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Design of a Smart Cart App for Automated Shopping in Supermarkets

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Abstract

In today's society, many things are becoming smarter, mostly with the help of the Internet of Things. Taking a look at smart shopping, several optional ways of shopping have been introduced in recent years to enhance and streamline shopping. Some of these are online shopping and self-services which include self-checkouts and handheld scanners. This has been a successful approach, which can be seen by the fact that one of the biggest grocery shopping chains in Sweden called ICA has 1.5 million customers in their loyalty program where around 30% of these use handheld scanners. These 30% bring about 60% of ICAs total revenue in some of their biggest stores. However, one of the major challenges with self-services is that they are very expensive, as a system for an average sized store in Sweden can cost around 1.5 million SEK, which makes it difficult for smaller stores to offer this service. A way of combating this could be to create a smartphone shopping application (Smart Cart app) with a user-centered design, which has a strong likelihood to lower the costs as well as save time. Previous research has shown attempts of similar technologies, however, some of these had limitations in the presentation of their design and user research. This study aims to explore the possibility of designing a Smart Cart application prototype with a user-centered approach based on Human-Computer Interaction (HCI) to extend upon previous proposals.

User data, which has been analyzed to find key points in design, has been gathered by a questionnaire with 275 participants and interviews with 3 people. This data has been used together with information from a literature review in order to design the Smart Cart app prototype, which is a visualisation of the study results. The prototype is supported by an analysis which shows why it is important to involve users in the design process and what should be considered when doing so. The study also found a desire for such an app as, for instance, 51.7% of self-scanning customers would consider using it. In addition, results also support that when users accept and are familiar with certain functionalities in applications, they are more likely to adopt the application. The majority of the participants have a positive attitude towards applications in smart shopping and have similar desires of functions and appearance.

Lastly, future research is needed on different aspects and point of views for further development of the Smart Cart application and other similar applications.

Abstract in Swedish

I dagens samhälle blir många saker smartare, främst med hjälp av Internet of Things. En överblick på smart shopping visar att flera alternativa sätt att shoppa på har introducerats under de senaste åren för att förbättra och effektivisera shopping. Några av dessa är online-shopping och självtjänster som inkluderar självutcheckningar och handhållna skannrar. Detta har varit ett framgångsrikt tillvägagångssätt, vilket kan ses av det faktum att en av de största dagligvaruhandelskedjorna i Sverige, ICA, har 1,5 miljoner kunder i sitt lojalitetsprogram där cirka 30% av dessa använder handhållna skannrar. Dessa 30% ger cirka 60% av ICAs totala intäkter i några av deras största butiker. En av de stora utmaningarna med självbetjäning är dock att de är mycket dyrt, då ett system för en genomsnittlig butik i Sverige kan kosta cirka 1,5 miljoner SEK. Detta gör det svårt för mindre butiker att erbjuda denna tjänst. Ett sätt att överkomma detta kan vara att skapa en applikation för smartphone-shopping (Smart Cart-app) med en användarcentrerad design, som med största sannolikhet sänker kostnader samt sparar tid. Tidigare forskning har visat försök på liknande teknologies, men vissa av dessa hade begränsningar i presentationen av sin design och användardata/användarforskning. Denna studie syftar till att undersöka möjligheten att utforma en Smart Cart-applikationsprototyp med en användarcentrerad design baserad på Human-Computer Interaction (HCI) för att utvidga på tidigare förslag.

Användardata, som har analyserats för att hitta viktiga punkter och önskemål i design, har samlats in genom ett frågeformulär med 275 deltagare och intervjuer med 3 personer. Denna data har använts tillsammans med information från en litteraturöversikt för att utforma prototypen för Smart Cart-appen, som är en visualisering av studieresultaten. Prototypen stöds av en analys som visar varför det är viktigt att involvera användare i designprocessen och vad som bör beaktas när man gör detta. Studien fann också en begäran efter en sådan app, då exempelvis 51,7% av självscannande kunder skulle överväga att använda den. Dessutom stöder resultaten också det faktum att om användaren accepterar och har en bekantskap med vissa funktioner i applikationen, är de mer benägna till att ta an applikationen. Majoriteten av deltagarna har en positiv inställning till applikationer inom smart shopping och har liknande önskemål om funktioner och utseende.

Slutligen behövs framtida forskning om olika aspekter och synpunkter för vidareutveckling av Smart Cart-applikationen och andra liknande applikationer.

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1. Introduction

There is a constant search for innovative solutions to simplify and expedite the everyday life of people. Due to long working hours and a busy lifestyle, people are looking for smart solutions to get the utmost of their spare time left.
Grocery shopping is an unavoidable task that must be carried out and there are many ways in which customers could do so. Online shopping has been introduced as an alternative to shopping in stores. In store shopping has been simplified with the introduction of self-scanning and self-checkout systems, which is appreciated by customers. In fact, one of the biggest supermarket chains in Sweden, ICA, has 1.5 million customers in their loyalty program who use self scanners, which is 30% of their entire clientele [23]. The self-scanning and self-checkout service have been successful in speeding up the shopping process, due to the fact that the customers scan their groceries either through a scanner or at the checkout and pay by themselves [1], [2].

1.1 Internet of Things

One of the main concepts used to develop smart environments such as smart supermarkets with various self-checkout systems is the Internet of Things (IoT). IoT in simple words means to take something, anything, and connect it to the internet, like for instance a phone, TV or laptop etc. As a result of this, the device, which in itself might not carry a lot of information, gets access to an infinite amount of information from the internet. This ability to send and receive information makes the thing smart. For example, although a smartphone itself does not have every song to have ever existed stored on it, you can still search and listen to about any song you wish, due the fact that the phone is connected to the internet from which you can stream songs. The internet can be seen as one big cloud of storage which any device can connect to. Devices connected to the internet can collect, receive, send and act upon information, one of the most widely used methods of doing so is with the use of sensors. Sensors, which you can read more about in section 2.3.1, along with an internet connection allows information collection from the environment which leads to more intelligent decisions being made. You could suggest that sensors are used by machines to make sense of the world in the same way that humans use their sense of hearing, touch, smell and sight to make sense of the world [26], [27], [28].
New innovative implementations within IoT are constantly developing and ease the everyday life of people. The amount of active IoT device connections grow by approximately 10% annually. In 2019 there were 8.3 billion active devices, this number is estimated to increase to 21.5 billion by 2025 [45]. As a result of this, we will probably see more of what can be achieved with IoT such as an increased amount of smart stores, smart carts and other smart environments.

1.2 Problem Definition

There is still a possibility of long queues despite the use of a self-service counter, in the event of having many users at the same time. Additionally, there is a limited amount of self scanners available in each store, there is also a limited amount of checkouts for self-scanning users. Furthermore, self scanners can be expensive, especially for smaller supermarkets, which also contributes to the limited availability of devices. In 2020, the average price of a self scanner is estimated to 8000-10 000 SEK per device, which can amount to big costs for supermarkets when purchasing multiple devices as well as the maintenance of the devices and associated system [43], [44]. The costs for a whole system (scanner, checkouts etc.) in an average sized Swedish store is

approximately 1,5 million SEK. In addition, maintenance of the system (service, reparation, support etc) costs about 100 000 SEK annually [44].

Another problem encountered is the lack of understanding on how to design and develop an application that supports an automated and enhanced shopping experience in supermarkets. By automatisation, we mean reducing the number of supermarket staff, providing more power and control to shoppers, reducing the time spent on check-out queues, and reducing the average time spent on grocery shopping. Although automatisation is important, there is also lack of research on how to actually design and develop such an application while focusing on user research and HCI theories.

Furthermore, we want to research the possibility of faster checkout, the ability to remove and review scanned products, and payments by easy sign in with BankID, which is a Swedish electronic identification application based on an individual's personal identity number [30]. Also, there is a greater awareness on nutrition and dietetics, more people are conscious of their health, in particular the nutrition of the products they choose to purchase. As a result of this, we would like to put focus on making product and nutrition information easily accessible . Solving these factors has benefits such as freeing staff which could favour a store both economically and by increasing in-store productivity. This can further lead to better customer service and increase the overall quality in the store. The aim of this research was to make it available for other developers with similar ideas to take advantage of the information provided, as at the time of writing such research was very limited.

1.3 Global Pandemic — Covid-19

At the time of writing, a global pandemic is occuring, a virus called Covid-19 is spreading rapidly all over the world. One of the main procedures to fight the pandemic is by social distancing and having good hand hygiene by washing and sanitizing hands. This project exemplifies how to simplify such procedures by having your own device to both scan and pay with and not having to socialize in a way which could spread the virus further. By increasing social distancing and reducing physical contact in stores, the spread of viruses in grocery stores can be decreased [31].

1.4 Research Questions

This research contributes to how a smart-cart application can be developed by using theories and principles from the field of human-computer interaction, HCI, and interaction design. Our research questions are the following:

1. What should developers and designers consider when developing these kinds of applications?
2. How can HCI be applied to enhance the user experience?
3. How to understand the usability and acceptance of a Smart Cart app in Swedish supermarkets?

The focus is on how to design an app for easy payment solutions as the assumption is that easy payment solutions is the deciding factor which determines whether a shopping application is considered having high usability and be frequently used. Furthermore, our goal is to answer how such a design should look to the eye, in order to satisfy and attract customers, as well as fulfilling their needs and having a high level of usability. Although some attempts have been made on developing automated shopping apps, little research has been found on how to design such applications. On

the contrary, whilst developing these kinds of applications, we believe that the design is one of the key elements for widespread usage and ultimately contribute to its success. This is why research on the design and usability of the application is the main focus throughout this thesis.

1.4.1 Method

To answer the research questions, a literature review was conducted followed by both qualitative and quantitative methods, in particular, interviews and questionnaires. The data collected was then used to create a prototype. The purpose of the chosen methods was to obtain a general understanding of people's experiences with self-scanning and self-checkouts in order to develop a more user-friendly smartphone alternative. In addition, to collect information on how such an app is perceived and received by potential users, as well as gaining knowledge of HCI and how it can be used for application design. Besides having a general understanding, we were also aiming for deeper focus on specific topics by conducting interviews with employees that have different roles and positions in grocery stores and related companies. A further explanation on the methods can be found in section 3.

The methods to answer our research questions were chosen because of the variety of data that they would generate. As this data was going to be used for both answering the research questions, and for design decisions in the prototype, that is presented in section 4.7, we believed that the methods were the most appropriate. The prototype was designed in order to visualise the answers of the research questions and to display the initial layout, based on data gathered from potential users.

An observation was also planned to take place in order to generate more data of shopping behaviours, but had to be reconsidered due to the global pandemic, Covid-19. Other methods, such as focus groups, could also have been used to help answer the research questions. However, as it can be difficult to encourage unknown people to participate and to get a broad representation of people, which was what we needed, this option was not used.

1.5 Limitations

The user interface was designed for android software platform, however, other platforms are also taken into consideration for the future. Additionally, the final application was not implemented directly in a device or a cart due to lack of time and resources. Instead, a prototype was presented. Research on how to structure and implement code was not made in order to keep focus on the topic of the thesis. The payment system was simulated and there was no access to a real price or product database. A few preset products were used for the purpose of testing the application. The main usage of the application was intended for supermarkets since they usually provide self-scanning services. Furthermore, there were some limitations to our overall work such as the Covid-19 pandemic which made it hard to conduct face to face interviews and limited some of our research options. Moreover, due to the broad research field, it made it easy to get off track and distracted by other irrelevant information which could take up unnecessary time. Another limitation caused by the broad research field was to know what information to use in the text and what was relevant, so that it could stay in the correct direction and become too general.

2. Background and Related work

Smartphone users have increased in the last decade. In 2011, which was around the time when smartphones first reached the Swedish market, only 27% of the Swedish population at the age of 12 and above had a smartphone. This number had increased to 85% in 2017. In 2019, this number had reached a total of 89% [34], [35]. Today, smartphones are used frequently in different environments as a helping tool in many daily situations. Thus, by taking advantage of technologies that are already available on the market, time and resources can be preserved. As the traditional way of shopping is no longer the only way to shop, there has been a lot of work and research done to make the shopping experience smarter and more efficient. Today the main self-service system is self-scanning and self-checkout, which most big supermarkets offer. However, lately smart systems with the usage of smartphones have started to slowly develop. The Internet of Things has opened doors to take smartphones even further by the development of concepts such as smart environments which includes smart supermarkets. There is a constant development within the field which has brought smart environments such as Amazon Go and introduced the idea of Smart Carts. Although the two latter systems are not as widely used as self-scanning and self-checkout due to the fact that they are still in an early development process, they open doors for further development and innovation. This section describes the details about the design and development processes of each system mentioned above [26], [27], [28].

2.1 HCI: Human-Computer Interaction

An important research field for smart environments is HCI, which studies the interaction between humans and computers. When computers came in the 1940s, they were not easily accessible to everyone. Those who interacted with the computers at that time were mostly engineers or scientists and their focus was on programming and building the hardware, not the interaction. As time went by, computers became more common in peoples homes and workplaces. In other words, computers became available for many users with different needs. It became clear that human factors matter for usability, which resulted in the rise of HCI in the 1980s [12]. By studying the interaction, it brings an understanding on how people use their computers and other devices, how they are perceived, which tools facilitate the interaction, and how to make them more user friendly. Furthermore, HCI contributes to realising the importance of the user's experience when working with software and user interface design. This is achieved by combining computer science with other aspects such as psychology, cognitive science, ergonomics and human behavior [11], [12]. The goals are to create systems that are as successful and functional as possible, along with having a user-friendly design and keeping the users needs in mind. It is essential to have systems that satisfy the user.

2.1.1 UCD: User-Centered Design

User-centered design is an iterative process that focuses on the users and their needs during the development process from the very beginning until the end. This is achieved by involving the users in key points of the project, and integrating their thoughts as well as for their validation in the design. Developers and designers cooperate with users and the interaction between all participants contributes to a deeper understanding of the user and their needs, what they do and don’t want [32], [33].

To be able to involve users and understand what is significant for a mobile app or any system from a user perspective, the project team needs to do *user research.* It is an important step towards creating a product with a high usability. User research is done to collect information from users and gather feedback. Without actually doing research on what users want and need, there won't be any information to work with. By receiving feedback, the developers will know what can be improved, if they have made any mistakes and/or what is beneficial and approved by the users [33].

There are several ways to do user research depending on the type of system, such as focus groups, field studies, eyetracking, intercept surveys and so on. However, the focus in this section is on those user research methods that are appropriate to do for mobile app development. For instance, storyboarding can be used early in the design process. It is a visual representation with drawings of what the user can do, how they will do it and what order they will do it in. A storyboard might include drawings of UI elements, pictures, design ideas and layouts which could help to understand the users actions and their motives when they are or will be using the system. Eventually, the storyboard is shown to the users, the users' workflow is observed to see if it matches their needs and the developers and designers' visions [46]. By doing a storyboard, developers and designers might discover new possibilities in their system and also realise what is necessary or unnecessary for a good user experience. Any miscommunication or misunderstanding between the users needs and the developers and designers ideas become clearer when the workflow is visualised [33]. Storyboards can be very powerful when designing apps because they can provide different scenarios and designs easily without having to actually implement anything. Instead, the user is presented with the storyboard and their actions and thoughts can be analysed to make appropriate changes, and then try again to improve the design.

Another way to do user research is by a prototype, which is a model of the application or system design that is used to provide the users with a "sample" of the application that they can test. This is also a way of visualising and showing the users what the application intends to do. When the user sees and tests the prototype, they can comment and give feedback so the developers and designers can avoid mistakes early in the development process [33]. This approach has been used in this thesis and the method is described in section 3.4, the prototype itself is presented in section 4.7.

Although user-centered design is based on user research, some principles can be used as guidelines. Professor Don Norman, known for his research in design, cognitive science and usability, has defined six general principles, which are summarized below [36]:

- **Visibility** - By providing visible functions, users will know what to do.
- **Feedback** – Provide users with feedback so they know how to continue. Feedback can be by audio, tactile, verbal or a combination. For instance, a spinning wheel while something is loading.
- **Constraints** – Restricting the kind of user interaction that can be done at a certain time.
- **Mapping** – The relationship between controls and their effects. For instance, pressing the key "A" on a mobile keyboard will display the letter "A" on the screen.
- **Consistency** – Interfaces should be designed consistently, the same elements should be used for the same tasks. For example, the back button should always bring the user to the previous page. If the back button has different actions, the interface becomes inconsistent.

- **Affordance** – Is the term for the relationship between how an object is perceived and what it actually does, in other words, if people will know how to use it. A phone might have a home button for clicking, which makes it easier for people to figure out how to use it. This is just as relevant for a website or any other system, users should be able to know how to access information without any struggle.

This kind of user-centered approach ensures that the users needs are taken into consideration from start, the decisions made for the design are mainly decided by users and from their perspective. In other words, the system is created to fulfill the users needs by embracing their ideas. Furthermore, it is crucial to understand that there is more to user-centered design than aesthetics and the appearance of a system. Although these aspects are important, user-centered design is to achieve an understandable and usable system based on user interests and needs [32], [33].

2.1.2 UI: User Interface

The user interface is the main component for communication and interaction between the computer, phone, tablet (or any other similar device) and the user [13]. It is what the user sees on the screen when using the computer/device. The user can interact with the computer primarily by using input devices, such as a mouse and/or a keyboard. Many devices also support touch technology. For instance, the user interface is presented on the screen and a person might navigate to a button on the screen by moving the mouse and clicking on the desired button, or touching the screen. Buttons, scrollbars, images and all other controls are a part of the interface. Similarly, a web page displays content to users through the UI, which makes the entire web page a part of the UI as well. The user only has to focus on the controls on the screen (like scrolling and clicking) and not on the software that actually performs the tasks [13]. In short, the UI can be viewed as the link between humans and computers/devices, as it allows users to control the device by providing an interface.

2.1.3 Importance of UI design and User Experience (UX)

As the user interface is such an essential component, it is important to have an appropriate and thoughtful design. Although the interface is the part that enables interaction in a system, many users perceive the interface as the *actual* system. As a result of this, the user's impression of the whole system is often based on the experience they get from the interface [13]. Therefore, there are principles that are followed by designers to create something that is satisfying and user-friendly, to make a good impact. A few of those, set by User Advocate Jacob Nielsen, are the following [14]:

- Visibility of status, meaning that the user should always be informed about the status of the page/system through the UI and receive feedback. Error messages should be displayed when needed, and show suggested solutions.
- Using words and phrases that are familiar to the user, as well as being consistent and following standards.
- The design should be aesthetic as well as minimalistic, and avoid irrelevant information, to keep focus on the visible and relevant parts.

By creating a good design, the UI will be easy to use and help the user to complete their tasks with no issues. Thus, having satisfied users that are more eager to use the system since they find it enjoyable, which also makes them more productive [13]. A poor UI design can be misleading and can confuse the users, which makes the system less desirable to use. Complicated functions that take time to understand and long response times make the users stressed. It causes frustration when the user is not

able to perform a desired task because of confusion, lack of simplicity or incorrect information. Furthermore, there is a chance that the system will not be used to its full capability, since the user might settle on using the basic functions and not the entire system [15]. As a result of this, it is less likely that the system will be used at all, even if it provides the user with all the desired features.

Besides having a good UI design, the UX, which stands for User Experience, also plays a big part in the development of systems and HCI. As mentioned earlier, UI design is the design that the users see in front of them. However, the UX is about their feelings and what they feel when they interact with a system. UX designers focus on listening to the users and their needs, exploring their emotions and attitude towards different products. They look deeper into what users want from the system and what is usable for them. By doing interviews, observations, surveys and case studies, UX designers collect information on a psychological level to get a deep understanding of the users emotions [16].

2.1.4 Acceptance and Adoption

All systems within the field of smart applications and smart products are in some way related to user acceptance and adoption. Although many models and explanations have been proposed for the purpose of understanding and predicting user acceptance and adoption, the Technology Acceptance Model (TAM) has been used and discussed more frequently than others. The TAM was first defined by Fred D. Davis in 1985, and derived from The Theory of Reasoned Action (TRA) by Fishbein and Ajzen in 1975. TRA focuses on explaining human behaviour and attitude towards performing a task from a social-psychology perspective. The technology acceptance model on the other hand, focuses on the technological aspect as well, by trying to predict the users intentions as well as motivation to use a technology. The information is then used to predict if the user will accept and be able to adopt the technology and to what degree. This is called the Behavioral Intention, which measures the probability of a person performing a task or behaving in some kind of way. The person's intention of doing something is determined by their attitude towards the technology. By using the Behavioral Intention it becomes more evident to see a person's intentions of using a technology. The more intentions a person has for the usage, the more likely it is that he or she will actually use the system [29].

The technology acceptance model also shows that a person will use a system or a technology if the system is believed to be beneficial or helpful for their tasks. This is called Perceived usefulness. There is also the term Perceived ease of use, which stands for how easy it will be for a person to use the new system. If the system is not easy to use, there will be a negative attitude towards it. Perceived ease of use is believed to have an impact on Perceived usefulness, due to the fact that a system which is easy to use will have a higher degree of usefulness [29]. Fig 1.2 to the right shows the model by Davis.

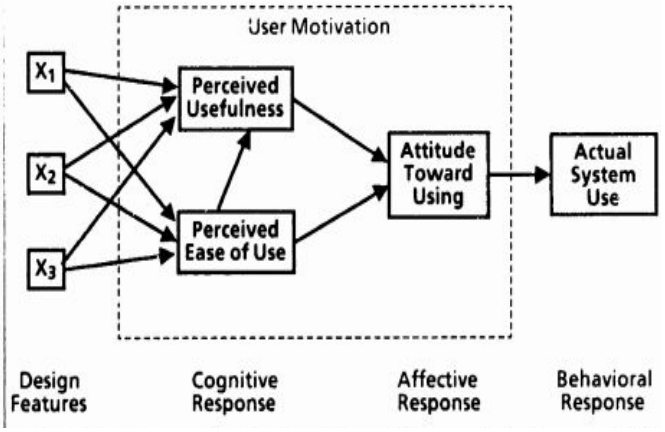

Figure 1.2: Technology Acceptance Model
Source: [29, p. 24, fig.1]

2.1.5 Conclusion

The theories and principles mentioned above are important aspects that should be considered when developing products, especially in the field of smart shopping and smart environments. By studying and learning about HCI we got a greater knowledge about how to make design decisions which benefit the user and lead to a wide spread of usage. For instance, when designing and developing a Smart Cart app, we need information from users to understand what they would like to see in the app and how they would like to use it. This is where UCD comes in and puts focus on users and their needs, not the designers and developers. After all, we are trying to get the users to use the final product, not our code. The only thing users get to see is the user interface and it has to be user-friendly and easy to adapt. When creating our prototype, we carefully thought about placement of elements, colour, size, layout and the overall design. Furthermore, the Technology Acceptance Model described how users perceive new systems which is also important to consider, as adoption of a technology plays a big role in the acceptance of systems. All these theories and principles together support the design and development of Smart Cart apps because they prove that in order to solve a problem, we need to first understand who is having the problem and why.

2.2 Related Work

2.2.1 Internet of Things and Smart Environments

The Internet of Things is frequently used within smart environments. One way of illustrating IoT and smart environments is by the Amazon Go stores. Amazon Go has replaced human cashiers by billing customers through a credit card which is connected to their Amazon account and detected when they leave the store. In contrast to in-person retail, technology is used to automatize the shopping and reduce queuing etc. However, the true power of IoT comes with the possibility of being able to do all four when it comes to collecting, sending, receiving and acting upon information, a further explanation of this is described in 2.2.4.

Moreover, when it comes to regular supermarkets, temperature control is an area where IoT can be used, for example to control the temperature within the store's different cold areas, such as vegetable and fruit departments, cold drinks department and other departments where temperature control is usable. By sensors, the store can control whether to increase or decrease temperature within the departments [26], [27], [28]. Other significant examples of how IoT is growing within the smart supermarkets field is the development of self-checkouts, Smart Carts, Scan and Pay applications etc.

It is all done by the help of sensors and hundreds of cameras and other technologies and is all possible with IoT, as sensors along with the internet and an array of algorithms can make anything a smart thing [26], [27], [28], [4], [5].

2.2.2 Scan and Pay Mobile applications

In the last decade, scan and pay mobile applications have evolved. One of the companies that have tried this approach is ICA, which is one of the biggest supermarkets in Sweden. ICA introduced a self-scanning function in their app in 2014, and the idea was inspired by a student thesis from KTH by Olausson and

Stockman [7], [8], [9]. To use the application customers downloaded the ICA app which is called “ICA Handla”, and by using the app they could scan an item and thereafter pay for it in the app by scanning a QR-code at the register. In addition, each customer could create a personal shopping list which was updated automatically based on what items that had been added to the virtual cart in the app. The application was tested in 10 stores, but was taken out of use due to low success rate compared to the total costs of the self-scanning function and maintenance [23], [7], [8], [9].

Another similar but a bit more successful approach is the Mishipay application which was introduced by Mustapha Khanwala in London in 2015 [10]. The application, which works similarly to other Scan and Go applications has been successful to a certain degree.

However, it seems that shops do not adopt these kinds of applications as the growth of it is not as big as it could have been for what it contributes to within the market [10]. This indicates that there is still a long way to go to integrate these kinds of applications within the market. It seems as if there are some obstacles which prevent the applications from reaching their full potential and some of them might be due to lack of user research, which was also mentioned by the Product Area manager when implementing the ICA handla self-scanning function in the app [23].

2.2.3 Self-checkout and Scan and Go

Most shoppers might have encountered a self-service system in supermarkets or big grocery shops. It is a part of a technological development that creates cooperation between humans and computers, which makes it no surprise that it is widely used in big stores [23]. When using the self-checkout as shown in fig. 2.2 customers scan all their items at once and pay at the station. Usually, there are a few employees by the counters for assistance. This type of checkout is most commonly used by customers with a small amount of items, since there is usually a limit of 10-15 items [38]. The other type of self-service is called “Scan and Go”, see fig. 2.1, where customers need a membership card to get access to a handheld scanner. Customers are then able to scan their items right off the shelf with the device. After scanning an item, they can just put it in their cart and pay at a checkout station before leaving. To exit the store, customers who use self-services have to scan their receipt at a gate for it to open.

Figure 2.1: Handheld scanners
Source: [51]

Figure 2.2: Self-checkout register
Source: [52]

2.2.4 Amazon Go

The first Amazon Go store opened in Seattle in 2017 and is based on what Amazon calls “Just Walk Out Technology” which means that no checkout is required, see fig. 2.3. Today, in 2020, Amazon Go has expanded to 25 stores in four different cities in

the United States [47]. Amazon Go is an app-based shopping experience where the customers just go to the store, take the items they want and walk out. This is possible through advanced technology used by the developers which includes artificial intelligence, machine learning, image recognitions, big data, analytics, deep learning algorithms and Internet of Things. The customer tags their smartphone with the store through a 2D barcode, see fig. 2.3 and 2.4. Photos are taken when entering the store, any time a product is picked up and when leaving. This is used for tracking the customers as they move throughout the store and to see what items are picked up or put back by the customer. The shelves are equipped with sensors which detect if a product is taken off or returned to it. Each customer has a virtual cart which is supervised through this system. Upon walking out, the customer is then charged through their Amazon account and gets the receipt in the app [4], [5].

Figure 2.3: Amazon Go store
Source: [50]

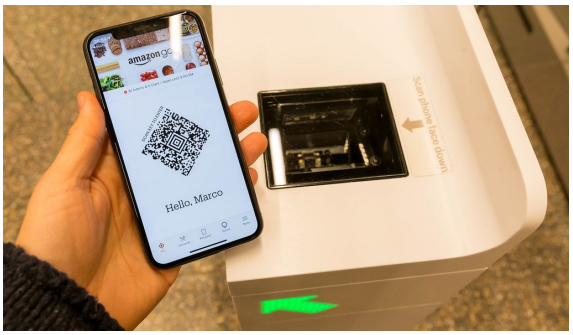

Figure 2.4: Amazon Go check-in
Source: [49]

Although Amazon Go has opened its first store, it still faces a lot of restrictions and challenges. For example, only approximately 20 people could be in the store at the same time, as the system could not keep up with more people which could lead to it crashing. In addition, there are challenges to the system when it comes to groups of people shopping together. For example if a child or a partner would pick up an item to the cart which belongs to the checked in user, the system was not advanced enough to recognize what happened. Furthermore, the system faced challenges with recognizing if a customer changes clothes, wears a mask or takes off their jacket etc [4].

Technologies used in Amazon Go:

	Person	Shelf	Entrance/Exit
Hardware	Smart Device (Smart Phone)	Cameras, pressure sensors, infrared sensors, scales, volume displacement sensors, light curtains, etc.	2D Barcode
Software	Amazon Go app	Warehouse Management System(WMS)	Customize system

Figure 2.5 : Amazon Go technologies
Source: [14]

2.2.5 Smart Cart

In the last decade the development of Smart Cart has taken its turn [19], [20], [21], [22]. Many different developers have attempted to develop the perfect Smart Cart with different functionalities. For example, in 2017 Karjol, Holla and Abhilash proposed a Smart Cart based on a barcode scanner, camera, weight sensor, a small computer and the customer's own phone for display [20]. The customer logs in to the system through an application and their customer ID. Furthermore, they connect to the cart via the cart ID. Once logged in and connected, the customer can pick up any item and scan it on the barcode scanner placed on the cart. The item is then placed in the cart, which for security reasons is equipped with a weight sensor so that theft and mistakes can be prevented. The Smart Cart system is connected to a database system through WI-FI which makes it possible for customers to have and follow up on their own shopping lists created by themselves in the application [20].

Similarly, Gangwal, Roy and Bapat made an attempt on developing a Smart Cart with similar functions but with a camera based scanner to tackle issues such as removing an item or adding more items than scanned etc. However, the Smart Cart developed by Gangwal et al. did not require the customer to use their own smartphone for display as it is connected to a base station which the system of the cart communicates with. Furthermore, the Smart Cart makes usage of image processing by locally comparing pictures taken by the same camera used for scanning. These images are locally stored and run through an image comparison algorithm to make sure that the item which was scanned is placed in the cart and not another one. While this comparison is taking place the item is held at a slab on top of the cart, where the item is first put by the customer. When the comparison is done, the slab lets the item into the cart. If the item scanned does not match with the picture, the information is transmitted to a base station [19].

On the other hand Prem, Bangre, Kavya and Varun Attempted to create a Smart Cart with self routing based on RFID where each item is tagged with an RFID tag. The customer connects to the trolley by tapping the card on a reader which is placed on the trolley. The card is given to the customer when registering. Once the customer picks up an item, they scan it and the prepaid amount updates automatically. As the cart is self-driven, it stops if the customer stops through reading the distance between the cart and the customer. The whole process which is explained in fig. 2.6 is also based on the customer providing a shopping list with products which the trolley will navigate to. Although the approach is acceptable, having to pre top up the card and going through the registration process makes it less likely to be used as it makes the process less time efficient. In addition, RFID tags are more expensive than barcodes which makes the approach less economical [21].

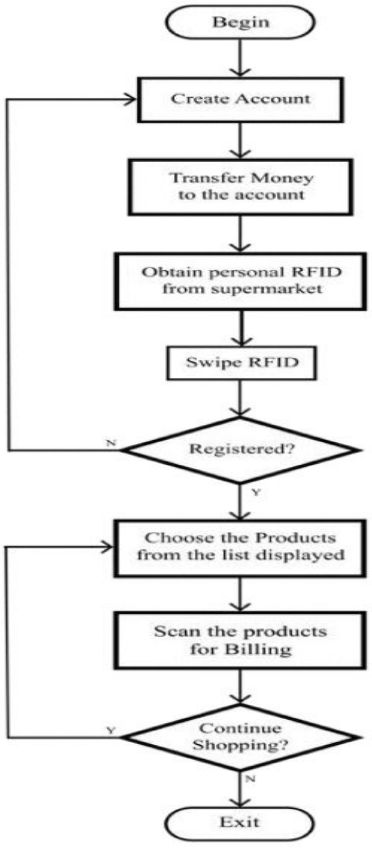

Figure 2.6: Smart Cart Process
Source: [21 fig.5]

2.2.6 Conclusion of Related Work

In conclusion, findings from Amazon Go show that there is a desire and usefulness in smart environments with mobile application solutions, and the fact that Amazon Go has expanded so rapidly shows that there is a big interest in these kinds of technologies within Smart shopping. In addition, the research made on scan and pay mobile applications provided an overview of how such applications could be designed and what functions could be used in the prototype which is presented in section 4.7.

The wide use of current self-scanning systems in supermarkets such as self-checkout and Scan and Go proves that people actually do look for optional ways of shopping. This was an indication for the authors that by introducing more options, such as a shopping application, people might accept it as an alternative as well. Lastly, the research on Smart Carts made in this section provided the authors with information on how similar projects have chosen to implement their solutions. The sometimes complicated solution, such as having a slab and having to pre-topup a card is something that the authors of this thesis will try to avoid or simplify when considering the prototype design. Moreover, we have taken inspiration from all the related works and found pieces in them which was good for our application such as implementing a shopping list, providing an easy member login and having simple payment options.

2.3 Related Technologies

For the development of these kinds of products there are many different technologies involved. The combination of hardware and software makes it possible to create advanced systems with many different functions. The systems are often made up of components such as sensors, cameras, RFID tags along with the software for the system.

2.3.1 Sensors

Sensors can be used in automated shopping in many different ways, for example to enhance security or to track customer activity throughout the store. The sensors can be implemented in anything from shelves to automatic doors normally found in supermarkets. Sensors work by responding with an electrical signal when it receives a stimulus or signal. However they work in different ways depending on if the sensor is passive or active. Active sensors require an external source of activity in the form of voltages or currents whereas passive sensors are self-generating and don't require this external activity [17], [18].

One of the most widely used active sensors in the field of smart shopping are motion sensors. For example, they are used for automatic doors to function and are based on ultrasonic sound waves. Automatic doors work by having a detector attached to the door which covers a specific area. The door will automatically open if someone stands in front of it as the waves that the detector is reading are getting blocked. As the sensor senses this due to the disturbance of the normal pattern, it triggers an action which in this case is to open the door. However, the action being triggered can be anything from setting of an alarm to closing all exits etc. In other words the triggered actions are not limited to anything specific, but can be adjusted depending on area of usage. In addition, sensors can measure anything from temperature, force, flow, position, light and intensity etc. They are often a part of a bigger system and several sensors can be involved in such a system [17], [18].

On the other hand, passive sensors are programmed to read changes in emitted energy levels in order to detect activity by recognizing changes in the enclosed area. When the energy levels are changed they are noticed by a photodetector. The photodetector transfers the electric current converted from the wavelengths to a computer unit in the device. An alarm is then triggered if the photodetector senses a disturbance to the variations of energy levels within the enclosed area. Passive sensors can be used for sensing for instance light, temperature and vibrations in the environment. An example of a passive sensor can be metal detectors, which are widely used today in airports and other crowded areas such as events and concerts. In addition, metal detectors are widely used in stores as anti theft systems [17], [18].

2.3.2 Radio-frequency identification (RFID)

Radio-frequency identification (RFID) is used to identify objects through its advanced technology based on reading radio waves. The radio waves are used to read a unique identifying number from a chip belonging to the object. RFID tags can be divided into two different groups, active and passive. Both active and passive tags provide an identification number related to the tagged object. However, active tags have their own power source like for instance a battery in order to run a microchip circuit which broadcasts a signal to a reader. To illustrate this, it works in a similar way to how a phone transmits signals to a base station. On the other hand, passive tags don't have batteries as they draw power from the reader through electromagnetic waves in their antenna. There are also tags called semi-passive tags which have a battery only for the function of its circuitry but when it communicates it draws power from the reader [41], [42].

2.3.3 Cameras

Cameras have been used within the field of smart shopping by working as barcode scanners and for identification etc. [4], [19]. For instance, Amazon Go uses cameras as observers as well as image sensing cameras. Observing cameras are placed all around the Amazon Go store for customer identification and tracking, which allows the customer to move freely throughout the store. Cameras are also placed in front of shelves to get an image of the time a customer approaches a shelf and what items they pick [4]. Furthermore, cameras can also be used for barcode scanning by either placing a camera on a Smart Cart or using a smartphone camera. Barcodes represent information that is readable for a computer, as a visual object. The information is encoded and has binary reflective values, such as white or black, that can be decoded to read the barcodes information [24]. When an item is “scanned” by using the camera, a photo of the barcode is taken and the barcode is decoded with Image Processing techniques. The item is then identified, and can show and process relevant information about the item from a database [19].

3. Study

In this section, the methods that were mentioned in section 1.4.1 are described and discussed. The four methods that we used in this study were literature review, questionnaire, interviews and prototyping. First, we did a literature review to get an overview of what has already been done and what we could contribute to. The literature review was also conducted specifically to help answer research question 2 and 3, by providing information on HCI and different guidelines. Then, by using the information found in the literature review, a questionnaire was conducted to collect qualitative data. It was for the purpose of answering research question 1 and 3, by realising what the users in the questionnaire would prefer, want and what their intentions with using a shopping application were.

Furthermore, to get a better understanding of smart shopping and self-scanning systems, we conducted interviews after the questionnaire with three different people who all have a role in smart shopping. Lastly, prototyping was used to create a visualisation of data collected from the previous methods.

3.1 Questionnaires

Questionnaires are commonly used in many fields of research. By asking different people the exact same questions in the same way, it becomes easier to compare and analyze answers from different perspectives. Furthermore, questionnaires generate a high quantity of information from a large group of people in a short amount of time. Thus, having the possibility to generalise the results, which was what we were trying to achieve [40].

Also, the whole process of questionnaires is fairly straightforward and is simple for respondents to complete without having to spend too much time on reading the questions. While questionnaires are usually quick to conduct, by providing an online questionnaire, respondents can still take their time and answer at their own pace if needed. Moreover, it has been shown that respondents answer more honestly if an interviewer is not present [39], [40]. On the other hand, there is an increased risk of misunderstandings if the question is misleading or poorly written [39], [40].

3.1.1 Implementation of questionnaires

In this research, a pilot study was distributed before the actual questionnaire in order to find and correct any inconveniences. We chose to do questionnaires because, as mentioned, a large amount of information can be collected from many people in a short amount of time, which is what we needed in order to both understand users and to get a good amount of data to use when taking design decisions. The questionnaire, which was web-based and created with Google forms, was only distributed in Sweden and was therefore in Swedish. It was placed in different groups on social media with many active users, a few of those groups were ”Västra-Hamnen koll”, ”Vi som bor i Malmö”, ”Vad händer i Göteborg?” and “Köp och sälj Malmö Skåne”, which all have thousands of active members of different ages and genders. These groups are general neighbourhood groups and/or shopping groups, therefore, they provide a good representation of opinions of those who do grocery shopping. Quantitative data was collected from 275 participants between all ages, and the age also provided an overview of the age groups that were represented. This was important for us as we wanted all age groups to be included in order to get a better variety and unbiased data. The

answers from questionnaires can be presented and analysed in a comprehensive and clear way.

When opening the questionnaire, the respondents answered how old they are and then they got to choose their preferred way of shopping. There were three options to choose from: self-checkout, self-scanning and staffed checkout. Depending on their choice, there were around 15 questions in total with multiple choice questions, which were mandatory. Additionally, there were also open-ended questions which were not mandatory. These were a form of follow-up questions with free-text fields, where the respondents could motivate their answers and add comments if they wanted to. Thus, providing a deeper understanding of their answers and thoughts. All questions were written in a simple way with very few technical words to make it easy for the respondents to understand and avoid misunderstandings. The respondent should not have felt confused or experienced any trouble with understanding the questions.

The results of the questionnaires are presented through visualisations such as charts and graphs, with their corresponding numeric values in percentage and can be found in section 4.1, 4.2 and 4.3.

As the questionnaires provided a general overview of the results and did go into details, the interviews described below in section 3.2 were conducted. This was done in order to get more information based on factors which are outside of the customer and user perspective.

3.2 Interviews

A qualitative semi structured interview with the purpose of reaching a deep understanding along with a broad information flow from a few participants was conducted. However, this also means that the qualitative results attained can not be generalised. One of the general weaknesses of interviews as mentioned by Larsen in [25] is when the results are going to be applied as a method for research backing, thus the interviews were carried out while bearing in mind the disadvantage of using interviews to support research. On the other hand, interviews allow deeper understanding of a specific topic, awareness of the human choices and often provide answers which can be hard to obtain by using other research methods. To achieve more depth in the answers, the interviewer could lead the conversation by asking follow-up questions. Thus, the interviewer is considered as being a part of the conversation in contrast to being a passive person. Therefore, it is important for the interviewer to be aware of their presence and attitude as it can affect the response of the informant [25].

Due to Covid-19, the interviews were conducted by phone which can have both advantages and disadvantages. As the interviews do not need to take place as an arranged meeting but rather can be set in any environment, the informant is likely to feel safer due to the fact that they easily and abruptly can end the interview at any time. On the other hand, phone interviews come with a difficulty of interpreting certain answers due to the interviewer not being able to see the respondents gestures, facial expressions as support for interpretation to one's response [25].

3.2.1 Implementation of interviews

The purpose of the interviews in this research was to be used in the aspects where the questionnaire was not enough. The participants brought insights from a professional perspective, which brought more knowledge to us about self-scanning systems. The first one was with Nikko Harrison, products area manager at ICA, and the summary

can be found in section 4.4. The second one was with a register manager at ICA Maxi and can be found in section 4.6, and the last one was with Petter Lagström, business area manager at Idnet, which can be found in section 4.5.

To achieve the feeling of a safe atmosphere, the interview questions began with questions that only needed concrete answers such as work duty and age. In addition, individual interview guides were made for each participant based on the person being interviewed. However, the common factor of all interviews was the formulation of open questions. It creates the opportunity to achieve comprehensive answers through space for thought and reflection which is also why we chose interviews. The different interviewees were asked between 5-20 questions depending on their role and the data that they could provide.

All interviews were transcribed by one of the authors of this thesis while the other was holding the conversation. After being conducted, the interviews were analysed with a thematic approach. Meaning, that we tried to look for patterns of opinions and attitude towards our ideas along with getting specific and explanatory answers, which were needed for our research such as data on specific costs and expenses.

As interviews usually need to be planned and scheduled it can be hard to find participants, especially if you are looking for people within a specific field. This limited our research to only 3 interviews due to some participants being unavailable or hard to reach, although the intention was to conduct around 6-8 interviews.

3.3 Literature review

The literature review that is presented in section 2, was conducted to get a better understanding of what research has shown so far and what changes and/or improvements can be made. In addition, the literature review was used to provide an overview of the key concepts in this thesis, for example, HCI theories, related work and technologies within smart environments. By doing this, we can avoid repeating what has been done before, and place our own research in this context. By looking at where we stand today, one can also argue why more research is needed in the area as well as finding gaps. Furthermore, when reviewing different types of research, we were able to see different perspectives and concepts. These differences can help identify conflicting evidence. We got a bigger picture of how previous workers differ; what strengths and weaknesses exist, and that there are different theories, hypotheses and results [37].

3.4 Prototyping

Prototyping is a method that takes place between developers and potential users, where a prototype of the system is built in an iterative process. This process is reworked in iterations until the prototype is acceptable and can be developed into a real product [48].

The prototype is designed by collecting information, such as user research or from other concerned sources, which helps to determine the system requirements. Then, when the prototype is built and accepted, it can be used as a model for a real system. By creating a prototype, time and resources can be saved and errors in a real system can be reduced or prevented. Also, users are involved and can influence the design and implementation during the process which might lead to higher user satisfaction [48].

3.4.1 Implementation of prototyping

The method was chosen to create a visual representation of the Smart Cart app, which has been designed with user-centered design based on HCI theories and data collected from the other research methods in this section. The application is intended to be developed in the future by the help of the research made in this thesis. In addition, the intention is also for it to be used as a foundation or inspiration for other developers or people of interest. Three iterations were made before the final result, the first one focused on functionality, the second one on design and the third one on both of them together. The resulting prototype with the last and final attempt is found in section 4.7.

4. Results

The results of this study are used, amongst other things, to create and design the prototype along with gaining knowledge for the development of the product. Functions and design patterns in the application were chosen and prioritised based on the questionnaire results, research on HCI and the interviews made with respondents who all have a role in smart supermarkets. As mentioned in section 3.2.1, one of the interviews was made with a Product Area Manager for a similar project made by ICA where they tried a self-scanning function in their application. This was done to gather information to see what kind of research has been made already, and what results they got. Moreover, interviews were also conducted with a register manager at ICA as well as a sales manager at IDNET, which is a company that supplies stores with self-scanning systems. In the questionnaire we tried to gather general preferences on design and development from a user's point of view. From the research and literature review on HCI by Nielsen and Norman, we created a prototype.

The initial question asked in the questionnaire was what type of checkout service the customer uses when they shop, thus the answers of the questionnaire are based and divided into 3 ways of preferred shopping. The preferred shopping options were Scan and Go, Self-checkout and Staffed-checkout. The results are presented below, note that some answers that were considered less relevant and are not included in the diagram as they only had 1 respondent, which did not affect the study.

4.1 Questionnaire results: Scan and Go (43.6% 120/275 respondents)

When respondents were asked for what reasons they use Scan and Go, this was a multiple choice answer:

- 81.7% answered that the reason for using the handheld scanner is that they can avoid queues,
- 80% answered that it is faster,
- 67.5% answered that it is because they can pack their groceries straight into their bags,
- 68.3% answered because you are able to see the prices and total sum directly,
- 60% answered that it is easier.

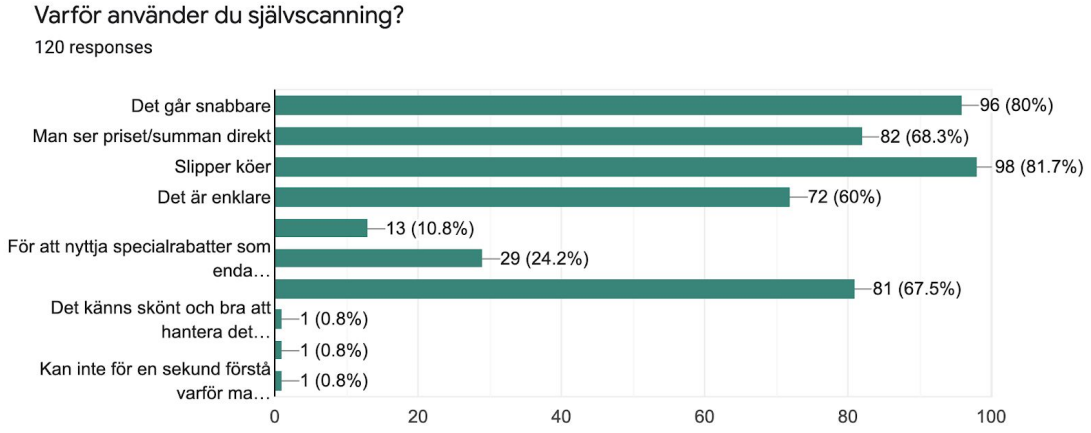

Figure 4.1 - Table showing reasons for using Scan and Go, text to option number 5 was cut off in Google Forms, should have said: Avoid social contact with staff.

- 92.5% of the respondents felt that they save time by using Scan and Go.

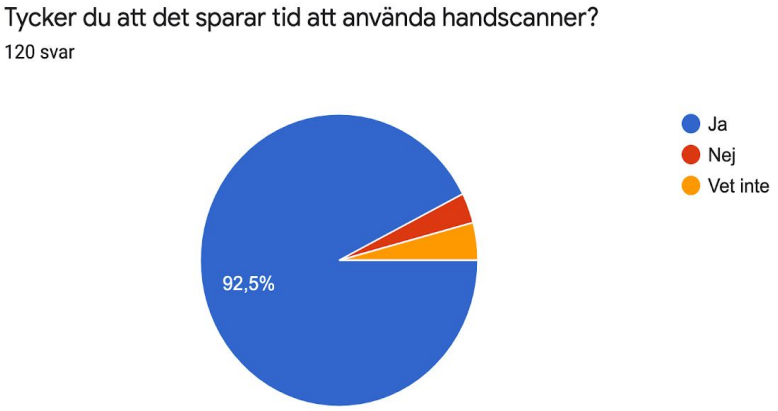

Figure 4.2 - Pie chart for if the respondents thinks they save time by using self-scanning

Furthermore, the respondents had the option to freely answer if they would like to change anything to improve their Scan and Go experience, the main topics which were discussed here were: To scan with a phone instead, to have smaller scanners, to have scanners that have touch support etc.

When the respondents were asked if they would consider to use an app in their phones instead of the Scan and Go device:

- 51.7% answered “yes”,
- 27.5% answered “maybe”,
- 20.8% answered “no”.

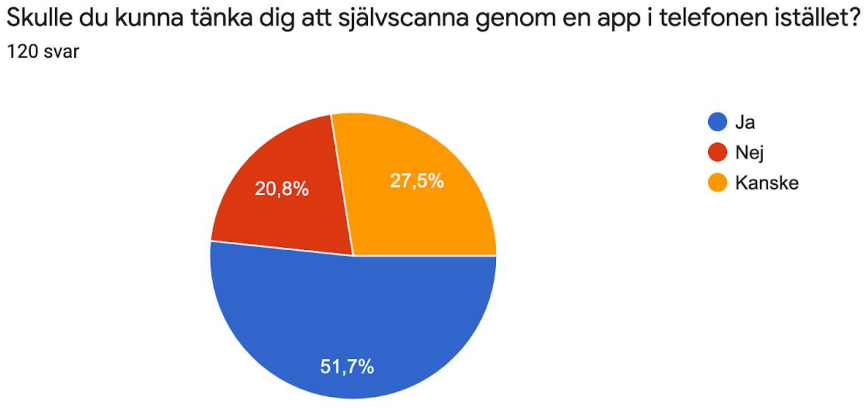

Figure 4.3 - Pie chart for if the respondent would consider self -canning in a phone application instead

The respondents were also asked if a specific function or reason would make it more likely for them to use an app for self-scanning (respondents could freely choose from several predefined answers and/or add their own options), and 60.8% replied that they felt comfortable using their own phone. 43.3%* answered that the function of seeing all offers in the phone would make it more likely for them to use the app and 39.2% answered that not having to use a physical membership card could be a reason. In addition, 31.7% replied that they wanted to avoid the self-scanning devices.
** Text to option number 2 in fig. 4.4 was cut off in Google Forms, should have said: See all offers in my phone*

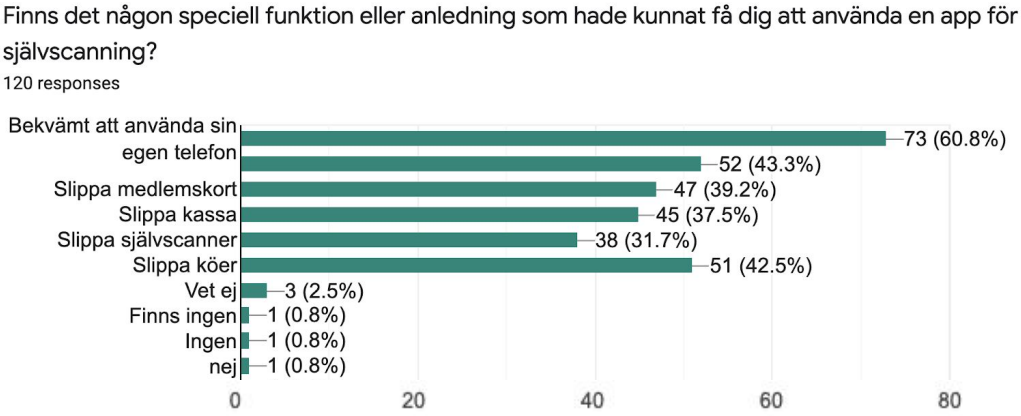

Figure 4.4 - Table for functions/reasons that would make respondents use an app for self- scanning, text to option number 2 was cut off in Google Forms, should have said: See all offers in my phone

Moreover, the respondents were asked about functionality, in particular if they would like to be able to see information (nutritional value) about the scanned items, have a possibility to create shopping lists and/or get suggestions on similar items.

On having information (nutritional value) about items:

- 45% answered “yes”,
- 24.2% answered “don’t know”,
- 30.5% answered “no”.

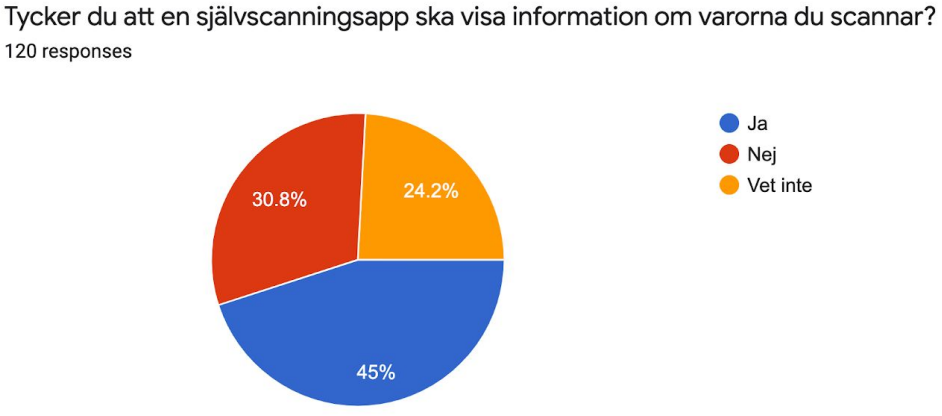

Figure 4.5 - Pie chart showing if respondents think that a self--scanning app should show product information

To create shopping lists:

- 71.7% answered “yes”,
- 17.5% answered “don’t know”,
- 10.8% answered “no”.

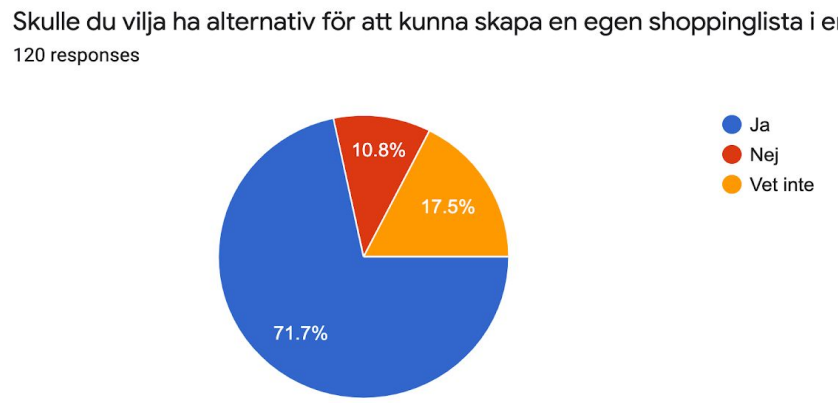

Figure 4.6 - Pie chart for showing if respondents want a function of creating own shopping list in the app

Preference on showing similar or suggested items to items that are already scanned:

- 39.2% answered “yes",
- 10.8% answered “don’t know”,
- 50% answered “no”.

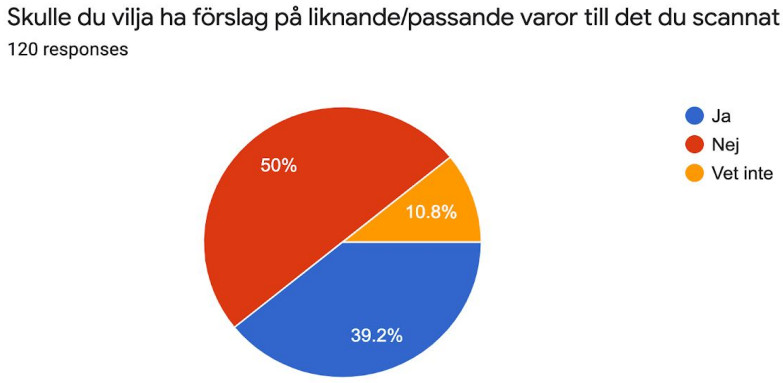

Figure 4.7 - Pie chart for showing if respondents want suggestions similar/relevant groceries to the ones already scanned

Also 65.8% of the respondents preferred simple use to a wider range of functions. However, 19.2% prefered a wider range of functions over simplicity. The remaining 15% answered that they don't know if they would like easier use or more functions.

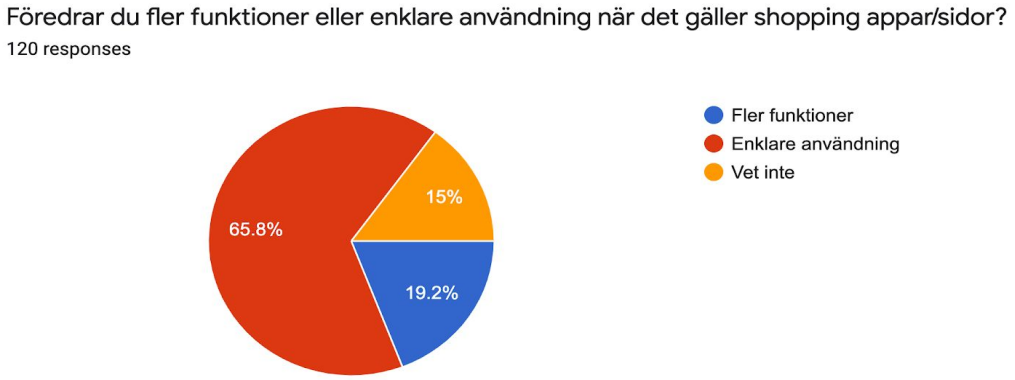

Figure 4.8 - Pie chart for showing if respondents prefer more functions or simple use

Moreover, when the respondents were asked to freely answer what they personally think would prevent people from using a self-scanning app, the common topics when concluding the answers were that elders might find it hard to use smartphones and generally it seemed that they might find it hard to adapt to, and use a Smart Cart app. Also the respondents thought that complexed technology might be the reason people would not use such an app.

4.2 Questionnaire results: Self-checkout results (26.5% 73/275 respondents)

When asked why respondent's use the self-checkouts, this was a multiple choice answer (Note that some answers are not included in the diagram as they only had 1 respondent etc and did not affect the study):

- 89% answered that it is faster to use the self-checkout,
- 78.1% answered to avoid queues,
- 41.1% answered that it is easier,
- 20.5% answered that it is for avoiding social contact with staff.

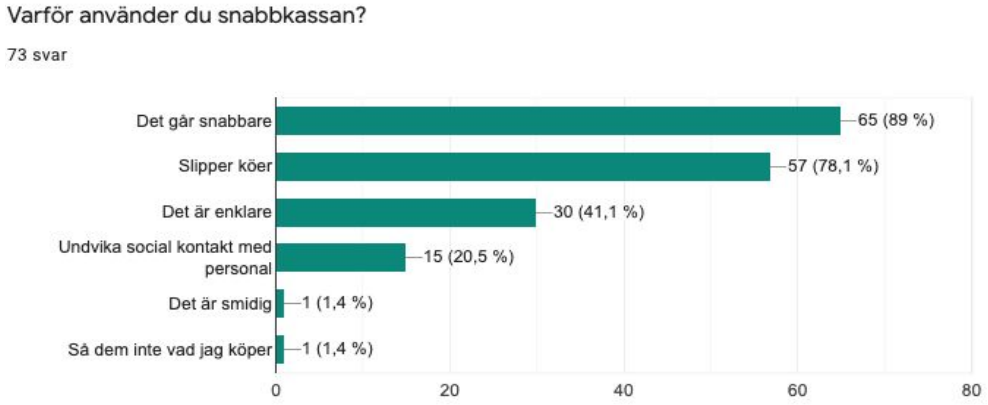

Figure 4.9 - Table showing reasons for using Self-checkout

- 94.5% believe that they save time by using self-checkouts.

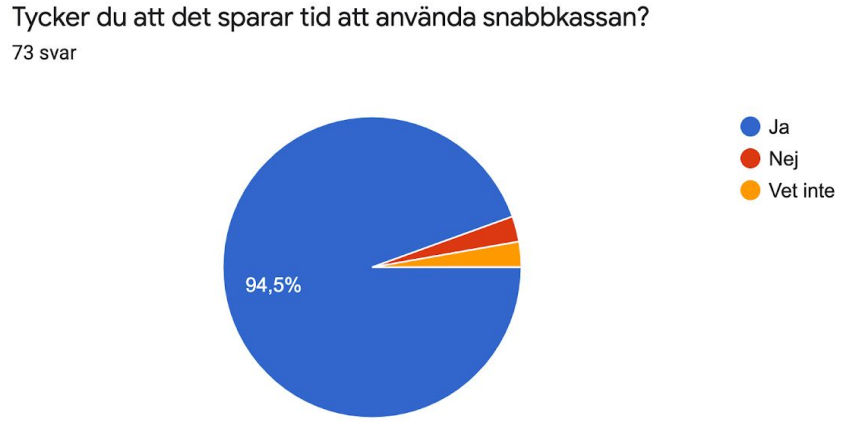

Figure 4.10 - Pie chart for if the respondents believe they use time by using the self-checkout

Moreover the respondents were asked if they could consider to use an app for self-scanning in their phone instead:

- 65.5% answered “yes”,
- 23.3% answered “maybe”,
- 11% answered “no”.

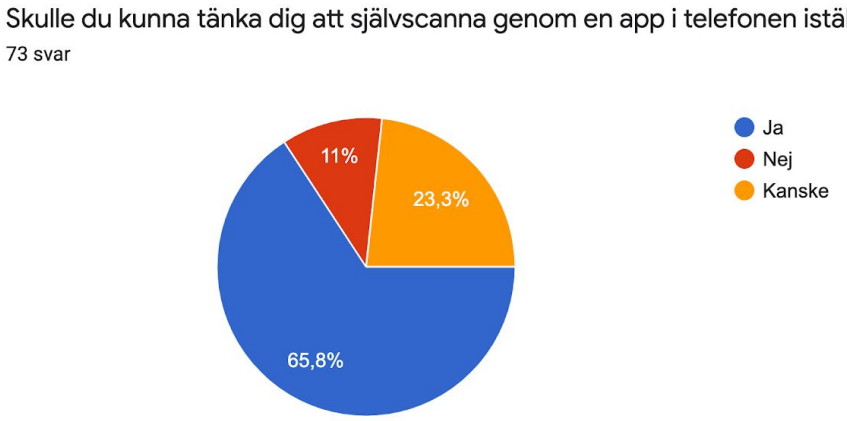

Figure 4.11 - Pie chart for if the respondent would consider self-scanning in a phone application instead

The most common reason for saying yes was that the idea sounds like a smooth and fast solution. To elaborate, the respondents were asked if any specific function or reason would make them use an app for self-scanning. The respondents had some predefined alternatives to choose from, and could add their own alternatives as well. The most common answers was that it was more comfortable to use one's own phone (61.6%), avoid queues (74%), see all offers in the phone (63%), avoid physical membership card (34.2%), avoid staffed checkout (39.7)%, avoid the Scan and Go self-scanning device(32.9%). When asked if the respondents would like to change anything to improve their self-checkout experience the most common answers were to be able to remove scanned items easier, have more checkouts and to be able to scan more items (as there often is a limit of 10-15 items) at self-checkouts.

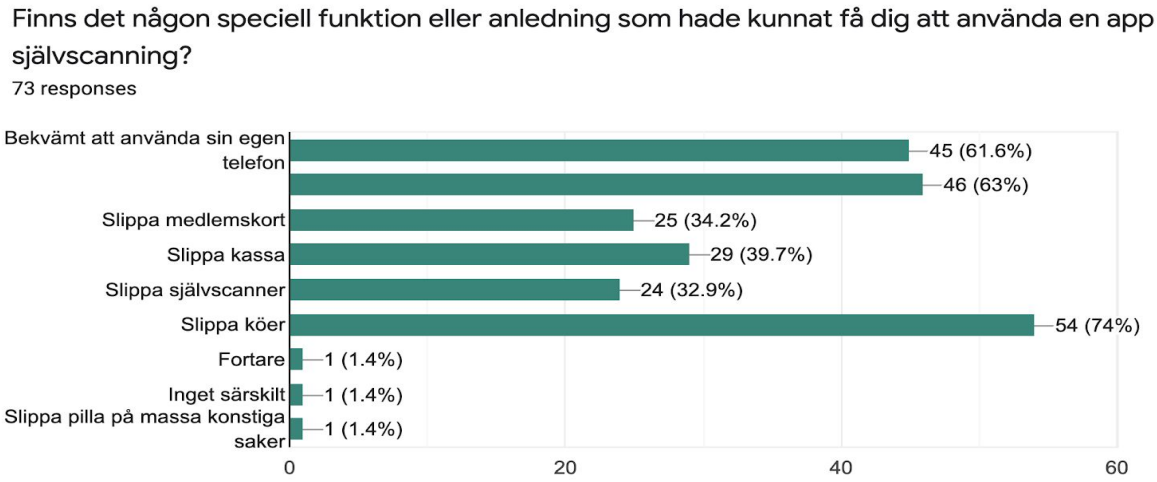

Figure 4.12 - Table for functions/reasons that would make respondents use an app for self- scanning, text to option number 2 was cut off by Google Forms, should have said: See all offers in my phone

The respondents were also asked about functionality, particularly if they would like to see nutrition information about the scanned items, have a possibility to create shopping lists and if they wanted to get suggestions on similar items. On having information (nutrition value) about the items scanned:

- 69.9% answered “yes”,
- 21.9% answered “don’t know”,
- 21.9% answered “no”.

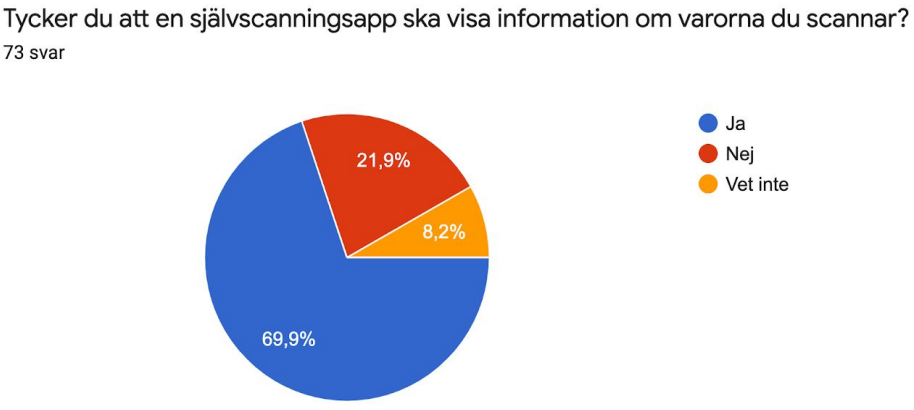

Figure 4.13 - Pie chart showing if respondents think that a self-scanning app should show product information

On the question of being able to create shopping lists:

- 84.9% answered “yes”,
- 9.6% answered “don’t know”,
- 5.5% answered “no”.

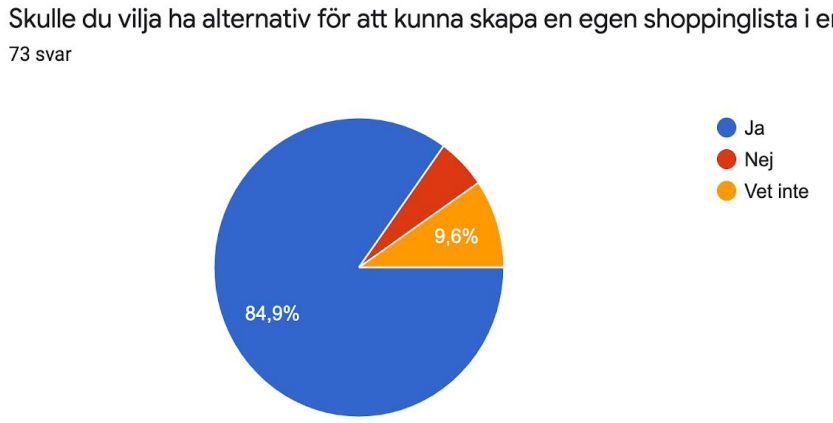

Figure 4.14 - Pie chart for showing if respondents want a function of creating own shopping list in the app

Preference on showing similar or suggested items to items that are already scanned:

- 46.6% answered “yes”,
- 9.6% answered “don’t know”,
- 43.8% answered “no”.

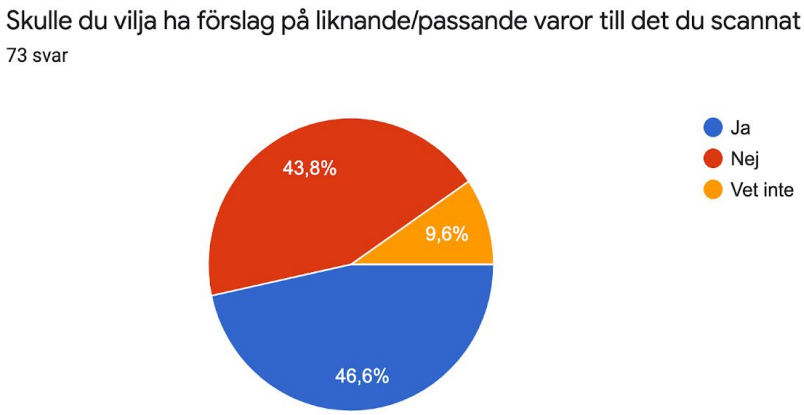

Figure 4.15 - Pie chart for showing if respondents want suggestions on similar/relevant groceries to the ones already scanned

In addition, the respondents were asked if they prefer simple use to a wider range of functions, 72.2% answered that they would prefer simple use whereas 21.9% prefered a wider range of functions over simplicity and 5.5% answered that they don't know.

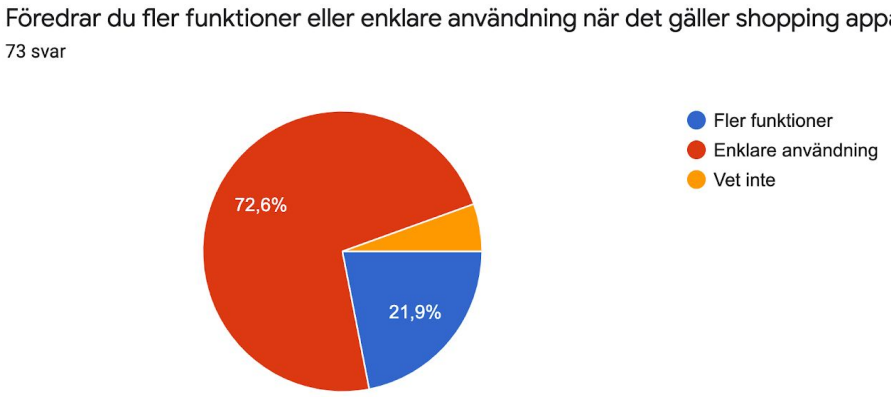

Figure 4.16 - Pie chart for showing if respondents prefer more functions or simple use

When asked what the respondents thought would prevent people from using an app for self-scanning, the main topics of the answers were similar to the ones in 4.1 (Scan and Go results). The main topics were about elders, and that they might not be used to smart technologies which could lead them to not using such an app.

4.3 Questionnaire results: Staffed checkout results (29.8% 82/275 respondents)

When asked why respondent's use the staffed checkout, this was a multiple choice answer (Note that some answers are not included in the diagram as they only had 1 respondent etc and did not affect the study):

- 45.1% answered that it is more comfortable not having to do everything yourself,
- 35.4% answered that it is easier,
- 18.3% answered that they prefer social interaction with the staff*,
- 13.4% answered that it is faster.

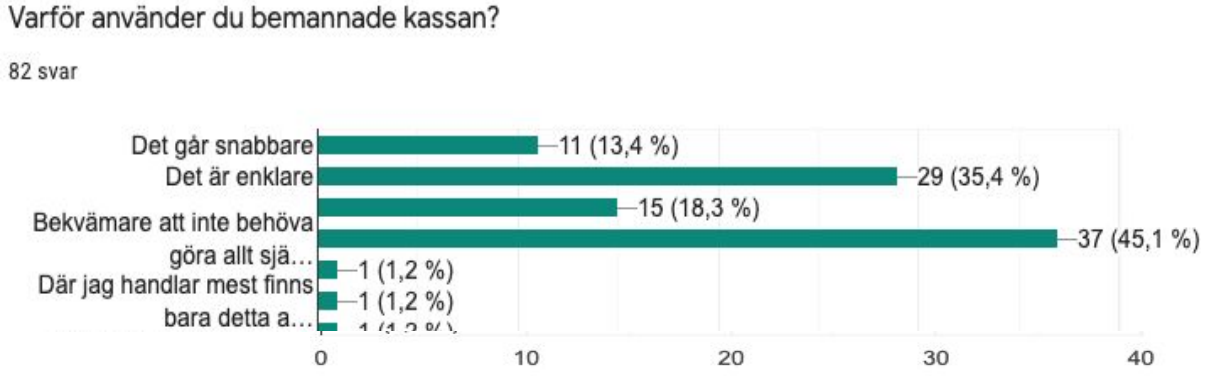

Figure 4.17 - Table showing reasons for using staffed checkout, text to option number 3 was cut off in Google Forms, should have said: Prefer social contact with staff

When asked if the respondents think that the staffed checkout saves more time compared to the self-scanning and Scan and Go:

- 20.7% answered “yes”,
- 23.2% answered “don’t know”,
- 56.1% answered “no”.

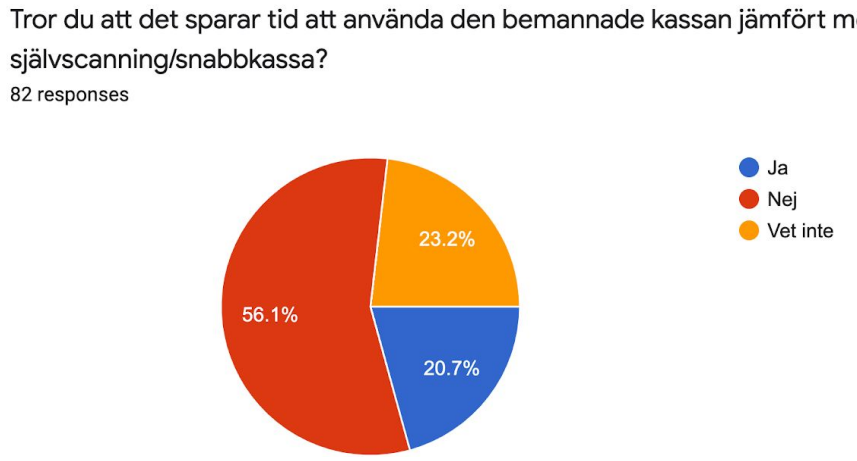

Figure 4.18 - Pie chart for if the respondents believe they use time by using the self-checkout

The respondents were also asked if they would consider using an app for self-scanning instead and:

- 43.9% answered “yes”,
- 32.9% answered “maybe”,
- 23.2% answered “no”.

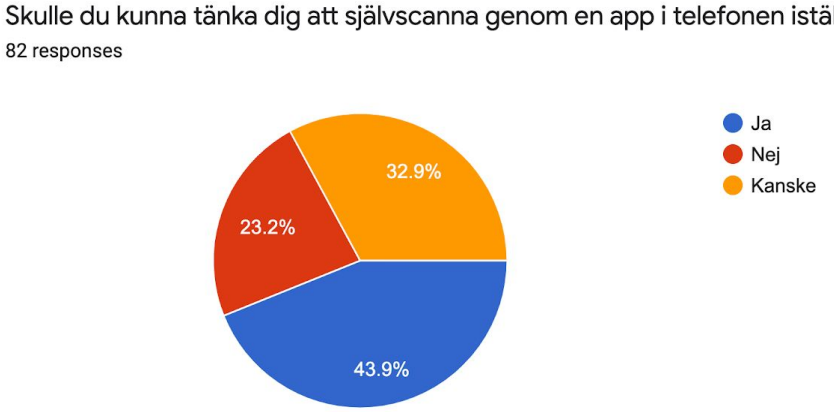

Figure 4.19 Pie chart for if the respondent would consider self-scanning in a phone application instead

The question could be elaborated on why they answered in a certain way, and if the respondent answered yes the most common answers were that it would be faster and a smooth process. Those who answered no are mostly those who are satisfied with their current way of shopping, by using a staffed checkout without any changes.
There were some reasons which could make the respondents consider using an app for self-scanning, 49% answered that they could avoid queues, 48.8% felt it would be comfortable to use their own phone and 45.1%* would like to see offers directly in their phone. Also, 25.6% answered that they would like to avoid a handheld scanner, 20.7% answered they would like to avoid a register and 15.9% would like to avoid having to bring their membership card.

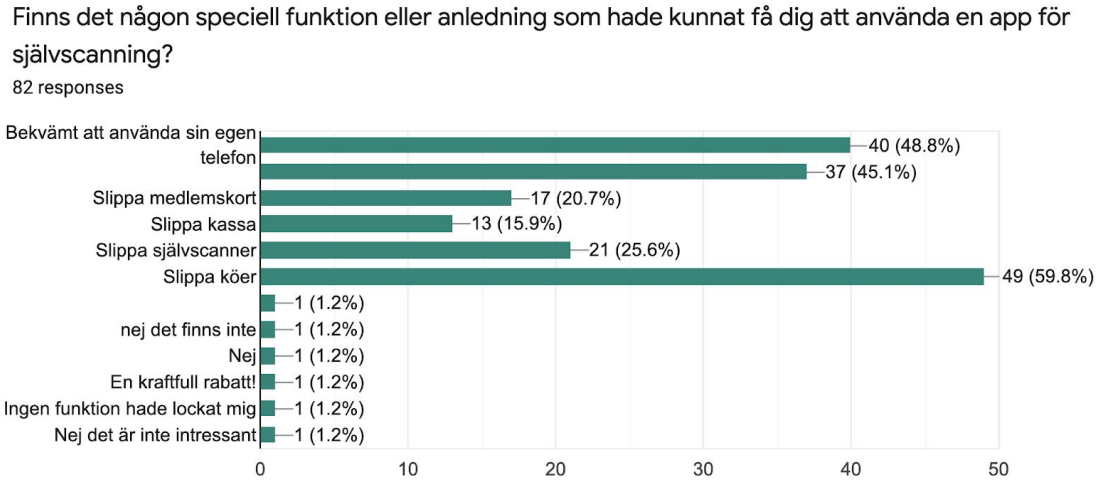

Figure 4.20 - Table for functions/reasons that would make respondents use an app for self- scanning, Text to option number 2 was cut off in Google Forms, should have said: See all offers in my phone

The respondents were also asked about functionality, in particular if they would like to be able to see information (nutritional value) about the scanned items, have a possibility to create shopping lists and/or get suggestions on similar items.
On having information about items:

- 68.3% answered “yes”,
- 13.4% answered “don’t know”,
- 18.3% answered “no”.

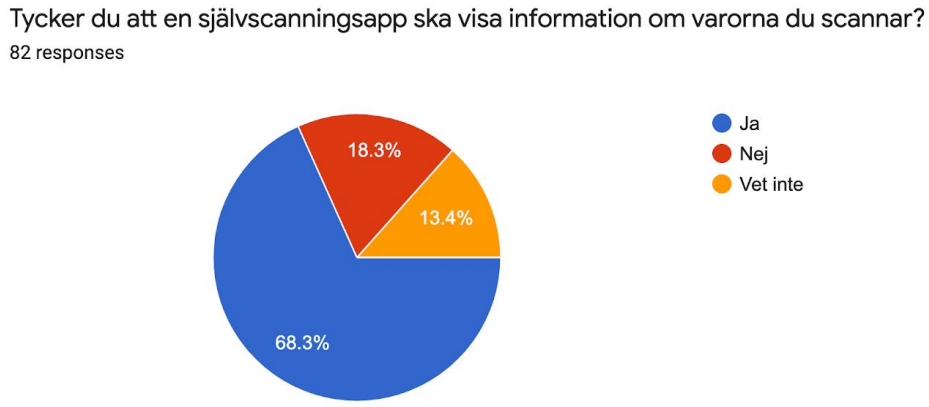

Figure 4.21 - Pie chart showing if respondents think that a self-scanning app should show product information

To create shopping lists:

- 78% answered “yes”,
- 13.4% answered “don’t know”,
- 8.5% answered “no”.

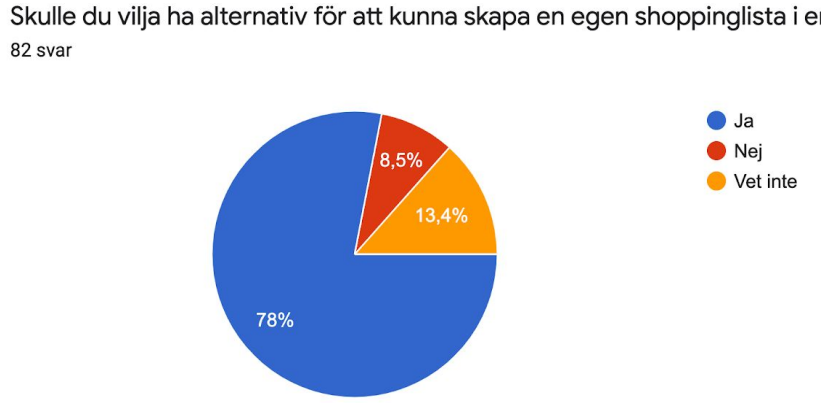

Figure 4.22 - Pie chart for showing if respondents want a function of creating own shopping list in the app

Showing similar or suggested items to the items already scanned:

- 52.4% answered “yes”,
- 13.4% answered “don’t know”,
- 34.1% answered “no”.

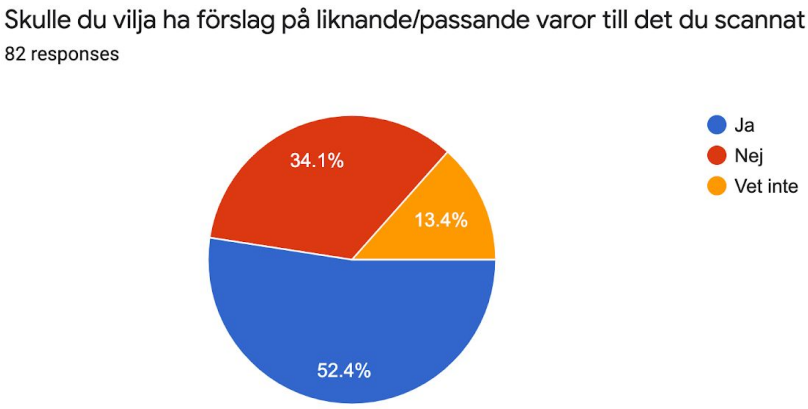

Figure 4.23 - Pie chart for showing if respondents want suggestions on similar/relevant groceries to the ones already scanned

Furthermore, 70.7% prefer simple use to a wider range of functions. However, 11% prefered a wider range of functions over simplicity. The remaining 18.3% answered that they don't know if they would like easier use or more functions.

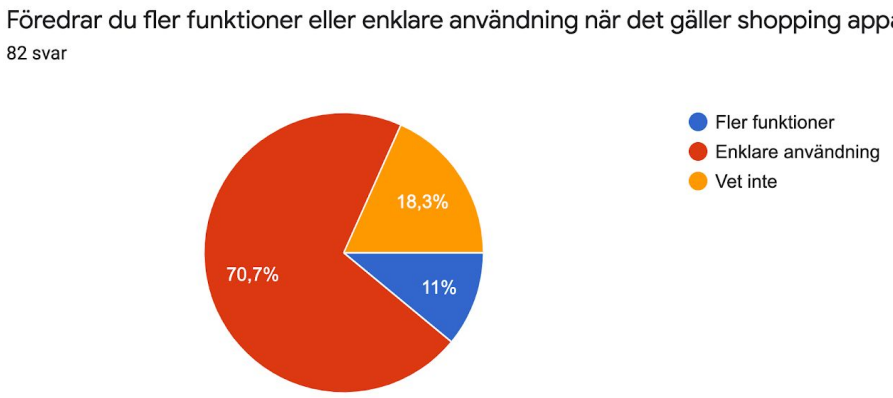

Figure 4.24 - Pie chart for showing if respondents prefer more functions or simple use

The respondents were also offered to answer what they think would prevent people from using an app for self-scanning, the answers were mostly about lack of knowledge (new technology), complexity of the app and that the elderly might experience problems.

4.4 Interview with Nikko Harrison, Product Area Manager at ICA Sweden.

Nikko was a part of the project for integrating a self-scanning function in the ICA Handla-app in 2014. The self-scanning function was tested in 10 pilot stores that varied in size, some of which had handheld self scanners available, whereas some of the smaller stores did not. The function for self-scanning was removed from the app in 2018. The reason for trying out the self-scanning function in the app was based on the fact that it felt like a good idea, without having much data to start with. They knew that regular self-scanning with a handheld device is very expensive and smaller stores might not be able to afford it. Their goal was to build a cheaper solution as well as decreasing the need for handheld devices, specifically for smaller stores that might not have handheld scanners available. When the self-scanning function was tried out it did not succeed in any of the 10 stores. The reason for this was not fully clear, however a guess was that there was no need amongst the customer for it or that there were obstacles that were hard to bypass by the customers. For instance, downloading the app (if they did not already have it), signing in, learning to self-scan, lack of clear instructions, fear of incorrect scanning and fear of complicated checkout registers. In the payment function that ICA had in their app, the customer still had to complete their payment at a register.

Furthermore, the ICA-group tried to test the app in a specific store by investing in marketing by educating the regular staff, having event staff and offering a 20% discount on purchases for everyone that used the self-scanning in the app. This was a more successful approach for about 2 weeks (while the discount was offered), however the revenue that came from the app decreased to about 3% of the stores total revenue after the discount expired. Although the revenue decreased, the store still wanted to

have a self-scanning function in the app due to the low cost which was estimated to about 5000 SEK/month. However, the maintenance costs were too high compared to the amount of stores that were suitable for the implementation as there was no need for mobile self-scanning in stores that already had handheld scanners.

According to Nikko, the handheld scanners bring up to 60% of the total revenue in a few of the big stores, around 1.5 million people use the handheld scanners today which is about 30% of their total loyalty clientele (those customers who are a part of their loyalty system). Furthermore, Nikko also mentioned that a good use case for a self-scanning function in an app would be stores that are small but still big enough for providing self-scanning services. He believed that with the right marketing and good overall pricing, a self-scanning app could succeed, particularly in smaller stores that can not afford handheld self-scanning devices. In addition, it could also be successful in big stores such as IKEA as the customers usually spend longer time in these kinds of stores while ”strolling around”. The payment solutions are also considered very important to make such an app successful. When asked what could have been done differently in developing the self-scanning function in the app, the emphasis was on the internal system, for example the communication between the different systems in the backend and the app itself. As self-scanning systems already are very big and complex, with many different parts that communicate (such as scanners, registers, offers etc), it is important to have a good internal solution when developing an app. He also believed that in the near future, with the development of store solutions such as Amazon Go, a mobile self-scanning app could get a helping push to success.

The solution and idea was based on helping small stores rather than being user-centered. It was mentioned that no kind of user-research was seen or made during the time Nikko worked with the project. However if the app was made today, they would have made a very thorough user-research with e.g. a prototype along with other methods to understand what is good or bad for such an implementation in the app.

4.5 Interview with Petter Lagström, Business Area Manager at Idnet AB, Sweden.

Petter is the Business Area Manager at Idnet, which is a company that provides supermarkets, such as Coop (swedish supermarket chain) with self-scanning systems. The main purpose of the interview with Peter was to get information about cost and maintenance. He estimated that one handheld self-scanning device costs around 10 000 SEK, and a whole system with every piece of hardware can cost around 1.5 million SEK. Furthermore, Petter assumed that the maintenance cost for the system, such as repair and support, could be roughly 100 000 SEK per year.

4.6 Interview with N.N, Register Manager at ICA Maxi Supermarket.

The Register Manager at Ica maxi supermarket estimated the price of a handheld scanner to be approximately 10 000 SEK. This was very expensive and unreasonable according to the manager. However, although the scanners need to be repaired on a regular basis, the self-scanning system has a long lifetime with the estimation being “a couple of years” as long as it is maintained. The annual revenue that comes from self-scanning at that specific store with approximately 666-767 thousand customers a year, is estimated to be 35% of the total revenue of the store which was quite low compared to the average revenue coming from self-scanning at other ICA stores.

However, the manager believed that this revenue had increased lately due to the Corona pandemic, which was happening at the time of writing in 2020. The manager was unsure if the store made economic savings based on having a self-scanning system. When asked about if the store management could imagine using a self-scanning app in the future instead of the handheld scanners, the manager was convinced that this would be the case in the future. However, N.N mentioned that ICA is not very fond of buying systems from third party developers and that they would be more likely to invest in an app if it was developed by ICA themselves. When asked about functions and implementation that the manager thought would be good in a self-scanning app, N.N said that customers should be able to remove an item easily if they scan something wrong or change their minds over an item. In addition, they should be able to add a shopping list which automatically updates if the customer scans that item into their shopping cart and the customer should be able to see offers in the app. Moreover, the manager also believed that a self-scanning app could replace the self-scanning system existing today.

4.7 Prototype

A prototype has been developed as a result of the findings from the studies made. The design decisions have been made based on the literature review results as well as the results from the questionnaires and interviews. A wireframe and the resulting prototype pages are presented below (on the next pages). The analysis of these results will be presented in section 5.

4.7.1 Wireframe:

4.7.2 Individual prototype pages and description:

Figure 1 - Scan Shop

Figure 2 - Sign in

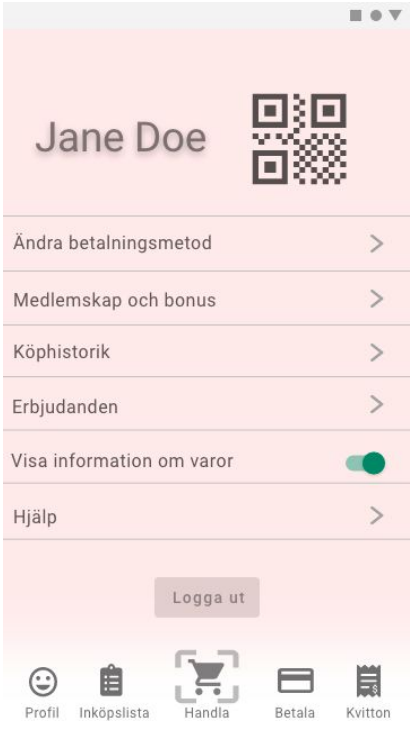

Figure 3 - Profile

The first fragment (fig. 1 - Scan Shop) is displayed when the app is started and asks the user to scan a QR-code, which is located by the entrance in the connected store. There is also an option for logging in without shopping, e.g. if the user wants to see their shopping history, shopping list or change settings. Once this is done, the user is directed to fig. 2 (Sign in). If the user connects with a store, the name of the store is displayed. To sign in and use the app, the user signs in with BankID (the app opens in the background for verification). The BankID also verifies the membership for the store, so the customer does not need to use their physical membership-card. Once logged in, the third fragment which is shown in fig. 3 (Profile) will automatically be displayed for the user. This is the user profile page, where the user can change and view their settings. At the top the name and surname of the user is displayed along with a QR code for the user which can be used for administrative enquiries in the store. There are five options with a forward arrow which is a general representation for moving to the direction of that statement.A new fragment will open with the specific information e.g “help” (future work which will lead to a web page), changing payment method (fig. 17 - Card Payment), membership and bonus (fig. 5 - Membership), purchase history (fig. 18 - Receipts) and offers for the store (fig.4 - Offers). Furthermore, the user can toggle whether to show information about products and lastly there is a sign out button which, if clicked, will lead back to fig. 1.

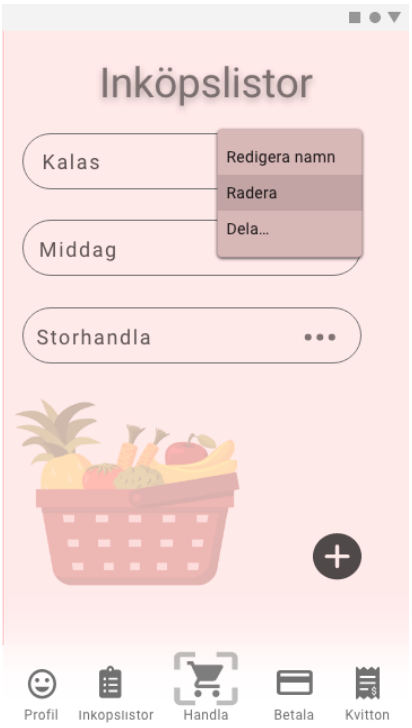

Figure 10 - Shopping lists

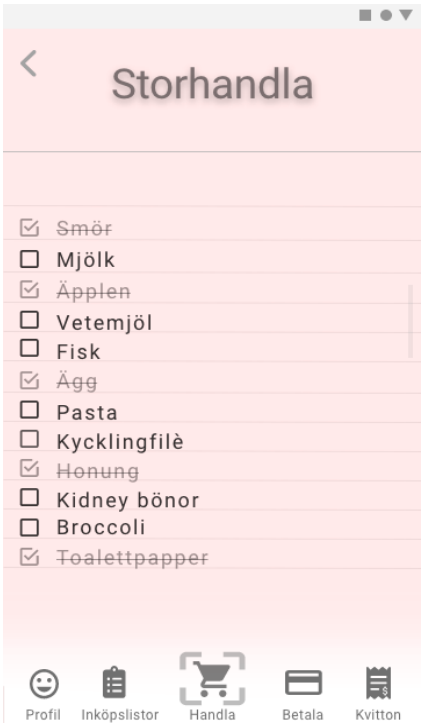

Figure 11 - Shopping list

Through the bottom navigation, the user can click on “Inköpslistor” (Shopping lists) which will lead them to the shopping list fragment (fig. 10 - Shopping list). There is a “+” (add) button in the bottom right corner which, once clicked, will add another shopping list component (button) under the last one. Each list is displayed as a button with a three dot action-button to its right side which can be used to change the list settings. The available options will appear if the action menu is clicked: Change name, Delete, Share... (future work). If the user clicks on one of the shopping lists (buttons), the chosen list will open and display the items in it, as shown in fig. 11 (Shopping list) where ”Storhandla” is used as an example. They can add new items or delete existing items by clicking on the rows and adding or deleting text. New rows are created after each click on the ”Enter” key in the keyboard. Once items are added, they are displayed with an empty checkbox. The user can click on the item to mark it as added, which puts a check in the box and strikethrough text for visual representation.

Figure 6 - Scan and Shop

Figure 7 - Swipe up for cart

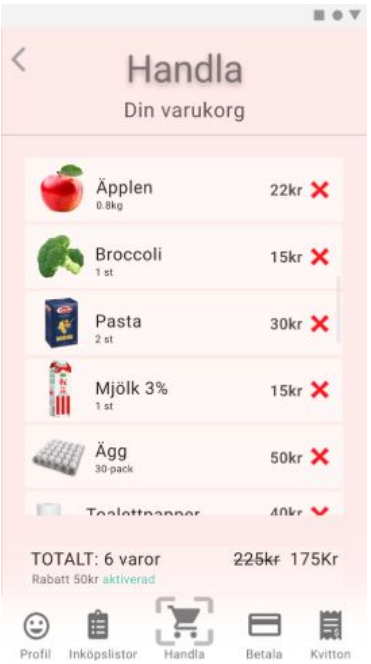

Figure 8 - Cart

Figure 9 - Product information

By clicking ”Handla” (shop), which is the emphasized button in the middle of the bottom navigation, the user is presented with the scanner view as seen in fig. 6 (Scan and shop). The phone's camera is used for scanning items. Below the scanner is a bar with arrows that are pointing upwards. This is used to show that the user can swipe up from the bar and see their shopping cart, like fig. 7 (Swipe up for cart) shows. When swiping up from the bar, the shopping cart view is ”dragged up” to eventually replace the scanning view and fully display the shopping cart, as seen in fig. 7 and 8 (Cart). The shopping cart is displayed with all the items that have been scanned and their price. An item can be removed by clicking on the red cross at the right-hand side of each item. At the bottom, the total price of all scanned items is also displayed along with discounts (if activated). An arrow for going back to the previous page is placed in the top left corner so that the user can go back to scanning. Each item in the list is also a clickable button which, once clicked, will lead to fig. 9 (Product information). In fig. 9, the information about that item is displayed, with nutrition information, brand and type of product.

Figure 13 - Choose payment

Figure 12 - Reconciliation

If the user clicks on “Betala” (Pay) in the bottom navigation menu, they will be navigated to fig. 13 (Choose payment), and an option of paying with Swish or card will be displayed. The options are clickable buttons and once clicked they will lead to fragments in fig. 14 (Swish payment) or fig. 17 (Card payment). When the user clicks on one of the payment options, a popup (fig. 12 - Reconciliation) might automatically be displayed if the user gets an “avstämning” (reconciliation). If this happens, a QR code along with a request to contact a cashier at the self-scanning checkouts will be displayed. The cashier will then be able to scan the QR code to see the users purchase. This is done for theft prevention purposes as well as preventing the human errors that can occur. Once reconciliation has been made, the user is sent back to fig. 13. If there is no reconciliation, the user just proceeds with the payment, which can be seen in the figures below.

Figure 17 - Card Payment

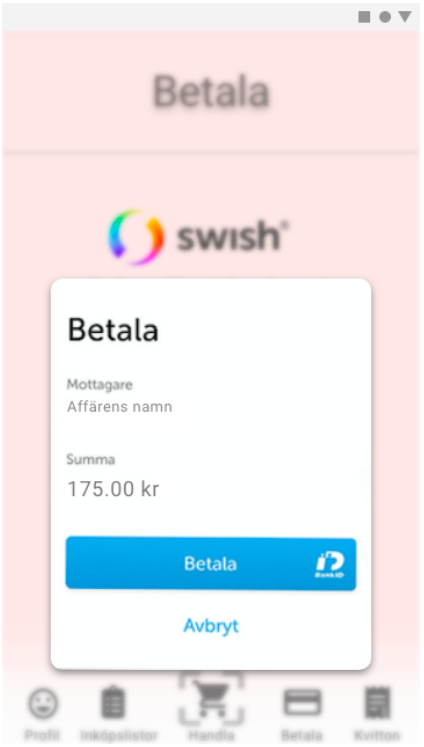

Figure 14 - Swish Payment

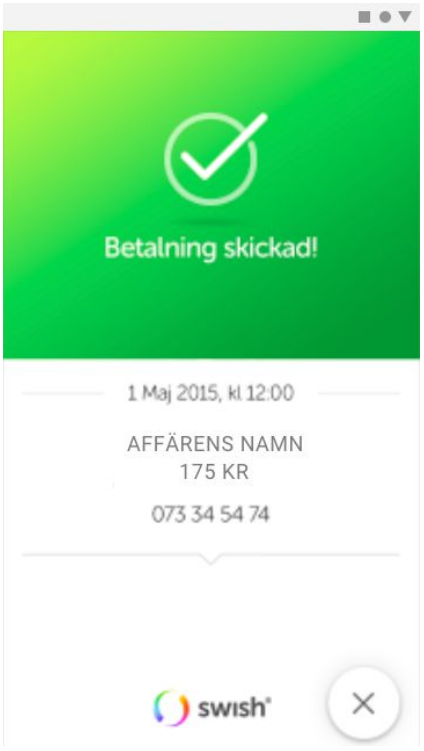

Figure 15 - Swish Confirmation

If the option to pay with a card is chosen in fig. 13, the user's card details are displayed in a list (if saved) as shown in fig. 17 (Card payment). The user can choose to pay with an already saved card by clicking on it in the list, or pay by adding a new card in the input fields displayed under the already saved list items. If the user wants to pay with a saved card, the chosen card is marked with a green border and the user then clicks on the blue “Betala” (pay) button to pay with this card.
On the right side of each list item, a red cross is displayed so that the user can delete a saved card. The user can also pay with a card without saving it by clicking on the blue “Betala” (pay) button after filling in the card information in the fields. On the other hand, if the user chooses to pay with Swish in fig. 13, they will be directed to fig. 14 (Swish payment), and the total amount will be displayed under “summa”. The user will then have to sign the payment with BankID by clicking on the blue “Betala” (Pay) button which is provided by Swish. Once the payment has been processed, the confirmation, which is presented in fig. 15 (Swish Confirmation), is provided by Swish. A button “X” is displayed in the bottom right corner to go back to the Shopping App.

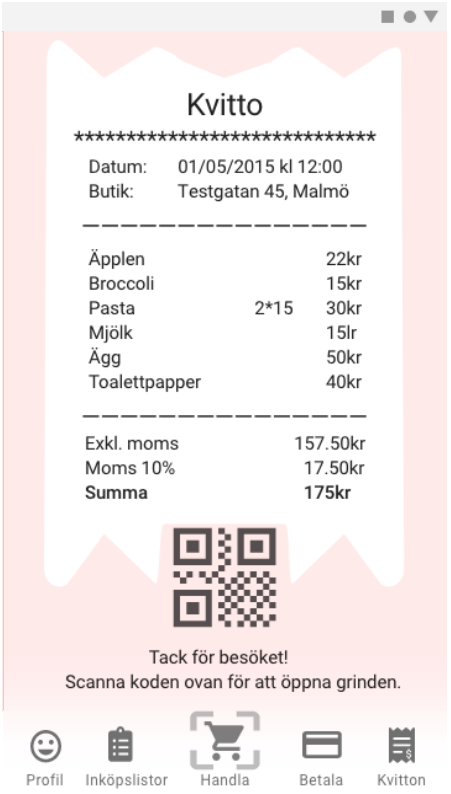

Figure 16 - Receipt

Figure 18 - Receipts

Once the user has paid for their items, they will get a receipt with information about their purchase as shown in fig. 16 (Receipt). The receipt has a QR-code which is used to open a gate to exit the store. The user is informed on how to use the QR-code.
The receipt will be saved in ”Kvitton” (Receipts) located in the bottom navigation menu, which is shown in fig. 18 (Receipts). By clicking on ”Kvitton” (Receipts) the user can see all their previous receipts with date and amount. If the user clicks on a receipt, they will be able to see the chosen receipt like in fig. 16 (but with an inactive QR-code). The bar at the top is used for different dates e.g. displaying receipts from today, the latest week, month and so on. The arrow pointing downwards implies that the user has different options.

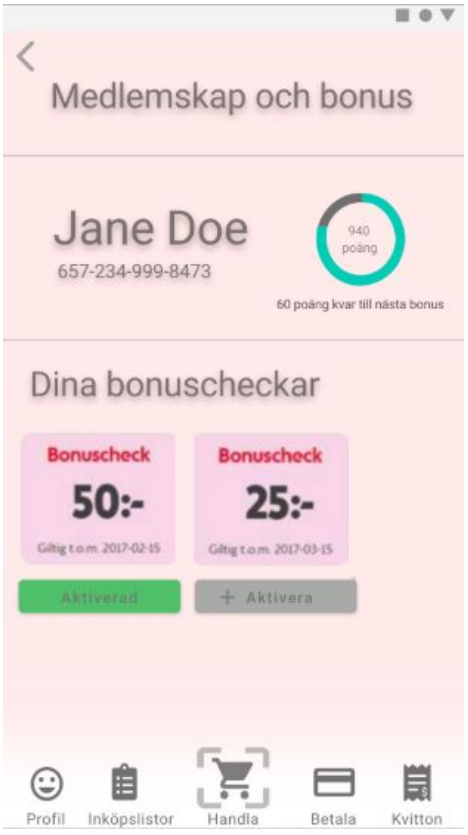

Figure 5 - Membership

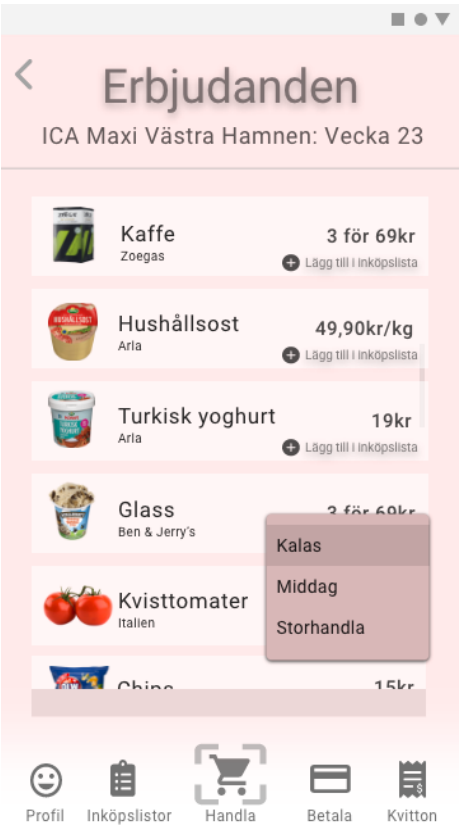

Figure 4 - Offers

The membership and bonus view which is presented in fig. 5 (Membership) displays the users name, membership number, bonus points and their bonus checks. A circle to the right of the name shows the amount of current bonus points and how much is left for the next bonus by providing a visual representation. In the example in fig. 5, the user has collected 940 points and needs 60 more to receive a new bonus check. The checks can be used by pressing the gray button ”+ Aktivera” (“+activate”) and the discount will be added to the shopping cart, fig. 8 (Cart). Once the button is enabled, it changes to a green color with the text “Activated” and can be disabled by clicking on it again, which turns it back to gray, this is done to create a visual representation. There is also a fragment for offers for the current store and current week, this is shown in fig. 4 (Offers). This fragment can be reached from the profile fragment, which is accessible through the bottom navigation menu. In the Offers fragment the user can add a listed item to their shopping list by clicking “(+) Lägg till i inköpslista” (Add to shopping list). A menu that shows all the saved shopping lists appears and the user can choose which list they want to add items to. In the figure, it shows that “Glass” (Ice cream) is added to the list called “Kalas”.

5. Analysis

Data collected from both the interviews and questionnaire implied that the attitude towards phones and applications within smart shopping were positive as a whole. In the interviews, two out of three of the respondents were asked about their attitudes towards such an application. When interviewing the Product area manager of ICA, he believed that there is great potential in a Smart Cart application and with the right price, marketing, education and user research, it would be a success. In addition, the Register manager at an ICA Maxi store had similar beliefs and thought that such an app would be successful very soon as technology is developing and phones are more frequently used as time goes by. These respondents both have experience and knowledge within the field of self-scanning and shopping due to their positions and area of responsibility. As a result of this, they have valuable opinions because they have a real insight of the field and therefore their answers and explanations are reliable. This supports the demand for mobilising the self-services so we were assured that there is potential in such an application.

The positive attitudes were also seen from the respondents in the questionnaire where 51% (Scan and Go users), 65.8% (Self-checkout users) and 43.9% (Staffed checkout users) said that they would use an app in the phone instead of their current way of shopping. Also, 27.5% (Scan and Go users), 23.3% (Self-checkout users) and 32.9% (Staffed checkout users) answered maybe on the same question. These numbers imply that the majority of customers have some kind of interest and desire to use an application for scanning instead of their current way of shopping. Lastly, this could also support the behavioral intention in the technology acceptance model, as phones are already accepted by users and are not seen as a new technology on its own. Users are already motivated to take their smartphone usage one step further by for instance using it for smart shopping. Furthermore, by asking people with different roles in the field of shopping e.g. managers in different areas and customers, we got a better insight from different perspectives which confirmed our initial thoughts that there is a bright future for a Smart Cart application, especially if designed and developed properly.

Moreover, although 45.1% of customers who use staffed checkouts said that it was more comfortable for them to not have to do everything themselves, 43.9% said that they would consider using a self-scanning app instead and 32.9% said maybe. In the same group of respondents, 56.1% answered that they do not believe that a staffed checkout is faster than self-services. This shows that even in the less likely group of customers, 49% still could consider using an app in order to avoid queues and 48.8% felt it would be comfortable to use their own phone, which is also supported by the behavioral intention in the technology acceptance model.

With the findings from several forms of research mentioned in this thesis, a prototype was created to visualise the users thoughts, needs and desires along with theory in HCI and other related and similar technologies. For instance, in the questionnaire, the respondents were able to give their own thoughts on what reasons or functions that would make them use a Smart Cart app (some options were predefined, but they could also add their own). Here, the main reasons and functions chosen were: comfortable using their own phone, avoid membership cards, avoid checkouts, avoid Scan and Go devices and avoid queues. These answers can all be seen as helpful and a way to ease customers' shopping experience when using self-services. The technology acceptance model can be applied here as well, to convey that perceived ease of use along with

perceived usefulness plays a big part in the acceptance and adoption of a new system, as every reason mentioned by the participants is perceived as helpful and useful. In the prototype, these are all factors that we have taken into consideration by for instance implementing membership through bank ID and by letting the user avoid queues at checkout registers through the payment methods (Swish, Card payment) in the application.

The prototype has also been created to visualise how an application of our purpose could be designed and developed. The idea is to use the prototype to develop the future app. Our approach has taken all previous sections into consideration when designing the prototype and also by keeping in mind the discussed theories and principles. The design decisions for the UI have been taken based on the research made on HCI along with the questionnaire and interviews conducted. For instance, the color scheme and layout was chosen based on Nielsen's principle to provide a minimalistic and aesthetic design. All colors have been chosen to blend well together and the analogous colors create a good structure. To keep focus on relevant information, certain objects and text have been highlighted with a lighter/darker colour whereas others have been blurred out in the background as something else demands more attention. Based on visibility of status, every page has a headline for easy navigation and the user is always informed about the current page. Nielsen also set the principle of using familiar words which we feel is very important since the idea of a self-scanning app is relatively new and should not scare away users due to fear of new technology and/or technical phrases.

Some of our decisions were based on Norman's principles as well. One main principle is visibility and we made sure that the user is always presented with every possible function in a clear way without having to doubt what options they have and what they can do in the app. The navigation bar at the bottom in the prototype is a good example of this as the user has the possibility to always navigate back and forth between the functions no matter what page they are at. The interface is consistent and has a high affordance, which are also two of Norman's principles. In terms of consistency, all the same elements are used for the same tasks. Back buttons are placed in the same place on the pages and always bring the users back to a previous page. A red cross is always used to delete something, the three dot action-button is always used to open options/sub-menu, and when a scrollbar appears, the user is always able to scroll in the page. This is actually also one way of bringing in Nielsens principle about using something familiar as well, since most smartphone users can recognize the elements we have used and what they are used for. Looking at Norman's principle of affordance, we tried to make elements that are easy to understand and know what they are used for as well as guiding the user. A few examples are the use of lists, add-buttons (with a + symbol), arrows pointing forward to show content and a small bar with arrows pointing up which shows the user that they can swipe up from the screen to display other content.

A lot of decisions were based on the answers in the questionnaire as well, such as what information to have and not to have. For instance, the login function that is intended to connect the user to the store membership, was made based on the questionnaire. In addition, the decision on making it optionable on showing information about items was also made based on the questionnaire as there was not a convincing opinion whether or not the users wanted this function. In addition we had an idea about a function where the user can get suggestions on similar items to those they have scanned. The answers varied from 34-50% (based on their preferred way of shopping) saying they did not want this function. This also supports the fact that user research is important and although a developer or designer might think a function is a

useful and great idea, users might think otherwise. In our application, we have focused on the functions that were supported by a majority of the users.

Moreover, the questionnaire made it clear that easy payment options such as Swish are very desired, as it was mentioned by many respondents in the open questions in the questionnaire. It can even be considered a deciding factor on whether people will use a Smart Cart app or not. This function was also supported by the interviews conducted as the product area manager for ICA mentioned that they implemented a payment solution in their app, but the customers still had to go to a register to actually complete the payment, which was not appreciated by them. It would have been better for the customers to avoid the need of going to a register at all, which is why we decided to include smooth payment options directly in the phone. Also, a shopping list is included in the design as 71.7-84.9% of the respondents of the questionnaire voted for such a function. A few of those also wanted it to be shareable, however, this function is not a part of the prototype yet but is part of the future work. From the interviews with several different participants within the grocery shopping field, we learned that an application as a whole could be an economical advantage for grocery stores. However, from the interview with the product area manager for a similar project at ICA we also learned that user research is an essential factor for such an app to succeed even though it is economically cheaper. This has been taken into consideration when creating the prototype and we have put a lot of effort into the design decisions as a result of it.

6. Discussion

The overall findings were consistent and expected from the existing literature. However, the importance of the design process and user research in the findings was not expected to be so essential. We have seen that the idea of a shopping app is very relevant, hence the amount of related work. On the other hand, the systems that already exist might not have been able to reach their full potential, as they are not as widely-used as they could have been bearing in mind that IoT is growing so fast (by 10% a year [45]) and is used by many. Through the research that we have made, we are convinced that one of the reasons for this is the lack of understanding user needs which is a consequence of insufficient user research from a HCI point of view. As one of the goals of this thesis was to answer how design of a Smart Cart app should look to the eye, in order to satisfy and attract customers, as well as fulfilling their needs and having a high level of usability; we have answered the previously mentioned research questions below.

What should developers and designers consider when developing these kinds of applications?
When developing and designing such applications as a Smart Cart app, it is important to consider how to enhance and streamline the shopping experience. In this project, one of the approaches to achieve this is a fast checkout method with bank payment and Swish in the application design, which was implemented in order to offer smooth checkouts. This was done due to the fact that so many of the respondents in the questionnaire highlighted the importance of easy payment methods. In addition, an easy login process with BankID that connects to the store membership, as well as getting the receipt in the device are both functions that are implemented for enhancing and streamlining the shopping experience. Both of these ideas were considered due to the questionnaire and interviews conducted. The fact that the user can avoid using a scanner and can use their own phone instead is also a way of enhancing the shopping experience as a whole. Generally, the enhancement and streamlining is done by making the shopping experience more of a walk in, walk out activity in a similar way to how Amazon Go stores and their technologies operate. Moreover, the customer should do as little as possible, but through different technologies such as those mentioned in section 2.3, their task should still be possible to perform effortlessly and efficiently.

How can HCI be applied to enhance the user experience?
From the research made on HCI in section 2.1, it became clear that focusing on the overall design but also the individual elements when developing these kinds of applications is essential in order to make the application desirable for the user. For instance, the importance of reusing elements and colours if they imply the same thing. In other words the developers and designers should be consistent throughout the design process. In addition, the overall design should provide all necessary functions in a clear and comprehensive way but still manage to be aesthetically pleasing and minimalistic. This is done by incorporating theories and principles such as the design principles mentioned by Norman and Nielsen, as well as the other theories within HCI. Furthermore, it is important to consider the purpose of the application from a user's point of view by doing a lot of user research such as sending out questionnaires and conducting interviews. As the application is going to be used by the users, this step is vital for the application to be desirable. In the prototype design, this was done by reusing elements and colors, keeping a consistent design and providing all necessary functions. In addition, potential users got to decide whether to implement or remove

certain functions by answering what they preferred in the questionnaire. Also by considering the theories and principles in each iteration of the prototype design, we were able to improve and reconsider design decisions more efficiently.

How to understand the usability and acceptance of a Smart Cart app in Swedish supermarkets?
As mentioned, by using the technology acceptance model it is implied that a user is more likely to use a system if it is beneficial or helpful for their tasks in some way. This model is also useful for trying to predict a users intention and what attitudes they have towards the technology. The findings have shown us that a higher usability leads to a greater chance of acceptance, thus the usability of a system should be considered throughout the whole development and design process, which can be done through using UCD. As grocery shopping is a task that is performed by a variety of ages and genders, it is particularly important to focus on the usability of the Smart Cart app, as it is used by a widespread group of users which all have different technological knowledge and experience. In Sweden, implementations such as Bank ID and Swish are very widely used and already accepted by many users. These implementations are used in most shopping applications that are on the Swedish market today, including the most successful ones. By implementing functionality which is already accepted by the users, they are more likely to feel familiar with the applications, and accepting it. This is the part of the usability acceptance model that we have taken most use of when trying to understand and figure out the usability and acceptance of a Smart Cart app in Swedish supermarkets.

Nevertheless, this research does not imply that it is impossible for an application to reach success without user research, since there is always a possibility of other aspects for success such as innovation, general need or desire etc. In addition, a big factor of creating a successful application is the implementation of code itself. Since the code is the foundation of an application and a vital part in the actual development, it has to be written with good quality and structure. This is a limitation in our research as we have not looked into how the code should be written and how it can affect a Smart Cart application. In this thesis, it was assumed that the code was properly constructed and of high quality. The point that we have been trying to prove and contribute to is that by considering theories and principles in HCI, along with good user research, there is a higher possibility of creating applications which can be accepted and adopted easily by the users, by being helpful, usable and beneficial.

6.1 Future work

The intention is to use the prototype for the development of the application. The software is intended to be used in a physical smart cart with a built-in smart device along with sensors and cameras for image recognition and gps for navigation. This means that more research in other aspects is needed for further development of this application. Research is also needed to identify other important perspectives of a development process, such as focusing on the coding and the process involved when doing so. Moreover, some of the functions in the application have no solution yet, such as being able to share shopping lists with other users as well as having a help section. These functions are the ones that are prioritised for the future, but a part of the future work is also to consider other functions. We believe that by developing a high quality software, it can have usage in both phones and smart carts in the future of smart shopping.

7. Conclusion

As previously mentioned, the goal of this research is to provide an overview on how to create a better and faster shopping experience for customers in supermarkets. This is achieved by creating a prototype for an application with focus on usability, by using theories and principles from HCI as well as researching other related technologies within the field of IoT, specifically smart shopping. Based on both a qualitative and quantitative analysis of our study, which included a questionnaire, interviews and a literature review, it can be seen that most customers have similar needs and desires which can enhance and streamline their shopping experience. The results show the importance of user research and how different theories and principles in HCI are helpful in highlighting what decisions to make in terms of usability, design and functionality. Our research indicates that with the right user research along with appropriate functions and design, applications overall have a higher chance of success. In addition, it shows that even with a successful team of developers, the user perspective is always a key factor in the development as the intention of an application is to satisfy the end users. To conclude our thesis, we have decided to share a few points that might not always be considered, which we learned from our findings and results.

- Use already known functions and implementations for the application in order to enforce familiarity within users, such as: BankID, Swish, Kivra (app for electronic documents from authorities, and receipts from stores), Facebook login, Google login etc.
- Make sure users are included and asked about opinions on **specific** functions which the development team wants to implement, as users might not even desire such functions.
- As a developer it is easy to get caught up by implementing more and more new functions as time goes by. However, from our research we actually found that simplicity is desired rather than a large amount of functions. As systems get too complicated, they can lose users, especially those with less technological knowledge.
- Instead of focusing on new implementations, focus should be on updating, improving and simplifying existing technologies and functions. This might not always be obvious as developers might be focused on complex functions rather than usability and simplicity.

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APPENDIX

A. Questionnaire questions

1. Hur gammal är du?
   - Under 18
   - 18 - 25
   - 26 - 35
   - 36 - 45
   - 46 - 55
   - 55+

2. Vilken av dessa alternativ använder du mest?
   - Självscanning med handhållen scanner
   - Snabbkassa där du scannar varor själv direkt i kassan
   - Bemannad kassa

Om personen väljer "Självscanning med handhållen scanner" i fråga 2:

1. Hur ofta använder du självscanning på en skala från 1-5 där 1 är aldrig och 5 är alltid?

Aldrig 1 2 3 4 5 Alltid

2. Varför använder du självscanning? *
Lägg gärna till ett eget svar under "Övrigt"

- ❏ Det går snabbare
- ❏ Man ser priset/summan direkt
- ❏ Slipper köer
- ❏ Det är enklare
- ❏ Undvika social kontakt med personal
- ❏ För att nyttja specialrabatter som endast gäller kunder som självscannar
- ❏ Kan packa ner varor direkt i kassen/vagnen
- ❏ Other:_____

3. Tycker du att det sparar tid att använda handscanner? *

Ja
Nej
Vet inte

4. Upplever du att självscannern är klumpig och/eller stor? *

Ja
Nej
Vet inte

5. Skulle du vilja ändra på något för att förbättra din självscanningsupplevelse? Isåfall, vad?
_____
_____

6. Skulle du kunna tänka dig att självscanna genom en app i telefonen istället? *
Appen kommer ha inbyggd betalfunktion via Swish eller kortbetalning, du får kvittot direkt i mobilen (Som när man beställer något online, då behöver du inte använda dig av någon kassa alls)

Ja
Nej
Kanske

7. Beskriv gärna varför du svarade ja/nej/kanske på föregående fråga.
_____
_____

8. Finns det någon speciell funktion eller anledning som hade kunnat få dig att använda en app för självscanning? *
Lägg gärna till ett eget svar eller önskemål på "Övrigt"

- ❏ Bekvämt att använda sin egen telefon
- ❏ Se alla erbjudanden direkt i telefonen
- ❏ Slippa medlemskort
- ❏ Slippa kassa
- ❏ Slippa självscanner
- ❏ Slippa köer
- ❏ Other:_____

9. Tycker du att en självscanningsapp ska visa information om varorna du scannar? *
Exempelvis näringsinformation och innehåll

Ja
Nej
Vet inte

10. Skulle du vilja ha alternativ för att kunna skapa en egen shoppinglista i en självscanningsapp? *

Ja
Nej
Vet inte

11. Skulle du vilja ha förslag på liknande/passande varor till det du scannat i appen? *
Till exempel om du scannar chips får du förslag på dipp

Ja
Nej
Vet inte

12. Vad tror du skulle hindrat folk från att använda en app för självscanning?
_____
_____

13. Om du tidigare handlat online via telefonen, vilka sidor/appar har du använt dig av mest?
_____
_____

14. Föredrar du fler funktioner eller enklare användning när det gäller shopping appar/sidor? *

Fler funktioner

Enklare användning
Vet inte

15. Vad tror du det är som har gjort att en självscanningsapp inte används idag trots utvecklingen/användningen av appar?

_____
_____

16. Om du själv skulle ha skapat en sådan app, vilka funktioner skulle du vilja ha med/ansett som viktiga?

_____
_____

Om personen väljer "Snabbkassa där du scannar varor själv direkt i kassan" i fråga 2:

1. Hur ofta använder du snabbkassan på en skala från 1-5 där 1 är aldrig och 5 är alltid?*

Aldrig 1 2 3 4 5 Alltid

2. Varför använder du snabbkassan? *
Lägg gärna till ett eget svar under ''Övrigt''

- ❏ Det går snabbare
- ❏ Slipper köer
- ❏ Det är enklare
- ❏ Undvika social kontakt med personal
- ❏ Other:_____

3. Tycker du att det sparar tid att använda snabbkassan? *

Ja
Nej
Vet inte

4. Skulle du vilja ändra på något för att förbättra din upplevelse med snabbkassan? Isåfall, vad?

_____
_____

5. Skulle du kunna tänka dig att självscanna genom en app i telefonen istället? *
Appen kommer ha inbyggd betalfunktion via Swish eller kortbetalning, du får kvittot direkt i mobilen (Som när man beställer något online, då behöver du inte använda dig av någon kassa alls)

Ja
Nej
Kanske

6. Beskriv gärna varför du svarade ja/nej/kanske på föregående fråga.

_____
_____

7. Finns det någon speciell funktion eller anledning som hade kunnat få dig att använda en app för självscanning? *
Lägg gärna till ett eget svar eller önskemål på "Övrigt"

- ❏ Bekvämt att använda sin egen telefon
- ❏ Se alla erbjudanden direkt i telefonen
- ❏ Slippa medlemskort
- ❏ Slippa kassa
- ❏ Slippa självscanner
- ❏ Slippa köer
- ❏ Other:_____

8. Tycker du att en självscanningsapp ska visa information om varorna du scannar? *
Exempelvis näringsinformation och innehåll

Ja
Nej
Vet inte

9. Skulle du vilja ha alternativ för att kunna skapa en egen shoppinglista i en självscanningsapp? *

Ja
Nej
Vet inte

10. Skulle du vilja ha förslag på liknande/passande varor till det du scannat i appen? *
Till exempel om du scannar chips får du förslag på dipp

Ja
Nej
Vet inte

11. Vad tror du skulle hindrat folk från att använda en app för självscanning?
_____
_____

12. Om du tidigare handlat online via telefonen, vilka sidor/appar har du använt dig av mest?
_____
_____

13. Föredrar du fler funktioner eller enklare användning när det gäller shopping appar/sidor? *

Fler funktioner
Enklare användning
Vet inte

14. Vad tror du det är som har gjort att en självscanningsapp inte används idag trots utvecklingen/användningen av appar?
_____
_____

15. Om du själv skulle ha skapat en sådan app, vilka funktioner skulle du vilja ha med/ansett som viktiga?

_____
_____

Om personen väljer "Bemannad kassa" i fråga 2:

1. Hur ofta använder du den bemannade kassan på en skala från 1-5 där 1 är aldrig och 5 är alltid? *
Aldrig 1 2 3 4 5 Alltid

2. Varför använder du bemannade kassan? *
Lägg gärna till ett eget svar under "Övrigt"

- ❏ Det går snabbare
- ❏ Det är enklare
- ❏ Föredrar social kontakt med personal
- ❏ Bekvämare att inte behöva göra allt själv
- ❏ Other:_____

3. Tror du att det sparar tid att använda den bemannade kassan jämfört med självscanning/snabbkassa? *

Ja
Nej
Vet inte

4. Skulle du vilja ändra på något för att förbättra din upplevelse vid den bemannade? Isåfall, vad?
_____
_____

5. Skulle du kunna tänka dig att självscanna genom en app i telefonen istället? *
Appen kommer ha inbyggd betalfunktion via Swish eller kortbetalning, du får kvittot direkt i mobilen (Som när man beställer något online, då behöver du inte använda dig av någon kassa alls)

Ja
Nej
Kanske

6. Beskriv gärna varför du svarade ja/nej/kanske på föregående fråga.
_____
_____

7. Finns det någon speciell funktion eller anledning som hade kunnat få dig att använda en app för självscanning? *
Lägg gärna till ett eget svar eller önskemål på "Övrigt"

- ❏ Bekvämt att använda sin egen telefon
- ❏ Se alla erbjudanden direkt i telefonen
- ❏ Slippa medlemskort
- ❏ Slippa kassa
- ❏ Slippa självscanner

- ❑ Slippa köer
- ❑ Other:

8. Tycker du att en självscanningsapp ska visa information om varorna du scannar? *
Exempelvis näringsinformation och innehåll

Ja
Nej
Vet inte

9. Skulle du vilja ha alternativ för att kunna skapa en egen shoppinglista i en självscanningsapp? *

Ja
Nej
Vet inte

10. Skulle du vilja ha förslag på liknande/passande varor till det du scannat i appen? *
Till exempel om du scannar chips får du förslag på dipp

Ja
Nej
Vet inte

11. Vad tror du skulle hindrat folk från att använda en app för självscanning?
_____
_____

12. Om du tidigare handlat online via telefonen, vilka sidor/appar har du använt dig av mest?
_____
_____

13. Föredrar du fler funktioner eller enklare användning när det gäller shopping appar/sidor? *

Fler funktioner
Enklare användning
Vet inte

15. Vad tror du det är som har gjort att en självscanningsapp inte används idag trots utvecklingen/användningen av appar?
_____
_____

16. Om du själv skulle ha skapat en sådan app, vilka funktioner skulle du vilja ha med/ansett som viktigt:
_____
_____

B. Interview questions

Intervju med ICA Kassachef:
1. Hur mycket kostar ert självscanningssystem (hela med kassor & skannrar)
2. Hur mycket kostar underhållet per år?
3. Hur mycket kostar en självscanner separat?
4. Tycker ni att det är ett rimligt pris för en självscanner?
5. Ungefär hur länge brukar en scanner hålla?
6. Hur mycket kostar en själv checkout kassa?
7. Cirka hur många kunder har ni per dag för självscanning (antal el procent)
8. Hur många kunder har ni totalt per år ?
9. Hur många procent av dessa kunderna använder självscanning?
10. Hur många procent av era intäkter kommer från självscanning kunder?
11. Vilken målgrupp (ålder/kön) använder mest självscanning?
12. Hur mycket sparar ni jämfört med att bara ha vanliga kassor?, har det lönat sig att ha självscanning med scanner?
13. Hade ni kunnat tänka er att erbjuda en app med scanning och betalning direkt i telefonen istället för kassor och skannrar om det hade varit billigare alternativ för er som butik?
14. Vad hade fått er att investera i en sådan app?
15. Vad hindrar er från att göra det?
16. Vad bör man tänka på utifrån ditt perspektiv med erfarenhet av kassor, som utvecklare kanske inte har i åtanke?
17. Vilka hade varit den bästa målgruppen tror du?
19. Tror du att en app hade kunnat ta över de självscanners som finns idag

Intervju med Säljare av Självscanningssystem:
1. Vad heter du?
2. Vad är din roll på arbetsplatsen?
3. Vad kostar era självscannar som ni har levererat till exv coop?
4. Vad kostar 1st scanner ungefär?
5. Vad kostar hela systemet?
6. Vad är det för Underhållskostnader per år på ett sådant system?

Intervju med Area Product Manager:
1. Vad heter du?
2. Vad är ditt ansvarsområde på ica? Vad är din befattning?
3. Vad fick er att vilja testa en mobil app från hela början?
4. Varför fungera inte appen i praktiken?
5. Vad specifikt gjorde att ni la ner projektet?
6. Var det något specifikt som inte fungerade med appen alls? Eller funka den bra bara att den inte användes?
7. Tror du att lösningen skedde för tidigt? Hade det varit annorlunda idag?
8. Stötte användarna på specifika problem? I så fall vad
9. Funkar icas medlemskap med bankid?
10. Ifall ni skulle ha gjort det igen, vad hade ni velat ändra på?
11. Är en scanning app fortfarande aktuellt?
12. Tror du corona hade gjort att appen används mer?
13. Hade ni inte gjort några undersökningar eller något alls innan projektet? Typ med användare , user research etc?
14. Hur många kunder har ni totalt per år ?
15. Hur många procent av dessa kunderna använder självscanning?
16. Hur många procent av era intäkter kommer från självscanning kunder?
17. Hur mycket kostar en självscanner separat?