusted before they are placed automatically. This feature has been selected by only 23.53 % of all retailers. Even though it was mentioned by some retailers in the interviews that orders take up a large amount of their working day, it seems like the retailers still prefer doing the orders by themselves rather than relying on the POS system.

A function for automatic price changes based on suppliers' prices has been selected by roughly more than one third of the retailers (38.24 %). While this function shows some potential to further decrease the manual work of the retailers, the overall interest does not seem to be high enough to motivate this requirement to be a must-have requirement. However, once the most important functionalities have been incorporated, this function might be interesting to be added later.

20.59 % of retailers have selected a function for error prevention such as random stock counts to check the accuracy of the inventory system. As this is a rather low percentage, this requirement will be put in the could-have category as it does not add too much value as well, even though it can make sure that the system's accuracy is better as it would be without it. However, the main reason for the inaccuracies is assumed to be the infrequent updates rather than small inaccuracies due to reasons such as theft.

The retailers have not shown large interest in the connection of their POS system to other external platforms as only 20.59 % of retailers have selected this requirement. For Company X it might also make sense to leave out such a function, as it could give competitors the opportunity to also connect to the retailers stores and offer them a similar service. However, if other platforms should be connected that add another service for the retailers and the demand for this function increases, this function might need to be included.

Various measurement units have only been selected by 20.59 % of all retailers. This makes sense, since this only comes in handy for stores that sell fresh products and thus, might base their prices on the weight of the product. Perhaps this function should only be included for grocery stores that sell fresh products.

5.1.4 Want-to-have requirements

This category represents those requirements that are not essential to be included now but might be interesting later (Heerkens & Winden, 2017). In this case, these are also the requirements which have only been selected by a very small number of retailers and thus are not worth to be included in a standard system that will be offered to all retailers.

The fully automated orders have only been selected by 17.65 % of the retailers. In addition to that, this function becomes obsolete if the adjustable automated orders are included in the system.

A connection with other retailers to drive down the purchasing costs has also raised very little interest among the retailers and was only selected by 8.82 % of the retailers. Besides, this function requires a lot of coordination and Company X's role would change from simply offering a marketplace for the retailers to becoming a business partner that helps them to improve their business.

Finally, the individual promotions for customers will also be put into this category for the moment. Even though 47.06 % of retailers have said that they would like to have this feature, the overall importance of the customer relationship management function shows to be of little importance to them. The average importance is 2.3 with the smallest standard deviation among the functional requirements categories. This shows the consensus about the low importance of this feature. Also, only 11.76 % of retailers would consider a switch due to a better customer relationship management function. These low numbers simply do not motivate for integrating such a complex function yet. However, if the system shows widespread acceptance and the retailers' interest in this feature rises, Company X should consider implementing it at a later stage to add more value for the users.

5.1.5 Modelling functional requirements

The functional requirements are visualized in Figure 28. The requirements are sorted by their functionalities and by their requirement category which is done in a hierarchical order. The most important requirements are represented at the top of the figure while the less important requirements are shown at the bottom. This figure can help Company X when communicating and discussing the requirements both internally as well as externally to suppliers of POS systems and retailers. Company X is recommended to focus on implementing the must-have and should-have requirements for the initial design of the POS system. These are the requirements which will allow the system to work properly, and which were requested by a respectable number of retailers. After these requirements are implemented, a later version of the system can add more additional functionalities to give more value to the retailers implementing it.

Figure 29 shows what the data updating process would look like if all the must-have and should-have functionalities as indicated above are included. The system automatically updates the stock levels whenever a price or stock changes. This allows the system to always be up to date. Additionally, the retailers have a function allowing them to add their own product information. This takes away a part of the workload from the Company X employees. In the interviews, some of the employees explained that this was useful, as they were able to spend their time on other tasks, such as improving other processes or adding new features to the marketplace. Nevertheless, the information that is added by the retailers needs to be checked in some way to make sure that it adheres to Company X's standards. Only if this is fulfilled, the new products can be added on the web shop.

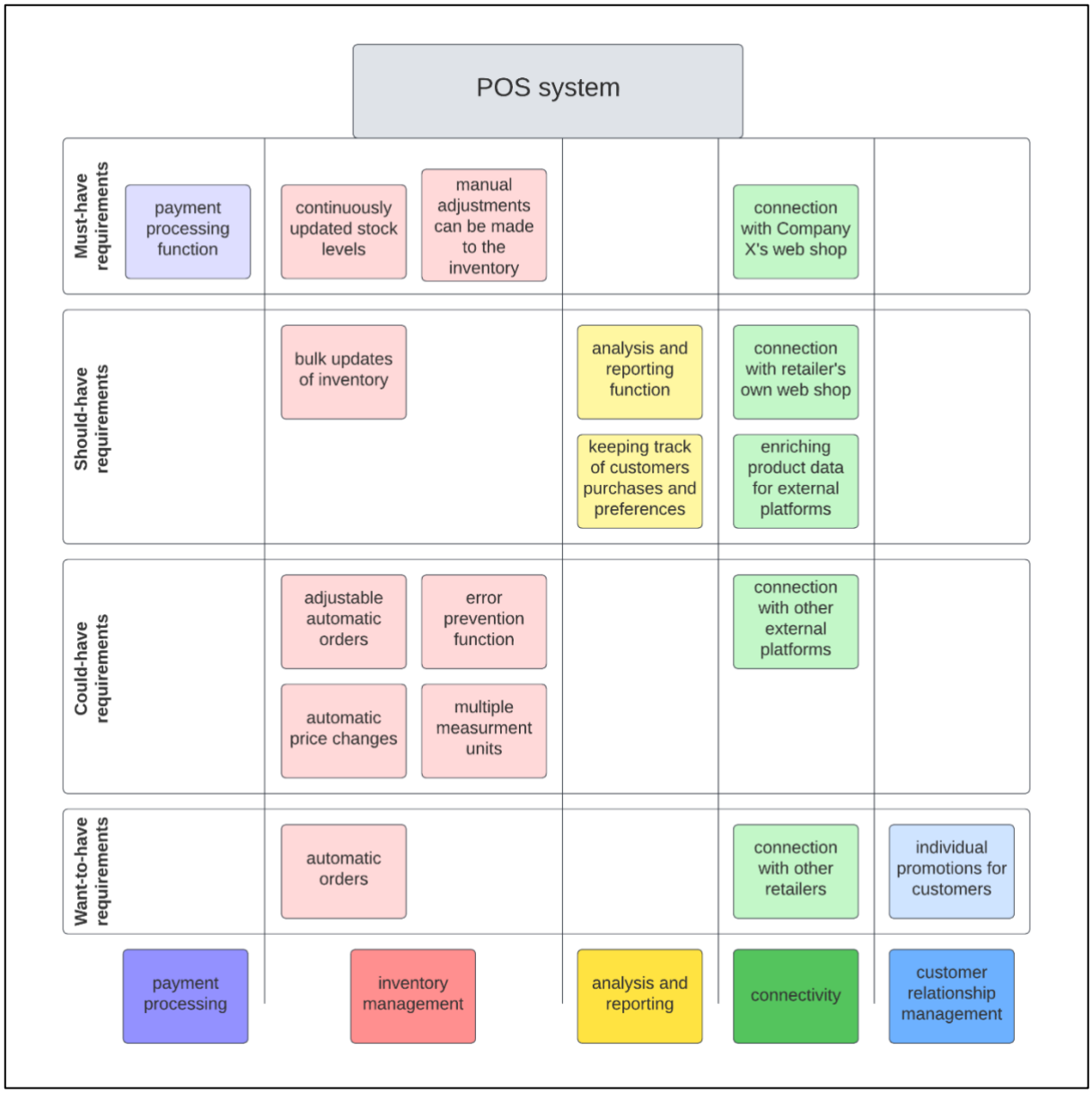


Figure 28: Visualization of functional requirements

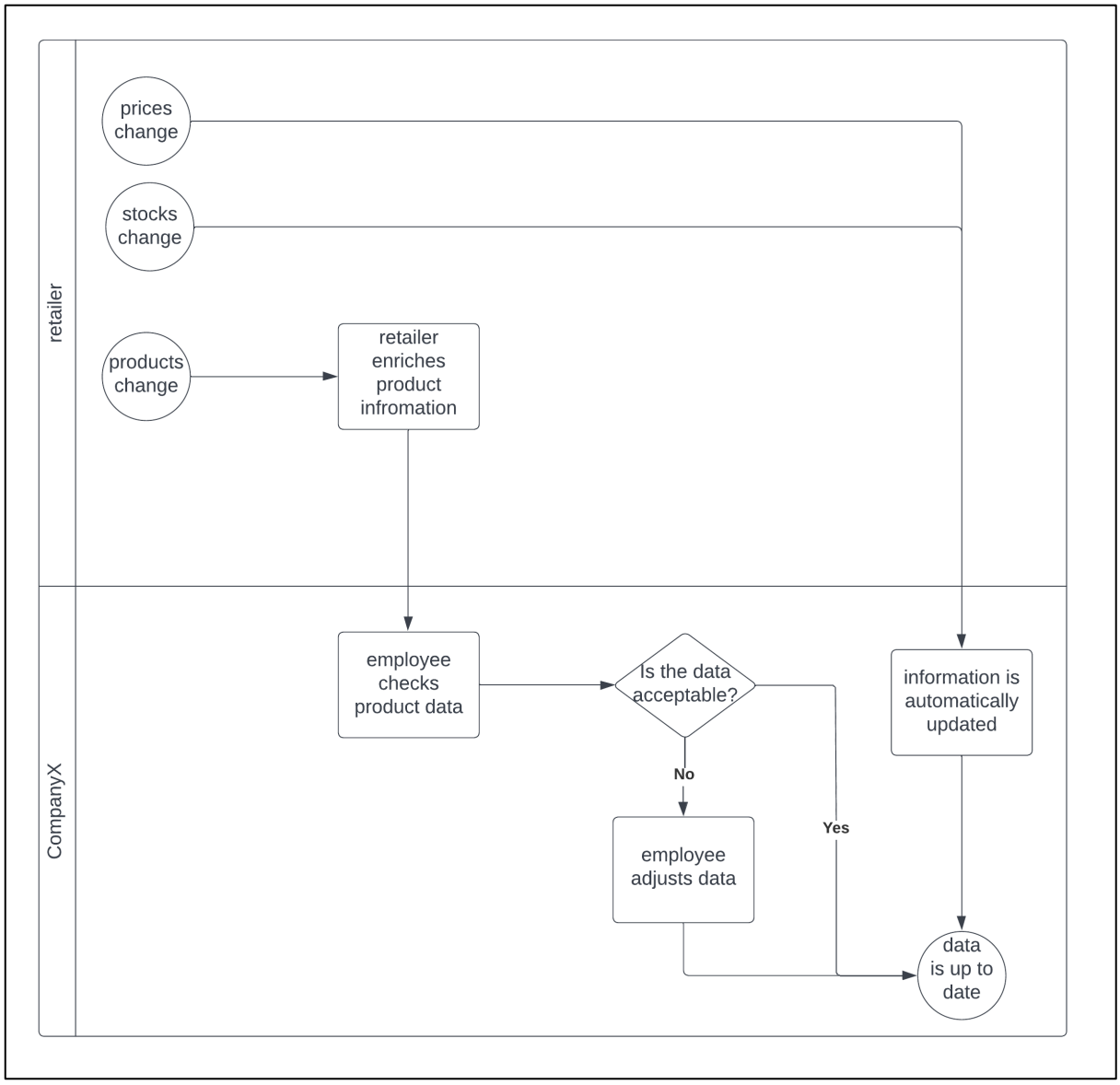


Figure 29: BPM with must-have and should-have requirements

5.2 Assigning weights for evaluation of non-functional requirements

Opposed to the functional requirements which can either be implemented in the new POS system or not implemented, the non-functional requirements cannot be implemented or not. They are more like the characteristics of the POS system and one can only assess their performance. However, they can be assigned weights based on their importance to help Company X put the right focus during their design phase. In case Company X decides to outsource the design of the POS system or decides to purchase another company's POS system, this can help them to decide for a system based on the retailers' preferences. For example, Company X could grade the different criteria on a scale from 1 to 5. In combination with the weights that are given based on the importance as assessed by the retailers, this gives the POS systems' grading more depth. Thus, important criteria have more impact on the overall grade than less important criteria. If two POS systems achieve the same total amount of points, the difference between the criteria's weights can still give Company X an indication which of the two systems is more valuable to them. Table 6 shows the average importance of each of the three categories as well as their standard deviation. It shows that security is regarded as the most important non-functional requirement as it has an average importance of 4.15 and the lowest standard deviation. This shows that there seems to be some consensus among the

retailers. However, usability shows to have an almost equal importance. Only deployability is has been regarded slightly less important, but it is also not far off. All the non-functional requirements must be respected to a large extent in the design phase. Their high importance shows how important a secure and well-running system is to the retailers.

Requirement category	Average importance	Standard deviation
Usability	4.13	0.87
Deployability	3.71	1.06
Security	4.15	0.83

Table 6: Mean and standard deviation of the non-functional requirements' importance

It makes sense to assign weights based on their relative importance, meaning that the differences in the weight should represent the rather small differences as the three requirements seem to be of similar importance. Using the following calculations, the overall weights of the non-functional requirements are decided. The calculations show that the system's performance in the usability and the security categories should have a higher influence on the final score than the performance in the deployability criteria. If the numbers were to be rounded one could say that the usability score makes up 34 % of the score, deployability makes up 31 % of the score and security makes up 35 % of the score.

$$\text{Weight usability} = \frac{4.13}{(4.13 + 3.71 + 4.15)} = 0.3444$$

$$\text{Weight deployability} = \frac{3.71}{(4.13 + 3.71 + 4.15)} = 0.3094$$

$$\text{Weight security} = \frac{4.15}{(4.13 + 3.71 + 4.15)} = 0.3461$$

Equation 1: Calculation of non-functional requirements' weights

The same procedure can be performed for the more specific criteria that make up these categories. That leads to the following weights for the different categories.

5.2.1 Weights of usability requirements

The sum of the average values of the usability requirements' importance as assigned by the retailers is 28.2. Thus, each usability requirement's average importance is divided by this value.

$$\text{Weight user friendliness} = \frac{4.4}{28.2} = 0.1557$$

$$\text{Weight operability} = \frac{4.3}{28.2} = 0.1515$$

$$\text{Weight effectiveness} = \frac{4.2}{28.2} = 0.1472$$

$$\text{Weight availability to all employees} = \frac{4.1}{28.2} = 0.1461$$

$$\text{Weight customer service} = \frac{4.0}{28.2} = 0.1418$$

$$\text{Weight time efficiency} = \frac{3.9}{28.2} = 0.1396$$

$$\text{Weight compliance with standards} = \frac{3.3}{28.2} = 0.1182$$

Equation 2: Calculation of the usability requirements' weights

5.2.2 Weights of deployability requirements

The sum of the average values of the deployability requirements' importance as assigned by the retailers is 15.2. Thus, each deployability requirement's average importance is divided by this value.

$$\text{Weight support during installation} = \frac{4.2}{15.2} = 0.2731$$

$$\text{Weight affordability of the system} = \frac{4.1}{15.2} = 0.2711$$

$$\text{Weight quick installation} = \frac{3.8}{15.2} = 0.25$$

$$\text{Weight expandability of the system} = \frac{3.1}{15.2} = 0.2018$$

Equation 3: Calculation of the deployability requirements' weights

5.3 Requirements to be included in the POS system's design

In this chapter the functional requirements' importance as assessed by the retailers is considered to sort them based on the MoSCoW rule. According to this rule, must-have requirements, should-have requirements, could-have requirements, and want-to-have requirements are established. For the initial design, Company X should focus on implementing the must-have and the should-have requirements as these bring the most value to the POS system and are regarded to be of the highest importance for the retailers who will eventually be using the POS system. After the POS system is established and the most important requirements are integrated, the remaining requirements can be added to the POS system to give it more advanced features adding more value and making the POS system stand out from others.

Next to the functional requirements, the non-functional requirements' importance is also taken into consideration in this chapter. Based on the average scores of the various requirements, weights are assigned to them. These weights help Company X to put focus to the right requirements when designing the POS system or to make a more elaborated choice when deciding to purchase a POS system from an external supplier. If the focus is to be set differently, the weights can obviously be altered to Company X's preferences. Overall, the non-functional requirements are more important to the retailers than the functional requirements. This shows that a well-functioning system is important than a system with too many features which does not work well.

6 Likelihood of a new POS systems' implementation

It this chapter it is analysed how likely the retailers are to switch to a new POS system. To understand this, both information from the interviews as well as form the survey is used. Finally, the main reasons for switching the POS systems are explored. This information is valuable for Company X because it allows them to understand the actual needs of their partners and can allow them to design the POS system in a way that best fits these needs. In turn, this can make a successful introduction of the POS system more likely.

6.1 Likelihood of an implementation as indicated in the interviews

The interviewed employees have different opinions on the likelihood of an implementation of the new POS systems at the retailers. Two of the five interviewed employees believe that the overall readiness among the retailers to make a switch to a new POS system is rather low. They believe that it needs a lot of convincing to make many retailers switch the POS systems. One employee believes the retailers' readiness to be above average. They experienced many retailers to be complaining about their current systems. Thus, they think that they would be ready to make a switch if offered the chance to do so. The remaining two employees think that the retailers are overall very likely to make a switch if the new system works better than their current systems.

The main potential problems with the implementation as indicated by the interviewed employees are the time and effort that are associated with the implementation of a new POS system. As it was explained earlier, the retailers are usually very busy and do not want to spend much time on tasks that are related to Company X. Costs that could be included with the switch were another frequently mentioned potential problem. Furthermore, overcoming the force of habit is also mentioned to be a potential problem. Some retailers have been working with the same systems since a long time now and as they are not proficient with technology, switching to a new POS system is no simple task for them. Company X's employees expect these retailers to be very hesitant to a switch. Lastly, the employees also expect the complexity and length of the development and instalment phase to be a burden that needs to be overcome.

The interviewed retailers indicated their readiness to switch POS systems in a comparable way. When asked whether they could imagine using a POS system that was brought to them by Company X, two retailers said that they could not imagine this. One of them believes the switch to a new system would take too much time and would be too complicated for them. The other one said that such a system would not bring any new value for them and thus, they would not use it. The other three interviewed retailers could imagine using a system by Company X, but only under some conditions. Two of these retailers explained that they imagine the switch to the new system could be hard. The implementation of all the products into the new system could be quite difficult and take a lot of time. They would need additional personal to make the switch and thus, would only make the switch, if Company X offered some help with the installation. The other retailer who could imagine using a POS system by Company X doubts the technical feasibility of the POS system. For them it seems very complicated to combine all the objectives of the retailers and the features. However, if the system worked properly, they would believe such a system to be very interesting and useful and would consider using it.

6.2 Likelihood of an implementation as indicated in the survey

Figure 30 shows how the participating retailers assessed their likelihood of switching to a new POS system. More than half of the retailers showed to either have a neutral or positive attitude towards new POS systems introduced by Company X which is a good starting point for introducing the new POS system at least partially. Nevertheless, it should not be ignored that

there are also many retailers that do not show any or only very low interest in a new POS system. It needs to be further investigated why these retailers do not have interest in the system.

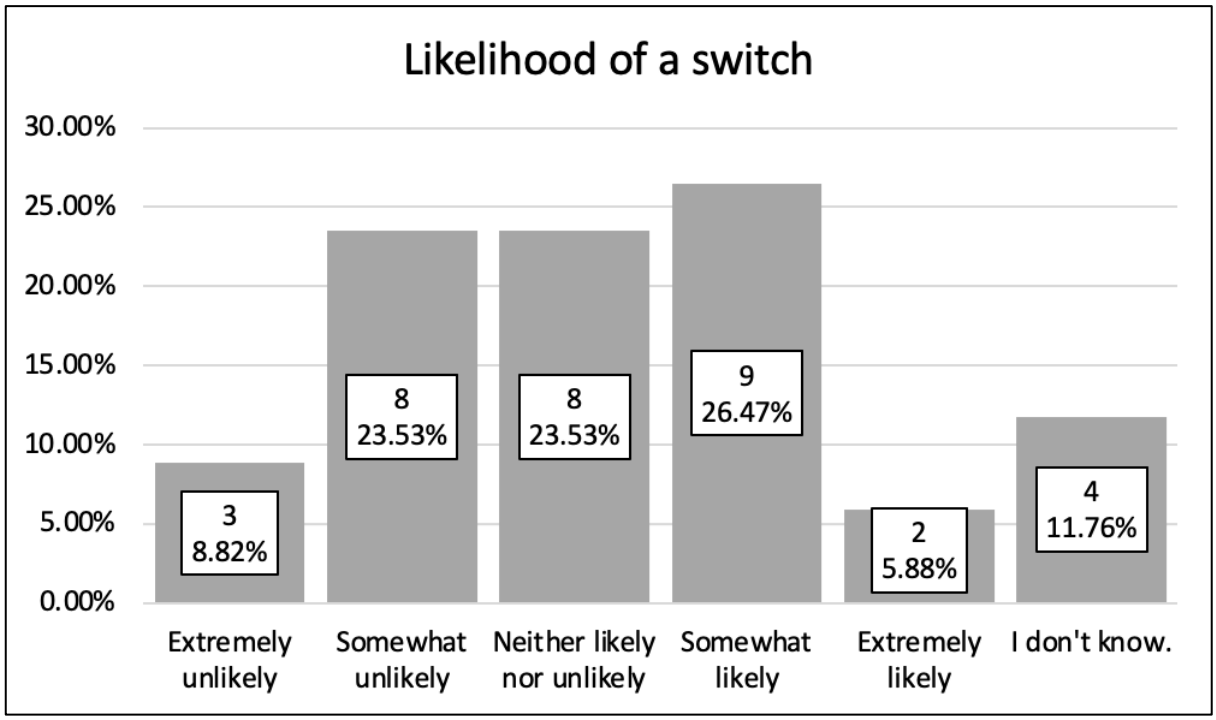


Figure 30: Likelihood of switching POS systems

Figure 31 shows the numbers of participants who selected the various reasons for a switch. The main reason why the retailers would switch is better usability. 50 % of the participants indicated that they would switch their POS system in case the new system had a better usability. This again underlines what was already expected and expressed in the interviews by Company X's employees. Next to that the inventory functions and the analysis functions are common reasons for a switch to a new system.
Striking is also that even though the security and the deployability of the POS system received very high values in terms of importance, they are not the reasons why the retailers would switch their POS systems. This shows that they place high value on these requirements and want to have them as "given".
With 26.47 %, quite a large percentage of the participants does not find any of the reasons persuasive enough to motivate switching to a new system. Company X is advised to conduct further research on what is needed to motivate these retailers to switch their POS system or what hinders them from switching POS systems now.

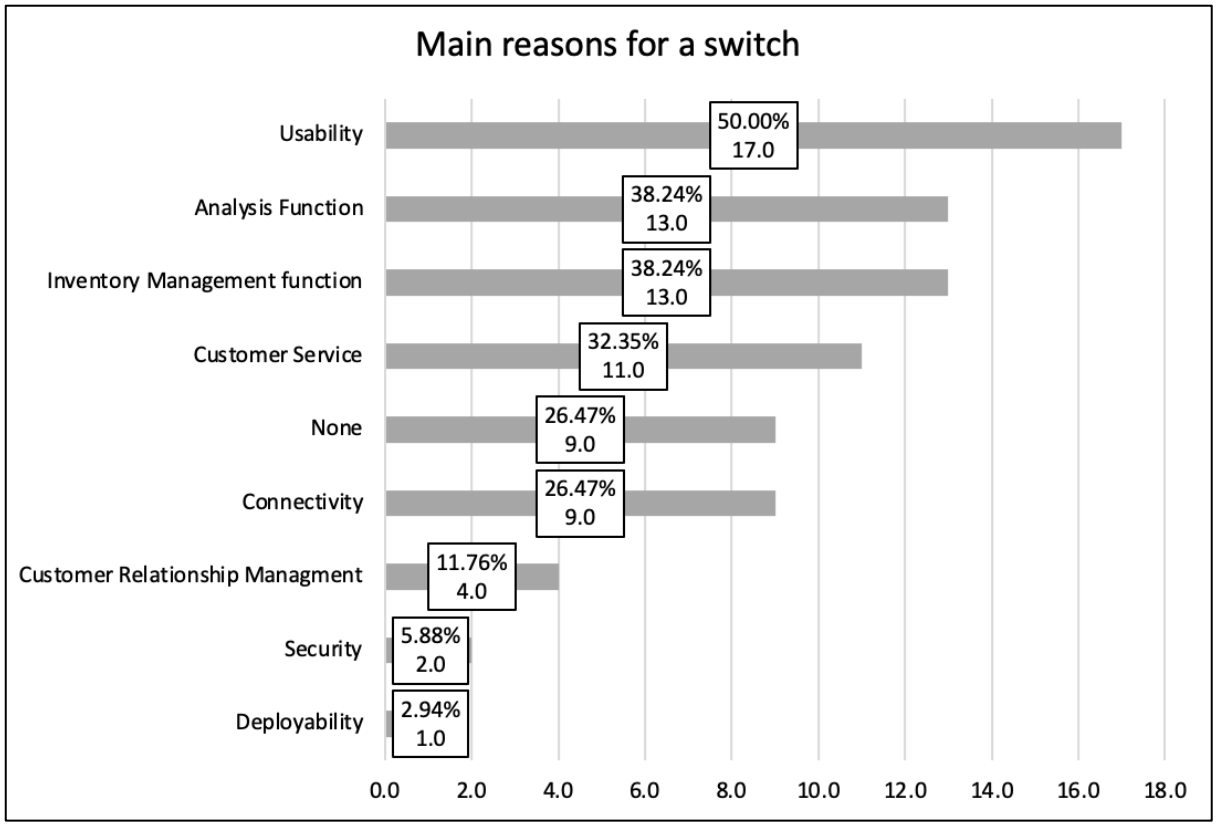


Figure 31: Reasons for switching POS systems

6.3 Likelihood of an implementation and reasons for it

In this chapter the overall likelihood of the retailers to switch to the new POS system is analysed. On average, the likelihood of the retailers is 2.91. The percentage of retailers who are either neutral or positive towards a new POS system is 63.33 % if the "I don't know" answers are ignored. This shows a good potential for a successful partial introduction of the POS system. As the retailers cannot be forced to use the POS system, it might be a good idea to first introduce the POS system at the retailers that are more likely to switch to the new system and approach the other retailers again at a later stage.

The most important reasons for a switch are a better usability of the system as well as an analysis and reporting function and an inventory function. This means that Company X should put special focus on these requirements when designing their POS system. In addition to that, they should also make sure that these functions are presented to the retailers in a good fashion showing that their needs have been understood and considered for the design of the system.

In Chapter 7 potential trends among the sub-groups of retailers are identified. Thus, special preferences among less interested retailers are pointed out. Excelling at these requirements can be important when trying to convince less interested retailers to switch to the new POS system.

7 Trends among sub-groups of retailers

In this chapter potential trends among sub-groups of retailers are identified. These sub-groups are made up of retailers that share some characteristics such as the industry they operate in. This information can help Company X to get a better understanding of their retailers and to understand whether certain groups need special attention.

7.1 Correlation between the number of selections and the likelihood of a switch

The numbers in Figure 32 represent the average number of selections that the participants made when asked for their main reason for switching to a new POS system. These numbers of selections are grouped by the likelihood of the participants to make a switch. It shows that those retailers who have indicated that they are likely to make a switch would make a switch for more reasons than retailers who are unlikely to switch POS systems.

For Company X this implies that it will be very important to understand the needs of the retailers who are unlikely to switch their POS systems as they will only be willing to switch their POS systems for very few reasons. Thus, excelling at these requirements is of high importance for convincing the less interested retailers. The retailers that have indicated multiple reasons for a switch are more likely to find a feature that convinces them to switch POS system if compared to the other retailers, so they will most likely not need much convincing.

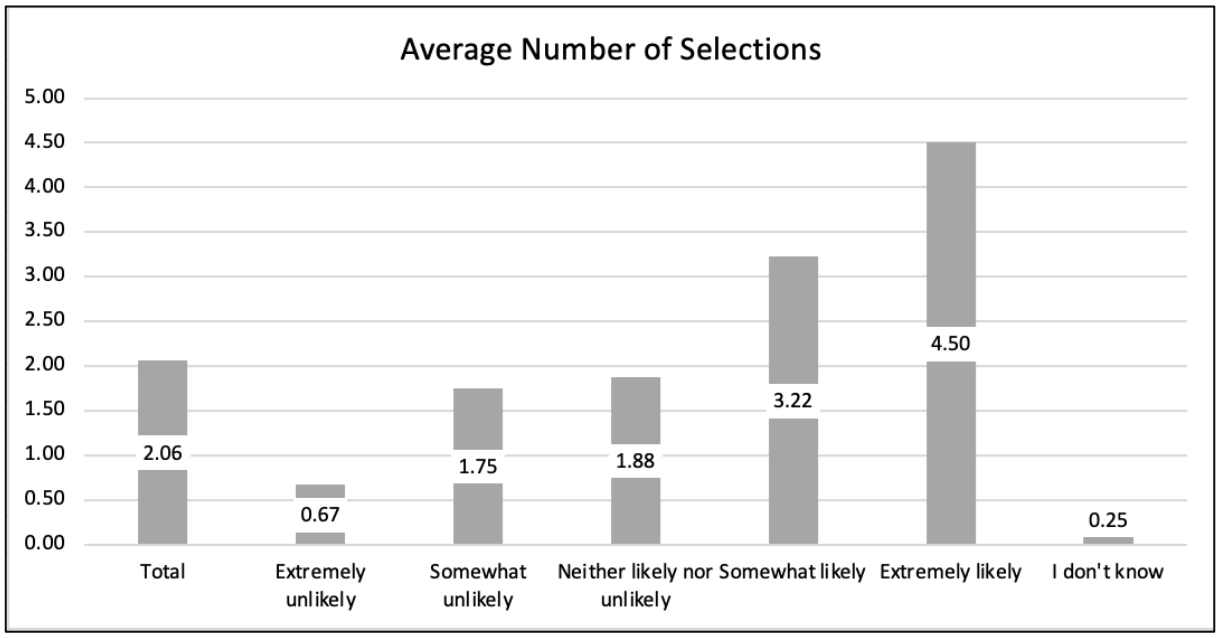


Figure 32: Mean number of selections for reasons of a switch per likelihood level

7.2 Comparison of retailers that are likely and unlikely to switch POS systems

For a comparison between the unlikely and likely retailers, they were divided into two groups. The “unlikely” group is made up of the retailer that have indicated that they are either “extremely unlikely” or “somewhat unlikely” to switch to a new POS system. The “likely” group is made up of the retailers who indicated that they are “somewhat likely” or “extremely likely” to make a switch. Both groups consist of 11 retailers each. The retailers that said they were “neither likely nor unlikely” to use a new POS system as well as those that answered “I don’t know” were left out from this comparison.

In Figure 33 the retailers of the “unlikely” group assessed the importance of an inventory management function and an analysis and reporting function within the POS systems significantly less important than the “likely” group. For the inventory management function,

the difference in the average importance is 1.0 and for the analysis and reporting function the difference is even larger with 1.2.
To understand whether there is an association between a retailer's likelihood to switch their POS systems and how they assess these two functions' importance, the correlation coefficient is taken into consideration. In this case, the Spearman's rho correlation coefficient needs to be used (Cooper & Schindler, 2013). The Spearman's rho correlation coefficient between the likelihood to switch POS systems and the importance of an inventory management function for this sample is 0.419. The correlation coefficient between the likelihood of a switch and the importance of the analysis and reporting function is 0.424. At a 0.05 significance level, both correlations are significant. This implies that a retailer who assesses the inventory management function and the analysis and reporting function as more important, is also more likely to switch to the new POS system. However, for the other functional requirements no such correlation was found.
This means that retailers who understand the importance of an accurate inventory management and an analysis and reporting function are structurally more likely to request a system that can provide them with these functionalities. Company X is advised to help the less interested retailers understanding the benefits of these functionalities. A potential way to do this could be experience reports of the retailers who are applying the new POS system. Statistics such as reduced costs are also a strong motivator.

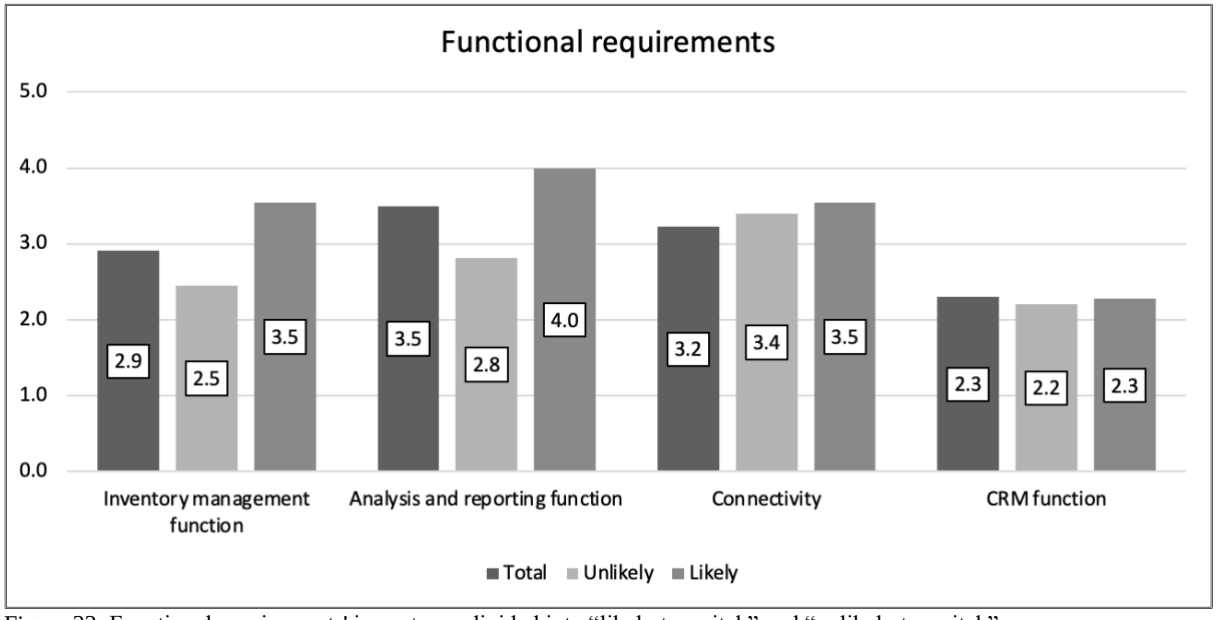


Figure 33: Functional requirements' importance divided into "likely to switch" and "unlikely to switch"

In Figure 34, again, there are differences in the average scores of the importance assigned to each category. For usability, the "likely" group assigned an average score that is 0.7 higher than the "unlikely" group. However, the correlation coefficient for these variables is 0.361 which is only close to being a significant correlation. The differences in the other two categories, deployability and security are less significant. However, it is striking that the "unlikely" group assessed the POS system's overall deployability's importance to be higher than the "likely" group. This is the only case this happened. The correlation coefficient for these variables is -0.281 which is also not significant, but it suggests that retailers find a fast and easy installation process more important if they are less likely to switch systems in the first place.

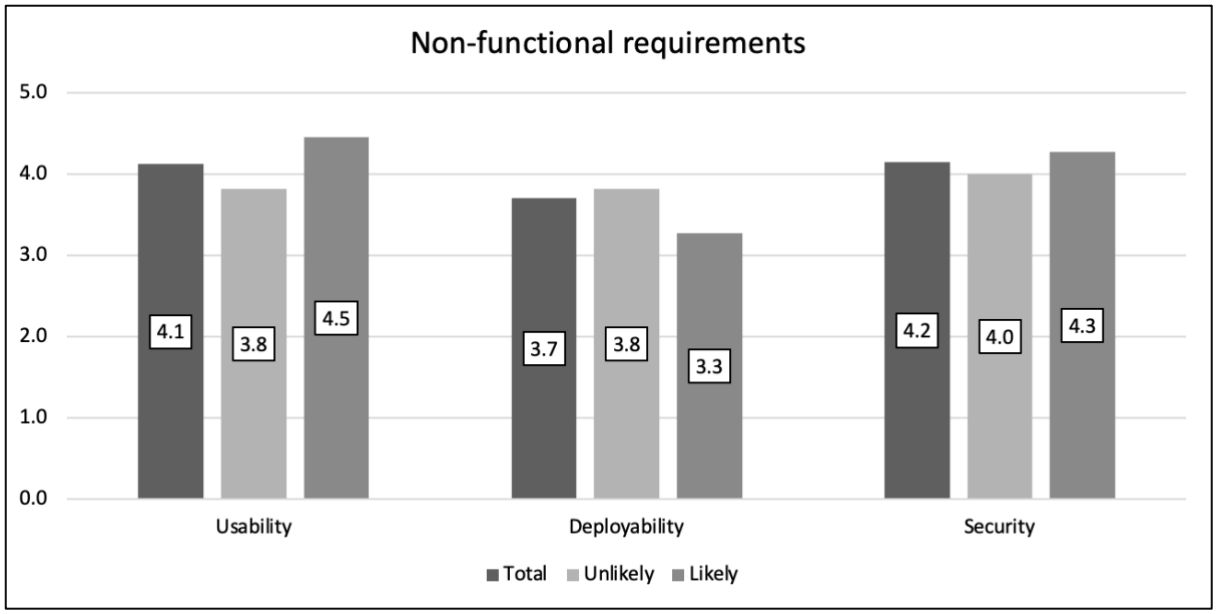


Figure 34: Non-functional requirements' importance divided into “likely to switch” and “unlikely to switch”

Figure 35 below compares the share of retailers in the respective groups, that would switch their POS systems for the indicated reasons. It shows again that the “likely” group has a very high motivation to switch POS systems if the inventory management function and the analysis and reporting functions are better. A better usability and better customer service were also both chosen by more than 50 % of the retailers that are in this group. It is also striking, that no retailer from the “likely” group chose no reason to be motivating enough. The retailers of the “unlikely” group got the highest score in “none of the above”. 45.5 % did not find any of the potential reasons for a switch motivating enough to switch their POS systems.

There are two ways to interpret this large number. Either the reasons for a switch that were proposed were not suiting these retailers’ needs, or they simply do not want to switch their POS system at all. Further investigation of Company X is advised to understand which of these two is the actual reasons for this.

The averagely lower scores on the importance of the various functions in a POS system, however, indicate that they do not feel the need to switch to a new system, as they also do not see a high value that would be added with these functions. In contrast, the “likely” group sees high importance in the features. If they do not have these functionalities in their current systems, this is a great motivation for a switch.

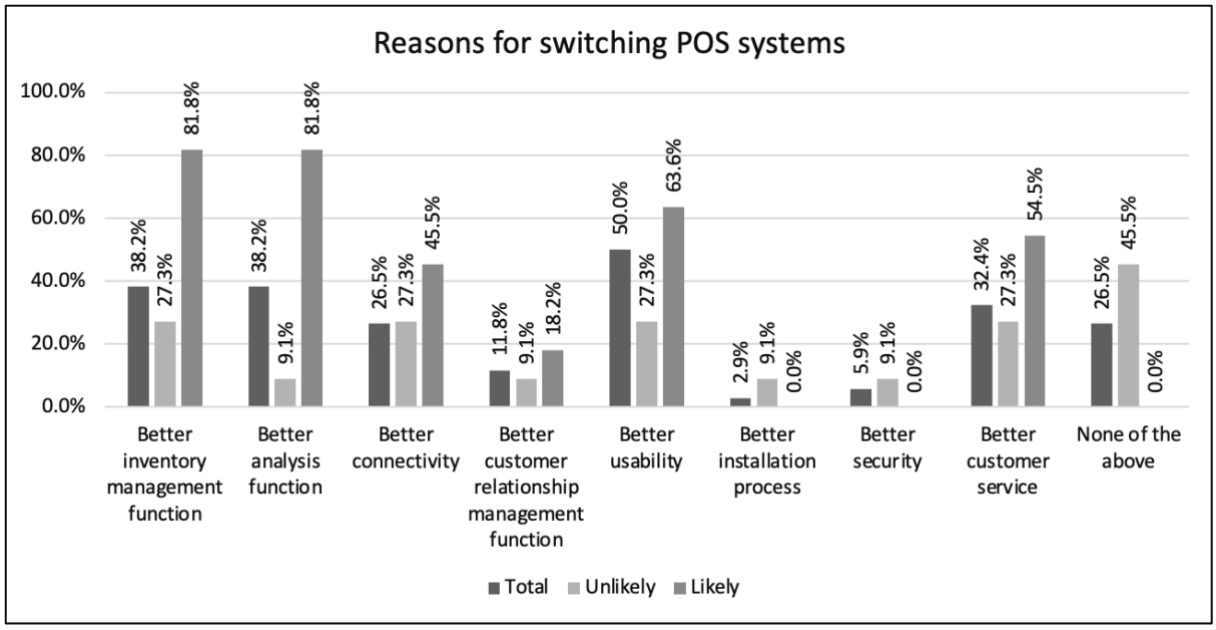


Figure 35: Reasons for switching POS systems divided into "likely to switch" and "unlikely to switch"

It can be concluded that the group of retailers which is already likely to switch to a new POS system, would appreciate if the new system had a good inventory management function and an analysis and reporting function. In addition to that, for these retailers the usability of the system matters a lot. In contrast to that, the retailers who are currently unlikely to switch their POS systems need to be researched further. The real reasons why they are currently not likely to switch to a new POS system need to be understood. In case Company X wants to implement the new POS system at the "unlikely" retailers, they should emphasize the ease of the installation process, as the retailers of the "unlikely" group have indicated that this requirement is important to them.
As it seems like the retailers of the "unlikely" group do not believe functions such as an inventory management function or an analysis and reporting function to be very important yet, it might also be necessary to educate them further on the potential benefits of such functionalities. However, this can be a very time-consuming step and Company X needs to assess the value of such a campaign. It might be a good idea to start implementing the new POS systems at the retailers that already show a big interest in a new POS system and then show the remaining retailers the benefits through experience reports of the retailers. This could help them to understand the value of a more advanced POS system and thus, could increase their likelihood to introduce a new POS system.

7.3 Correlation between the demographic variables and likelihood of a switch

Company X's management also expressed the desire to understand whether correlations can be found between the likelihood to switch and the variables that were assessed within the so-called "categorial questions" in the beginning of the survey. These variables are the time a retailer has spent with the current POS system, the time a retailer has been working with Company X, the number of incomplete orders, and the number of employees. None of these variables shows any significant correlation with the likelihood for a switch, so it can be assumed that the likelihood of a retailer to switch their POS system does not depend on any of these variables.

7.4 Comparison of retailers from Food & Drinks industry to the other retailers

Figure 36 shows a pie chart representing the respective industries in which the various retailers operate. The largest number of participating retailers operate in the Food & Drinks industry. This industry deals with fresh goods, which can potentially perish. In addition to that, it was already identified in the interviews that these retailers potentially sell items not in units but by weight. As this group of retailers is respectively large, it can be interesting for Company X to verify whether the needs of retailers from the Food & Drinks industry are significantly different from the needs of the remaining retailers.

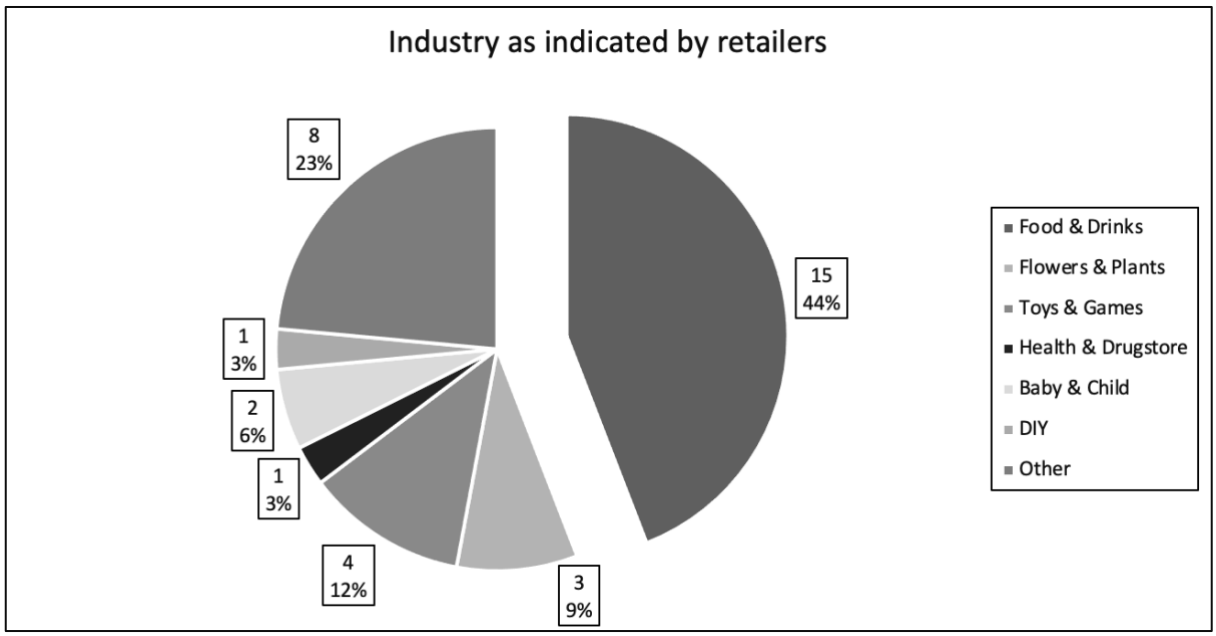


Figure 36: Industries as indicated by retailers

The sample can be divided into two groups. These are "Food & Drinks" and "Rest". 15 retailers belong to the Food & Drinks industry while 19 retailers belong to another industry. Figure 37 shows how the two groups have assessed the importance of the various requirements.

The most striking differences in the importance of the functional requirements can be observed in the inventory management function and the connectivity function. The retailers of the Food & Drinks industry assessed the importance of the inventory management function on average 0.8 points lower than the remaining retailers. In turn, the Food & Drinks industry assessed the importance of the POS system's connectivity 0.6 points more important than the rest. However, these differences are not significant.

In the more specific requirements, the most striking differences can be observed in the inventory management features. While no retailer of the "Rest" group indicated that they would like a feature which allows for different types of stock keeping, 53.3 % of the retailers from the Food & Drinks industry would like such a feature. Next to that, almost twice as many retailers from the Food & Drinks industry would like a feature that allows for automatic price updates based on the suppliers' prices, when compared to the remaining retailers where only 26.3 % indicated interest in this. In case Company X decides to offer different versions of a POS system for different groups of retailers, they should consider implementing these features additionally to the features that exist in the general version of the system. In the other more specific requirements no significant differences can be observed.

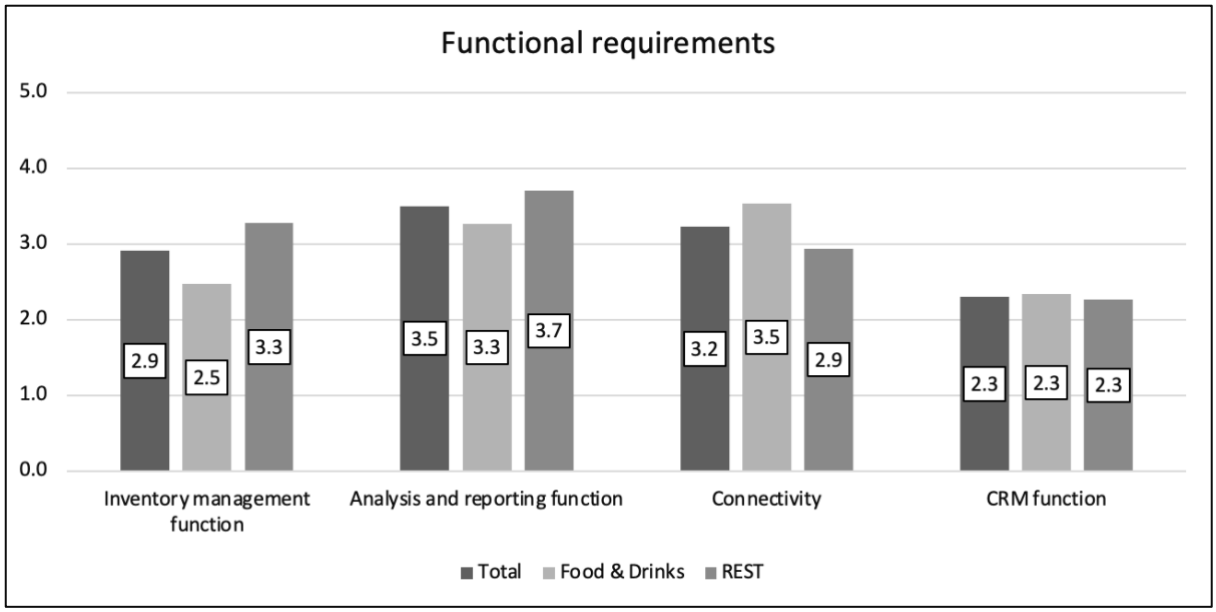


Figure 37: Functional requirements' importance divided into “Food & Drinks industry” and the rest

As can be seen in Figure 38, the two groups show a similar assessment of the importance of the non-functional requirements, so no significant differences can be observed there.

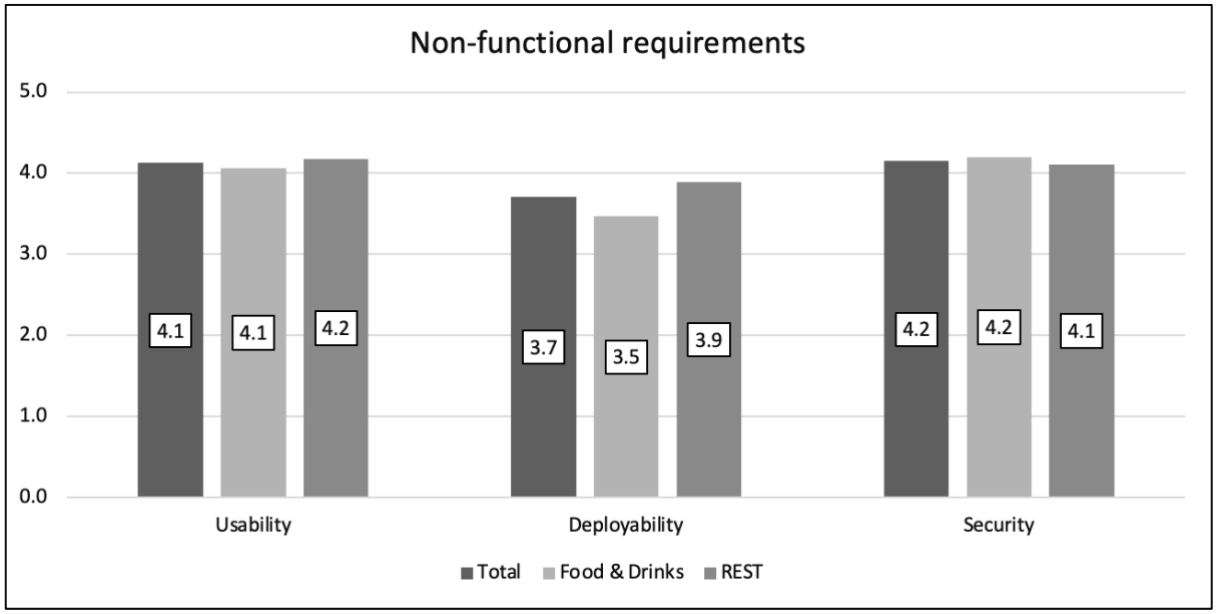


Figure 38: Non-functional requirements' importance divided into “Food & Drinks industry” and the rest

The group of retailers from the Food & Drinks industry shows a slightly lower interest in switching to a new POS system. They have indicated a likelihood of a switch to be at 2.7 while the rest of the retailers indicated an average likelihood of 3.2. Figure 39 shows the percentages of retailers of the respective groups that have selected a certain reason for switching their POS systems. The percentage of retailers from the Food & Drinks industry that would switch their POS systems due to a better inventory management function and for a better analysis and reporting function is larger than the percentage of the remaining retailers. Even though they have assessed these features less important than the other group, they would switch their systems if these functions were better in a new system.
If Company X decides to try to convince the retailers from the Food & Drinks industry to switch to their new POS system, these features should be ideally performing better than the old

POS systems, that the retailers are currently using. To understand the problems, the retailers are having with their systems now, further research at these retailers needs to be performed. This could be done as a part of the design phase.

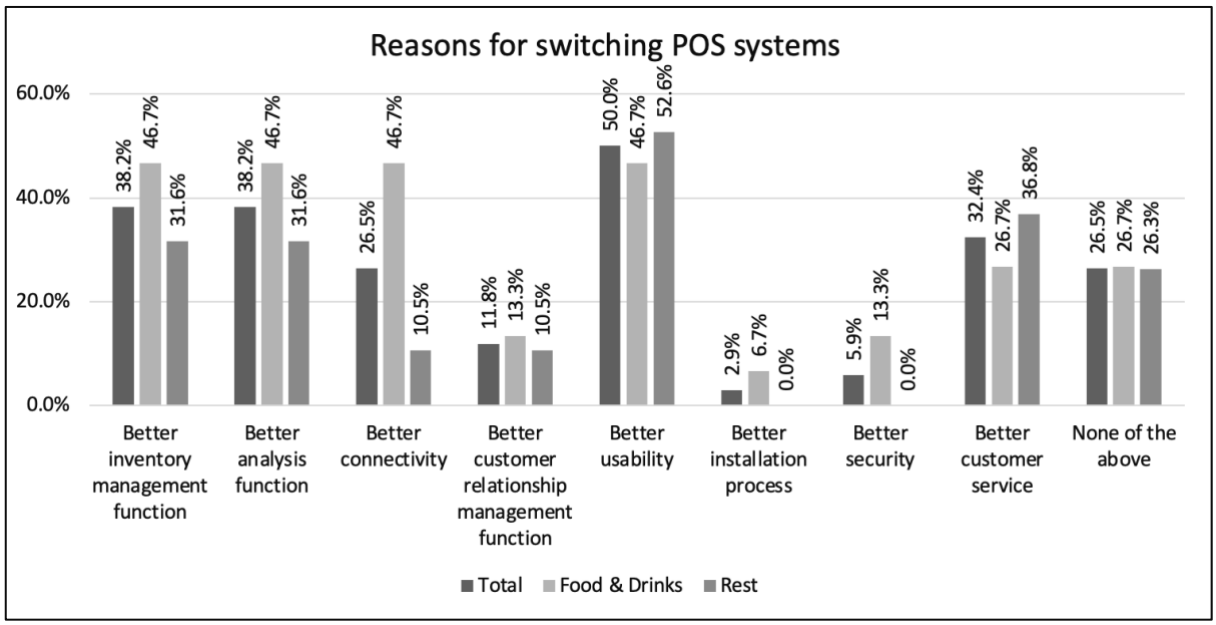


Figure 39: Reasons for switching POS systems divided into "Food & Drinks industry" and the rest

7.5 Trends among sub-groups of retailers identified in the data

The sample of retailers can be divided based on two characteristics. Firstly, the retailers are either likely or unlikely to switch to the new POS system. The retailers that are likely to switch the POS system have indicated significantly more reasons motivating them to make the switch. This means that the unlikely retailers' needs should be put special focus on as the performance of a single requirement has a higher relative importance. Next to that, retailers that assess the importance of an inventory management function and an analysis and reporting function to be high are structurally more likely to switch to a new POS system. Therefore, Company X is advised to consider performing a campaign that will educate the retailers on the importance of these functions.

The other characteristic on which the sample can be divided is the industry they are operating in. Retailers of the Food & Drinks industry have shown an interest in an inventory function that offers different stock measurement units and automatic price updates based on suppliers' prices. For a more successful introduction of the POS system at the Food & Drinks retailers, Company X should consider adding these functionalities specifically for the systems installed at their locations.

8 Discussion and Conclusion

8.1 Discussion of results and recommendations

8.1.1 Reflection on research method

In this research the requirements engineering process was applied to establish a set of retailers' requirements for allowing for a successful introduction of a new POS system that constitutes a potential solution for decreasing the number of refunds at Company X. Initially, the current situation of refunds was checked, and the problem owners were identified to be the retailers that do not use POS systems allowing for a live connection between their store and Company X's web shop.

In the first step, potential requirements were identified through interviews with samples of the stakeholders that are the retailers who are the main users of the POS system and Company X's employees who are indirectly affected by the POS system. Besides that, potential requirements from literature were found that added onto these requirements. The requirements were divided into functional and non-functional requirements and categories of requirements were established within both groups. The functional requirements were divided into requirements of an inventory management function, an analysis and reporting function, the system's connectivity, and a customer relationship management function. The non-functional requirements were divided into requirements for the system's usability, deployability, and security.

Using a survey that was conducted with the retailers these requirements' importance was assessed and the functional requirements were sorted based on this importance according to the MoSCoW rule while the non-functional requirements were assigned weights that allow for a better evaluation of their performance based on the retailer's needs.

These requirements are documented and visualized. The retailers' likelihood for introducing the new POS system was assessed and their main motivation for switching was assessed as well.

Finally, sub-groups of the retailers were identified to check for trends among the sample of retailers.

Overall, this research method has helped a lot to give Company X insights into the research population's needs for a POS system. These insights are of great use for the design phase of the POS system and the assessment of the retailers' likelihood gives Company X a good indication of how much interest their retailers have in a new system.

8.1.2 Combining this solution with previously explored solutions

Compared to previously explored solutions from Lute's (2022) research, designing or purchasing a new POS system and integrating it among the retailers, takes a much longer period to be implemented than updating the merchant portal which allows for quicker adjustments. Next to that, resources that are necessary to implement this solution are expected to be much more. Therefore, it seems reasonable that the previously found solutions should be introduced first. After they have been implemented, it should be checked how much the situation has improved already and Company X should make an assessment whether a new POS system is still a feasible solution to further decrease the remaining number of refunds.

New POS systems would also require the retailers to change a big part of their business, and this takes more time and effort to adapt to.

An advantage of this solution compared to Lute's (2022) proposed solution is the shift towards more automation which removes potential human errors and leaves less work for both the retailers and Company X's employees.

8.1.3 Limitations of this work

The main limitation of this work is the limited number of participants in the interviews among retailers as well as in the survey. A larger number of participants would give a more comprehensive picture and be less prone to errors or bias. A survey among all retailers as addition to the survey among Company X's partners could have been used to make a comparison between these groups. With the number of retailers being limited to cooperating retailers, the information gathered within this research is only relevant for Company X and does not necessarily help other companies with their POS design, since the preferences among other retailers could be different.

Furthermore, the quality of the inputs would potentially increase if the survey was designed in a different way. One example that potentially shows a lack of understanding are the responses to questions regarding the CRM function. Even though the overall importance of the CRM function was assessed comparatively low with an average score of 2.3, the specific functionalities were selected to be interesting by roughly half of the research population. This contradiction could be seen as a lack of understanding which can be an indication for a need of improvement in the survey design.

In the survey, the retailers were asked what the reasons for making a switch to the new POS system were. However, they were not asked what would be reasons for them to keep using their current POS system. This information might be of great importance to understand the barriers when trying to introduce a new POS system. These barriers should be investigated in further research.

The first language during the research process was English, while many of the retailers' first language is Dutch. This might have lowered their readiness to take part in the research. Even though the survey and mails were also available in Dutch, communication through the phone was on English since the main researcher does not speak Dutch fluently.

8.1.4 Recommendations for future research and implementation

In the future, Company X is advised to perform further research on the importance of the additional requirements that were mentioned by the retailers in the survey. This helps to guarantee that the POS system is not designed without important functionalities.

The retailers that have indicated to be unlikely to introduce the new POS system should be identified and researched in more detail to understand, how Company X can add features to the POS system that these retailers consider to be important. This will make them more likely to being open towards changing their POS systems.

While the drivers for changing POS systems were identified to a great extent in this research, barriers have not been given much attention. In further research by Company X the barriers faced when trying to implement the new POS system should be identified.

A cost analysis should be conducted which compares the cost of integrating the POS system to the cost of refunding orders in the future. This way, Company X can understand when it makes sense for them to integrate the new system.

Lastly, Company X should investigate whether it makes more sense for them to design the POS system internally or whether they should outsource this activity. This can be a crucial step as the design will require many resources which are not currently available at Company X.

8.2 Conclusions

8.2.1 Requirements to be included in the POS system

The functional requirements that should be implemented in the design of the POS system were identified in Chapter 5. Priority should be given to the requirements that make up the must-have as well as the should-have functionalities. The must-have functionalities include the payment processing function, the continuously updated stock levels which can be adjusted

manually to take care of errors within the system, and a connection between Company X and the retailers. Without any of these functionalities the system would not work at all. The should-have functionalities are the functionalities that have been assessed to be very important by the retailers. One of these is the analysis and reporting function that was recognized to be the most important functional requirements. More specific functionalities of this category need to be identified using the additional requirements mentioned by the retailers as a starting point. Another function that was identified to be of high importance is a feature to simply track the customers' purchases and preferences. It should also be possible to connect the system to the retailers' own web shops. Furthermore, the system should enable the retailers to enrich the product information with images and product descriptions to allow for more autonomy and to take some work away from Company X's employees who are currently responsible for performing this task. The last should-have functionality is a function to make bulk updates of the inventory in case for example a delivery of new products comes in at the retailers and many products' stocks must be updated simultaneously. These are the functions that Company X is strongly advised to implement in the first design of the POS system.
After that, Company X can also think about adding more of the other functionalities of the could-have and want-to-have category. This adds more value to the system. However, they should keep in mind to not integrate too many functionalities if they are not desired by many retailers. This can make the system very complex and harder to understand each of the functionalities. Consequently, high complexity could decrease the user-friendliness. The requirements organized by the MoSCoW rule are shown in Table 7.

Requirement category	Requirements
Must-have	- Payment processing function - Continuously updated stock levels - Connection with Company X's inventory repository - Manual adjustments can be made to the inventory
Should-have	- Analysis and reporting function - Keeping track of customers purchases and preferences - Connection with own web shop - Enriching product data such as descriptions and images - Bulk updates of inventory
Could-have	- Adjustable automatic orders - Automatic price changes - Error prevention function - Connection with other external platforms - Multiple measurement units
Want-to-have	- Automatic orders - Connection with other retailers - Individual promotions for customers

Table 7: Requirements organized based on the MoSCoW rule

Since the non-functional requirements were given a high importance among all retailers, they must be given special attention throughout the design phase. A well-functioning and secure system which is installed easily is very important to the retailers. However, these characteristics are not considered to be the main motivation for switching the POS system, but they can be regarded as must-haves for the retailers to even consider implementing the new POS system. When these characteristics are achieved trials or experience reports can be used to communicate the good performance of these requirements.

8.2.2 Likelihood to introduce the new POS system

In the survey 63.33 % of all retailers indicated that they are either neutral towards introducing the new POS system or they have a positive attitude towards it. This shows great potential for a successful initial round of implementing the system. As the introduction of the POS system cannot be forced on the retailers, but needs to be accepted by them voluntarily, the retailers that have shown higher interest in the system should be asked to implement the POS system first.
Experience reports of these retailers can help to persuade the remaining retailers as well. Especially good performances in the few requirements that were identified to be of high importance for the group of retailers less likely to make a switch should be highlighted to show them that their needs were considered for the design of the system. These requirements are non-functional requirements as well as the system's connectivity. As the correlation between placing a high importance on the analysis and reporting function and the inventory management function and a higher likelihood to introduce the new POS system exists, it should be considered to take action to educate more retailers about the importance of these functions. This can be done as a way of further motivating the less interested retailers in the system.

8.2.3 Effect of introducing the POS system

In case the POS system would be initially only introduced to the retailers that have a neutral or a positive attitude towards the introduction of the system, the system would be expected to help decreasing the number of refunds by about 63.33 %. This could lead to a decrease of refunds from currently 11.66 % of refunded orders in 2022 to 4.28 %. Thus, it has the potential to more than halving the number of refunds. On top of that, the retailers would be more autonomous when adjusting their products on the web shop and more automation would be included in the system which could help to significantly decrease the workload of Company X's employees that is related to keeping the web shop up to date. Instead, they could perform other tasks that add more value to Company X.

8.2.4 Considerations regarding sub-groups among retailers

For retailers of the Food & Drinks industry, Company X is advised to consider implementing two additional requirements which have been identified to be important only by this group of retailers. The functionalities are an option for different stock measurement units as well as automated price updates based on the retailers' suppliers' prices.
Next to that, special attention should be placed on the requirements that are more important to the retailers showing less interest in the new system. Since these retailers have shown interest in only few requirements, these should be fulfilled with excellence to convince them of the new POS system.
Furthermore, it was identified that retailers are more likely to consider switching POS systems if they place higher importance on the inventory management function and the analysis and reporting function. These are two great benefits that come with integrating more advanced POS systems and Company X should consider educating their retailers on the benefits that come with such functionalities to make them more likely to switch POS systems which provide them with these options.

References

[1] Cooper, D. R., & Schindler, P. S. (2013). Business Research Methods, 12th Edition (12th ed.). McGraw-Hill Education.

[2] Eskandari, S., Clark, J., & Hamou-Lhadj, A. (2016). Buy Your Coffee with Bitcoin: Real-World Deployment of a Bitcoin Point of Sale Terminal (S. Eskandari, J. Clark, & A. Hamou-Lhadj, Eds.; Vol. 13, Issue IEEE International Conference on Ubiquitous Intelligence and Computing). IEEE. https://doi.org/10.1109/uic-atc-scalcom-cbdcom-iop-smartworld.2016.0073

[3] Farrell, S. (2016, May 22). Open-Ended vs. Closed-Ended Questions in User Research. Nielsen Norman Group. Retrieved September 22, 2022, from https://www.nngroup.com/articles/open-ended-questions/

[4] Heerkens, H., & Winden, A. V. (2017). Solving Managerial Problems Systematically (1st ed.). Noordhoff Uitgevers.

[5] Insfrán, E., Pastor, O., & Wieringa, R. (2002). Requirements Engineering-Based Conceptual Modelling. Requirements Engineering, 7(2), 61–72. https://doi.org/10.1007/s007660200005

[6] Johnson, J. (2022, April 18). Everything You Should Know About POS Systems. Free Management Library. https://managementhelp.org/what-is-a-pos-system

[7] Jovancic, N. (2022, May 4). 8 Demographic Questions Every Quality Survey Needs to Contain. LeadQuizzes. Retrieved September 22, 2022, from https://www.leadquizzes.com/blog/demographic-questions/

[8] Kabir, A., & Han, B. (2016). An Improved Usability Evaluation Model for Point-of-Sale Systems. International Journal of Smart Home, 10(7), 269–282. https://doi.org/10.14257/ijsh.2016.10.7.27

[9] Lee, H. J., Lee, Y., & Won, D. (2014). Protection Profile for PoS (Point of Sale) System. Lecture Notes in Electrical Engineering, 495–500. https://doi.org/10.1007/978-3-642-40675-1_74

[10] Lute, S. (2022, March). Improving retailers' inventory updates in an online shopping platform. University of Twente.

[11] Mulder, L. (2021, May 12). CONSISTENT PRODUCT AVAILABILITY LEADS TO IMPROVED CUSTOMER EXPERIENCES. dotActive. Retrieved May 27, 2022, from https://www.dotactiv.com/blog/consistent-product-availability

[12] Nuseibeh, B., & Easterbrook, S. (2000). Requirements engineering. ACM Press. https://doi.org/10.1145/336512.336523

[13] Ramadan, N., & Megahead, S. (2016, September). Requirement Engineering Framework [Illustration]. Requirements Engineering in Scrum Framework. https://www.researchgate.net/figure/Fig-1-Requirement-Engineering-Framework-32-Requirements-Elicitation-It-is-the-process_fig1_308186449

[14] Rudeck, E. (2013, January 22). Why Requirements Engineering should matter to your company. Concurrent Engineering. Retrieved June 28, 2022, from https://www.concurrent-engineering.co.uk/Blog/bid/90476/Why-Requirements-Engineering-should-matter-to-your-company

[15] UKEssays. (November 2018). The Customer Response Options To Service Failures Information Technology Essay. Retrieved from https://www.ukessays.com/essays/information-technology/the-customer-response-options-to-service-failures-information-technology-essay.php?vref=1

[16] Qualtrics XM // The Leading Experience Management Software. (2022, July 27). Qualtrics. Retrieved August 12, 2022, from https://www.qualtrics.com/

[17] Zave, P. (1997). Classification of research efforts in requirements engineering. ACM Computing Surveys, 29(4), 315–321. https://doi.org/10.1145/267580.267581

Appendices

A. Survey shared with retailers

English

Information and Consent

Hi! I am Simon van Almsick from CompanyX and I am currently performing research for my bachelor thesis at the University of Twente. I would like to ask you for a short moment of your time.

CompanyX is currently looking at ways of improving the data inaccuracies between the retailer's inventory and CompanyX's web shop, as these inaccuracies are the main reason for the frequent refunds which are annoying for both the retailers and CompanyX.

One potential way of improving this situation is introducing new point-of-sale systems (POS systems) at retailers and connecting these with CompanyX's web shop to always keep track of the inventory levels. A POS system is basically your payment system which can connect to different parts of a business and provide many possibilities of improving various tasks that need to be done. To understand the needs of retailers for these POS systems, I am conducting research among the retailers.

Previous to this survey, interviews with a small sample of retailers were conducted. In these, potential functionalities of POS systems that might make your life as a retailer a little bit easier. In this survey you will be asked mainly about how important you consider the

different functionalities, so CompanyX gets a better idea, what you would like to see in a POS system.

Overall the survey will take 5-10 minutes. It will not include any personal questions. Your answers cannot be directly linked to you or your business as all answers will be recorded anonymously. Participation is voluntarily and you can leave the survey at any moment without consequences.

If you agree that your anonymised answers are used in the research please indicate so below and you will be directed to the survey. If you do not agree, the survey is automatically ended.

If you would like to get further information on the research, feel free to contact me via the contact information from the email.

Thank you!

I have read and understood the information regarding this research. I allow my anonymised answers to be used in the research.

I do not want to take part in this survey.

Categorial questions

First, I would like to ask a few questions about you, the retailers.

In what industry do you conduct business?

Food & Drinks
Home & Interior
Fashion & Beauty

Flowers & Plants
Toys & Games
Health & Drugstore
Baby & Child
DIY
other:

Do you use a POS system in your store?

Yes
No
I don't know.

For how long have you been using your current POS system?

for...

How long have you been working with CompanyX now?

since...

How many (in percent) of your orders through CompanyX cannot be completed due to missing items in the store?

How many employees do you have, that (would) use the POS system?

technical requirements

Inventory management in a POS system

How important is it for you, that a future POS system can help you with the inventory management?

Not at all important
Slightly important
Moderately important
Very important
Extremely important
I don't know.

Please choose from the list below, which of the inventory management functionalities you could imagine using in your store.

Continuously updated stock levels
Bulk updates of inventory (e.g., by uploading delivery lists to the system)
Manual adjustments to the inventory
Different types of stock keeping. (e.g., unit, weight)
Inventory can be read by other systems (e.g., own web shop, CompanyX)
Automatic updates on prices which are based on changes by your suppliers
The system urges you to do random stock counts to check the accuracy of the inventory
Automatic orders whenever a certain stock level is reached
Semi-automatic orders whenever a certain stock level is reached (this will let you make adjustments to the orders)
None of the above

Would you like to see other functionalities related to inventory management in a POS system?

No
Yes, I would like to see the following functionalities:

Analysis and reporting of sales data

How important is it for you, that a future POS system can help you analyse your sales data?

- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important
- I don't know

Would you like to see any specific functionalities related to analysis and reporting in a POS system?

- No
- Yes, I would like to see the following functionalities:

Connectivity of the POS system

How important is it for you, that a future POS system can be connected to other programs?

- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important

- I don't know

Please choose from the list below, which of the connectivity functionalities you could imagine using in your store.

- Live connection with CompanyX to continuously update the stock levels and prices
- Live connection with own web shop
- Live connection with other external platforms (such as other service providers)
- Product descriptions, images can be added within the POS system to allow a faster onboarding on external platforms
- Connection with other retailers to streamline the purchasing process and to drive down costs
- None of the above

Would you like to see other functionalities related to the connectivity of a POS system?

- No
- Yes, I would like to see the following functionalities:

Customer relationship management in the POS system

How important is it for you, that a future POS system offers some form of customer relationship management (such as individual

advertising, promotions, etc.)?

- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important
- I don't know

Please choose from the list below, which of the customer relationship management functionalities you could imagine using in your store.

- A functionality to keep track of customers' purchases and preferences
- Individual promotions for customers based on their purchases and preferences
- None of the above

Would you like to see other functionalities related to customer relationship management in a POS system?

- No
- Yes, I would like to have the following functionalities:

non-technical requirements

Importance of usability, deployability and security in POS systems

Usability

How important is the overall usability of a POS system for you?

- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important
- I don't know

How important are the following aspects of usability for you?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important	I don't know
User-friendliness	○	○	○	○	○	○
Good customer service	○	○	○	○	○	○
Time efficiency	○	○	○	○	○	○
Availability to all employees	○	○	○	○	○	○

	Not at all important	Slightly important	Moderately important	Very important	Extremely important	I dor knc
Operability (the system works in its entirety)	○	○	○	○	○	○
Effectiveness (tasks can be done completely with few actions)	○	○	○	○	○	○
Compliance of the system with standards for IT/POS systems	○	○	○	○	○	○
	Not at all important	Slightly important	Moderately important	Very important	Extremely important	I dor knc

The installation process

How important is it for you that the POS system can be easily installed?

Not at all important
Slightly important

Moderately important
Very important
Extremely important
I don't know

How important are the following aspects of the installation process for you?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important	I do kn
Affordability of the system	○	○	○	○	○	○
Quick installation of the system	○	○	○	○	○	○
Support during the installation	○	○	○	○	○	○
Expandability of the system (e.g., to a new store)	○	○	○	○	○	○

Security

How important is the system's data security for you?

Not at all important
Slightly important
Moderately important
Very important
Extremely important
I don't know

likelihood of introducing the POS system

Switching to a new POS system

How likely is your store to switch to a new POS system, if it meets your requirements as indicated above?

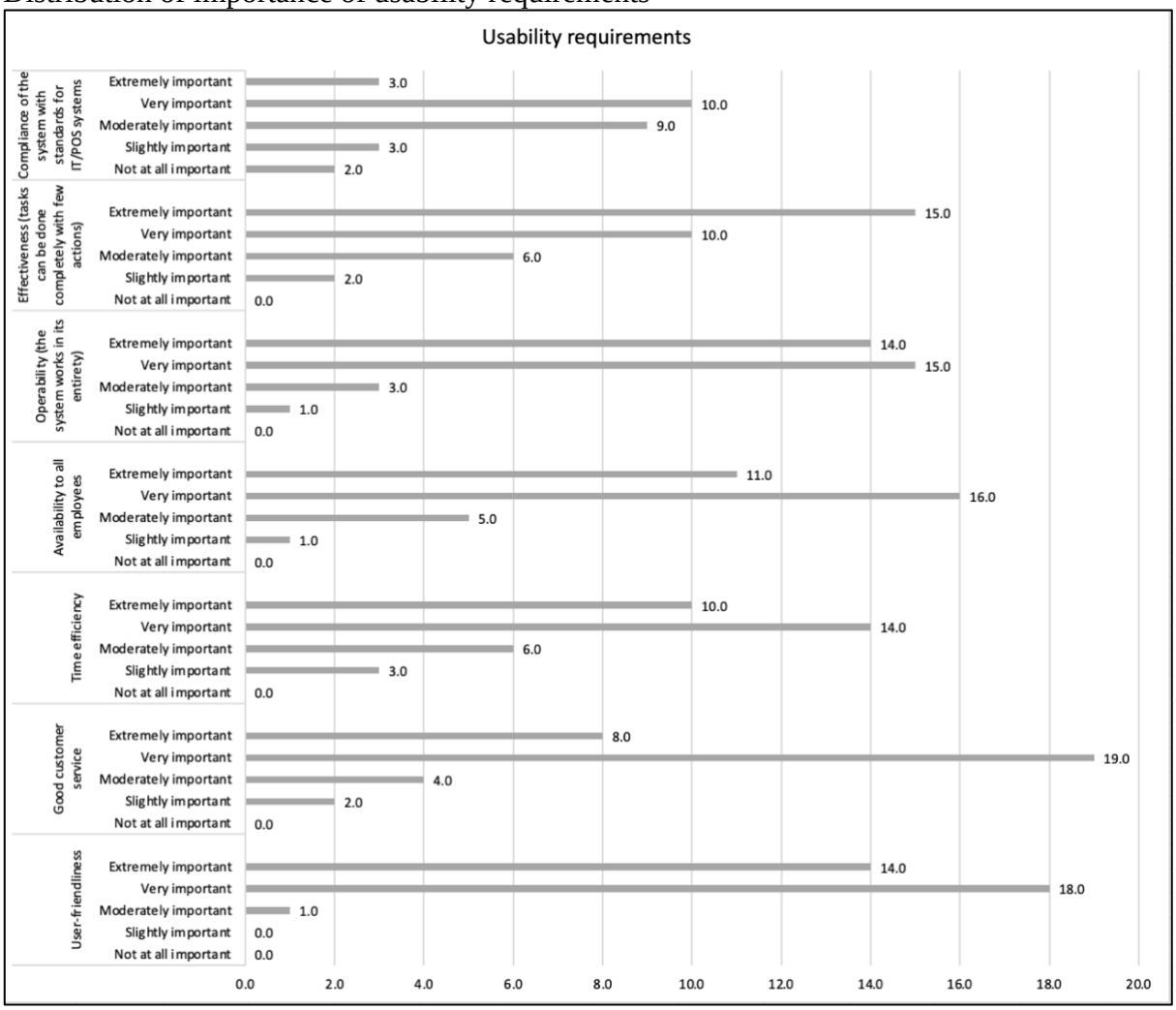
Extremely unlikely
Somewhat unlikely
Neither likely nor unlikely
Somewhat likely
Extremely likely
I don't know

Please select from the list below the main reasons why you would consider switching to another POS system.

Better inventory management function

Better analysis function
Better connectivity
Better customer relationship management function
Better usability
Better installation process
Better security
Better customer service
None of the above

B. Distribution of importance of usability requirements



C. Distribution of importance of deployability requirements