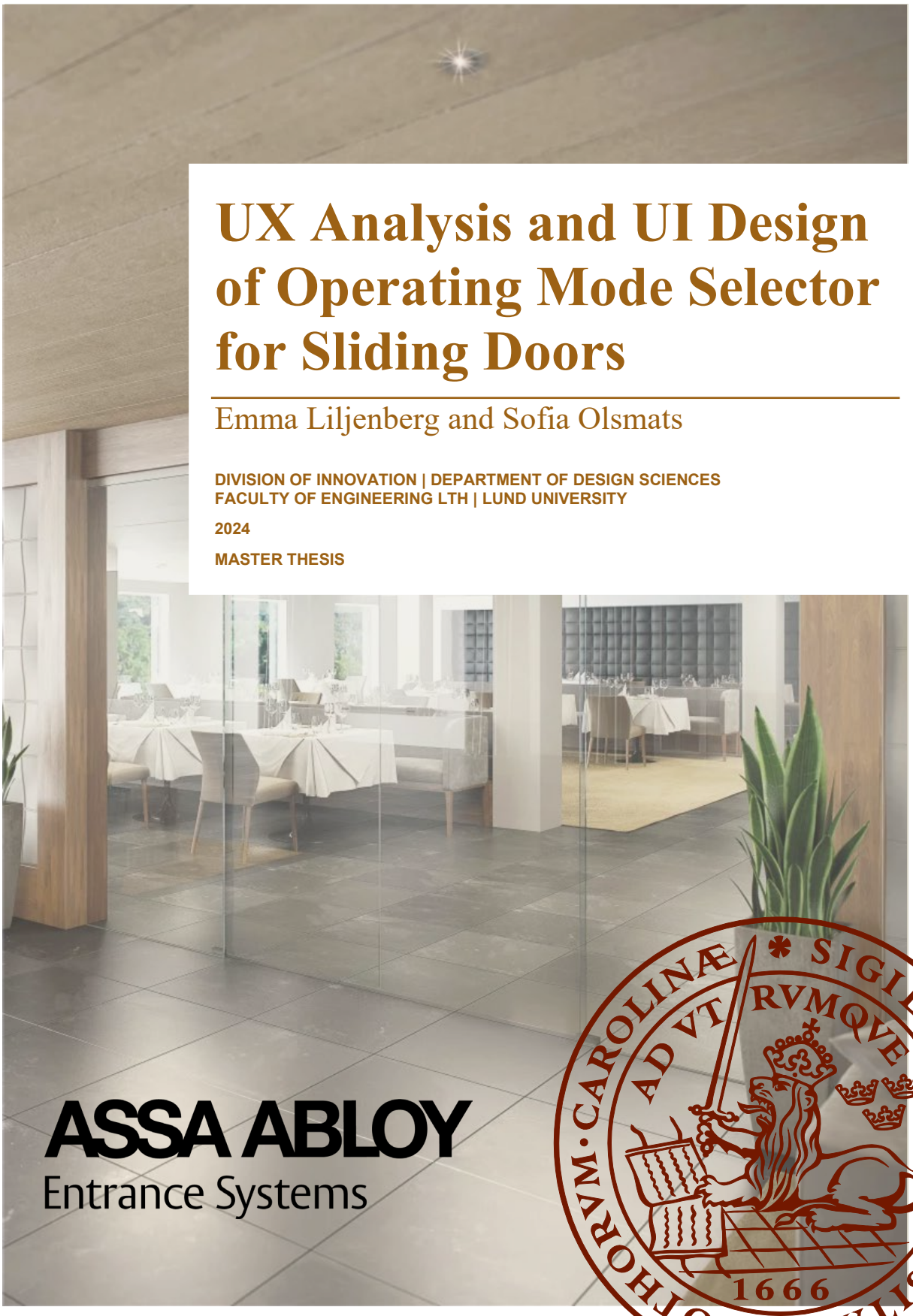

UX Analysis and UI Design of Operating Mode Selector for Sliding Doors

Emma Liljenberg and Sofia Olsmats

DIVISION OF INNOVATION | DEPARTMENT OF DESIGN SCIENCES
FACULTY OF ENGINEERING LTH | LUND UNIVERSITY

2024

MASTER THESIS

ASSA ABLOY
Entrance Systems

UX Analysis and UI Design of Operating Mode Selector for Sliding Doors

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Abstract

The innovation of automatic sliding door systems over the past decades has resulted in high-tech automatic sliding doors, where accessories and user interfaces have not been developed to the same extent. As a result, operating mode selectors for sliding doors has become outdated and difficult for users to operate. The purpose of this master's thesis was to propose a new design for operating mode selectors in collaboration with ASSA ABLOY Entrance Systems, based on the end-users and their needs.

To achieve this purpose, a thorough user experience analysis was conducted, primarily based on users in the retail segment. The user study included interviews and focus groups to define user needs through quantitative and qualitative analysis. Several concepts were developed, with two concepts being further refined through three iterations to ensure good usability. A final assessment was conducted by the users, where one concept was selected and refined.

The final result was a modern touchscreen with a graphical user interface where the door mode could be changed with a click or by swiping the screen. The innovative features of the concept included automatic switching to *Exit only* mode without user intervention, assistance during door malfunctions, and authentication for login by using a tag. Evaluations indicated that the solution was an improvement over current solutions, it was perceived as clear, it provided good feedback, and created a sense of security for the users.

Keywords: ASSA ABLOY Entrance Systems, user experience, usability, user interface, interaction design, sliding door

Sammanfattning

Innovationshöjden för automatiska skjutdörrssystem under de senaste årtionden har resulterat i högteknologiska automatiska skjutdörrar, där tillbehören och användargränssnitten inte har utvecklats i samma utsträckning. Det har lett till att programväljare för skjutdörrar blivit omoderna och svåranvända för användarna. Syftet med denna masteruppsats var att tillsammans med ASSA ABLOY Entrance Systems föreslå en ny design av programväljare baserad på slutanvändarna och deras behov.

För att uppnå syftet genomfördes en grundlig användarupplevelseanalys mestadels baserad på användare i återförsäljningssegmentet. Användarstudien innefattade bland annat intervjuer och fokusgrupper för att genom kvantitativ och kvalitativ analys definiera användarnas behov. Flera koncept togs fram, där två koncept vidareutvecklades i tre iterationer för att säkerställa att de hade bra användbarhet. En slutgiltig bedömning utfördes av användarna, där ett koncept valdes och förfinades.

Slutresultatet blev en modern pekskärm med ett grafiskt användargränssnitt där läget på dörren kunde bytas med ett klick eller genom att svepa fingret över skärmen. Konceptets nyskapande funktioner var att läget på dörren kunde bytas till *Exit only* automatiskt utan användarnas ingripande, hjälp vid dörrfel erbjöds, och att autentisering för inloggning skedde genom användning av tagg. Utvärderingar gav att lösningen var en förbättring från nuvarande lösningar, att den upplevdes tydlig, hade bra feedback och skapade trygghet hos användarna.

Nyckelord: ASSA ABLOY Entrance Systems, användbarupplevelse, användbarhet, användargränssnitt, interaktionsdesign, skjutdörr

Acknowledgments

This report is the result of a Master's Thesis in Mechanical Engineering with Industrial Design. The thesis has been conducted at the Division of Product Development at Lund University and in cooperation with ASSA ABLOY Entrance Systems.

We would like to extend our gratitude to our supervisor Anders Warell and co-supervisor Håkan Eftring for their design guidance and support throughout the project. We would also like to thank ASSA ABLOY Entrance Systems for the interesting project description and the warm welcome, especially from our local supervisors Louise Bannersten and Roger Dreyer.

Lastly, this project would not have been possible without the expertise and dedication from the employees at ASSA ABLOY Entrance Systems who were always keen to help. A special thank you to the retail employees around Lund who participated in interviews and testing which provided us with plenty of valuable feedback.

Lund, May 2024

Emma Liljenberg and Sofia Olsmats

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1 Introduction

ASSA ABLOY Entrance Systems, hereby referred to as ASSA ABLOY, is an international company providing entrance systems, such as automatic sliding doors, for various sectors. Today the product development process for automatic sliding doors and their corresponding door accessories has mainly been technology driven. To remain competitive in the market for sliding doors, ASSA ABLOY has identified a need to investigate the user experience of the door accessories. The current user interface portfolio consists of a variation of interfaces which have been developed according to technological feasibility. The goal of this master's thesis was to develop a design concept for a next generation operating mode selector (OMS) for sliding doors using design methodology from a user experience point of view.

1.1 Purpose

The purpose of this master's thesis was to gain user insights directly from the end users, conduct a user study and design a user interface (UI) from a user experience (UX) analysis. The aim was that the solution to some extent would be implemented in the future, therefore providing value both for ASSA ABLOY and for the users considered during the project. Design methods were used iteratively to create the next generation user interface for an OMS, the device that sets the door mode to *Auto*, *Closed*, etc., for sliding doors.

1.2 Limitations

The scope of the project was limited to conducting a UX analysis and UI design of the OMS interface; therefore, the technical functionalities of the concepts were not considered. The reason for this was time limitation, and prioritization of the UX design approach. To make the visual prototype feasible for manufacturing, other aspects need to be analyzed such as components, costs, and environmental sustainability. Further limitations are listed below.

The three largest customer sectors for ASSA ABLOY Entrance Systems are healthcare, transportation, and retail. Since behaviors with the door can vary depending on the sector, only one sector, the retail sector, was chosen to be the focus for the project. One of the reasons was because people who work in the retail sector were assumed to be more accessible during the user study than people who worked in healthcare or transportation. Specific users could not be identified and contacted with help from ASSA ABLOY since the project required end users and not only customers, which in this case are not equivalent to each other. For convenience reasons, the project was executed in Sweden with users who work in retail stores in Sweden.

The user study, analysis and concepts were developed with generic automatic sliding doors in mind, not any specific model of door. The extent and format of the user study was limited by the availability of the user.

2 Background

In this chapter a background of the subject and the thesis is presented. It includes a presentation of sliding doors and current solutions for mode selection. Also, the user is defined.

2.1 Sliding doors

One of ASSA ABLOY entrance systems products are sliding doors, which are automated doors used in entrances, passages and for rooms. The doors are equipped with sensors, making them able to open and close in synchronization with people passing through them. The doors can open from one direction or two directions. There are two main types of sliding doors:

- *Automatic sliding doors*
  Sliding doors with one blade moving in each direction. Could open from one side or from both directions, see Figure 1. In the remainder of the report, this was the type of sliding door that was referred to.
- *Telescopic frame automatic sliding doors*
  Sliding doors opening with two blades moving in each direction. Could open from one side or from both directions, see Figure 2.

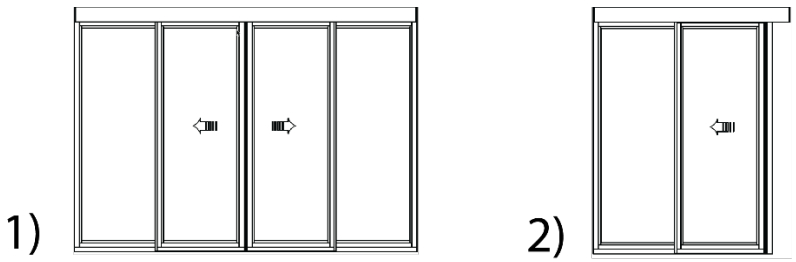

Figure 1: Drawing of automatic sliding doors. 1) Opens from both directions. 2) Opens from one direction.

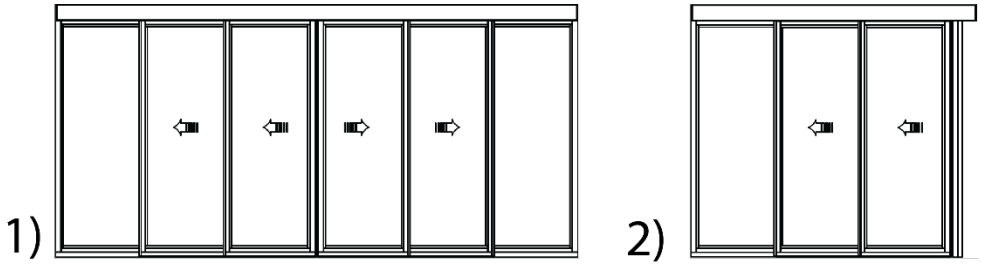

Figure 2: Drawing of telescopic sliding doors. 1) Opens from both directions. 2) Opens from one direction.

2.2 Operating Mode Selector

Sliding doors can be set to different operating modes. To control the operating modes, all sliding doors are equipped with an operating mode selector. The OMS is the interface which the user interacts with to select the state of the door.

ASSA ABLOY provides two different solutions today: one with a key and one with buttons activated by touch. Both solutions contain the same operating modes:

1. *Hold open:* The doors stay full open, allowing people to walk in and out.
2. *Auto partial:* The doors automatically open and close when the movement sensors are activated from the inside and outside, with a smaller opening width.
3. *Auto:* The doors automatically open and close when the movement sensors are activated from the inside and outside.
4. *Exit only:* The doors automatically open from the inside when the movement sensor from the inside is activated.
5. *Off / Closed:* The doors are closed and locked.

ASSA ABLOY expressed a wish to implement the following options for operating modes in future solutions:

6. *Eco:* An environmentally sustainable door width option. Could be implemented for *Auto* and *Exit only*.
7. *Exit only partial:* The doors automatically open from the inside when the movement sensor from the inside is activated, with a smaller opening width.

2.2.1 **Manual key solution**

This is a mechanical interface installed on the wall next to the sliding doors. The OMS has six different modes explained with symbols using arrows and lines, (see

Figure 3), which controls the operating mode for the sliding doors. A key must be inserted in the keyhole to allow changing of the operating mode. The direction of the key indicates the current mode. When the key is pointing towards R and a small object, such as a paperclip, is pushed in the hole, the OMS resets.

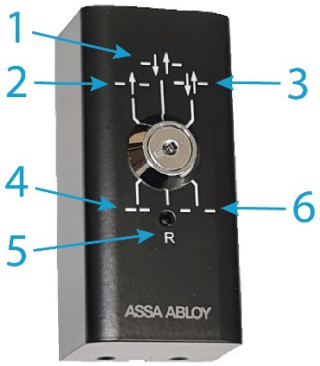

Figure 3: Program selector, manual key. 1= *Auto*, 2=*Exit only*, 3=*Auto partial*, 4=*Closed*, 5=*Reset*, 6=*Hold open.*

2.2.2 **Touch activated button solution**

This is a physical product installed on the wall next to the sliding doors. The OMS has five different modes explained with both symbols and text (see Figure 4), which controls the operating mode for the sliding doors. There is a touch interface which activates the mode associated with the symbol that is pressed. When pressed, the button lights up in blue and provides visual feedback. The users can authenticate themselves using a physical key or by typing in a code directly on the buttons (each mode is given a number, hence numbers used for the code).

In the bottom of the OMS, there is a small hole with a button that can be pushed by a small object, such as a paperclip, to reset the sliding doors.

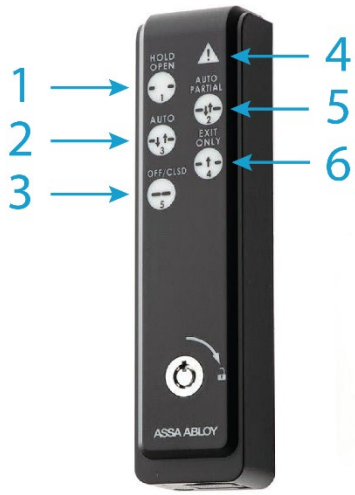

Figure 4: OMS with touch. 1= *Hold open*, 2= *Auto*, 3= *Closed*, 4=Warning triangle, 5=*Auto partial*, 6=*Exit only*.

Besides the different modes, there is a triangle with an exclamation mark that lights up if there is an error in the door system. Depending on the color of the triangle, different actions are required from the user.

- Red – Indicates an error in the operator. The *Reset* button can be pushed. If the error remains a service technician is needed.
- Yellow - A yellow light flashing indicates that maintenance is needed.
- Magenta – A magenta light flashing indicates a status or condition that can only be solved by the owner.
- Green - A green light will flash whenever a button is pressed while typing the passcode. When the correct passcode is entered, the green light is continuously lit. Also, a green light will flash four times per second when a new operation mode has been selected but not yet confirmed.

2.3 Users

Multiple people use sliding doors regularly, but few interact with the OMS. The users in this project were people who interacts with an OMS as part of their job. The defined target group was the Swedish retail segment. For this reason, the users considered in this thesis was employees and managers of physical retail stores (the primary users), but also service technicians from ASSA ABLOY who installs and perform service of the products (the secondary users).

The customers of sliding doors are usually people who own or manage the building. In this case, the customer was therefore not the same as the user. During this thesis, only the users defined above will be considered when mentioning the user.

3 Method

The methods which have been applied in the thesis are presented in this chapter.

3.1 User experience design

User experience design is a design process where the interaction between the product and the user is the primary focus. UX design involves designing enjoyable and efficient products or services that align with the users' needs in their realistic context. The user experience is defined as "A person's perceptions and responses that results from the use or anticipated use of a product, system or service" (Interaction Design Foundation, 2016).

3.2 Double diamond process

The double diamond process (Design Council, 2024) is a framework and visual representation of a divergent and convergent thinking design process, see Figure 5. It is a widely used process in the design community and includes a large variety of design and product development methods. The double diamond can be divided into four separate phases, each one with a different purpose. These are explained below.

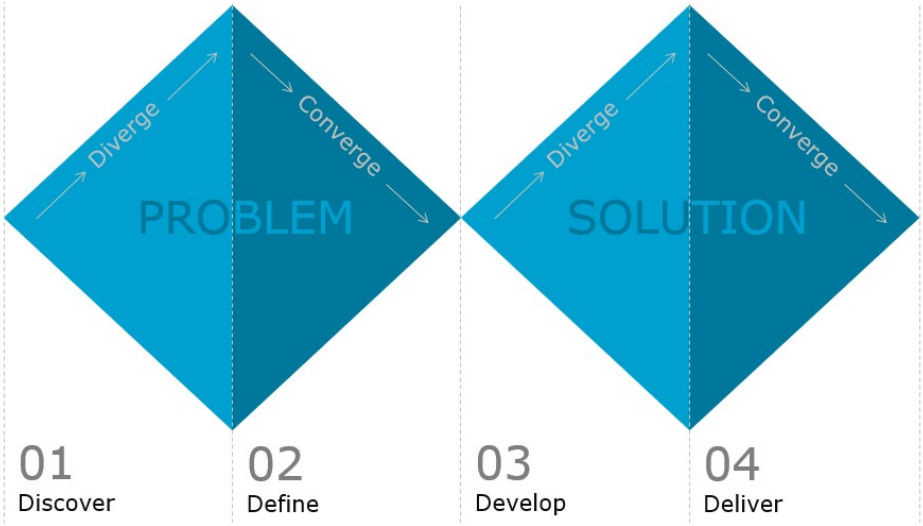

Figure 5: Illustration of the double diamond process.

- *Discover*

The discover phase is a divergent thinking phase, represented by the first half of the first diamond. In this phase insights regarding the problem are gathered with the aim to receive sufficient information to be able to understand the user.

- *Define*

The purpose of the define phase is to use convergent thinking and the gathered insights from the discover phase to the define the challenge in a narrowed format.

- *Develop*

The first half of the second diamond is yet again a divergent thinking phase called develop. This phase consists of ideating different solutions for the problem.

- *Deliver*

The deliver phase aims to find one final solution and improve it. It is the last stage, and convergent thinking is applied.

Double diamond was used as a structure for the whole thesis. Since the thesis included a user study which was then the foundation of a product development process, the two parts of the double diamond was applicable. The first part, discover and define was applied for the user study and for defining the user needs. The other diamond, develop and deliver included ideation of concepts, prototyping and finally refining a final solution.

3.3 Ethical user research

It is important to consider ethics while conducting any research including human participants. Since the thesis included user research and tests, the principles of ethical user research were applied to ensure that all data gathered from the participants have been conducted under ethical conditions. A set of principles which was applied in user studies are defined to ensure ethical research (Hvas Mortensen, 2020). The principles are listed as follows:

- *Be honest.*

  Present the purpose for the research, who the stakeholders are and how the results will be used. A complete and honest description allows the users to decide for themselves however they want to participate or not and can often ensure that they will not encounter any surprises during the project and withdraw their consent.

- *Be sensitive.*

  Consider the users experience during the sessions. They should feel comfortable and be assured that they are not doing anything wrong. If any particularly sensitive or private information arises the researcher should ensure that only a small number of people participate and observe.

- *Represent your participants accurately.*

  Present an honest overview of who the participants are, what they have said and consider how their comments can be perceived out of context. It should be clear what the findings are based on through traceability and subjective arguments. It is also important to monitor and observe the participants without influencing them.

- *Obtain consent and permission.*

  Consent must be clearly obtained from the participants, either verbally or in writing. This should be done before starting the session. The participant should be informed that their consent can be withdrawn at any time without providing a reason.

- *Do no harm.*

  The research should not harm the participants in any way. The risks for the participants can never outweigh the benefits they get from the results. This involves not pressuring the participants and acquiring additional confirmation from them if the consequences of using the data is uncertain.

- *Make sure participants data is secure.*

It is important to follow through with protecting the participants anonymity, both while collecting and presenting the research. All sensitive information that does not contribute to the research should be removed, and the remaining information should be either masked, pseudonymized or generalized (Devane, 2022).

- *Do not waste your participants' time.*

The participants time must be respected, and they should be able to decide when and for how long they wish to participate. How long the individual sessions last depend on who the participant is, their schedule, the purpose of the session and if they are being compensated for it.

3.4 Identifying customer needs

Part of the thesis was to define user needs. One method which can be used is "Identifying customer needs" (Ulrich & Eppinger, 2016). It is a substantial method and is appropriate when dealing with a large amount of user data. Since an extensive user research was performed, the method was considered relevant for identifying user needs.

The identification of customer needs is divided into five steps:

1. *Gather raw data from customers.*
   This can be for example be done through interviews, focus groups and observations of the user.

2. *Interpret the raw data in terms of customer needs.*
   To interpret the data into customer needs as efficient as possible, there are a few rules to follow:
   a. *Express the need in terms of what the product has to do, not in terms of how it might do it.*
   b. *Express the needs as specifically as the raw data.*
   c. *Use positive, not negative phrasing.*
   d. *Express the need as an attribute of the product.*
   e. *Avoid the words must and should.*

   If there are customer statements from several user groups, it is recommended to distinguish between the needs from the different user groups.

3. *Organize the needs into a hierarchy of primary, secondary, and (if necessary) tertiary needs.*

Since the needs statement could be a large amount of data that is difficult to summarize, step three is to organize those needs into hierarchies. The list will consist of primary needs, which will be further characterized by secondary needs. If necessary, the secondary needs can be broken down into tertiary needs. The procedure should be performed as follows:

   a. *Print or write each needs statement on a separate card or self-stick note.*
   b. *Eliminate redundant statements.*
   c. *Group the cards according to the similarity of the needs they express.*
   d. *For each group, choose a label.*

4. *Establish the relative importance of the needs.*
   The next step is to decide the relative importance of the needs. It could either be done by the team, or through a survey filled in by the customer where they are asked to rank the different needs. The outcome is a numerical weighteing of the needs due to their importance. All needs must not be marked as important. If a need is not yet widely recognized, but not yet fulfilled by existing products it is a latent need. Fulfilling latent needs can result in greater customer satisfaction.

5. *Reflect on the results and the process.*
   The last step is to reflect upon the result and verify that it is valid compared to insights from the user study.

3.5 Prototyping

When working with new product ideas, there are a variation of techniques on how to prototype the concept. In this thesis, prototypes were developed and tested. For this reason, various methods for prototyping was applied.

Two ways of prototyping is through works like or looks like protypes (Lukman, 2022).

- *Works like prototype*

A works like prototype should demonstrate the workflow and how the product would work in reality. It should enable testing the interaction and flow of the product.

- *Looks like prototype*

A looks like prototype should give a physical and visual representation of how the product would look like according to size, shape and visuals. The prototype does not need to function.

The techniques that are used when prototyping depends on the purpose for building the prototype. The techniques vary in levels of complexity and are therefore divided into two different categories: low- and high-fidelity prototyping (Sharp, Rogers, & Preece, 2019).

- *Low-fidelity prototyping*

A low-fidelity prototype does not have to look or work the same way as the final product. The purpose of the prototype is instead to build the idea in a quick, simple, and cheap way. Low-fidelity prototyping is a useful first step to quickly visualize and modify a concept. Examples for techniques used in low-fidelity prototyping are listed below.

  - *Sketching:* Can be done in 2D using pen and paper or in 3D using materials such as cardboard or foam.
  - *Storyboarding*: A combination of sketches put together in a specific sequence describing a possible user scenario.
  - *Wizard of Oz:* A user testing method for software prototypes. The user interacts with the prototype as they would with the final product or solution, while the responses from the software are simulated by a human operator.

- *High-fidelity prototyping*

A high-fidelity prototype resembles the final product more than a low-fidelity prototype both visually and functionally, for instance by involving more technical components both in terms of hardware and software. This enables the prototype to be tested in a more realistic context which provides valuable feedback from the users.

4 Theory

In this chapter, the theory which the thesis builds upon is presented.

4.1 Product requirements

All door solutions provided by ASSA ABLOY are certified and must comply to ISO standards. The standards which affect the OMS as a product were considered in the product development process, while some standards which only affect other parts of the sliding door system was not included in this thesis.

According to safety personnel from ASSA ABLOY, the relevant information regarding the OMS from the ISO standards were the following:

SS-EN 16005:2024 (Svenska institutet för standarder, 2024)

- *4.7.2 Additional requirements for doorsets in escape routes and emergency exits, 4.7.2.1 Mode selection*
  When an operating mode selector is used, the off operation shall be clearly identified and marked on the OMS. If a "locked" mode of operation is available, accessing the mode operation shall be protected, e.g. by an access code or a key, so that changes can only be made by authorized personnel.

- *4.5.3 Remote activation*
  Remote activation enables a doorset to be activated by a remote command that may be initiated some distance from the doorset. The remote command may be given by e.g. an evacuation alarm, a centralized control station following mains power failure or other sources. Remote activation for doorsets in escape routes or emergency exists should only initiate opening of the doorset or keeping the doorset in an open position.

IEC 60335-1:2012 (Svenska institutet för standarder, 2012)

- *U.1.1 Definitions relating to remote functionality*
  - *U.1.1.1 Authentication*
    Provision for confirming that the entity sending or receiving a message is what, or who, it claims to be.

- *U.1.1.2 Authorization*
  Means to ensure that the authenticated entity requesting access to information, functions or services has the required authority.

4.2 The seven design principles

Don Normans design principles (Norman, 2013) is a set of guidelines meant to be used in design to create efficient products. It is a tool describing different aspects to designing for user interactions and how these aspects affect the user. Norman defines the seven fundamental principles of design as followed:

1. *Discoverability*

   The user can determine what actions are possible to perform as well as the current state of the product or service.

2. *Feedback*

   The user is presented with full and continuous information during and after an action is performed. If the current state changes, the user can easily determine what it is.

3. *Conceptual model*

   The users carry a mental model of how a task should be done which helps create a conceptual model for the product or service. The mental and conceptual model does not have to be identical, but similarities help the user relate to familiar processes. A good conceptual model enhances both discoverability and evaluation of results while also helping the user understand and feel in control of his or her actions.

4. *Affordance*

   The user is provided with information regarding how he or she should interact with the device. Proper design encourages the user to perform desired action.

5. *Signifiers*

   The user understands where the desired action should take place from proper visual clues. Effective use of signifiers ensures both discoverability and good understanding and communication of feedback.

6. *Mappings*

   The user understands and follows the relationship between controls and their actions through placement and size hierarchy.

7. *Constraints*

The user is guided into actions by preventions in the design such as physical, logical, semantic, and cultural constraints. These also help the user interpret how to use the product or service and process the information correctly.

4.3 Usability

Usability can often be described as an umbrella term for five different usability attributes: learnability, efficiency, memorability, errors, and satisfaction (Nielsen, 1994). Utilizing these principles whilst developing a user interface and performing user tests can help to measure the prototypes usability, and therefore enhance the users experience whilst interacting with it.

- *Learnability*

The system should be easy to learn on the first try.

- *Efficiency*

Maneuvering the system should be efficient, easy, and quick once the user has learned how to use it.

- *Memorability*

A user returning from some time away should remember how to use the system without learning everything from scratch again.

- *Errors*

The system should minimize the number of errors occurring, their gravity and enable easy and quick recovery if one does occur.

- *Satisfaction*

The system should be pleasant to use, endorsing likability of the product or service.

4.3.1 **Thinking aloud**

Thinking aloud is a usability engineering method used for user testing where the user is asked to verbalize their thoughts (Nielsen, 1994). This enables the test moderator to understand how the user interprets and wants to interact with the product or service. A few advantages to using the method are quick feedback of individual elements to the solution, and the varied collection of qualitative data from a relatively small number of users. A consequence when using the method is that users might form wrong theories regarding how the prototype works, and these comments must be analyzed objectively.

4.4 The gestalt principles

According to psychologists the human mind perceives disconnected edges, lines and areas as whole shapes, figures, and objects (Johnson, 2021). This grain of psychology is called gestalt psychology and originates from German psychologists in the 1930s and 1940s (Soegaard, 2015). In this project the gestalt principles of visual perception that will be utilized are proximity, similarity, continuity, symmetry, and figure/ground.

- *Proximity*

The placement of objects affects how they are grouped together, for example by placing objects in lines forming separate rows or columns, or by using white space to separate one cluster from another.

- *Similarity*

In a cluster of objects, similar ones appear to be grouped. Examples of this principle are distinguishing bold, italic and regular text from each other, or connecting objects by illustrating them with the same, or similar looking, symbols.

- *Continuity*

When a shape or line is disconnected, the mind tends to fill in what is missing to perceive continuous shapes. In user interface design this can be exemplified by slider controls.

- *Symmetry*

The symmetry or simplicity principle explains how the mind perceives complex data in a way that simplifies its interpretation, for example by organizing information in tables.

- *Figure/ground*

The visual field can be structured to be perceived as the primary and secondary source of attention by differentiating the figure (the foreground) from the ground (the background). When shapes overlap each other, the smaller one is often perceived to be in front of the larger one. While designing user interfaces the principle is exemplified by using a non-ostentatious background to direct the users' attention to what is important, or by pop-up windows.

5 Discover

The purpose of the discover phase (see Figure 6) was to gather enough raw data to be able to define the work to be done. The process focused on understanding the user, the users' needs and the underlying context. This was executed through a user study including both retail employees and service technicians. The user study with the retail employees was the most extensive since they were the primary users. The user study was also complemented with input from interviews with ASSA ABLOY employees, and a benchmarking.

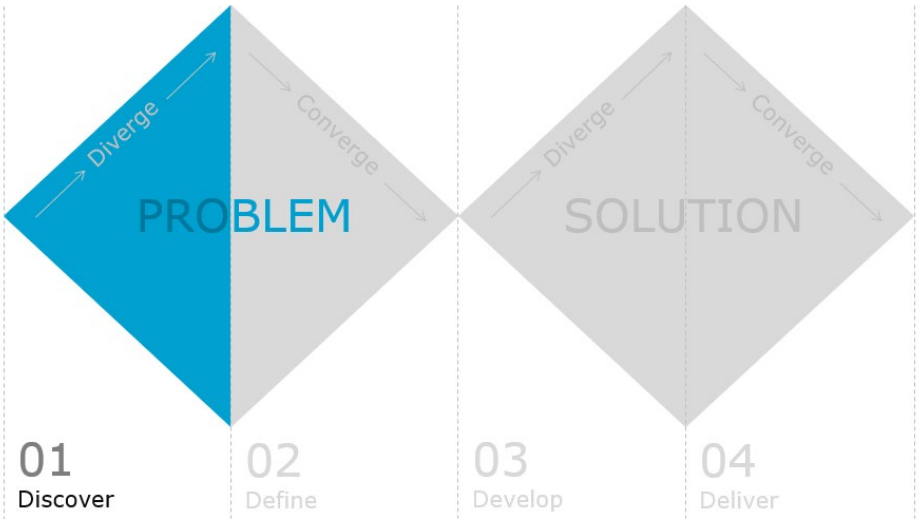

Figure 6: Double diamond illustration of the discover phase.

5.1 Quantitative and qualitative research

The definition of quantitative research is to produce consistent numerical data with high accuracy results. Qualitative research focuses more on gaining context and insights regarding user behaviors *(Unger & Chandler, 2024)*. The purpose of the research aligned mostly with the purpose of conducting qualitative research. Therefore, the main research methods were qualitative which resulted in many

relevant user insights. These insights were then confirmed using the measurable quantitative research.

It was important to find the user needs without limiting the width of insights from the user. It was also relevant to make sure that the data gathered was from the intended target group, and that the data could be properly analyzed.

5.2 User study

5.2.1 **Ethical considerations**

The ethical guidelines were considered throughout the entire user study. The users were clearly informed of the purpose of the research session, how the material would be used, who had access to it, and before starting they were asked to verbally express their consent to participate. The participants were also anonymous.

5.2.2 **Shorter interviews with retail employees**

To gain quantitative data from the users, 28 shorter interviews were conducted with users working in retail stores, see more details in Appendix B.1.1. Most of the interviews included one participant, however in some cases two people were interviewed together which created more discussions between the participants. The interviews were performed in Lund city and stores in Nova Lund with 20 female participants and 11 male participants. Their job descriptions and estimated age distributions are displayed in Appendix C. The purpose of the interviews was to get an overview of who the users were, when they use the product and how they use the product. The questions focused on how the user interacted with the OMS and how it affected them and their work. The interviews also enabled finding participants who would be interested in taking part in the focus groups.

5.2.3 **Focus groups with retail employees**

With the purpose of gaining a more profound understanding of the users and when or how the product is used, focus groups were formed (Wikberg Nilsson, Ericson, & Törlind, 2015). This method enabled the participants to add to each other's statements and discuss the questions together. The questions asked during the focus groups and the longer interview were more open-ended than the initial interviews, see details in Appendix B.1.2. They concerned the habits, pains and gains of the users. This ensured more qualitative material on the topic of entrances and how they

played into the users' routines. The gathered interview material included users from three groups: daily goods, pet accessories and a home improvement store.

5.2.4 **In depth interviews with service technicians**

In the second part of the user study the secondary users, service technicians were approached to gather input from a new perspective. From contacts within ASSA ABLOY two users were found that had a lot of practical experience in the field as well as knowledge regarding the maintenance and installation of both the door mechanism and the program selector. The interviews were conducted separately, one in person and one online, and questions were prepared to make the user reflect on previous, current, and future solutions. The users were well prepared and gave new insights into the product that had not yet been covered by the retail employees.

5.3 Input from ASSA ABLOY employees

To discover new elements for the product, employees from different parts of the organization were approached and interviewed. The aim of the interviews and meetings was to learn from their knowledge and understand how, and why, the product looks the way it does today. It resulted in product specifications. However, the specifications were considered more as recommendations to consider than strict requirements since the primary user and object of the thesis was the retail employee. See the recommendation from the ASSA ABLOY employees in Table 1.

Table 1:Product specifications from Assa Abloy.

Product specification
Eco should be implemented as an opening width, which was called upon later in the process.
The solution should have a modern appearance.
The solution should enable service technicians to perform good service.
The size should comply with standard sizes for current solutions.
The OMS must comply with ISO standards SS-EN 16005 and IEC 60335-1.

5.3.1 **Product owners**

The most valuable insights gained from the product owners were how the different mechanical and electrical components of the door cooperated with each other. They also demonstrated and explained what errors could occur, and how these errors present themselves for the service personnel to analyze and solve. In addition to

their engineering knowledge, the product owners were also able to respond to questions regarding the current and previous versions of the OMS.

5.3.2 **Test team**

ASSA ABLOYs' test workshop was where the doors and locking solutions were tested for errors, lifespan, and compatibility with new developments from the R&D department. The test team demonstrated how the OMS was connected to the sliding doors and how the OMS responded to door malfunctions. Observing how the equipment was tested provided further insights into the users' perspective and a more in-depth understanding of how the OMS and doors were connected.

5.3.3 **R&D for sliding doors**

The research and development department for sliding doors consisted of both software and hardware engineers. The main assistance received from the R&D department was guidance into data collection. Product manuals, contact information for employees in various parts of the organization, and previous OMS prototypes were provided.

5.3.4 **Market analysts**

Meetings with market analysts were conducted to gain knowledge into what direction the technological and design aspects of the sliding doors, and its respective door accessories, have been leading towards in the past. They also shared customer studies which analyzed the customers purchasing patterns and what product qualities the customers valued the most. The market analysts expressed a wish to develop a more modern looking OMS that could enhance their advanced technological solutions better.

5.3.5 **Sales department**

An interview with a sales representative, with more than 20 years of experience, was conducted. The questions focused on the sales experience, how a sale was done and the customer relationship. One of the insights were that they had to consider the distance between the door automation and the placement of the OMS when selling a package; if the distance was beyond 2m they could not sell the OMS with a touch sensor because of cabling difficulties. The reason that the customers chose ASSA ABLOY products instead of their competitors was assumed to be because of their high-quality products and great service agreements, which were highly profitable.

Another main takeaway was that the sales department prefers to sell only one solution, the touch OMS, because of personal convenience in their system. Although, the OMS with the key was sold more if they sensed authentication concerns. Selling the touch or the key OMS does not matter in terms of price since the selling price was equal.

5.4 Benchmarking

To gain an overview of the competitor's solution a benchmarking was made. A few of the biggest or most interesting competitor solutions in the same product category was selected for a short analysis, see Table 2 and
Table 3. The solutions were compared from experience, or by reading the competitors user manuals for their OMS that was found on their websites.

The mechanical solutions explicitly use symbols to communicate the modes (see Figure 7). The symbols are arrows, lines, locks, suns, snowflakes, and circles. Colors are used in the interface of the Tormax solution. The touch interfaces combine symbols with numbers and text (see Figure 8). The numbers are used for the passcode. Similar symbols as in the physical solutions are used, but with the addition of illustrations of the door in the different modes. *Exit only* sometimes comes with an option for a narrow opening width, *Exit only winter*. The text used in the different solutions is similar:

- *Closed / Off*
- *Open / Hold open*
- *Auto / Auto summer*
- *Partial / Auto winter*
- *Exit / Exit only / Exit summer / Exit winter*

Figure 7: OMS from: Doorson (Doorson, 2016), Record, Tormax (Tormax) and Assa Abloy with key.

Table 2: Benchmarking of physical OMS

Brand	**Doorson**	**Record**	**Tormax**	**ASSA ABLOY, key**
Interaction type	Knob	Buttons	Buttons	Key
Communication of modes	Symbols	Symbols	Symbols Color	Symbols
Interaction feedback	Tactile from twisting knob	Tactile from pushing button	Tactile from pushing button	Tactile from moving key
Current mode feedback	Visual from when marker algin with symbol	Visual from symbol on the screen	Visual from light displaying	Visual feedback from position of key
Error help	Warning indicator	N/A	N/A	Reset function
Authentication	N/A	N/A	N/A	Physical key

Figure 8: OMS from: FACE (FACE Automatic doors, 2024), Ditec (Ditec, u.d.), Doorson (Doorson, 2016) and Assa Abloy with touch.

Table 3: Benchmarking of touch OMS.

Brand	***FACE***	***Ditec***	***Doorson***	***ASSA ABLOY, touch***
Interaction type	Touch panel	Touch panel	Touch screen	Touch panel
Communication of modes	Symbols Numbers	Symbols Numbers Text	Symbols Text	Symbols Numbers Text
Interaction feedback	Visual, the symbol which is touched lights up	Visual, the symbol which is touched lights up	Visual, screen interface changes.	Visual, the symbol which is touched lights up
Current mode feedback	Symbol is light up	Indicated by blue light	Displayed large on the screen	Indicated by blue light
Error help	Information symbol flashes	Reset button in the bottom, the check symbol light up red	Error detection and description on screen, resest button	Warning triangle lights up
Authentication	Code or click on the logo	Code or key	Code	Code or key

6 Define

The purpose of the define phase (see Figure 9) was to use the gathered data from the discover phase to define the design challenge. A qualitative, quantitative and SWOT analysis were made. The analysis was also complemented with key take aways from the interviews with the ASSA ABLOY employees. The qualitative analysis led to a hierarchical list of user needs, the challenge defined in one sentence, and "How might we" expressions.

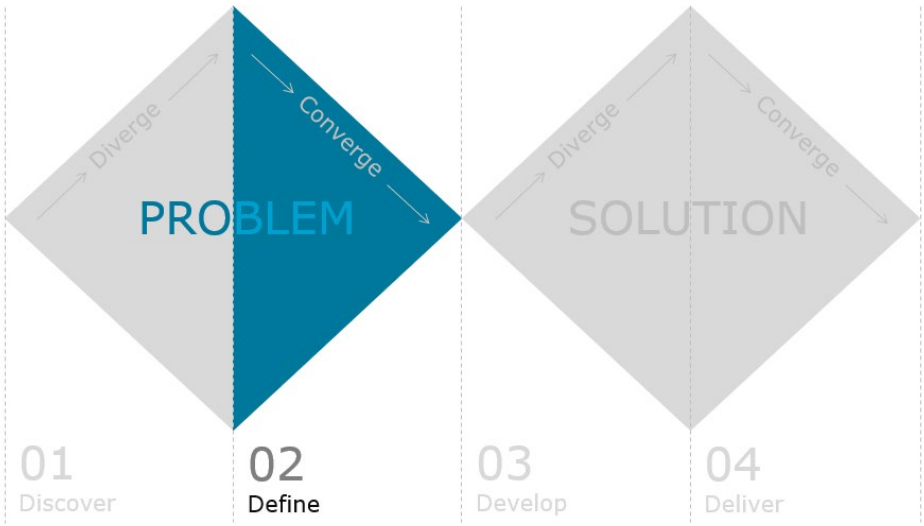

Figure 9: Double diamond illustration of the define phase.

6.1 Data analysis

The define phase started with collecting and analyzing data from the discover phase. To decide on what methods to use for the analysis, a short brainstorming of methods was conducted. It seemed relevant to conduct both quantitative and qualitative analyses. The quantitative analysis focused on finding patterns from a statistical point of view. The qualitative analysis provided insights regarding the user needs. The method chosen for the qualitative analysis was affinity diagramming.

6.1.1 **Quantitative analysis**

6.1.1.1 Retail employees

An excel-file was created with the responses from the interviews and focus groups, see Appendix B. The responses were systematically divided into different themes for two reasons: (1) to get an overview of how many mentioned a specific topic and what was said regarding the topic, and (2) to gather raw data regarding the type of OMS used, the type of retail store, the gender and age of the user etc.

Some of the key insights regarding the usage of the different modes can be seen in Figure 10, and were the following:

- The most common used modes were *Auto* and *Closed*. In the mornings, *Auto* was selected and used throughout the day. When closing the store, *Closed* was selected.
- *Exit only* was sometimes used before the store closed and helped the users during their closing routines. However, since the time before closing could be stressful, they did not always find the opportunity to go to the door and switch to *Exit only*.
- Only a few, 4/31 used *Auto partial*. Most people did not understand the difference between *Auto partial* and the regular *Auto*. Also, for a lot of doors *Auto partial* and *Auto* were installed with the same settings. Meaning, the users formed a mental model that *Auto* and *Auto partial* was the same function.
- A majority used the *Stay open* mode. The function was mostly used for carrying in or out goods, and avoided when the ventilation was on inside and if the users were scared about the risk of theft.

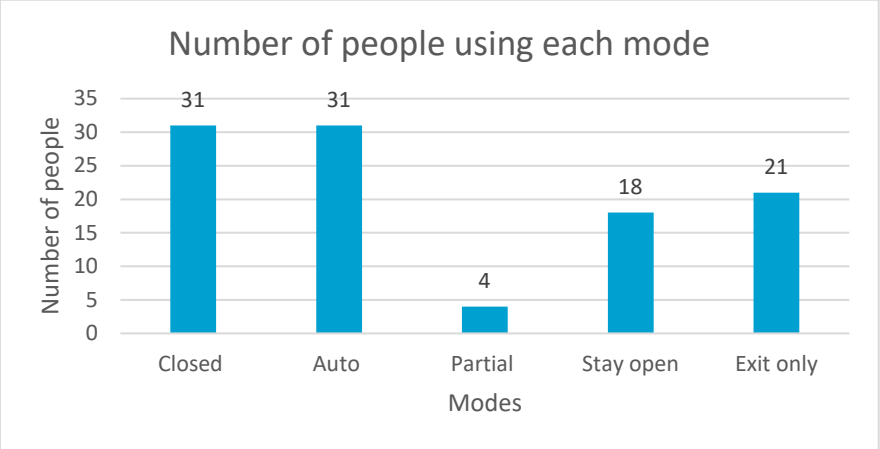

Figure 10: Number of people from the user study who used the different modes.

Observations not regarding the usage of modes, see Appendix C, were:

- In general, people barely noticed the doors and the mode selector. Their main goal when using the OMS was to open or close the store.
- They wanted a fast, easy interaction where their actions and consequences of their actions were clear.
- When opening and closing the doors, the users had to unlock/lock the mechanical locks on the doors in addition to changing the mode on the OMS. This was explained to be a Swedish standard.
- For the users using the key solution, many expressed that they thought the key was an unnecessary spare part that they could potentially loose. Causing a potential risk of not being able to open or close the store.
- Even though the door was not something they thought much about, their business was dependent on that the doors worked well. Whenever there was a door issue, it prohibited customers to enter the store leading to less business or a bad customer experience.
- Whenever a door issue appeared, it caused stress to the employees. Partly because it was hard to discover that there was an issue. Sometimes, customers had to notify the store employees. The other part was that they did not know what the issue was or how to fix it. Also, the issue needed to be solved quickly to enable people to get in and out of the store, leading to time pressure when solving the issue.
- 17 out of 31 experienced door issues when the doors either opened themselves, opened slowly, got affected by power outage or did not open for kids that were shorter than one meter.
- The manual was barely used, one out of 31 asked had ever used the manual.
- The participants in the user study were in general terms either (1) technically enthusiastic men, (2) older more inpatient women or men who were not prone to change or (3) younger females who were more cautious when interacting with the technical devices.
- The *Reset* button was used by very few, and it was tricky to use since they needed to find a paperclip to press it with. Instead, most people pulled out the power supply to the door whenever an issue appeared.
- Many users expressed a wish to be able to change the modes of the doors from the checkout counter. In case of theft they wanted to be able to close the doors from a distance. They also wanted to change the door operating mode to *Exit only* before closing from a distance.
- The risk of theft was mentioned the most from employees working in stores selling luxury brands or supermarkets.
- Who interacted with the OMS varied slightly between the different types of stores. In larger store chains, such as supermarkets, only a few people had access to the OMS. In smaller stores most employees were allowed to open and close the store.

6.1.1.2 Service technicians

From the interviews with the service technicians, some insights were collected:

- They wanted to be able to easily access and read error codes, both on site and from another location without having to open the beam above the doors.
- The OMS can be installed in the checkout counter if wires are drawn there. However, this would mean that the store would have to ask electricians to do this and then get it installed by ASSA ABLOY afterwards. This was expensive and not widely applied, however it was currently used for one retail franchise and at a few gas stations.
- They were instructed to install the OMS in clear line of sight to the door. This ensured that the door was maneuvered safely and that no one would be stuck in between the door blades while closing them.
- Service technicians wanted to be able to walk around the doors while changing the door operation mode to test the sensors.
- People often forgot to remove the key after changing the mode, even though they were not allowed to leave it in the OMS. If it was an emergency exit, only authorized personnel were allowed to change the door mode to *Closed*.
- The key authentication method seemed to be the simplest solution for the users since the code could be forgotten.
- They wanted users to be able to solve easier issues by themselves without having to call them. Examples of these issues were sensor issues or other errors when the only solution was to press *Reset*.
- When problems occurred that needed a service technician, they wanted to receive an instant notification with the error message to solve the issue as quick as possible.
- Service technicians did not usually install the *Auto partial* function. It required documents, and only if the customer asked for the specific installation and had the documentation prepared, they could install it.

6.1.2 **Qualitative analysis for retail employees**

All the questions and answers from the interviews and focus groups were collected and printed. It was a total of 74 pages of user statements. To get an overview and be able to work through the materials, a project room was provided. All the answers were taped up on the walls.

The first step was to find user statements which seemed interesting and could be used for a thematic analysis. The goal was to eventually find and define the user needs. To start the sorting process, statements that contained relevant information were marked with a highlighter throughout the room (see Figure 11). For some interviews, only one or a few statements were marked. Others contained more information, and a larger number of statements were marked.

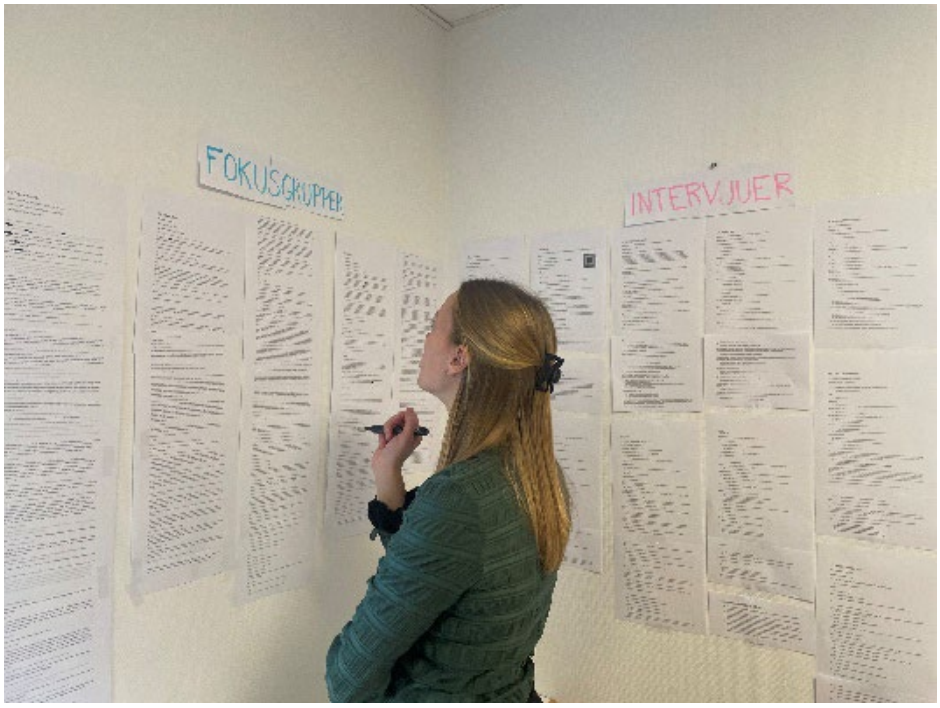

Figure 11: Marking customer statements.

When the interviews and focus groups had been reviewed, the marked statements were collected in a document. To maintain traceability to the user, all statements were marked with a number. For example, one user statement was "#2 It is cumbersome to take out the key, it can easily get lost". The number helped both to find correlations to the user and the statements, and to understand the context of the answer. Once all statements were collected in a document, they were printed, cut out and laid out on a table. It resulted in 170 statements from the interviews, and 264 statement from the focus groups.

6.1.2.1 Affinity diagramming

Since the mission was to understand the problem and the user rather than solving a predefined problem, affinity diagramming (Sharp, Rogers, & Preece, 2019) was chosen as the analysis method. Affinity diagramming is a thematic analysis where data is sorted into groups of statements which share similarities. From these groups, themes can emerge. It is an explorative method used to understand and make sense of large amounts of qualitative data. With those guidelines in mind, all the statements were sorted into groups of similar statements. The groups were marked with post-it notes with a headline that described the theme of the group, see the groups in Appendix D.

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6.1.3 **Qualitative analysis for service technicians**

The data from the interviews was gathered in two different ways; extensive notes were written down during the first interview, and the second one was transcribed by Microsoft Teams itself. This provided a good basis to start reading through them and identifying customer statements that contained relevant information regarding insights or usage of door and surrounding factors. The statements were highlighted digitally and subsequently printed out and taped to the wall. The names of the participants were anonymized.

The statements from the interviews were collected into a document and each statement was labeled with a hashtag to maintain their traceability, there was a total of 63 statements. The document was printed out and each statement was cut out separately to prepare for the thematic analysis.

6.1.3.1 Affinity diagramming

The clustering was done using the same method as with the retail statements, and the statements were sorted twice to ensure that the sorting was done currently (see Figure 12). Some of the themes shared similarities with the groups formed from the retail employees' statements, but it was important to define them separately from the service perspective as they were based on different motivations. The themes are described further in Appendix D.

Figure 12: Sorting customer statements.

6.2 User needs

After the affinity diagramming was done, 404 user statements had been sorted into themes. This data needed to be narrowed down without disregarding of its complexity, details, and information of the user. The chosen method was identifying customer needs which helped create an overview without limiting the range of needs.

6.2.1 **Translation to user needs**

From each cluster of user statements, one or a few user needs were interpreted with the help of the five rules for user needs translation. The needs defined represented the needs found in the statement for that cluster. The process was done independently for the retail employees and the service technicians, and the clusters were pasted to large papers to create an overview. To separate the user needs, different colors of post-its were used for needs for the retail employees and the service technicians.

6.2.2 **Hierarchical list of user needs**

Once all the user needs had been defined, they were collected in a document, printed out and cut separately to enable sorting. Since it was recommended to distinguish between the needs from different segments, the origin of the needs was marked out. The needs from the retail employees were labeled (R) and the needs from the service technicians were labeled (S).

When organizing the needs, their similarities and origin in terms of user and context was considered, and the clustering was done in iterations. The new labels of user needs were picked from the cluster or formulated separately. Once the correct groups had been formed, they were glued on papers with the label highlighted in pink.

The groups of needs were then grouped in a table and translated to English. Up to this point, it was important to keep the data in the original language to ensure the context would not be lost in translation. However, for the sake of the project they needed to be in English moving forward.

6.2.3 **Establish the relative importance of the needs**

The hierarchical list of user needs offered a summary of the user needs, but to make sense of which need was more important than another they were rated in relation to each other. This was essential since creating a solution that considers 76 separate needs without any trade-offs would be very challenging. The rating was performed within the team.

Since the needs from the retail employees originated from many different users, the number of users with statements below each need was counted. Some of the needs received a high number of statements from different users such as *inspire trust* and *low effort to use*. This number was not directly proportional to the importance of the need, but it was taken into consideration in combination with discussions within the team. Discussions was the only method used when rating the importance of the needs for the service technicians since the data only resulted from interviews with two users.

All needs were printed on a paper and the relative importance of the needs was highlighted using different colors. This was then translated into a list presented in Figure 13 where the number of *'s indicated its relative importance, with "***" marked as the most important needs. Latent needs were indicated by "!". Needs that did not receive a "*" or a "!" were still valued in the overall perspective but did not provide enough importance to be considered primarily.

* **(S) Enable service technicians to provide relevant value.**
(S) Enable problems requiring service technicians to reach them directly.
(S) Allow complex issues to be solved only by service technicians.
(S) Be economically justifiable

(R) Introduce something new.
! (S) Offer novelty value.

*** **(R) Prevent mistakes.**
(S) Be durable.
(R) Perceive as rigid.
** (S) Prevent serious consequences during use.
(R) Allow for mistakes.
(S) Adhere to laws effortlessly.
* (S) Make it easy to comply with laws and regulations.
* (S) Perform service without affecting current status.
! (R) Counteract theft.

(R) Offer assistance in problem-solving.
** (S) Guide users in troubleshooting.
! (S) Able to perform adjustments independently.
(R) Easy to reset.
(S) Offer quick problem detection.
** (R) Encourage users to solve simple problems.

*** **Easy to use**
(R) Enable quick use.
* (R) Invite usage.
(R) Low effort to use.
(S) Provide access to relevant documentation for installation
* (S) Offer easy installation.
*** (S) Make it easy to change modes.
** (R) Easy to use without experience.

** **(R) Ensure user limitation.**
(R) Be anonymous.
(R) Not attract attention.

(S) Easy to understand how to use.
* (R) Understandable without previous experience.
* (R) Contain few steps.
(S) Contribute to standardization.
*** (R) Clearly convey its functions.

*** (R) Structured logically.

*** **(S) Communicate what the door is doing in real-time.**
! (S) Provide a clear connection between interface and door.
(S) Enable status to be observed from different locations.
*** (R) Communicate current mode.
* (S) Clearly communicate status.

(R) Cooperate with other routines.
! (S) Enable adjustment of settings from the checkout.
(R) Adjustable.
(R) Facilitate during closing routine.
** (R) Feel safe to use.

*** **(R) Highlight problems and their causes.**
(R) Inform about problems.
(S) Provide information about past issues.
* (S) Save and display history.
(S) Able to identify errors automatically.
* (S) Show where the problem is.
(S) Clearly convey what the problem is.

*** **(R) Operate without supervision.**
(R) Enable quick entry.
* (R) Open and close as desired.
(R) Not disrupt the customer's experience.
*** (R) Inspire trust.
* (R) Reset in an unnoticeable manner.
(R) Prevent customers from entering outside of opening hours.
(R) Allow customers to exit but not enter.

*** **(R) Provide confirmation of completed action.**
** (S) Provide clear feedback during use.

** **(R) Easily accessible when needed.**
(R) Quickly accessible.
(R) Easy to find.
! (S) Enable the door to be adjusted both near and far from it.
* (S) Offer short startup during service.
! (S) Function without complements.

! (R) Contribute to a welcoming experience.
(R) Enable staff availability to customers.
(R) Enable staff to interact with customers.
(R) Contribute to a clean environment.

Figure 13: Hierarchical list of customer needs with importance rating. * are critically important needs and ! are latent needs.**

6.2.4 **Reflection on the results and the process**

As the last part of identifying customer needs, a reflection on the result and the process was made. A wide range and number of users in the specified target group were included in the user research, therefore sufficient data was deemed to be provided. Latent needs were found which could be used for creating an innovative solution. Also, some users were found which expressed interest in participating in further research.

From analyzing the data, the user could be further understood. Most of the needs were expected beforehand, however this needed to be confirmed from the users themselves. Some needs were more unexpected and provided new elements to the problem to be solved. To summarize the process, the most important and latent needs are listed in Table 4.

Table 4: The most important and latent user needs.

*Most important needs ****	*Latent needs !*
(R) Provide confirmation of completed action.	(R) Contribute to a welcoming experience.
(R) Operate without supervision.	(S) Function without complements.
(R) Highlight problems and their causes.	(S) Enable the door to be adjusted both near and far from it.
(R) Communicate current mode.	(S) Offer novelty value.
(S) Communicate what the door is doing in real-time.	(R) Counteract theft.
(R) Structured logically.	(S) Able to perform adjustments independently.
(R) Clearly convey its functions.	(S) Provide a clear connection between interface and door.
(S) Make it easy to change modes.	(S) Enable adjustment of settings from the checkout.
Easy to use	
(R) Prevent mistakes.	
(R) Inspire trust.	

6.3 Key takeaways ASSA ABLOY employees

From the interviews with the ASSA ABLOY employees a few key takeaways were identified that were relevant for the OMS and the future solution. The takeaways were considered when creating and evaluating the solutions.

1. *Modern look:* There seemed to be a general need for providing an OMS which looked modern and aligned with modern technology.

2. *Quality*: An important value for ASSA ABLOY was the quality of the products and their service.
3. *Service*: Something that seemed to make ASSA ABLOY unique in the market, and that they were proud of, was their ability to offer great service for their customers. It was critical that the solution would enable the ability for service technicians to perform good service.
4. *Applicable for the users:* Some solutions that are sold to the customers are not always used due to complexity. However, it is desired to provide a solution which works in theory as well as in practice.

6.4 SWOT Analysis

To summarize the findings so far, and to identify the strengths, weaknesses, opportunities, and threats connected to the project, a SWOT analysis was executed. SWOT is a method that usually is used to analyze the business strategy in a company (Mind Tools Content Team, 2024). However, it was a relevant tool in this project to define the purpose of the product that will be developed. Since the solution might be on the future market, it was relevant to analyze what strengths, weaknesses, opportunities, and threats that were affecting the product. The analysis determined the jobs that needed to be done, and what would make a future product successful.

6.4.1 **Strengths**

ASSA ABLOY is a well-known brand, and they have been recognized for their service and quality of products. Their products are sold and used globally. They work closely with their customers, which enables great service and efficient communication. The company's infrastructure and resources enables the ability to create high-end technological products.

Sliding door systems are established worldwide, and those who have used one is quickly familiarized with its basic functions. From the user study, users generally found the OMS solutions from ASSA ABLOY easy to work with.

6.4.2 **Weaknesses**

The most common solution from ASSA ABLOY was the OMS with the manual key. It was a solution that had been used for a long time but gave both users and ASSA ABLOY employees the impression of being outdated since the product was not adapted for current and future technology developments and usability requirements. Also there were products on the market which had a more modern look and feel.

Even though the current solution offered a variety of functions for the user, most functions were not used or understood by the user. Also, from the user study it was found that the product was not always used as intended. The users found some guidelines difficult to follow, sometimes leading to security risks.

6.4.3 **Opportunities**

ASSA ABLOY has access to a wide range of technology internally, which could be applied to a new solution. Since the OMS design has not been subject to many major changes in the last decades, the opportunity arises to create a more radical innovation which can set the tone for the future (Pisano, 2015). Even though the solution does not necessarily require new technology, there is an opportunity to create something new in the market.

From the user study plenty of novel user needs were found. These included crucial needs and latent needs which when fulfilled would create greater user satisfaction. These findings could assist in finding a function or design which would provide extra value for the user.

6.4.4 **Threats**

The current solutions for the OMS are considered outdated, and the risk is that customers will prefer the competitors more modern products. If the product development process remains as routine innovation, meaning no change in technology or business model, ASSA ABLOY risks being outperformed by their competitors (Pisano, 2015).

Another aspect to keep in mind was to not let the user interaction become too complicated when introducing new technology. The risk when the intention is to provide more high-tech solutions is that the product becomes hard to use. The product should be designed for the user and user needs, not for the purpose of technology development.

The last threat concerns safety. The product is regulated by product standards to prevent hazards. Part of the standard is that if the door system is an emergency exit, only authorized personnel should have access to locking the doors. If this standard is not followed, it is a risk both for the user, customer, and ASSA ABLOY as a company. For this reason, it is important that the solution complies with and enables the user to follow standards and regulations.

6.5 Challenge in one sentence

After the user needs were defined, they were compressed to a format which could be used in the ideation process. Challenge in one sentence (Friis Dam & Yu Siang, 2020) is a method from design thinking where the purpose is to come up with a point of view (POV) and a how might we (HMW) expression. The point of view is one sentence that defines the challenge which should be addressed in the ideation stage. This includes the user, their needs, and insights about them. The HMW expression is a question that addresses the problem to be solved, formulated from the POV sentence.

6.5.1 **Point of view**

Since the user study covered two user groups, retail employees and service technicians, two different POV was created. A POV template was used to define the user, the need and the insight based on the hierarchical list of user needs (see Table 5).

Table 5: Point of view for retail employees and service technicians.

User	*Need*	*Insight*
An employee who works at a retail store with sliding doors	Change operating modes on sliding doors simple, quick and have their actions confirmed	The door function is expected to work without issues. They don´t pay a lot of attention to the door, and they don´t want to.
A service technician for sliding doors.	Access to relevant information regarding problems with sliding doors.	They want to perform good service and avoid unnecessary service calls. Fixing door issues should be quick and simple.

To articulate the POV the three elements (user, need and insight) were combined with the words “needs to” and “because” in between them, leading to the following POV:

1. A retail store employee needs to change the operating mode on their sliding doors in a simple and quick way where their intended actions are confirmed, because they expect the door to work without spending time and energy on adjusting it and resolving issues.
2. A service technician needs to have access to relevant information regarding problems with sliding doors because they want to offer the correct service efficiently and avoid unnecessary work.

6.5.2 **How might we**

Once the POV was defined, it could be reframed into a question. The HMW expressions were based on the POV statements. All expressions started with “How might me” and followed with the problem to be solved. The “how” explained that the problem was not yet solved, the “might” referred to that the solutions were possibilities and not definite, and the “we” created the understanding of collaboration. From the above defined POV the following HMW was defined:

1. *Retail employees:*
    a. How might we make changing the operating mode on sliding doors quick and simple for retail employees?
    b. How might we enable operating mode selection on sliding doors for retail employees in an effortless, fast and comprehensive way?
2. *Service technicians:*
    a. How might we provide relevant information regarding problems with sliding doors for service technicians to ensure correct and efficient service?
    b. How might we ensure that service technicians perform efficient service on the correct sliding door problem for their customers?

7 Develop

The purpose of the develop phase (see Figure 14) was to ideate and prototype different solutions to solve the defined design challenge. The phase began with an ideation phase including individual brainstorming sessions and brainstorming workshops, followed by concept generation. It led to two different concepts which were prototyped, tested, and improved through three design iterations. In the end of the phase one concept was chosen for further development.

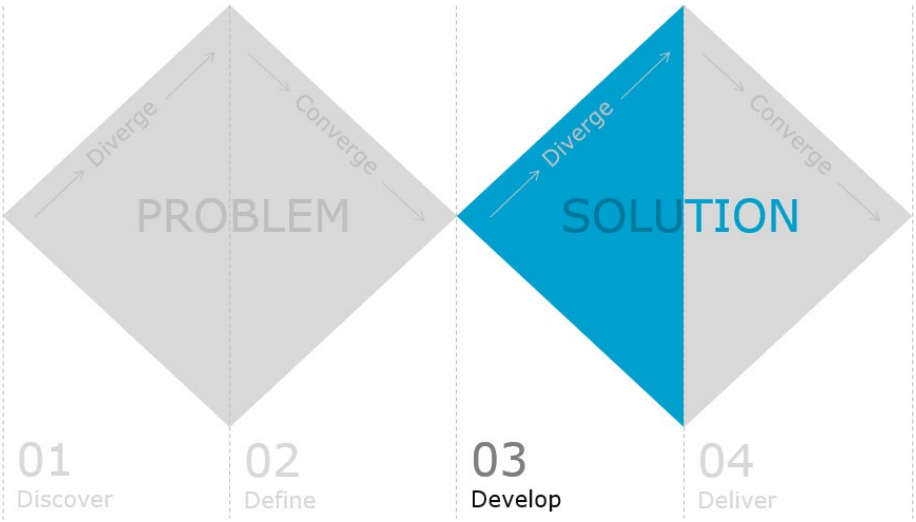

Figure 14: Double diamond illustration of the develop phase.

7.1 Ideation

7.1.1 **Brainstorming**

7.1.1.1 Workshops

To gain a broad variety of ideas from new sources two brainstorming workshops were conducted; one with engineers (see Figure 15) and one with students who study design (see Figure 16). The workshops were conducted in person with colored post-

its, papers, and markers to encourage creative thinking and collaboration (Wikberg Nilsson, Ericson, & Törlind, 2015). IDEO's 7 rules of brainstorming, listed below, were clearly presented prior to starting (IDEO, 2020).

1. *Defer judgement*
2. *Encourage wild ideas*
3. *Build on the ideas of others*
4. *Stay focused on the topic*
5. *One conversation at a time*
6. *Be visual*
7. *Go for quantity*

The first workshop was with the engineers, see detailed description in Appendix E. It was a scenario-based brainstorming workshop where a storyboard was combined with text to help the participants understand the users' behaviors and driving forces (Wikberg Nilsson, Ericson, & Törlind, 2015). To ensure the session would be less technically driven and more creative, a warmup was prepared which asked the participants to imagine solving the opposite problem (Suzuno, 2023). In addition, they were reminded to consider similar products and solutions in other markets and attempt to apply them to the new niche.

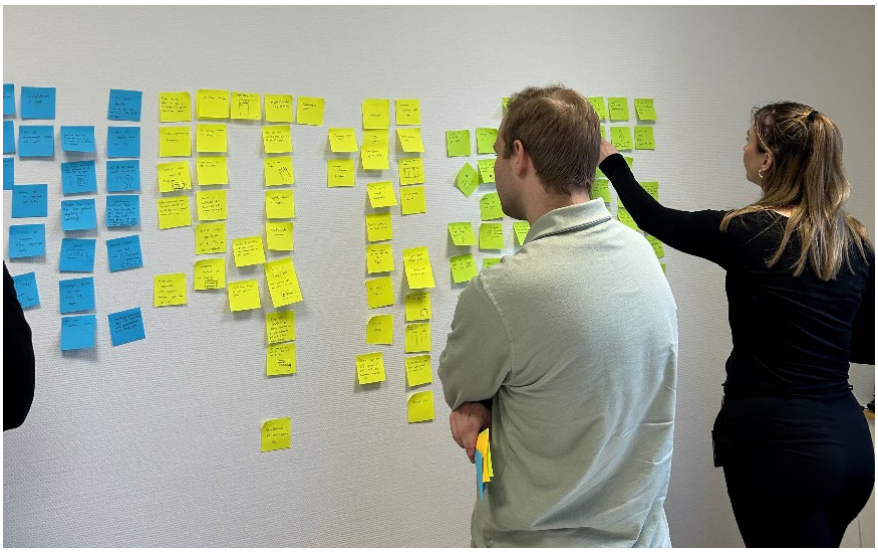

Figure 15: Participants from workshop 1 choosing post-its to combine to new ideas.

The second workshop was conducted with students in design, which meant the setup could be freer and more visual. Classic brainstorming was done followed by a variation of 6-3-5 brainwriting, an alternative brainstorming method developed by Bernd Rohrbach in 1969 (Mind Tools Content Team, 2024). The brainwriting methodology meant that each participant wrote one idea on three different papers during 5 minutes of individual brainstorming. After each round the participants swapped their papers, without speaking to each other or explaining their thoughts,

until each participant had contributed to all ideas. More information about the second workshop can be found in Appendix E.

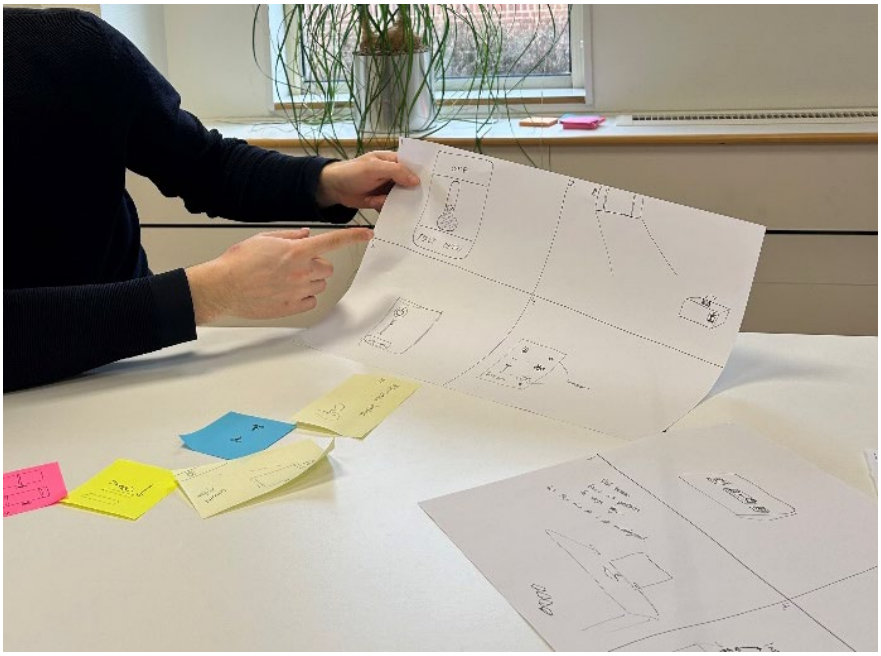

Figure 16: Participant from workshop 2 explaining a concept from the brainwriting session.

The two workshops resulted in over 200 ideas and parts of concepts. The needs that were considered during the sessions are listed in Table 6.

Table 6: Needs covered in workshop 1 and 2.

Importance rating	*User need*	*Workshop nr*
***	Prevent mistakes.	1 and 2
***	Easy to use.	1
***	Make it easy to change modes.	1
***	Provide confirmation of completed action.	1
**	Provide clear feedback during use.	1
***	Communicate current mode.	1
***	Highlight problems and their causes.	1
	Inform about problems.	1
**	Encourage users to solve simple problems.	1
**	Guide users in troubleshooting.	1
***	Structured logically.	2
***	Clearly convey its functions.	2
!	Enable the door to be adjusted both near and far from it.	2

7.1.1.2 Individual brainstorming

Following the brainstorming workshops, some more individual brainstorming was conducted to cover the remaining needs of high importance and some of the latent needs listed below.

- **** Operate without supervision.*
- **** Inspire trust.*
- **** Communicate what the door is doing in real-time.*
- *! Provide a clear connection between interface and door.*
- *! Counteract theft.*
- *! Able to perform adjustments independently.*
- *! Contribute to a welcoming experience.*

7.1.1.3 Concept generation

After the ideation workshops and the individual brainstorming the ideas were combined and adjusted. Around 120 partial and uncompleted ideas turned into 40 initial concepts, which upon further development resulted in 12 complete concepts. The 12 concepts were created with consideration to the product requirements from Table 4 to ensure that the authorization, in case the doors were an emergency exit, would be done correctly.

7.1.2 **Evaluation**

The 12 chosen concepts from the ideation phase were put on the wall. To decide which concepts to proceed with the team was given four stickers each to assign to their favorites (see Figure 17), using a method called dot voting (Gibbons, 2019).

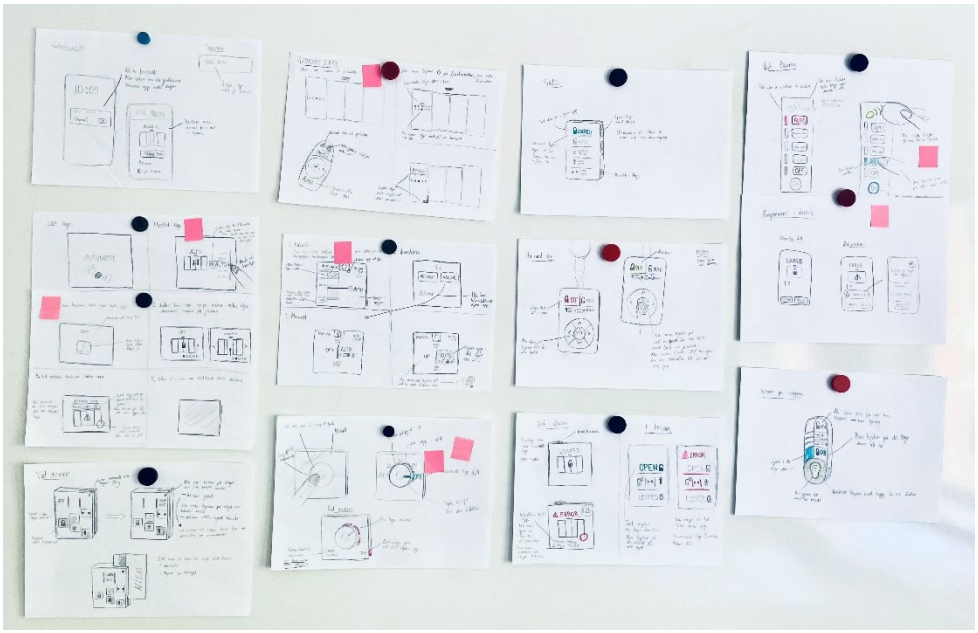

Figure 17: The 12 concepts evaluated with stickers.

After combining ideas, it resulted in five chosen concepts. See sketches and corresponding short descriptions below of the chosen concepts. The remaining six concepts that were not chosen are summarized in Appendix F.

Concept A: Invisible knob

See Figure 18. The device is flush before activation and is placed next to the doors. It is unlocked through fingerprint authentication when the users' finger touches the knob. Once authentication is approved, the knob extrudes and becomes visible. The indicator and current mode are highlighted and blinks. The user can change mode by turning the knob to the desired mode. To confirm the mode, the knob is pushed back in which makes the device flush. In case of issues, the mode text disappears, a fault message appears and the *Reset* button on the side lights up.

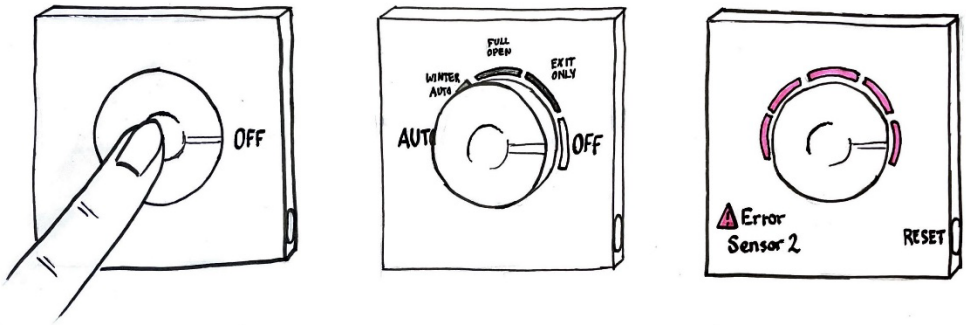

Figure 18: Sketch of concept A.

Concept B: Door display

See Figure 19. The door blades act as the display and is paired with a remote controller. In its sleep mode, one dot is highlighted on the door blade providing feedback of the current mode. By pushing the on button, the different choices of modes light up on the door blade. Through pressing the arrow button on the remote, the user can change between different modes. Once they have selected the desired mode, the user needs to push the OK button for the mode to be set. The remote can then turn off the illustration, going back to sleep mode. In case of problems, a fault message appears on the door screen and the door lights up where the issue is located.

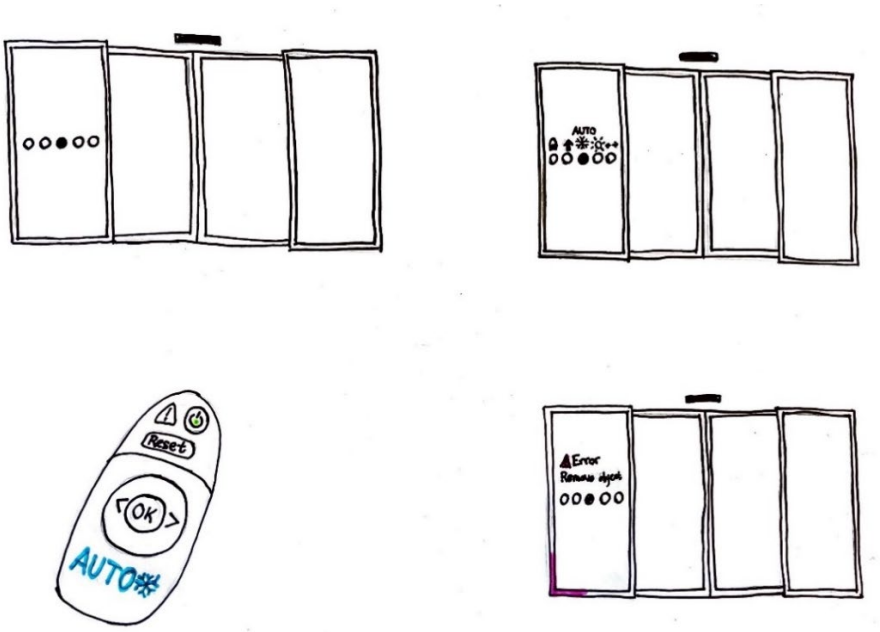

Figure 19: Sketch of concept B.

Concept C: Buttons with remote display

See Figure 20. This is an OMS with buttons for each mode that is placed next to the doors, and it is combined with a display by the checkout counter. In sleep mode, the current mode is highlighted through light indication. To change the mode, a tag needs to be put close to the OMS. Once the OMS unlocks, the set mode blinks, and the OK button lights up to let the user know that they must confirm the selection of mode. The remote display in the checkout counter shows the current mode by an illustration and short text. It also counts the amount of people which have passed through the doors and guides the user through door errors.

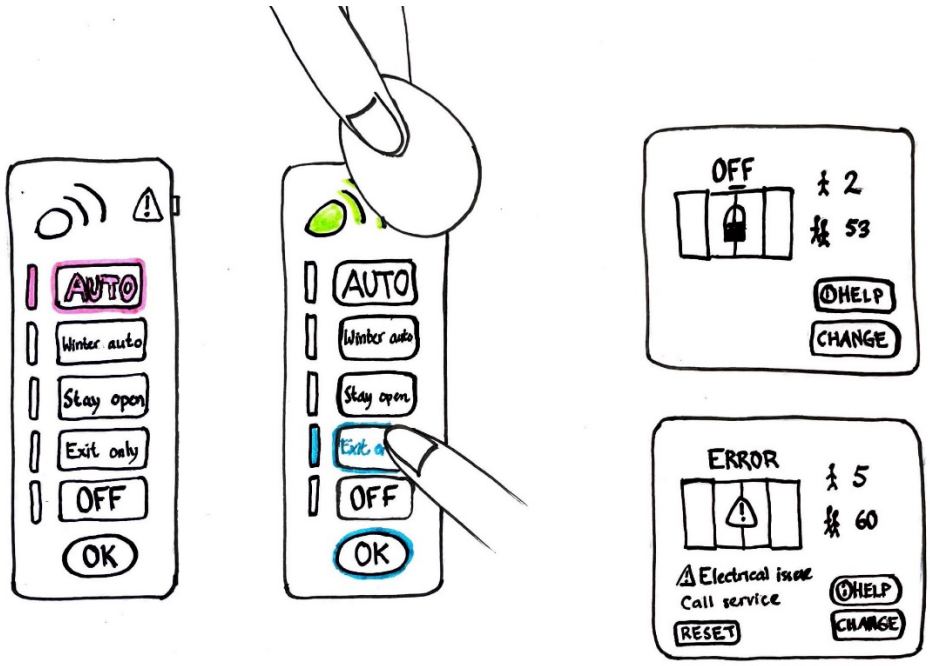

Figure 20: Sketch of concept C.

Concept D: Illustrating display

See Figure 21. The display is placed besides the doors and is activated by face detection technology or by scanning a tag. When someone is close to the display, the current mode is displayed in text. When logged in, the user can swipe between illustrations of the different modes to set another mode. In case of problems, an error message appears on the display and the issue is illustrated in relation to the illustration of the doors. After 2 minutes of inactivity the display is put into sleep mode.

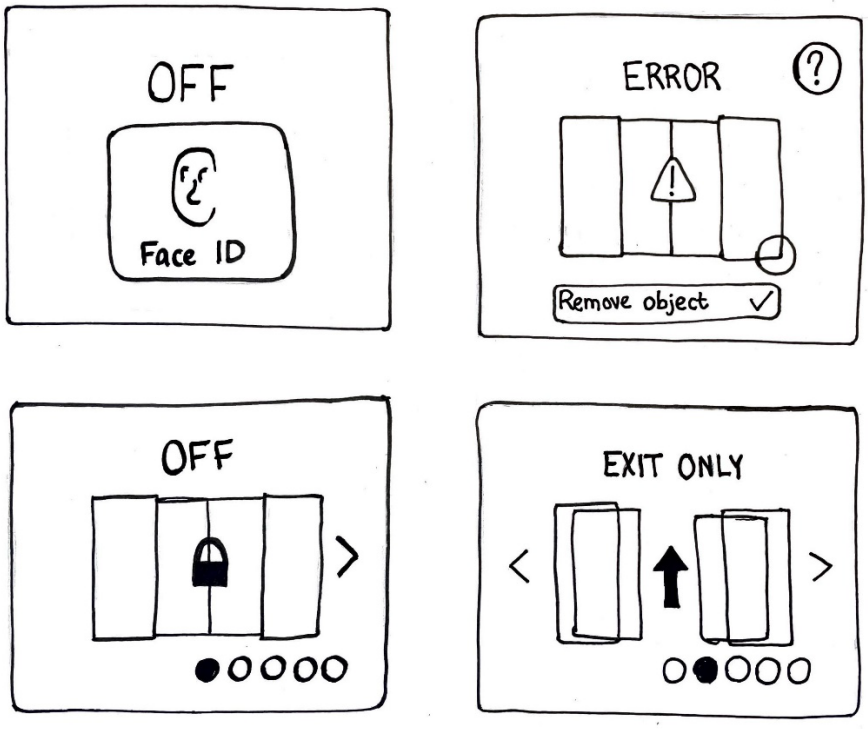

Figure 21: Sketch of concept D.

Concept E: Calendar

See Figure 22. The display is placed besides the doors and is dark when in sleep mode. When the user approaches a calendar appears with time stamps and information regarding all current modes for the day. This calendar is pre-installed and can be adjusted in the app. If the user wishes to manually change mode this is possible on the display, but to choose *Off* the user must authenticate themselves. In case of a problem, the display illustrates the problems' location and provides a short error message.

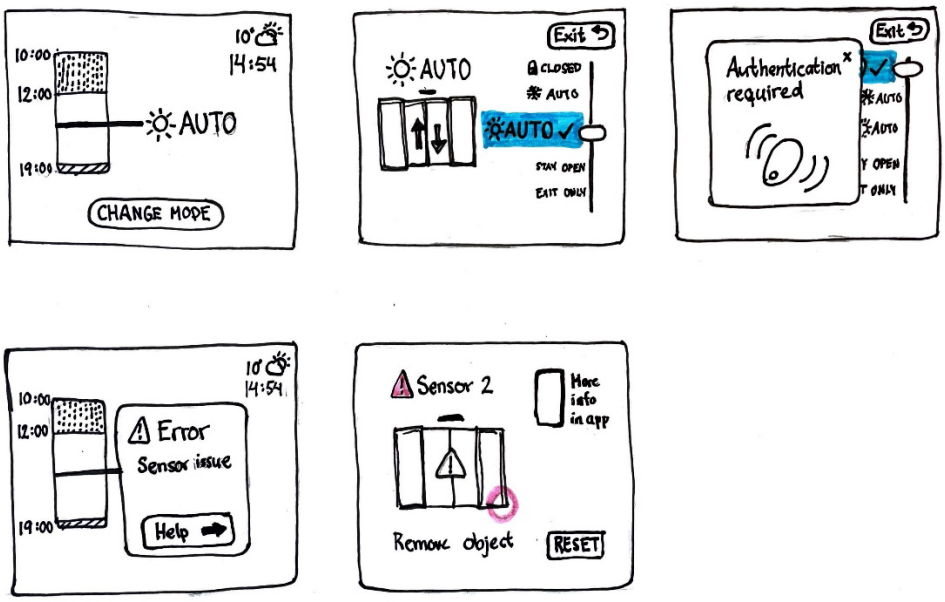

Figure 22: Sketch of concept E.

7.1.2.1 Concept scoring

Concept A-E were evaluated using concept scoring (Ulrich & Eppinger, 2016). The criteria that the concepts were evaluated against were the most important user needs (black text) and latent needs (purple text) user, however some of the needs were removed as they proved difficult to use when judging the concepts (see Table 7 and Table 8). In the tables the weight was calculated in percent. Modern looking was added as a selection criterion since it was expressed as a request from ASSA ABLOY employees.

The needs were given a weighted percentage out of 100 according to its relative importance when choosing a concept. Each concept was then rated according to the need from 1-5, where rate 5 means that the concept responds very well to the need and rate 1 means that the solution did not respond to the criteria. One concept was

chosen as the reference concept for each criterion separately, this is marked by **bold** rating values.

After evaluating concepts A-E, the top 4 concepts were combined to create two new improved concepts: AC (the invisible knob with remote display) and DE (the display screen with calendar mode). The evaluation of concept AC and DE followed the same concept scoring procedure and they were rated in relation to the remaining 5 concepts. The concept scoring matrix resulted in two concepts for further development, concepts AC and DE which were ranked as number 1 and 2.

Table 7: Concept scoring matrix with the concepts A, B and C.

Need		*Concept A*		*Concept B*		*Concept C*	
	Weight	Rate	Score	Rate	Score	Rate	Score
Modern looking	7	3	0,21	5	0,35	2	0,14
Provide confirmation of completed action.	10	5	0,5	**3**	0,3	5	0,5
Operate without supervision.	3	3	0,09	3	0,09	4	0,12
Highlight problems and their causes.	7	**3**	0,21	5	0,35	4	0,28
Communicate current mode.	10	**3**	0,3	1	0,1	3	0,3
Communicate what the door is doing in real-time.	7	2	0,14	1	0,07	5	0,35
Structured logically.	7	4	0,28	2	0,14	**3**	0,21
Clearly convey its functions.	7	2	0,14	2	0,14	3	0,21
Make it easy to change modes.	10	5	0,5	2	0,2	3	0,3
Prevent mistakes.	5	4	0,2	4	0,2	4	0,2
Inspire trust.	5	5	0,25	1	0,05	4	0,2
Function without complements.	2	3	0,06	1	0,02	1	0,02
Enable the door to be adjusted both near and far from it.	4	1	0,04	5	0,2	**3**	0,12
Offer novelty value.	4	1	0,04	5	0,2	4	0,16
Able to perform adjustments independently.	2	1	0,02	1	0,02	1	0,02
Provide a clear connection between interface and door.	6	1	0,06	4	0,24	**3**	0,18
Enable adjustment of settings from the checkout.	4	1	0,04	5	0,2	1	0,04
Weighted score			3,08		2,87		3,35
Rank			6		7		3

Table 8: Concept scoring matrix with the concepts D, E, AC and DE.

Need		*Concept D*		*Concept E*		*Concept AC*		*Concept DE*	
	Weight	Rate	Score	Rate	Score	Rate	Score	Rate	Score
Modern looking	7	3	0,21	3	0,21	3	0,21	3	0,21
Provide confirmation of completed action.	10	2	0,2	3	0,3	5	0,5	2	0,2
Operate without supervision.	3	3	0,09	5	0,15	4	0,12	5	0,15
Highlight problems and their causes.	7	5	0,35	4	0,28	4	0,28	5	0,35
Communicate current mode.	10	5	0,5	4	0,4	4	0,4	5	0,5
Communicate what the door is doing in real-time.	7	3	0,21	4	0,28	5	0,35	4	0,28
Structured logically.	7	2	0,14	2	0,14	4	0,28	2	0,14
Clearly convey its functions.	7	5	0,35	3	0,21	3	0,21	4	0,28
Make it easy to change modes.	10	3	0,3	1	0,1	5	0,5	2	0,2
Prevent mistakes.	5	3	0,15	2	0,1	4	0,2	2	0,1
Inspire trust.	5	3	0,15	3	0,15	5	0,25	3	0,15
Function without complements.	2	3	0,06	2	0,04	1	0,02	2	0,04
Enable the door to be adjusted both near and far from it.	4	1	0,04	4	0,16	3	0,12	4	0,16
Offer novelty value.	4	3	0,12	5	0,2	4	0,16	5	0,2
Able to perform adjustments independently.	2	1	0,02	3	0,06	1	0,02	3	0,06
Provide a clear connection between interface and door.	6	5	0,3	4	0,24	3	0,18	5	0,3
Enable adjustment of settings from the checkout.	4	1	0,04	3	0,12	1	0,04	3	0,12
Weighted score			3,23		3,14		3,84		3,44
Rank			4		5		1		2

7.1.3 **Reflection of results**

The two solutions chosen for further development were combined to enhance the strengths and eliminate the weaknesses of the previous solutions. They were sufficient from a user perspective as they had potential to fulfill many of the user's needs, and from a design perspective as they had different form and functionalities. The two final solutions also incapsulated most of the ideas in the five concepts, which ensured that these could be developed and tested with the users.

Concept AC was rated high in needs such as *provide confirmation of completed action* and *communicate what the door is doing in real-time*. This was because of the simplicity of the knob and the solutions similarity to existing turning-of-key solutions. Concept DE, however, differed more from the current solutions and was therefore rated higher for needs regarding novelty value, problem emphasizing and autonomy for the user.

7.2 The first iteration

7.2.1 **Prototyping**

The next step was to prototype the concepts, beginning with low fidelity prototypes. To make them true to size in accordance with ASSA ABLOY restrictions they could not be larger than 80x80 mm, including the borders if they were to be possible to implement. A touch screen with the outer measurements of 80x80 mm and the screen measurements of 72x72 mm was borrowed for the prototypes and user tests.

To make the report easier to follow, concepts AC and DE are henceforth referred to as the following:

- Concept AC: The invisible knob with remote display.
- Concept DE: The display screen with calendar mode.

During the prototype development, all user tests performed were under confidentiality from all parties involved.

7.2.1.1 The invisible knob with remote display

The knob was sketched out on paper (see Figure 23) to better understand its size and proportions which prompted adjustments of the button and surrounding lights. Next, all possible scenarios for the knob were drawn out on individual papers and combined to make sequences. The sequences were tested and rearranged until they appeared to be in a logical order.

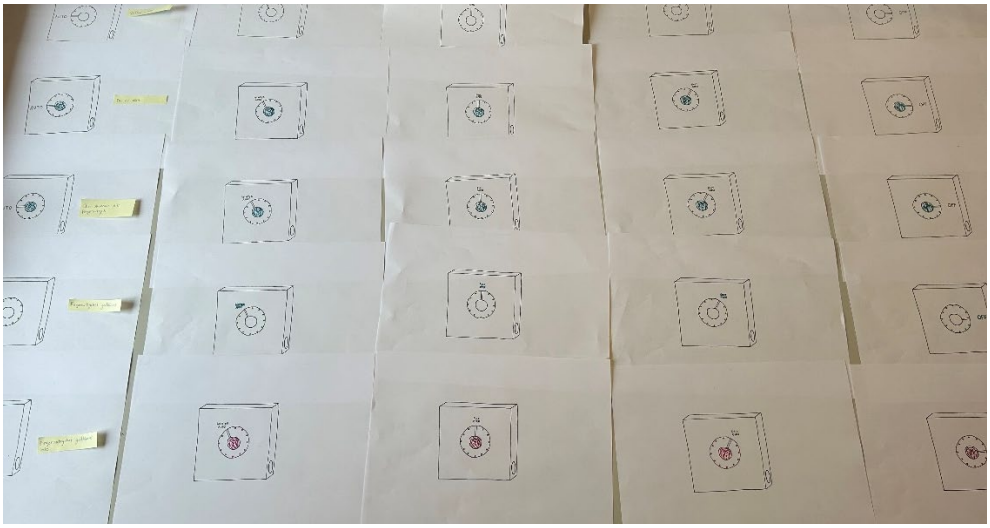

Figure 23: Paper prototype of knob.

After the sequences were decided upon, a digital prototype in Figma was created (see Figure 24) which was interactive through a touch screen. Figma is an interactive tool for prototyping digital user interfaces online.

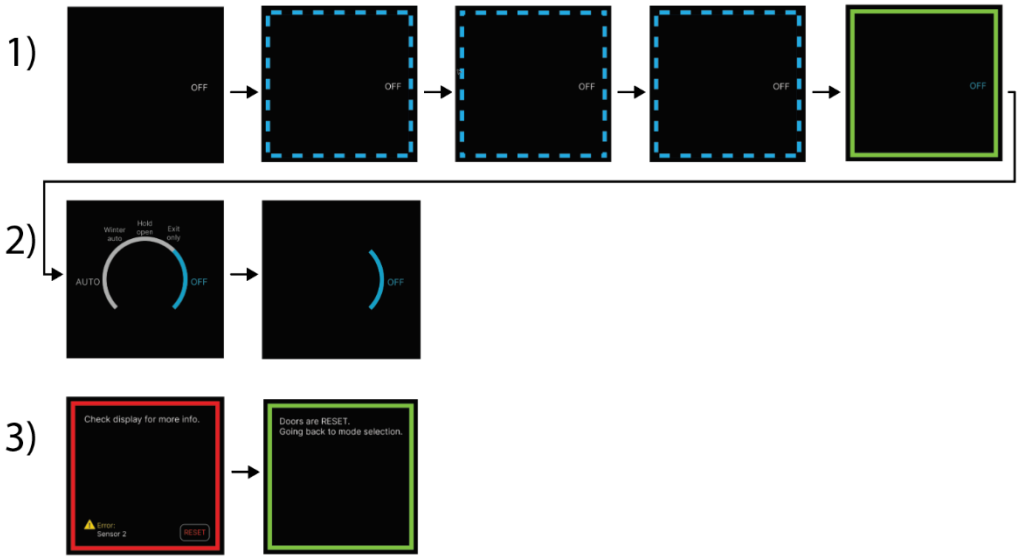

Figure 24: Figma prototype of knob in first iteration. 1) Flow from locked to unlocked *Off* function. 2) Flow from mode selection to choosing the *Off* mode. 3) Flow in case of error.

Foam was then used to carve out two physical knobs to complement the touch screen solution and to create a more looks like rather than works like prototype (see Figure 25). The Figma design was combined with putting the foam prototype on top of it to illustrate how a knob would work together with the graphical interface on a frame.

Figure 25: Creation of first physical prototype of knob.

7.2.1.2 The display screen with calendar mode

To begin prototyping the display solution, a simple storyboard was made on paper to discover what the flow and different screens could look like. Since the solution included different screens and a flow between them, Figma was considered a suitable format to use for further development of the prototype. The prototype was based on the first sketches in Figure 21 and Figure 22. The calendar mode, or timer function, was the home screen and the remaining modes could be manually selected from a swiping menu. See the screens from the prototype in Figure 26.

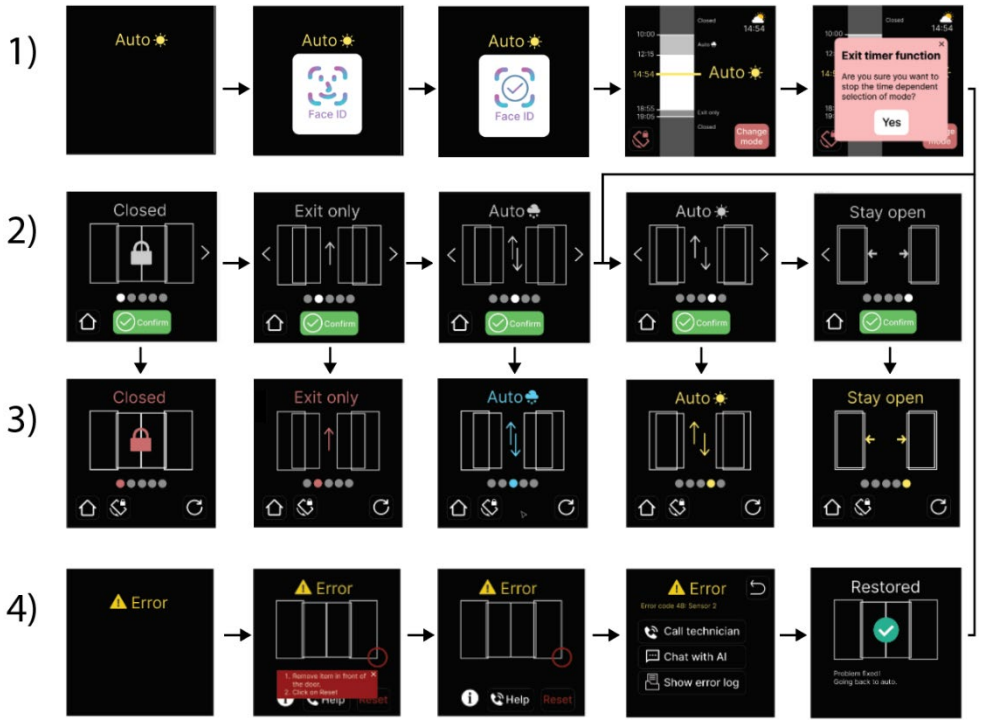

Figure 26: Figma prototype for the display solution. 1) Flow from locked screen to the home screen timer function. 2) The five manual modes while unconfirmed. 3) The five manual modes while confirmed. 4) The flow in case of error.

7.2.2 **User testing**

The prototypes in the first iteration were not fully functional, and therefore it would be problematic to conduct structured user tests. The reason for this was the risk that the user might focus more on the technical errors rather than give information on the intended design. However, it was preferable to gain user insights as early as possible in the process since a more refined and high-fidelity prototype would make users less prepared to critique it (Sharp, Rogers, & Preece, 2019).

Feedback was therefore collected from ASSA ABLOY employees trying out the prototypes. The screen version could be used directly on the screen, connecting it to Figma. The knob prototype was more complex and was tested with combining the Figma prototype on the screen with the physical knob on top. When the user would turn the physical knob, a wizard of OZ action was performed where the feedback of changing the modes was done manually and lit up on the screen.

With the user testing theory in mind, the focus was to evaluate the learnability, efficiency, memorability, errors, satisfaction of the interface and turn it into constructive goals for the next iteration.

7.2.3 **Insights**

The conclusions from the user tests were the following:

The invisible knob with remote display:

- It was not intuitive that the knob was activated by pushing it, instead many people tried to interact directly with the screen. Some people wanted to click on the screen to change the modes.
- Once they turned the knob, they thought the mode has been changed without requirements of any further action.

The illustration screen with calendar:

- It was not clear that the home button led to the calendar.
- Users wanted to swipe between the different modes.
- The calendar mode was hard to understand what it was and how it was supposed to be used.
- The different colors which appeared when a mode was chosen confused the users, red indicated that something was wrong and yellow indicated that it was not fully confirmed.
- In the error mode it was not enough attention on where the issue was.

After the input from the user tests and supervisors, it was clear what work there was to be done. First, to give both prototypes a fair chance they had to be on the same level when it comes to works like and looks like. This was a challenge for the invisible knob since it was a complex interaction, combining mechanics, tactile feedback, and an interactive graphic user interface. On the other hand, the display solution was much more of a works like and looks like prototype which could make it easier for the user to understand the product.

7.3 The second iteration

7.3.1 **Prototyping**

7.3.1.1 The invisible knob with remote display

One of the challenges with the knob solution was to reach the same level of high-fidelity prototype as the display solution. For this reason, a new prototype was created in Figma where the whole interactive flow worked as it was supposed to making it a works like prototype. The implemented changes from the previous iteration were the following:

- Two different authentication methods were implemented: fingerprint and tag. Both methods used signifiers as either a fingerprint symbol on the knob or a symbol of a tag to afford the user to use a tag to unlock (see Figure 27).
- The user could turn the knob on the screen, by dragging their finger in the direction they wanted the knob to turn to.
- A blue SET text was added in the middle of the knob, lightning up when the knob was unlocked to signify that the knob needed to be pushed to confirm the change of the mode (see Figure 28).
- The foam knobs were still used with the addition of a mechanical part; however, they were used more as a looks like prototype to visualize the size, shape, and tactile feedback.
- A green flush of the lights was added after the authentication to increase the visual feedback of the approval of unlocking.

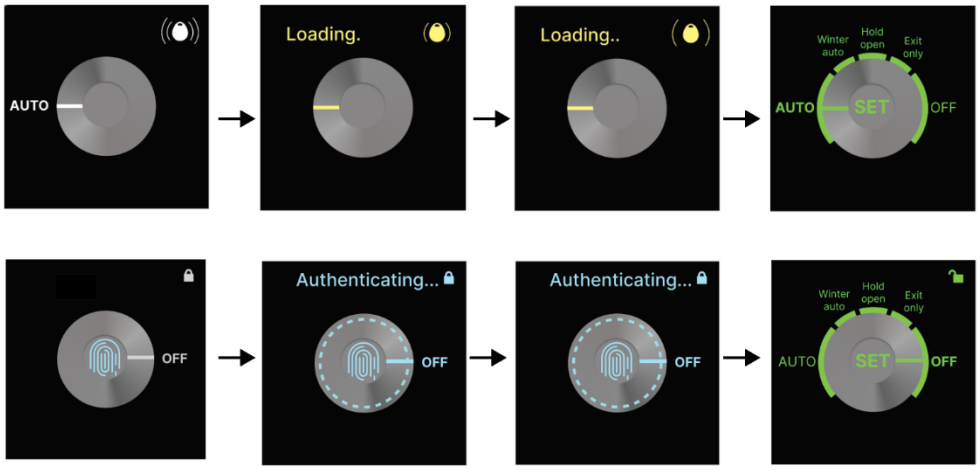

Figure 27: Figma design of authentication flow, with tag or fingerprint as activation of screen.

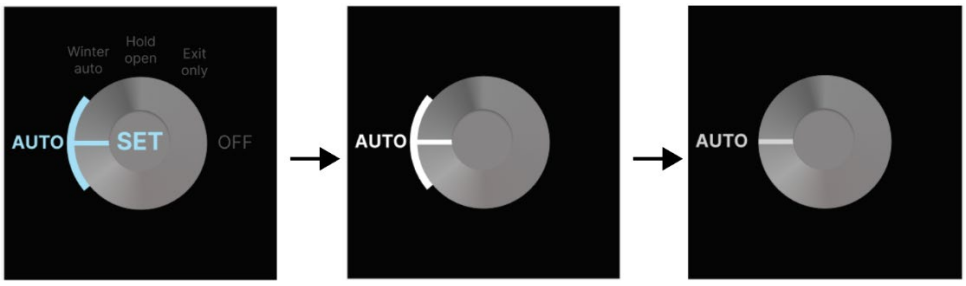

Figure 28: Figma design of changing the mode with the knob. First the user can drag the knob between different modes until they push SET. Then it turns white for a few seconds, and finally the screen locks.

Besides the selection of modes, the flow for error detection was updated and had the addition of an information display in the checkout. The frame which the knob was mounted to flushed red when an error occurred and referred to the information display for more information and problem solving, see Figure 29. In the information display, the user was provided with more information about door issues. It also indicated how many people who had walked by the door, and provided assistance to the user whilst problem solving, see Figure 30.

Figure 29: Design of how the knob looks when there is an issue with the door, and how it looks when it is resolved.

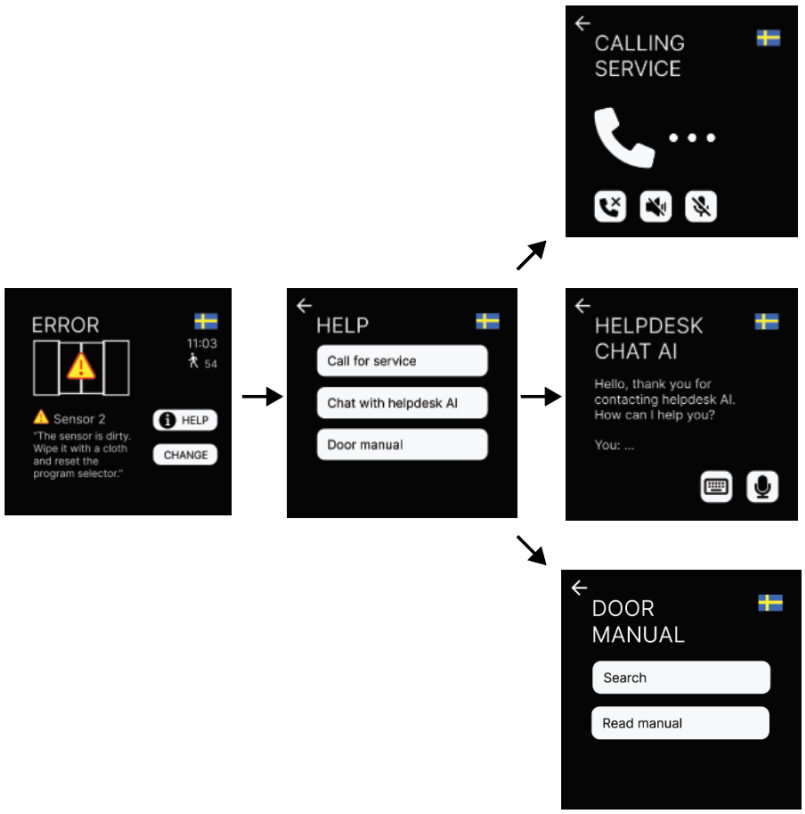

Figure 30: Figma design of information display in the checkout.

7.3.1.2 The illustration screen with calendar mode

Since the calendar mode was confusing for the user, the goal was to make it more understandable and to afford the user to use it instead of the manual modes. The previous home button required another action from the user compared to swiping between modes. To make the calendar mode more available and allow it to blend in, it was placed in the swipe flow as one of the modes. A new illustration was created to make it look more like a schedule, see Figure 31.

Since the different colors confused the user, the colors were uniform for each stage. Yellow was used when users swiped between different modes and a mode was not yet set, and to call for action to confirm the mode once decided. Green was applied when the mode was confirmed as feedback that the mode had been set.

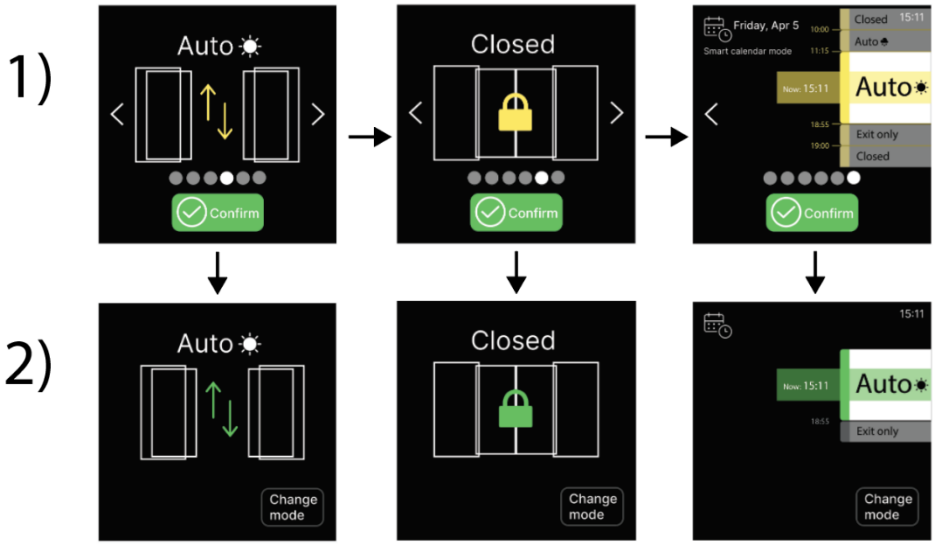

Figure 31: Figma design of the display solution, updated with uniform colors and new design for calendar function. 1) Some of the slides of what the modes looks like when choosing between them. 2) Some of the slides of what the modes look like when they are confirmed by the user.

The authentication method worked well during previous user studies. Therefore, there were no changes made to the face identification authentication. However, other authentication methods were investigated. Another relevant method was to use a tag to log in. Also, according to product requirements it was only necessary to authorize when closing the doors. Hence, it was a possibility to only require authorization when choosing the mode *Close*. Another version of the display flow was created where the screen was unlocked by touching it. Only when choosing *Closed* it asked for authorization by tag, see 2) in Figure 32.

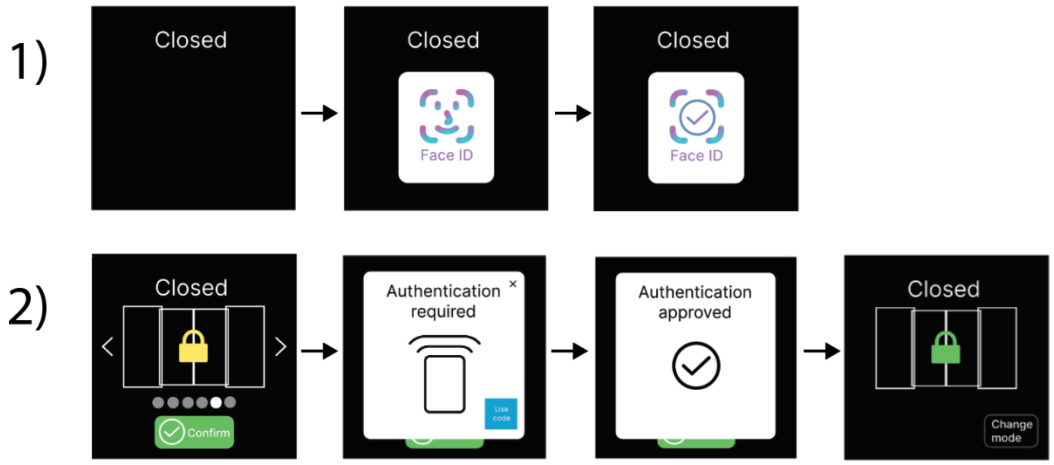

Figure 32: Figma design of authentication methods for the display solution. 1) Face identification. 2) Tag used to confirm setting a mode requiring authentication.

The error interface worked well form the first iteration, however it needed to display the problem more clearly. For this reason, a text box was added that pointed towards the issue. Also, an illustration of the issue was added, see Figure 33.

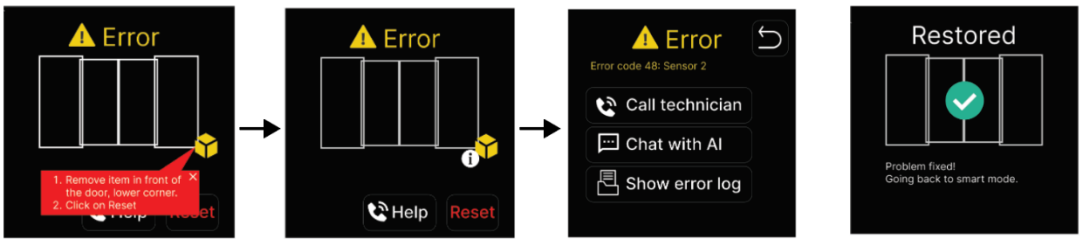

Figure 33: Error interface for display solution.

7.3.2 **User testing**

When conducting the user tests, the principles of user testing (Wikberg Nilsson, Ericson, & Törlind, 2015) were used to gain measurable and constructive results for further development. The purpose of the user tests was to find out how someone who has not seen the product before would interact with it, and what their impressions was. These insights would lead to highlighting areas for improvements, and to understand how the prototype answered to the user needs it was supposed to fill. Also, to understand what elements would benefit and offer value for the user.

A thorough test plan was conducted, covering scenarios where the users would get assigned to change modes depending on real life situations including problem solving errors with the door. Also, different verification methods were tested (fingerprint, face identification and tag). The tests took around 30-40 minutes per person.

Preferably, tests would be conducted with end users, but since the tests would take quite long to complete it was not considered ethical to preoccupy them for very long during work hours. Because the product should work well for people with no experience too, ASSA ABLOY employees were approached. Six people from ASSA ABLOY of various age, gender and technical expertise were invited to perform the user test. The users were familiar with the project and the product, but not in the specifics which made them good candidates.

During the tests, one moderator controlled the prototype and changed flows in between the different tests. The other moderator asked the questions and provided the assignments. The test was separated into two parts: one for the knob (3 tasks) and one for the display (5 tasks). Afterwards the user was asked questions regarding the prototypes as well as asked to compare them. A think aloud principle was used, and the person who asked questions took notes on both the answers, how the user acted and, on their think aloud thoughts.

7.3.3 **Insights**

After all tests were performed, the feedback from the user tests were discussed and a list of reflection and improvements to be made was conducted.

- *Authentication methods:* Face identification and fingerprint was considered easy to use, however it was discussed how it may be complicated to manage who had the access and not. It was considered easier to hand out a tag to a new employee rather than register their fingerprint or face identification.
- *The invisible knob:* The symbol of the lock in the flush state made people try to touch the lock instead of pushing the knob. The SET button was also forgotten often, and people perceived the mode to have been changed once the knob was turned. Using the word *Off* for when the doors were closed and locked was unclear. Overall, what people liked with the solution was the mechanical feedback, fast use, simplicity, and anonymous look.
- *The information display:* The information screen was only used when an error occurred, and it seemed like an unnecessary step to go to the checkout counter to get information from it. Especially since it could be a stressful situation when errors occur.
- *Display solution:* It was easy for people to understand how to lock up the screen and change between modes. The different modes were perceived to be clearly explained through graphics and text. Except the cloud and sun after *Auto,* which were causing confusion. Also, they wanted the option to access more information on what the different modes meant. The confirmed button was used most of the time, however the users did not feel certain that the mode has been changed once they pushed confirm. They were also confused on why they needed to confirm the mode.

- *Calendar function:* People seemed surprised when they swiped to the calendar function since it looked so different from the other pages of the modes. Once they knew what it was, they wanted to change the different times directly on the slide. Also, they wanted to have access to different settings depending on if it was a weekday, Saturday, or Sunday.

7.3.4 **Evaluation against user needs**

To maintain focus on the end users, the prototypes from iteration 2 were evaluated against the most important and latent user needs (purple text), see Table 9. The evaluation was done both through analyzing the features of the prototype in iteration 2 (black text), as well as how possible adjustments would better fulfill the user need (blue text). Some of these suggestions involved introducing an application as a supplement to the solutions. This idea was discussed both in the user tests and in the initial user studies since the service technicians already have an established app that they used during service calls. The application was only an idea and the specifics regarding how it would work and look like had not been discussed.

Table 9: Evaluation of prototypes against user needs.

Need	*Knob*	*Touch screen*
(R) Provide confirmation of completed action.	Usage of blinking lights while something is unconfirmed. Green lights confirm the action. Pressing is a mechanical confirmation.	Usage of the confirm button. After confirmation add a sleeping mode with grey text and small symbol, more anonymous than before.
(R) Operate without supervision.	N/A	The calendar mode.
(R) Highlight problems and their causes.	Connect to the app to read more. In case of problems: error triangle and red/yellow colors.	A clear error display.
(R) Communicate current mode.	Current mode is highlighted in a different color than the mode to be confirmed.	Highlight the dot corresponding to the current mode in another color. Opens to home screen for mode.
(S) Communicate what the door is doing in real-time.	Current mode always highlighted until mode is changed.	The dot/indicator is highlighted until mode is changed.
(R) Structured logically.	Different *Auto*-modes places besides each other. The most used modes *Auto* and *Closed* should be next to each other.	Since the order of the modes was unclear it will be adjusted.
(R) Clearly convey its functions.	Update the words according to survey. Consider using symbols.	Done by words, symbols and illustrations of doors.
(S) Make it easy to change modes.	It should only take one step to change between auto and closed.	Add arrows to make the mode selections loop.
Easy to use	Clarify the SET button more.	Clarify the *Calendar* mode.

(R) Prevent mistakes.	Ensure a smooth transition to the app. No confirmation should lead back to previous mode.	Clear confirmation of changes. No confirmation should lead back to previous mode.
(R) Contribute to a welcoming experience.	Possibility of getting notifications in the checkout counter when something happens by the door.	N/A
(S) Function without complements.	Focus more on the knob only. Offer fingerprint authentication.	Offer face identification authentication.
(S) Enable the door to be adjusted both near and far from it.	Add possibility to change settings from checkout counter or by app (by for example service technicians).	Enable for service technicians to change settings from an app.
(S) Offer novelty value.	The design is sleek and pops out. New authentication methods.	The *Calendar* mode. New authentication methods.
(R) Counteract theft.	Anonymous design and requires authentication. Consider closing the door from the checkout counter in the information display.	Requires authentication.
(S) Able to perform adjustments independently.	N/A	The *Calendar* mode.
(S) Provide a clear connection between interface and door.	Illustrations on the information display.	Illustrations of the door modes.
(S) Enable adjustment of settings from the checkout.	Could be done from the information display in the checkout counter.	An addition of the ability to change the schedule from another device (maybe the app).

7.4 The third iteration

Once the user tests in iteration 2 were completed, enough insights were collected to create prototypes which could be tested by the end users. The goal of the third iteration was to implement the feedback and insights from the user tests in the second iteration to develop the prototypes to a state where they looked and worked like the intended solution enough for an end user to evaluate them. Also, an eco opening width option was implemented as a request from ASSA ABLOY. The eco option is a more environmentally sustainable alternative to the manual width settings for the doors such as *Auto partial* and will be the preset option for future solutions.

To enable the end user to rate the solutions equally, both prototypes needed to be on a similar complexity level. The display solution was already in its intended format as a prototype. Therefore, it looked like it worked even though it was not connected

to a door. However, the knob had previously only been tested as a Figma prototype even though it was a three-dimensional product. For this reason, the focus in the third iteration was shifted to create a physical knob that was interactive and represented the final concept in an understandable way.

Most of the important needs were fulfilled if the changes from the evaluation of the user tests were implemented. However, the latent needs were not fulfilled by limiting the knob solution to not include its complementary display screen. From the user tests in iteration 2, the screen in the checkout counter seemed like an unnecessary step in the trouble shooting process. However, the screen, or alternatively an app, could fulfill the latent needs which the knob by itself did not fulfill.

The user tests in the second iteration took a long time for the user to complete. During the third iteration, the intent was to develop prototypes which would be tested by the end user. Therefore, those tests could not take longer than 10-15 minutes to remain ethical and respectful of their time. For this reason, there was not enough time to test both the troubleshooting and the change of modes. The troubleshooting was not as crucial to the project which made the new development in iteration 3 only focus on the changing of modes.

Since the troubleshooting functions were discontinued, continuing to develop an information screen or app for the knob would be unnecessary in the third iteration. This could however affect the results of the evaluation of the concepts, especially in regard to the latent needs. Although, it was a necessary compromise that had to be made to enable testing and evaluating of the solutions.

7.4.1 **Symbol survey**

A symbol survey was created with the purpose of understanding how different illustrations and words were interpreted by different people. This was especially important prior to continuing prototyping to ensure that nothing confused the users. Two copies of the survey were sent out: one to retail stores and one to friends, family and other ASSA ABLOY employees. Unfortunately, only two responses were collected from the retail store employees making the results from that survey unusable. However, the generic survey gathered 22 responses which can be found in Appendix G.

The main takeaways from the survey in terms of the symbols was that the design chosen for the illustration screen with calendar mode in the previous iterations was appreciated, although not always the winning one. However, the symbols were kept, with some alterations, to maintain a consistent theme.

Regarding the concepts all winners were chosen except for *Locked* and *Auto partial*. *Closed* was deemed more suitable than *Locked* since the Swedish sliding door market requires the doors to be locked manually in addition to turning off their

automatic functionality. Also, the concept *Auto partial* had been associated with a high level of uncertainty during the initial user study and therefore the term *Auto narrow*, suggested by a respondent, was used.

The last question of the survey asked the users if they preferred only symbols or only text since the knob solution only can include one of the two. The results were quite even but leaned towards only using symbols. However, from the results of the user study it was found that the end users preferred text over symbols. For this reason, text was used to explain the modes for the knob solution in the third iteration.

7.4.2 **Prototyping**

7.4.2.1 The invisible knob with remote display

The goal of the prototyping in the third iteration was to create a knob that was similar to what the final prototype should look like and work like. It included a physical knob that was flush when a mode was chosen, a popping out function for the knob and light indications. It needed activation from the user to be able to change modes. To test that interaction, a prototype was created were the knob popped out once it was pushed. Even though it was not fully how the final product would work (unlocking by a tag), it was as close as it could get for a rapid prototype.

The knob could be turned, and a blinking yellow light indicated which mode the knob currently was pointing at. When the user had turned the knob to chosen mode, they could push the knob to set the mode and make the knob flush once again. The mode that had been chosen was lit up in white light. To make this possible, both mechanics and electronics was necessary. An electrical engineer at ASSA ABLOY helped out with the light's interaction. Besides that, the construction and mechanics was created using 3D printed parts designed in CAD combined with a mechanical part that enabled the turning and pushing in and out for the knob.

A first version was designed, 3D printed, assembled, and combined with diodes controlled by a programmed Arduino. See Figure 34. The lights worked according to the plan (even though they were in the wrong color), when the button was pushed from the flushed state it went from green to blinking red. However, the light did not cover the both the indicator and the text of the mode and made an unclear impression. The text turned out to be hard to read. Also, this prototype had no space for the electronics.

Figure 34: First version of 3D-printed prototype.

For this reason, another version was created by using CAD and 3D printing where the lights inside was placed further from the text to make the light more even and lighting up all intended areas. The space for the electronics were updated to fit all the electronic content (Arduino, cables, and diodes). See the updated solution in Figure 35.

Figure 35: Updated prototype of knob.

Since the physical prototype was limited to the mechanics, a Figma version was also created to get an understanding of the visuals and the full interaction. Changes were made according to the insights from the user tests, how the previous prototype was rated against the user needs, and design principles (Norman, 2013). The changes which were made from the previous iteration was the following:

- The word *Off* was changed to *Closed* due to responses from the survey and feedback from the user studies. Winter and summer options were changed to wide and narrow.
- *Auto eco* and *Closed* had larger indicators and were placed on top since they should be the most used functions, hence creating hierarchy through mapping and communicating to the user that these are the modes which should be used primarily.

- *Exit only* could also be used as either narrow or wide, with inspiration from the benchmarking. To make the structure logical, the modes were organized using mapping. *Exit only* was below *Closed* since it was used before the *Closed* mode was used. Wide was above narrow. *Auto* had the same structure mirrored on the other side of the knob, creating a larger space between *Auto wide* and *Exit only wide* than the space between *Auto narrow* and *Exit only narrow*.
- To increase the discoverability for user to push the knob once the mode is selected, the previous selected mode was still lit up in white. The mode the knob was pointing towards was blinking with a yellow color to signify that was yet not set and demands an action from the user. Also, the middle of the knob was slightly rounded inwards and lit up in yellow displaying "SET" as a signifier for the user to push in the button to set the mode.
- The knob could now be turned without any physical constraints on the button since many users wanted to be able to go both clock and counter wise when changing modes.
- When the mode was SET, it went back to the locked interface immediately without the previous stages in between since they seemed unnecessary and created confusion.

Parts of the illustrations used in the Figma prototype are shown in Figure 36. When the knob was locked, the current mode lit up in white, and a tag symbol was visible. Once a tag was present, the text and light indication changed to yellow. Dots appeared to communicate the loading of the authentication. If the tag was approved, everything lit up green to confirm the approval. The knob then popped out, which enabled and provided discoverability of turning the knob to change the mode. When changing between the different modes, it should feel like a click between each mode to create tactile feedback for the user. Also, the mode which the knob points towards blinked in a yellow color. When the user pushed the knob back in, the mode was set and the interface went back to 1), locked mode. The user was now unable to make changes until they once again used the tag to make the knob go from flush to popped out.

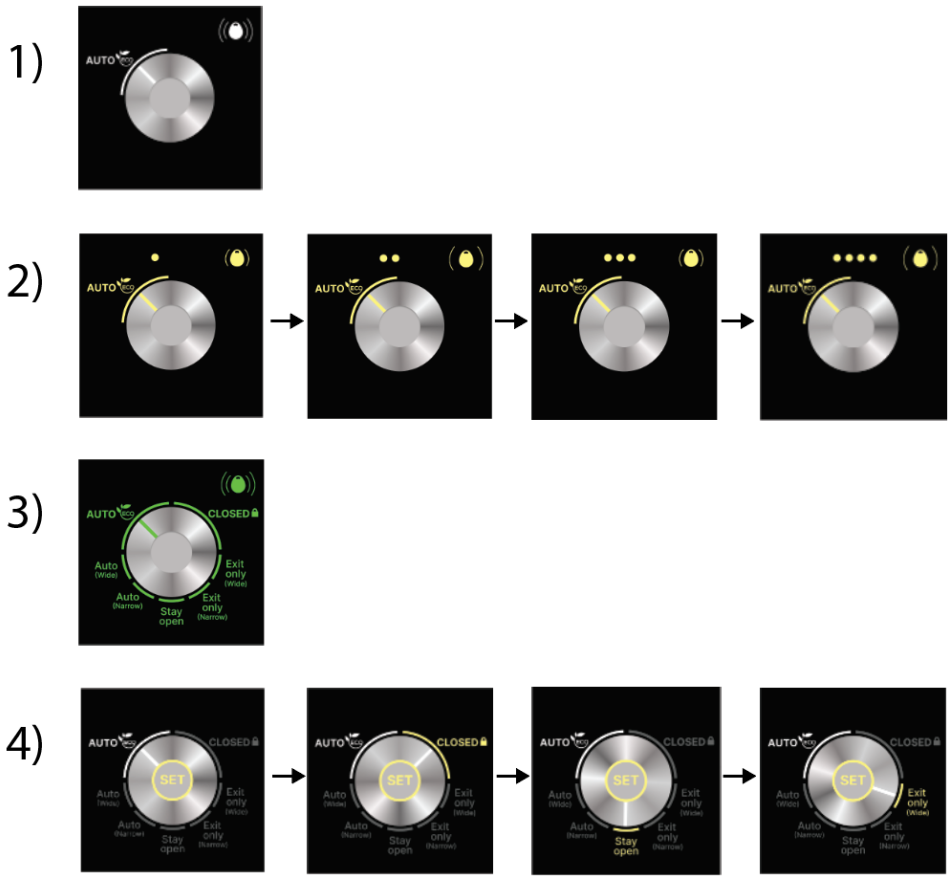

Figure 36: Figma prototype of knob; 1) Locked, 2) Loading after tag has activated unlocking, 3) Authentication by tag approved, 4) Knob is popped out, and can be turned between different modes.

7.4.2.2 The illustration screen with calendar mode.

The prototype of the display screen in iteration three remained its Figma format, but many improvements were made to solve the issues raised in the user testing phase. In addition, the user needs and design principles (Norman, 2013) were kept in close consideration while making the changes which are listed below:

- The authentication method was changed from face identification to tag identification.
- The number of modes was narrowed down from six to five, meaning that *Auto summer* and *Auto winter* was combined into *Auto*.
- Three options were added for the width and speed of the door opening for the modes *Auto* and *Exit only*, with inspiration from the benchmarking. These options were eco, wide and narrow.

- To improve the user feedback the difference between the viewed mode and the selected mode was highlighted by the dots above the confirm button. The yellow dot indicated the viewing mode while the white dot indicated the selected mode. These were swapped if a new mode was selected.
- The use of yellow and green was highlighted to further signify the difference between viewed and selected mode.
- An information bubble was added for each mode.
- The change mode button was swapped out for a timer function which made the screen automatically enter the locked mode if it had not been interacted with for a few seconds.

Many of the changes were made specifically to improve the calendar mode, these are listed below:

- The name of the calendar mode was changed from smart calendar mode to time installed mode, as requested in the symbol survey.
- The calendar mode was given a layout more similar to the remaining operating modes to ease interpretation and invite interaction.
- Since the users expressed a desire to click directly on the blocks in the calendar mode and edit them, this functionality was added. While in this mode the users were able to edit the operating mode, number of blocks, and start and end times for each block. All of these with fewer steps than in the second iteration.
- The changes to the schedule could be saved to different days: today, every day, each Thursday, or each weekday.
- A drop-down curtain menu with an arrow was added to signify where to find the schedules for the remaining days of the week. This replaced the symbol used in the second iteration that was not widely understood.

Parts of the illustrations and sequences of the Figma prototype for the display solution are visualized in Figure 37.

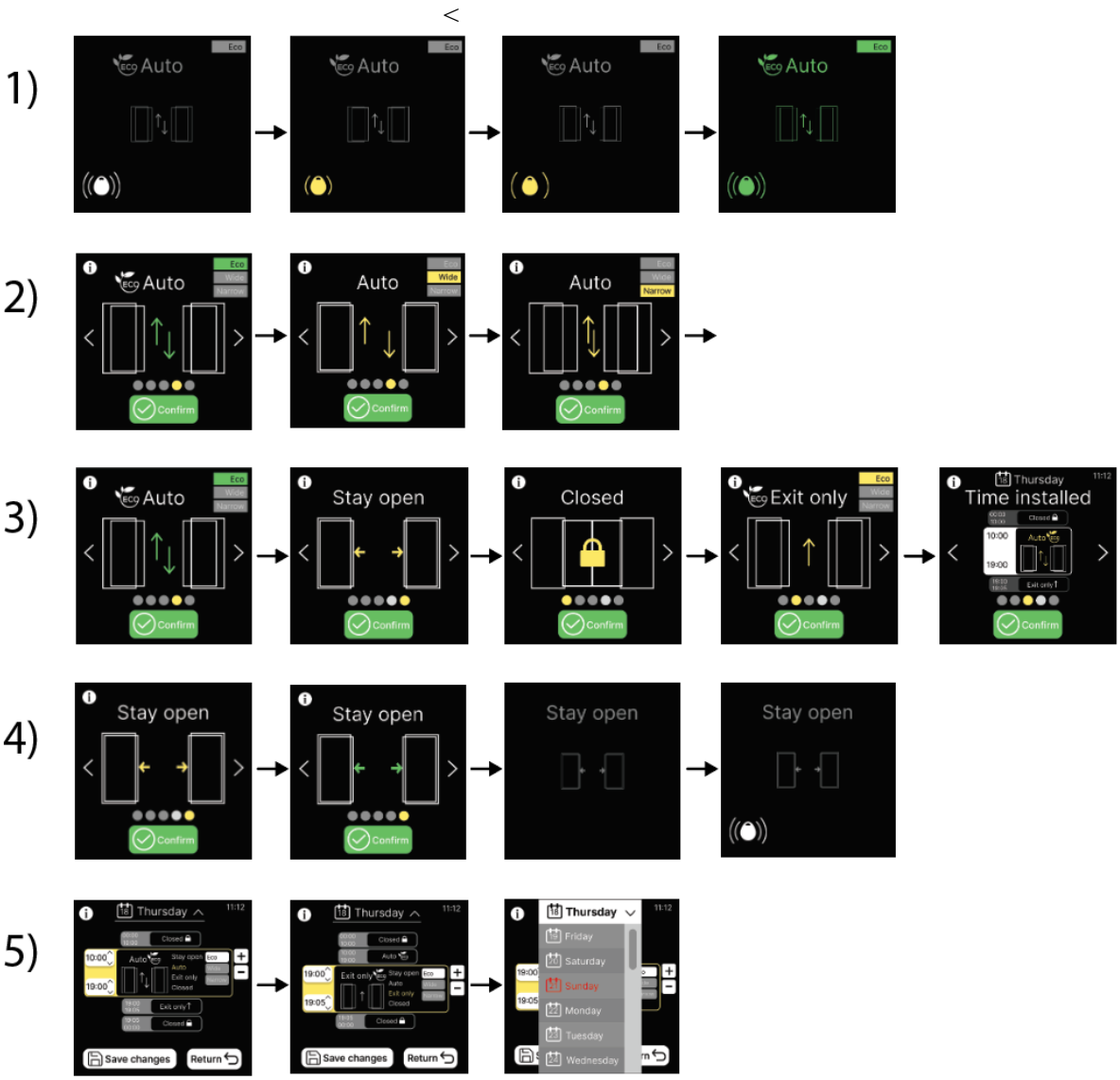

Figure 37: Figma prototype of display; 1) Unlocking while scanning tag, 2) The three different options for Auto mode highlighted by door illustrations with different widths, 3) Swiping between the five mode options while Auto eco is the current mode. 4) Clicking "confirm" and selecting *Stay open*, 5) Clicking on the calendar blocks to edit them.

7.4.3 **User testing**

In the third iteration the prototypes were ready to be tested with the original end users. The methodology was similar to the user testing in the second iteration, but simplified to ensure that each test would be short, maximum 10 minutes per test. A test plan was constructed and printed out for each prototype to make the test portable which was crucial since the users were unable to book a specific time slot and walk away from their work duties.

Eight users from four different stores took part of the user tests. Stores which were not very busy were chosen since no time was booked beforehand, but the type of store was not a deciding factor. Some of the participants recognized the project from the earlier user study. When users were approached, they were informed about the background and the confidentiality of the user tests. After confirming their voluntary participation, they were presented with the two prototypes. For each prototype, a set of short assignments was given to the users, and they were continuously asked questions. For the majority of the tests, they were allowed to click and interact with the prototypes in whatever way they wanted to. By using a think aloud process, their actions and thoughts were noted. The users only tested to change modes. The solutions which included troubleshooting and "extra features" were excluded in the test due to respect of the users' time. After the tests were completed, they were asked to fill out a form where they rated the two concepts. The results are presented in 7.4.5.

7.4.4 **Insights**

Following observations were made from the user tests:

Knob solution:

- When testing the physical knob, it was not clear that the first action required was to push the knob. Instead, people tried to turn the knob in the flush state or touch the words directly. Once they could turn the knob, the interaction was smooth.
- Not everyone pushed the knob back in to set the mode.
- They appreciated the feedback of light indication, enabling them to see the mode that has been set from a distance.
- The interaction was similar to the existing key solution, making it easy to use for people already using the existing product.

Display with timer:

- When testing the display solution, the action of changing between modes goes smoothly.
- The graphics seemed clear and self-explanatory.

- The function of the timer mode was understood quickly. Users had trouble with changing the time, they wanted to change it directly on the first page. Also, they wanted to be able to choose between standard opening hours.
- The automatic changing of modes to *Exit only* was expressed as valuable for the rush before closing time.
- Some users did not push confirm, they swiped to the desired mode and considered the mode to be set. When discussing the confirm button, some users thought of it as an unnecessary extra step. Others considered the confirm button as a clear confirmation of completed action.

Since the knob prototype was limited in complexity, it had no light indication on the knob as a signifier to push it. It could be an explanation for why it was an issue to find out that the knob should have been pushed. Otherwise, the prototype of the knob seemed to be understandable enough to indicate how the final solution would look like and work like.

For the display solution, the main issue remaining was that the end users did not want to use the confirm button. During the user tests in the second iteration, the confirm button was mostly used as intended. However, the end users seemed to prefer a faster interaction with fewer steps. Moreover, the timer function did not fully comply with the user's mental model.

Both solutions were considered to be better than the existing solutions according to all users participating.

7.4.5 **Individual evaluation form**

In addition to asking questions and writing down observations during the user tests, each user was asked to fill out an individual evaluation form which was printed out. The purpose of the evaluation form was to receive user feedback systematically to enable comparison of the data.

Five questions were formulated based on the most important needs (***) according to Table 4. Two of the most important needs, *highlight problems and their causes* and *operate without supervision*, were excluded from this evaluation since the display screen for the knob was discontinued and the troubleshooting functionalities were not tested. The users were asked to rank each statement on a scale from one to five, where one indicated that the statement was false and five indicated that the statement was true. The results from these questions are displayed in Figure 38.

- Question 1: It was easy to change the mode.
- Question 2: I received confirmation that the mode had been changed.
- Question 3: I felt confident that nothing could go wrong.
- Question 4: It was always clear which mode the door was set to.
- Question 5: The modes were arranged in a logical way.

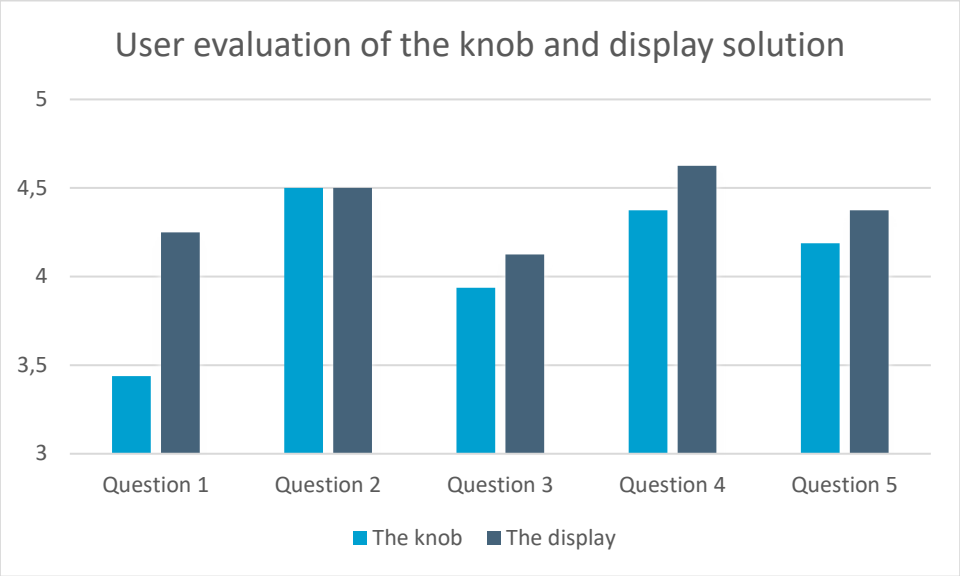

Figure 38: User evaluation of questions 1-5 after user tests.

Lastly, the users were asked which solution they preferred. This was done though a 0-10 evaluation scale, where zero symbolized the knob solution and ten symbolized the display solution. After summarizing all answers, the resulting number was 7.8. When asked which solution the users preferred, seven out of eight users strongly preferred the display solution.

8 Deliver

The purpose of the deliver phase (see Figure 39) was to refine and fully define the concept that was chosen during the develop phase. A few final adjustments were made and tested by end users before defining the final solution completely.

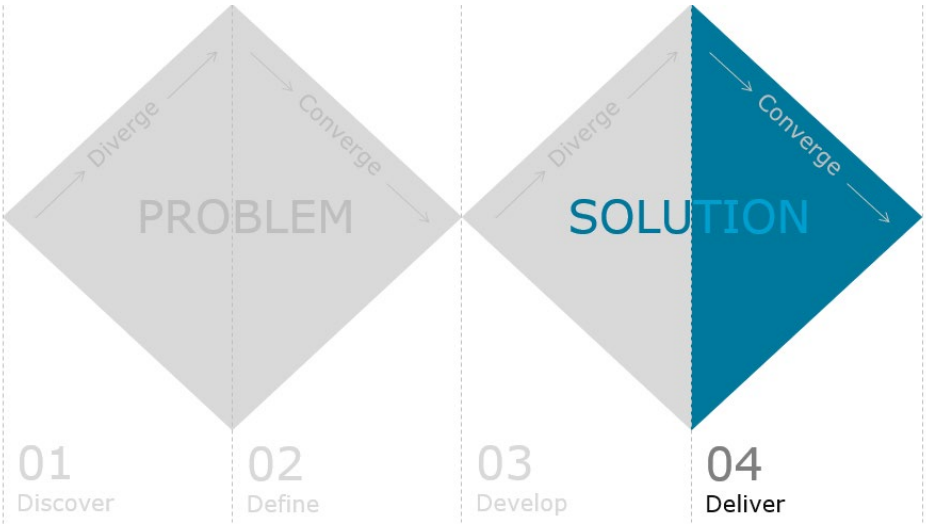

Figure 39: Double diamond illustration of the deliver phase.

8.1 Refining the prototype

The user evaluation in the third iteration resulted in one winning solution for further development: the display solution. To deliver a quality prototype that addressed the feedback from the user testing, a few additional adjustments had to be made. These are listed below. An overview of how the refined prototype looked like can be seen in Figure 40.

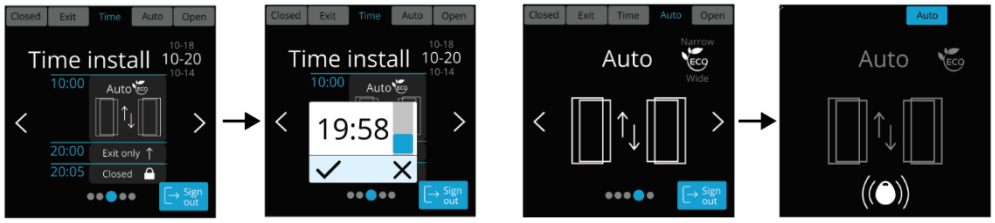

Figure 40: Figma slides with updated design; time installed page, changing of time, new layout for the modes, updated design for locked screen.

- The confirm button was removed. The motivation for this change was:
  - (1) The user needed to perform fewer mandatory steps. This was a user need, *contain few steps*, see Figure 13.
  - (2) In iteration 3 the users seemed to think the mode was changed once the name of the mode and the symbol appeared on the screen, and therefore did not feel the need to press the confirm button. This addressed the user needs *make it easy to change modes* and *prevent mistakes*, see Table 4.
- A button for signing out was added. This was not mandatory but worked as a shortcut for the users who wanted to enter the locked mode faster.
- The layout for the time installed, or calendar, mode was changed:
  - The scheduling options were changed from different days of the week to different opening hours for a retail store. The options created for the user tests were 10-14, 10-18 and 10-20. This change was based on suggestions from the users.
  - The start and end time for each block in the time installed, or calendar mode, was made editable in the home screen instead of having to enter an additional edit screen.
  - Changing of modes within the schedules was no longer possible. It was deemed both unnecessary and out of authorization for the most common user (a regular retail store employee).
- Boxes for each of the five mode selections was added on top of the screen to:
  - (1) Provide feedback and signify which mode was active.
  - (2) Show all possible modes.
  - (3) Allow the users to immediately enter another mode without having to press the arrows.
- The information icon was removed. The same pop-up window appeared if the title of the mode was pressed instead.
- The circles on the bottom of the screen which signified the swiping functionality were made smaller, except for the one for the active mode which was enlarged.

- The buttons for eco, wide and narrow were exchanged for a swiping selection.
- The color scheme was adapted for ASSA ABLOY colors, such as blue and white.

8.2 Evaluation

8.2.1 **User tests and individual user evaluation**

The purpose of these tests was to investigate if the refinements which have been implemented made an improvement of the user experience. The user tests were conducted similarly to the user test in the third iteration, see Figure 41. Five end users from three different stores participated in the tests. After they tried the prototype, they filled in the same evaluation form that was used in the third iteration and rated the solution.

Figure 41: User tests after refinements with end user.

8.2.2 **Insights**

Following observations were made due to the refined changes:

- The implemented shortcut buttons on the top of the screen were used in addition to the arrows to change between modes.
- The schedule seemed easy to understand. However, users wanted to be able to not only change minutes but also hours directly in the schedule. Few saw the hours option in the right top corner.

- Not everyone noticed how they could change between eco, wide and narrow. When getting tasked to do it, some of them instead tried to drag directly on the door illustrations or touch the illustration, waiting for a pop-up menu.
- When the users had swiped to a mode, they considered their task of changing mode completed. Few people used sign out.
- The automatic switching to *Exit only* in the time installed mode was highly appreciated.

The results from the individual user evaluation compared to the results from the third iteration are displayed in Figure 42. The questions were the same as used in the third iteration, see 7.4.5. For question one, four and five the refined solution received a higher score. Meaning, it was easier to change mode, it was more clear which mode the door was set to, and the modes were arranged in a more logical way. The removal of the confirm button could explain why the clarity of which mode the door has been set to had improved. The mode that was displayed on the screen was continuously the mode the doors were set to. On the other hand, question two got a lower score. Meaning the user perceived less confirmation of that the mode has been changed. An explanation for that could also be the removal of the confirm button.

In conclusion, having the confirm button slightly increases the confirmation of that the mode has been change. On the other hand, it decreases the clarity of what mode the door is currently in. Also, it adds an extra step after the users perceives the task to be completed. For this reason, it is arguable to have the confirmed button removed.

The score for question three, regarding how certain the users felt that nothing could go wrong, remained the same. During the user tests, the argument for the scoring was that it had to do with the format rather than the graphical user interface. In general, people did not always trust displays and electronic equipment to function without errors.

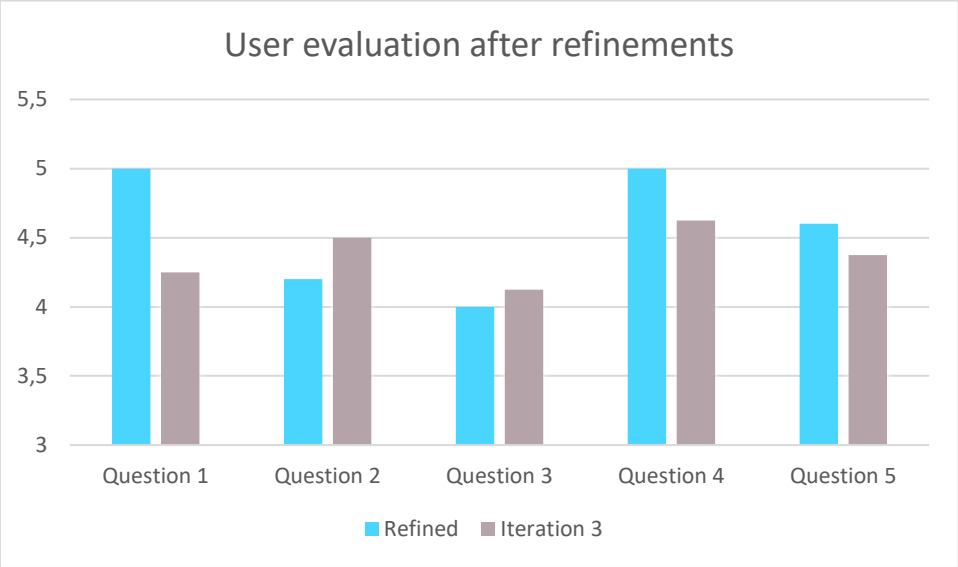

Figure 42: Results of the user evaluation of the display solution, iteration 3 compared to the refined solution.

When comparing the user tests from the third iteration to the ones made after the refinements to the design, the usability of the prototype was increased. The system was easier for the user to learn on the first try without having the confirmation button which was often forgotten. Overall, users of various ages and technical knowledge learned to use the system on the first try. The maneuver of the system was made more efficient, and it was a fast procedure from the users receiving assignments of changing modes to the completion of the task. Compared to the knob solution tested in earlier iterations, the interaction with the screen solution was often more efficient than the user interaction with the knob. Memorability was not tested since the user only tested the prototype ones. However, due to good learnability it could indicate a high memorability. When testing the error interaction, it was easy for the user to recover from the error and receive desired information. In general, the user satisfaction rate was high, even higher in comparison to the third iteration. The time installed function and the graphic illustrations was something the users was highly satisfied with and liked. To summarize, the usability of the refined prototype was good.

8.2.3 **Final changes**

The last additional changes made to the prototype are listed below:

- To confirm that the mode had been changed the words “Mode is set” and a confirm symbol was added to each slide.
- The delay time before entering locked mode was increased.

- The shortcuts, or opening hours option, for the time installed mode was removed.
- The hours and minutes were made editable separately in the time installed mode, and the changes made could be saved.
- When clicking on the door symbol for *Exit only* and *Auto*, the options for eco, wide and narrow appeared.

8.3 Presentation of Final Concept

After implementing the final changes in the prototypes, a final concept was created. The concept included an authentication process to enable the change of modes, an interface for when an error occurred and other functions and explanations for how the whole concept would work. See how the final concept would be implemented in relation to the sliding doors in Figure 43.

Figure 43: Prototype installed on the wall next to sliding doors. Produced in Adobe Photoshop.

8.3.1 **Authentication**

When the screen is in resting mode, it is locked and cannot be interacted with. While the screen is locked, it displays its current status through a graphic illustration combined with a text in grey. When a preprogrammed tag is put nearby the screen, the screen unlocks (see Figure 44).

Figure 44: User holding a tag towards the prototype.

The tag could be exclusively used for the screen, or it could be a tag already in use for another purpose. To visualize the unlocking, the tag symbol turns yellow and eventually green when the authentication is approved (see Figure 45). Once the screen is unlocked, the user can change between different modes. After there has been no interaction for 25 seconds, the screen locks and the user get automatically logged out. If the user wishes to manually logout and lock the screen, a sign out button is available during the change of modes.

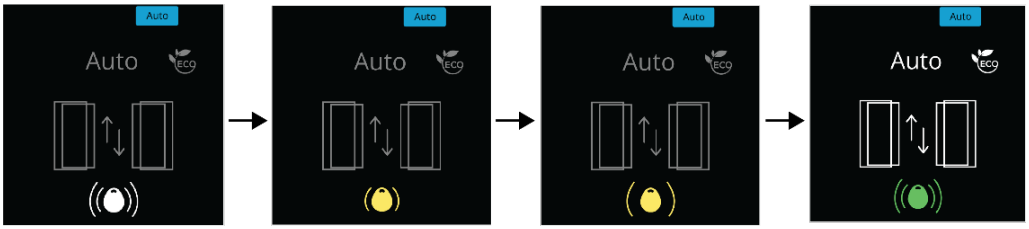

Figure 45: Authentication process in final prototype.

8.3.2 **Mode selection**

When the user is authenticated and logged in, the user can change between different operating modes for the connected sliding doors through the screen. The first screen that appears is the mode for which the sliding doors is currently in. To change between different modes, the user could either swipe left or right, push the arrow buttons or push the square buttons on the top of the screen to navigate to the displayed mode. When the user swipes or pushes the arrow button, they are directed to the next mode according to the order of the squares on the top of the interface. See Figure 46.

Figure 46: Mode selection in solution.

There are five main modes to choose between:

- *Closed*
- *Exit only*
- *Time installed*
- *Auto*
- *Stay open*

The actual mode of the sliding doors is controlled through which page that is currently displayed on the interface. If the illustration of *Stay open* is present, the doors should be set to the *Stay open* mode, see Figure 47.

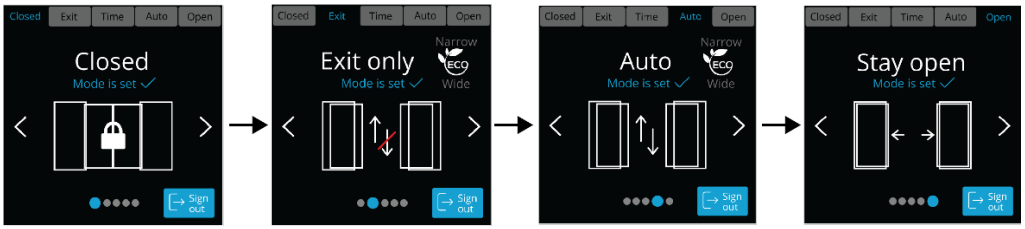

Figure 47: Switching between the modes *Closed*, *Exit only*, *Auto* and *Stay open*.

Once 25 seconds has passed by, or the user pushes the blue sign out button, a signing out screen appears (see Figure 48). The screen is visual for 4 seconds, and then the screen goes back to its locked state displaying the doors current status (see Figure 45). The signing out screen contains a green text informing the user that they are signing out, and what mode the doors are set to. The mode set for the sliding doors is always the mode the screen displayed prior to locking.

Figure 48: Graphical interface after signing out.

For the modes *Auto* and *Exit only*, the door width can vary between a narrow opening, a wide opening and opening width more optimal for energy savings (eco). When the user changes between the different modes, eco is always the suggested opening width and is preset. However, if the user wants to change the width of the door opening they are able to do it in two ways. In the right corner next to *Auto* or *Exit only* the three options are visible (see Figure 49). The user can change between them either by pushing the desired width (narrow, wide, or eco) or by scrolling through them. When a new width is selected, the illustration of the door is updated to illustrate the new door opening width set. The other option is to push the

illustration of the door. A pop-up menu will then appear (see the right picture in Figure 49) and the user can change between different opening modes in the same way. If they want to keep the changes, they can push the confirm button and the illustration will be updated. If they don´t want to make any changes, they can push the cross and the screen will turn to its previous state.

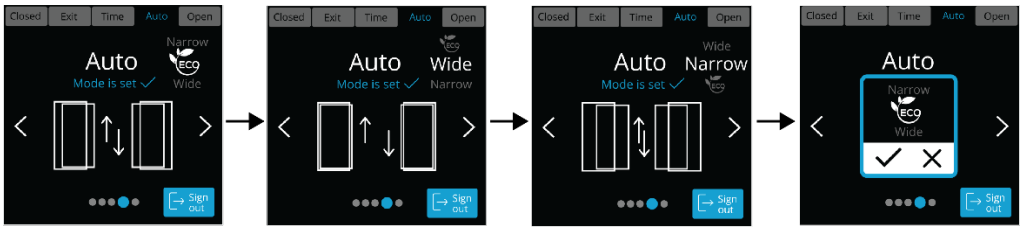

Figure 49: Changing the settings of the doors opening width between narrow, wide and eco.

If the user wants to know more about each mode, they can push the label of the mode and an information pop-up will appear, see Figure 50.

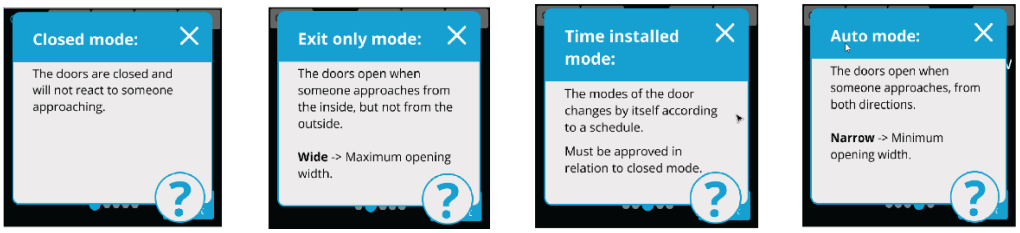

Figure 50: Information pop-up for the modes *Closed*, *Exit only wide*, *Time installed* and *Auto narrow*.

8.3.3 **Timer installed**

Apart from the modes *Closed*, *Exit only*, *Auto* and *Stay open* a timer installed function is added. The timer function can be found either by swiping from *Exit only* or *Auto*, or by pushing the top square button saying “time”. Similarly to the other modes, the timer installed function is set once the user switches to the page.

The timer installed function is pre-installed time dependent mode selection, where the doors are automatically put to the mode *Auto eco* at opening time. Thereafter, the mode is automatically changed to *Exit only eco* a few minutes before closing time and is eventually switched to *Closed* mode (see Figure 51).

If the user wants to change the suggested time for opening, *Exit only* and closing they can simple push on the displayed time. A pop-up will then appear where the user can scroll between what hour or minute the selected mode should start that particular day (see second picture in Figure 51). Changing the times will not affect the suggested times for any other day. If the time for switching to *Exit only* or *Closed* is changed, the other one will automatically follow. For example, if the closing time

is changed to from 18:05 to 19:05, the *Exit only* time will follow the same pattern and change from 18:00 to 19:05.

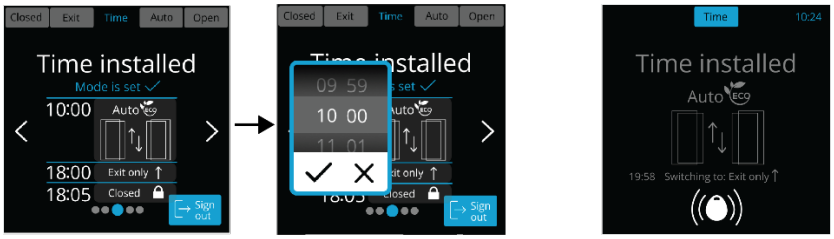

Figure 51: Time installation function.

At closing time, the doors will not close and lock until confirmation is given from the user. When the doors are in *Exit only*, and it gets closer to the closing time a pop-up will appear as in the left picture in Figure 52. The user must then confirm that everyone is out of the store and confirms by putting the tag towards the display. Then the preset schedule will continue as intended, with closing the doors.

The next day, the timer installed function needs approval from the user to allow the doors to open at the given time. For this reason, they are met with a message displayed in the third picture in Figure 52. The users give their approval by using their tag any time before the opening in the morning. Preferably, this is done at the same time as the user is unlocking all the physical locks.

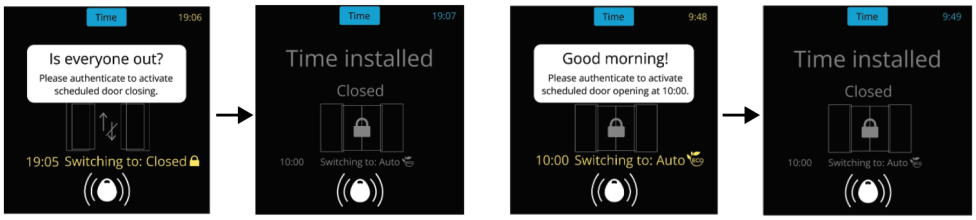

Figure 52: Authentication notice for opening and closing when using the time installed function.

The schedule is preset to standard opening times. These are connected to what day of the week it is. For example, the store might have shorter opening hours on Saturdays. The timer function will then suggest the preinstalled Saturday opening and closing times when using it on a Saturday. To change the suggested opening and closing times for each day of the week, the user needs to be a manager or for some reason be allowed that access. Regular users can only change the time for the present day.

8.3.4 **Error function**

When an error with the doors occurs, an alert is seen on the display. The mode which is still set to the doors are communicated from the blue square on the top of the

screen. When the user unlocks the screen with the tag, they are filled in with more information on the issue and receives a graphical illustration of what and where the problem is in relation to the doors (see Figure 53).

Figure 53: Error message for solution.

In this example, there is an object in the way of the door and the user is asked to remove it. However, the explanation could be applicable for all error codes. There is a *Reset* button available which can be used to reset the OMS. On the menu bar to the right, the user can find and extended menu which offers help with reporting the issue, chat assistant or finding the error log. Once the problem is fixed, the last picture in Figure 54 appears, confirming the issue has been solved.

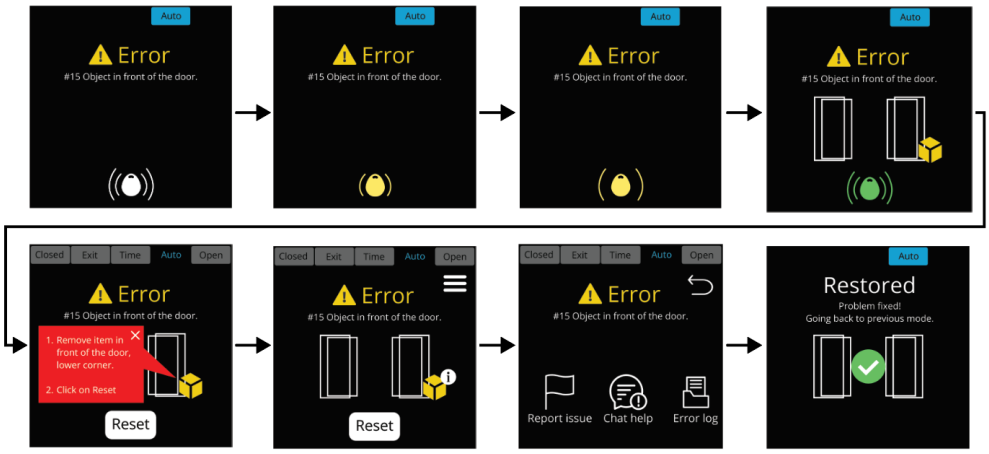

Figure 54: Interface for when an error occurs.

8.3.5 **Other functions**

Except form the above-mentioned functions, the solution includes more aspects which are not designed for the prototype:

- The design can be adapted for different door systems. The graphics of this design is designed for automatic sliding doors. However, the designs should look different for single side opening doors, or telescopic automatic sliding doors.
- The opening hours which are preset in the schedule could vary depending on the standards in the target location.
- To fulfill the needs for the service technicians, they could connect to the display through an app. In the app, they are able to override the OMS and change between the different modes. Also, they will gain more detailed error information. Preferably, they could get access to the error information from a distance whenever a user reports an issue.

8.4 Future improvements and recommendations

There were some functions and user needs which were not implemented in the final solution, and which preferably should be implemented in further development of the product:

- The word eco is used. However, it was not investigated how and if that word could be used or if it is a protected concept.

- Creating an information display for the checkout counter fulfilled several user needs, especially if it could prevent theft. For this reason, it is recommended to keep developing that product.
- Users wanted to be able to change the mode from the checkout counter. If there is a technical solution to that user need, it is recommended to install the OMS in the checkout counter.
- It is recommended to develop the app for service technicians.
- The Error function needs to be updated to enable the user to change the doors to either *Closed* or *Stay open*, so that they can open and close their entrance even though the issue is not resolved. Also, it needs to be more developed in general and adjusted to the different error codes and consider input from the service technician for which error the user can fix themselves, and which calls for a service technician.

9 Discussion

In this chapter the project is discussed including conditions for the thesis, the process, the method and the results.

9.1 Conditions for the thesis

The scope of this master's thesis was to design a concept for a user interface using design methods and a user experience analysis. Since the concept would depend on the users, their needs and the uncertainty of a design process, the result could not be defined in the beginning of the project. This allowed creativity and freedom in the concept generation phase. However, technical, and economic feasibility did end up affecting the outcome slightly to ensure that the final solution did not differ too far from something that could be developed further and implemented in the near future. An example of a concept that was dismissed because of this was enabling changing the mode of the door from the checkout counter. This was a requested feature from the users, but despite this ASSA ABLOYs' service technicians explained that it was difficult to implement since it required more electrical wiring and a clear field of vision from the OMS to the doors. Also, many users expressed that it was logical for the OMS to be placed next to the doors since it belonged together with the door. The combination of how it was logic for the mental model to have it placed next to the door, and the simple installment led to the decision to have the OMS placed by the door. However, insights like these are still valuable and could hopefully be implemented in future solutions.

Environmental sustainability was not a deciding factor in this project, however during further development it should be considered to ensure that the product can last long term. This includes analyzing the production methods, material sourcing and energy consumption. The touch display, in comparison to the current plastic key solution, could become unmodern quicker, but if the user interface is updated it might last longer. Although this is a risk with the suggested solution, graphical user interfaces are very common today and is therefore a necessity to comply to modern trends.

The user group in the project was limited to one of ASSA ABLOYs main customer sectors, the retail sector. This in combination with the geographical limitation of users living and working in Sweden helped to execute the project for practical

reasons. The end result is well adapted for the specific user group with over 40 end users included in the study, and could with some changes also apply to other customer sectors and geographical locations. Taking this into account, language options, legal requirements and customizable features should be considered in the next development phase. For example, the concept “closed” which is used in the Swedish version, could be swapped out for “locked” in countries that do not require mechanical locking in addition to the OMS locking system.

During the project, sliding doors of all models and brands were considered while conducting the user study and user tests since these aspects were not considered to affect the main functionality of the OMS. However, the users had different experiences with their current door system and OMS which could have affected their response during the interviews and tests. Since most sliding door systems have similar functionality, this factor was deemed insignificant for the outcome.

Lastly the time limitation influenced the project and its outcome. The project followed a time schedule which had allocated weeks towards ideating, prototyping etc. Since the project was based on a user experience analysis, the user study was quite time consuming, and the prototyping sessions had to be limited. In the end the prototypes were sufficiently advanced, but with more time they could have been improved even further. Time also affected the quantity of interviews and tests that could be conducted with the users, both from the projects’ perspective but also from the users’ perspective in terms of when they could take breaks from their work duties.

9.2 Process

Since the purpose of this project was to conduct a user experience analysis and develop a design concept that appeals to the user, the double diamond process was an appropriate method to use. The four alternating divergent and convergent phases allowed for both creative thinking and quick decisions, and the distribution between the phases ensured that all parts of the process was dedicated sufficient time and effort. A focal point in both UX design and the double diamond process is understanding the users, their needs and ensuring that the needs are met in the end. Therefore, the methods within the process in combination with design thinking helped empathize with the users which resulted in a solution well adapted for them. This in turn distinguishes the process and the solution from one that was pursued from a technical innovation perspective. If the timeframe was to be extended the final concept could be improved further by spending more time prototyping and user testing, although three design iterations was enough for the purpose of this master’s thesis.

9.3 Methods

9.3.1 **Discover**

Prior to conducting the interviews, the users' response to participating in them was uncertain. To remove some of the pressure associated with preparing an interview session ahead of time, the participants were approached spontaneously. This made the interviews lighthearted but could have comprised the ethical principle of properly respecting their time and could have made their decision to participate impulsive instead of entirely voluntary. However, the ethical principles were considered as strictly as possible, and every user was informed that they could retract their consent at any time without an explanation.

Every interview followed the same template, but since the duration of the interviews depended on the users' availability during working hours the quantity of questions and quality of responses was inconsistent. Some of the questions were also revised if they were deemed unnecessary or if the users felt uncomfortable in answering them. For security reasons many users denied answering questions regarding opening- and closing routines, and therefore they were only asked if the user mentioned the subject themselves.

The focus groups were harder to form than the short interviews since they required more than one participant, an undisturbed environment and took longer to complete. The main advantage of conducting focus groups was to receive the users undivided attention and gain a more in depth understanding of the users and their motivations. The focus was aimed more towards the users rather than their relationship to sliding doors or the OMS, both of which had been covered in the shorter interviews. This allowed one of the focus groups to be with users that lacked primary experience of working with sliding doors. In regard to the ethical principles, these could be properly discussed prior to starting the interviews with clear consent from the participants.

The user study with the secondary users, the service technicians, was not as extensive as the user study with the primary users. This was a result of time and project scope limitations. However, the interviews that were conducted provided useful insights into the product and provided user needs that if addressed would enhance the experience for the primary user as well. These needs mainly concerned the error functions and how the errors could be displayed.

The interviews with other departments within the ASSA ABLOY concern provided insights into the product as a whole from product development to sales. These insights could not be immediately transferred to user needs, but provided valuable background into the product, its history and its relation to different departments working tasks.

A primary need from ASSA ABLOY was to create a more modern looking solution. When analyzing the competitors in the benchmarking, some of them provided a more modern and elegant design in comparison to ASSA ABLOY. For example, the OMS from Doorson and FACE was conceived as more modern by the team. Even though the OMS from ASSA ABLOY is similar to the OMS from FACE, there is a significant difference in the design language. The program selector with key from ASSA ABLOY also has a more outdated look if it is compared to the Doorson knob solution.

Another discovery from the benchmarking was that competitors used exit only partial as a mode. This was an inspiration for applying a variation of opening widths for the final solution.

9.3.2 **Define**

The combination of quantitative and qualitative analysis provided a well-grounded basis for defining the user needs. However, the extent of the user study provided a large quantity of customer statements which had to be sorted. This was done through the method affinity diagramming. This was very time extensive, but properly dedicating this time to sort through the statements in sessions provided a thorough understanding of the problem statement, especially since the first round of sorting provided categories based more on verbal phrasing while the last round of sorting came closer to defining the fundamental needs.

Maintaining the traceability of the customer statements ensured that they could be grouped into categories that related to more than only one user. The needs from the primary (retail employees) and secondary (service technicians) users were combined but also separated since their needs did not always align. This ensured that the main user for each need could be traced which influenced the concept development and evaluation phase since the design could not appeal to both users as much. In another project the secondary users could be made primary users to design something that better fulfills their range of needs.

Ulrich and Eppinger's method of identifying user needs was used. Another method discussed within the team was to instead perform a function analysis (Wikberg Nilsson, Ericson, & Törlind, 2015), which includes defining what functions the final product should fulfill. The functions would then be assigned as a main function, part function, sub function or unnecessary function. Since the amount of data and groups already were large and complex, a function analyses were considered to be a to narrow method. Defining one main function, and a couple of part functions would exclude important findings in the interpretation of user needs. For this reason, the method of identifying customer needs (Ulrich & Eppinger, 2016) was chosen and applied. It was also an efficient method for dealing with the large amount of data, without loosing the depth of it.

The challenge in one sentence that were formed in the end of the define phase could not include all the most important needs and was therefore somewhat of a trade-off. However, this was a converging phase according to the double diamond methodology which was a good preparation for the ideation phase that followed.

9.3.2.1 Personal bias

The project was completed with the goal to not be subjective to bias. This was a challenge since the customer statements, although mainly direct quotes from users, had to be interpreted into needs. By understanding the surrounding factors contributing to the choice of wording, carefully formulating the questions aimed at the users and by using a design mindset this was done as successfully as possible. It was not possible to completely erase personal bias, but by continuously taking it into regard and questioning the answers in the eyes of the users, this was almost done.

9.3.3 **Develop**

9.3.3.1 Ideation

Conducting brainstorming workshops instead of only brainstorming individually allowed for a wider range of ideas. Since the workshops were executed differently and had different participants, they resulted in different kinds of ideas. The first workshop with engineers was carefully planned to ensure that the participants would think outside of the box, which worked out well. The second one required less preparation since the participants were already familiar with design thinking, and it resulted in more concrete ideas. Lastly, the individual brainstorming was done to reach for further ideas and cover gaps in user needs that had not yet been considered. It became clear that the user needs that were prioritized in the workshops were the most relevant to the primary user since the ideas from the individual brainstorming ended up being too extensive to continue developing. However, the idea generation phase ensured quantity over quality.

The secondary users, the service technicians, were not primarily included in the ideation. However, some of the functionalities included considered their needs such as the error detection and use of application. This compromise together with the limitation of not fulfilling all user needs influenced the concept generation phase since the solutions had to be prioritized and limited. Regardless of this, the concept generation was performed iteratively to ensure that as many ideas as possible were considered.

The overall solutions were created from parts of diverse ideas that would appeal to the end user. Since some of the users expressed that they were uncomfortable with advanced technology and unfamiliar solutions, the more out of the box and futuristic ideas were scrapped. This user centric approach was important and returned to many times in this part of the process. In the concept scoring phase two solutions were

created to enable comparison during testing and therefore avoid "The Pathos Problem" (Fitzpatrick, 2014) of accidental approval-seeking which can be strengthened when presenting users with only one solution. Although developing two separate prototypes, instead of one, did require more work and time in the prototyping phase. This was important to ensure good ideas were not dismissed too early in the process, and it enabled ideas to be tested in different ways between the mechanical and the digital prototype to ensure the functionality was used optimally.

9.3.3.2 The first iteration

The biggest challenge during the first iteration was to actualize the ideas into prototypes that could be tested with fair comparison. From the beginning the display solution had an advantage compared to the knob solution since it was easier to replicate the final look of a user interface compared to a mechanical solution with electrical components. The prototypes needed to be able to communicate its functions without verbal explanation. The prototypes in iteration one was of very low fidelity but provided a good basis for the following iterations.

9.3.3.3 The second iteration

The second iteration still consisted of relatively low-fidelity prototypes that were more looks like than works like, but the iteration was significant since it helped define what functions and elements that should be kept or disregarded of. For example, the information screen for the knob solution was removed and the authentication method was limited to using a tag since it was the most practically feasible option.

The structure of the user tests also helped highlight the main areas of improvement and provided valuable feedback from users that had not previously been involved in the brainstorming process of the project. This resulted in some new perspectives. Not testing with end users at this stage of the process was a conscious decision since the prototypes did not perform well enough to test with retail employees who did not have enough patience and time to spend on testing something that was half-finished.

9.3.3.4 The third iteration

The dispatch of the symbol survey initiated the third iteration which led to a few changes in the prototypes, but nothing too significant. The survey mainly confirmed the comprehension of the symbols previously chosen for the prototypes. Unfortunately, the survey did not reach enough end users to be able to use their feedback, but since the survey mainly concerned the general comprehension of symbols, the feedback from friends, family and ASSA ABLOY employees could be used.

The knob solution was subject to the most changes in this iteration to make it more works like, similar to the display solution. Despite major improvements it remained restricted in comparison to the display prototype since the proper functionality and

appearance could not be achieved. The difference in fidelity could have affected the results from the users' individual evaluation following the tests, despite explaining that the prototype was not final. However, this could not be avoided and in the end the users' decision was the most important.

Furthermore, it was unclear for the user that they needed to push in the knob to select the mode. On the physical prototype, no intended light was added in the middle of the knob to signify to the user that they needed to push in the knob. Also, it was not investigated if the action of pushing in the knob could be removed, allowing the user to only turn the knob to change mode. If these changes have been implemented, the results might have differed. For this reason, it is recommended to investigate solutions for the issue of confirming the mode if the knob solution is further developed.

Generally being able to test with the users was extremely useful in ensuring that their feedback and opinions were considered while choosing the winning concept. The team was slightly worried beforehand that the end users would not have time nor be interested in participating in the user tests. However, once one employee in a retail store participated in a user test, it prompted more people to try it as well. All users seemed interested and eager to share their feedback on the prototypes.

9.3.4 **Deliver**

After the third iteration, the initial idea was to make some last refinements and then consider the prototype deliverable. However, since mayor areas of improvements were discovered during the user tests in the third iteration it was not considered enough to only rectify them in the final prototype. In addition to the updated design, it was necessary to perform another round of the same user tests which was performed in the third iteration, but with the redesigned prototype. The reason was to confirm that the new design had better usability and fulfilled the user needs in a higher degree. It resulted in measurable data, making it clear that the updated design had a better usability and better fulfilled the user needs.

Some of the final design decisions made were based on ASSA ABLOY's design guidelines, such as using the colors blue and white. These guidelines were not mandatory to follow but helped visualize who the product was designed for.

Future improvements are presented in chapter 8.4. They are necessary to take into consideration if decided to keep working on the project and implementing the product. The prototype is only a part of the whole concept and is not fulfilling all user needs on its own. Also, new product opportunities were found which could fulfill remaining user needs. There seemed to be a need on the market for theft prevention connected to the doors, available in the checkout counter. This could be a great opportunity for ASSA ABLOY to be the first company to offer such a product since there seems to be a gap on the market regarding this feature. One

suggested solution is to continue to develop the information screen and combine it with functions which prevents or prohibits thieves from running out of the store with goods.

9.4 Final concept

9.4.1 **Evaluating against the design guidelines**

Throughout the design process, several design guidelines have been implemented in the solution.

Norman design principles was implemented in many parts of the design. In the locked screen, there was a tag symbol as a signifier to put the tag at the placement of the symbol on the screen to unlock it. The user then received visual feedback from the action when the tag symbol turned yellow. When the authentication was approved, the user received visual feedback of the approval when the tag symbol turned green.

Arrows were used on the left and right side when switching between modes as a signifier for the user to click on them. Also, the arrows were part of creating a conceptual model that there was content to be reached on the left and right side of the current page. Dots were used to create an affordance for the user to swipe, and moreover as feedback on the location of the current page in relation to the other operating modes. The top menu consisting of squares was also used to provide feedback of the current mode. Furthermore, it provided discoverability for the user to let them know what the possible options for action were. The top menu afforded the user to switch between modes, and the square buttons worked as signifiers to communicate to the user that they could also switch mode by clicking directly on them.

The user received feedback of the current active mode from the graphic illustration of the doors, symbol and describing text. The text “mode is set” combined with a confirmation symbol provided feedback on that the mode was set directly after switching to the page. When the user logged out, the page lit up in green as visual feedback of completed action and that the mode was set to the doors. *Auto* and *Exit only* was always preset on the opening width eco, using a constraint to encourage the user to use the more environmentally sustainable option eco.

Besides Normans design principles, the gestalt principles were used when designing the interface. The opening widths eco, wide and narrow were in close proximity to create the impression that they belonged together as different options. The same goes for the top menu of the different modes, where the options were aligned and grouped together using proximity. Similarity was used at all stages of the user

interaction to make the user understand that the same actions were possible or completed. For each page used when switching between modes, the door illustration and texts looked similar and were placed at the same location. All buttons and interaction elements were placed consistently throughout the design to create similarity.

For the illustration of the doors, the design was simplified and consistent throughout the interface according to the symmetry principle. Enough information was provided for the user to understand what the illustration symbolized, yet it was simple enough to not overwhelm the user. The visual perception of the door blades was that they together created a pair of sliding doors, due to continuity in the shape, colors, and placement. Whenever pop-up windows were used, the figure/ground principle was implemented creating the impression that the pop-up window was placed over the previous window. Resulting in that the primary attention from the user was directed towards the pop-up window and the action it required.

9.4.2 **Evaluating against the user needs**

How does the solution fulfill the most important needs defined from the user study?

- *(R) Provide confirmation of completed action.*
  Confirmation of completed action when changing mode is provided partly from the text saying “mode is set” combined with an approved symbol, but also from the whole page displaying the current mode.

- *(R) Operate without supervision.*
  The time installed function enables the user to have less supervision of the doors.

- *(R) Highlight problems and their causes.*
  Problems with the doors and their causes are highlighted through the error interface.

- *(R) Communicate current mode.*
  The current mode is communicated through a graphic illustration, with a text, symbol and by being highlighted as the current mode in the top menu.

- *(S) Communicate what the door is doing in real-time.*
  Same as communication of current mode, combined with communication of errors.

- *(R) Structured logically.*
  The order the modes were placed in was experienced as structured during the user tests, with closed on one end and stay open on the other hand. Having *Exit only* next to *Closed* made sense for the user.

- *(R) Clearly convey its functions.*
  The actions the user can make, and the functions the solution offers is clearly conveyed.

- *(S) Make it easy to change modes.*
  From the user tests, every user understood how to change between the different modes immediately. Through allowing three different interaction types to change the modes, it was easy for every user.

- *Easy to use*
  The usage included few steps and it was easy for the user to understand what to do.

- *(R) Prevent mistakes.*
  There are no large mistakes that easily can be made. To change opening time in the timer function, confirm is asked for so the user do not accidentally change the time.

- *(R) Inspire trust.*
  Through using several design principles in the design, the whole user experience inspires trust to the user.

How does the solution fulfill the latent needs defined from the user study?

- *(S) Offer novelty value.*
  The solution is in a new format and provides new functions.

- *(S) Able to perform adjustments independently.*
  The time installed functions make it able to perform adjustments independently.

- *(S) Provide a clear connection between interface and door.*
  The visual graphics of the doors provides a clearer connection between the interface and doors.

Latent needs not considered in the final solution:

- *(R) Contribute to a welcoming experience.*
- *(S) Enable the door to be adjusted both near and far from it.*
- *(R) Counteract theft.*

- *(S) Enable adjustment of settings from the checkout.*
- *(S) Function without complements.*

Even though they are not implemented in the solution, they are valuable to the user and would be worth considering in further development.

9.4.3 **Added value for the user**

The final solution provides many improvements for the user which cannot be found in the existing OMS solutions:

- *Time installed*
  The time installed function makes it less stressful at closing hours for people working in retail stores, so they do not need to hurry to the door and change to exit only during rush hours. The automatic opening in the morning contributes to an easier morning routine, with one less task to keep in mind. From the user tests, the users highlighted that the time installed function would add an extra value to the mode selector.

- *Feedback of mode from a distance*
  The blue squares visible on the top of the screen when the screen is locked are in different placements depending on which mode the door is set to. This enables the user to determine which mode the door is set to from a distance. The visual feedback was appreciated during the user tests, and the user expressed that it would save them time to see the mode from a distance rather than always having to walk upfront to the OMS and the doors. Also, if an error occurs there is a visible notification which can be seen from a distance.

- *Clearer connection between the modes and actual doors*
  The graphical illustrations of the doors in combination with symbols and texts makes it much easier for the user to understands the different modes compared to existing solutions, something which was mentioned in the user tests.

9.4.4 **Added value for ASSA ABLOY**

From the discover phase, various insights were collected regarding the OMS from employees at ASSA ABLOY. If the solution is implemented it would address many of their requests.

Many of the ASSA ABLOY employees expressed the wish for a more modern solution that is adapted to the users' needs. This will be fulfilled with the final

solution. The design of the OMS will also reflect the design of the sliding doors more than the existing OMS solutions. The value of the ASSA ABLOY brand was that people trusted the brand and their products. For this reason, it was valuable to live up to that expectation to remain the value of the brand. The solution, if applied well, could contribute to the high quality and service offering the brand stands for. By using the error interface and functions, the users will receive more precise and accurate service when errors occur. It will also be easier for the service technicians to resolve the issue. Since the service technicians are an important part of ASSA ABLOY's business model, it is valuable to serve to the needs of the service technicians.

Implementing the eco mode was a request from ASSA ABLOY. Through having the eco opening width as the preset option, the user is encouraged to primary use it as the choice of opening width. In the long run, it could lead to energy savings for the customers of sliding doors. Making ASSA ABLOY being able to offer a more environmentally friendly product.

In general, using a UX design approach in a technological driven company enables new improvements and areas of usage for the products which could not have been discovered by merely developing the technology.

9.4.5 **SWOT analysis**

Through implementing the final solution, the strengths and opportunities from the SWOT analyses can be utilized to its full potential. Meanwhile, by implementing the final solution, the weaknesses and threats that were found in the SWOT analysis could be prevented.

By using a digital touch display and applying the time dependent function, ASSA ABLOY would utilize their internal access to high end technology. Seizing the opportunity of a more radical innovation could lead to new markets and increased user satisfaction. The implementation of using a tag instead of a key or code for authentication both uses the strengths and prevents the threat of users leaving the key in the OMS. Also, it utilizes the resources that ASSA ABLOY possess since they already have knowledge and products in the segment of authentication methods and tag solutions.

Using the concept would provide a niche that no other competitor offers and would make ASSA ABLOY stand out on the market. A concept designed according to usability demands defeats the threat of the user perceiving it as difficult to use. Another threat would be to let the development of technology lead to a more complicated interface with less user satisfaction. Since the solution has been designed with the user experience in mind, making the interface as relevant and easy to use as possible throughout the process, that is no longer a threat.

9.4.6 **Alignment with ISO standards**

The solution aligns with the following ISO standards, making it applicable to use with all sliding doors in Sweden:

SS-EN 16005:2024 *4.7.2.1 Mode selection*

IEC 60335-1:2020 *U.1.1.1 Authentication, U.1.1.2 Authorization*

10 Conclusion

In this chapter conclusions from the thesis are presented.

As the technological development for sliding doors systems is evolving, the need for usability of the operating mode selector has increased. Through conducting a thorough user study and user experience analysis, this need has been confirmed. Previously, the current OMS solutions have not been analyzed according to usability demands. This has led to distress for the users due to low usability of the interface. As a result, the next generation user interface must be based on the users and their needs through a user centric design process.

Through combining a variety of design and product development methods, it resulted in accurate user needs and definition of the problem to be solved. Compared to developing a product merely from the existing products and competitors, going to the bottom of the user needs creates the opportunity to develop a more optimal solution that provides added value to the user. The feedback from user studies and user tests collected throughout the process ensured that the result was valid and verified. This was done with various stakeholders, but mostly with the end users which proved to be most beneficial.

The previous methods used by ASSA ABLOY has often been more technology centered, aiming to provide more functions and availability for the user to adjust more settings. On the contrary, it turned out that the user wanted a solution that was efficient to use, with few steps and adjustments to consider. The OMS is mainly used during opening and closing routines. For this reason, it should be designed to make it easy for the user to perform those tasks, without causing distress or be experienced as complicated. The final prototype enables a quick and effective interaction, and many functions were disregarded throughout the process as the end user wanted a simple product. Proving that by using a user centric design approach, it is possible to include multiple functions in an OMS without making it complicated.

The result was a modern user interface, which was proved to have higher usability and be preferred over existing from the result of the user tests. The time installed function proved to add value to the user during their closing and opening routine. The product also made it easier for the user to comply with laws and was designed to encourage a more environmentally sustainable usage. Overall, the result complied with design principles and offered a higher usability. The solution can be

implemented with available technology. Doing small and easy changes can make a huge difference.

The outcome of this project shows the importance of UX design in a highly technological product, and how it can create value for the user and competitive advantages for ASSA ABLOY. For further development of the product, it is of importance to keep the user needs and the user context in mind to achieve a high user satisfaction rate. ASSA ABLOY had an initial idea of the outcome, however the user study showed unpredicted insights leading to a result differing from the company's initial idea of the final product. The result demonstrates that even though a product works, new user needs can be discovered and fulfilled using UX methods leading to an improved product. The result of this thesis aims to encourage technology companies such as ASSA ABLOY to keep implementing UX design methods in their product development processes.

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Appendix A Work distribution and time plan

A.1 Work distribution

The workload was equally divided between Emma and Sofia and can be viewed in Table 10. For most tasks, both team members were involved. It was helpful to be able to discuss within the team, especially during the discover and develop phase. Having two people in the team enabled the team to build on each other's ideas which particularly was helpful when ideating. More autonomous tasks were done more separately since it did not require input from both team members to the same extent.

However, when creating the prototypes it was more efficient to divide the work. It would be too complicated if two people would work on the same prototype simultaneously. Anyhow, always being able to discuss the prototype with the teammate enabled faster problem solving, rapid continuous feedback, and provided multiple perspectives. We believe that working together as a team contributed to a prototype exceeding existing solutions.

Table 10: Work distribution between the team members, in percentage.

Task	*Emma*	*Sofia*
User study	50	50
Input from ASSA ABLOY employees	50	50
Benchmarking	40	60
Quantitative analysis	100	0
Qualitative analysis	50	50
User needs	50	50
SWOT analysis	0	100
Ideation	50	50
First iteration – knob solution	80	20
First iteration – display solution	0	100
Second iteration – knob solution	50	50
Second iteration – display solution	50	50
Third iteration – knob solution	0	100
Third iteration – display solution	100	0
User studies	50	50
Refine final concept	80	20

A.2 Project plan and outcome

The initial time plan can be seen in Figure 55. It can be compared to the time distribution of performed activities in Figure 56. In the beginning, the idea was to conduct two thorough design iterations including ideation, evaluation, prototyping, and user testing. However, it was more efficient to keep developing the concepts from the first iteration rather than starting the design process from scratch with a new ideation process. Iterating the chosen concepts created the opportunity to use elements from previous ideation process to solve design challenges discovered after each user test, resulting in a well thought trough design.

The initial idea was to only perform two rounds of user tests after each iteration. Due to the changed approach for the iterations, it enabled the team to instead perform four rounds of user tests. It turned out to be valuable to perform several iterations and receive feedback from the users multiple times. Even though the team considered the design to have good usability, areas of improvements could be found when conducting user tests, leading to the ability to improve the concepts.

The user study started before its scheduled time in the initial time plan. It enabled the user study to be extensive and include two user groups using both interviews and focus groups as methods.

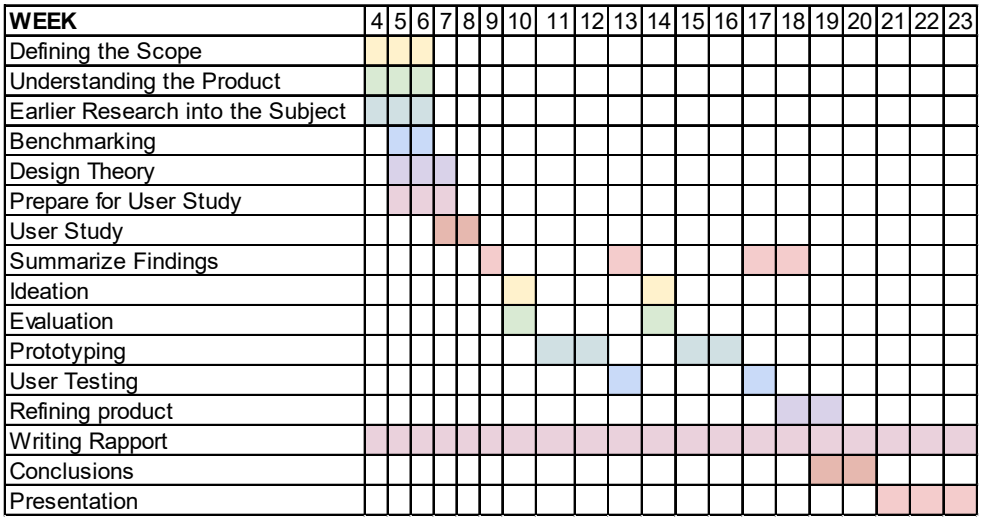


Figure 55: Initial project plan

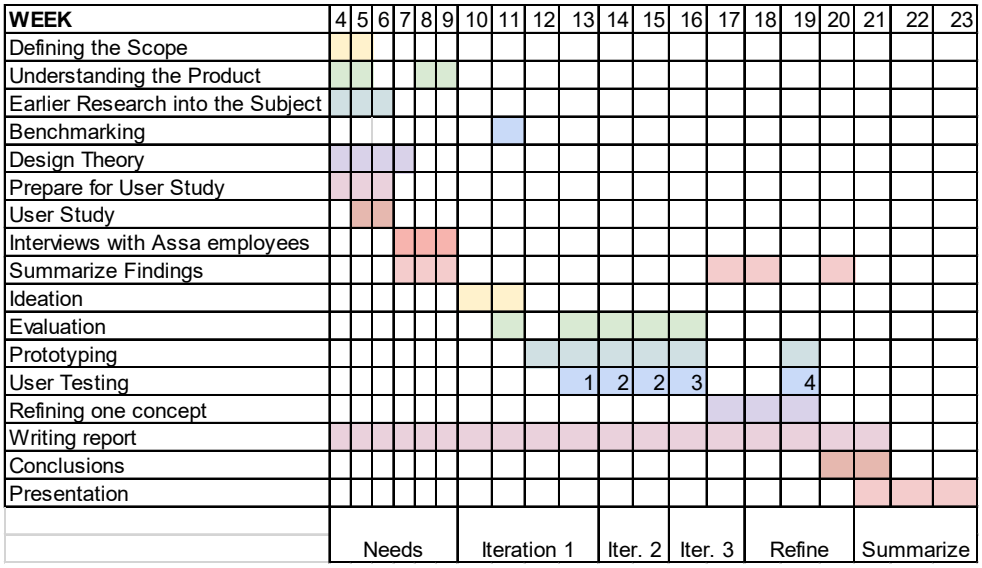


Figure 56: Performed activities.

Appendix B User tests

B.1 Test plan

B.1.1 Interviews

The interviews were conducted with people who worked in stores in Lund or Landskrona at their place of work, retail stores. To not disturb the users' working environment too much, the interviews were performed during hours when there were fewer customers in the stores. For stores which opened at 10 am, the optimal time was 10 am -11 am. After 11 am, the staff seemed busier, and most people said that they did not have the time to participate in the interview. For this reason, the interviews were mainly held between 10 am and 11 am on weekdays.

The users were approached in the stored during their working hours. Then they were briefed on the background of the project and asked if they were willing to answer a few questions. They were told their answers would be anonymous and could recall their consent to participation at any time. They were also informed that it would take no more than ten minutes. After a verbal consent from the user, they were asked structured questions which were prepared ahead. One person held the interview and asked the question, and the other wrote the responses in a notebook. After each session, the answers were transcribed to a document. Information such as from which store the user worked in, gender, position, and what OMS system they used were collected.

B.1.1.1 Questions

1. How long have you worked here?
2. What is your role?
3. Have you ever used the program selector, i.e., set the mode for the door?
4. When have you used it?
5. Who uses it in the company?
6. What does your opening routines look like?
7. What does your closing routines look like?
8. Do you ever change the setting during the day, e.g., if the weather changes?
9. If the weather is nice, do you change the settings?
10. Do you use any other settings or functions?
11. Which functions are you familiar with?

12. How did you learn to use the program selector?
13. Do you use, or would you consider using, the manual?
14. Has the door ever malfunctioned? What do you do then?
15. How do you perceive the store's security in relation to the doors?
16. Has anyone unauthorized ever changed the settings of the door?
17. What do you think about the placement of the OMS?
18. Could anything be made easier for you in relation to the door and the OMS?
19. Can you think of a function that is missing?
20. What is your general impression of the OMS?
21. Do you like the design, or would you prefer something else?
22. What is the most advantageous aspect of the door system you have today?
23. Thank you!
    If the person uses the door: Would you consider participating in a more in-depth interview about the door? Alternatively, can we shadow you during opening or closing routines to see how you interact with the OMS? Would it be okay if we get your email address or phone number? The purpose of this is to potentially follow up or test our future concept.

B.1.2 Focus groups

The users from the interviews who expressed interest in participating further were asked to take part in a longer interview during a lunch or coffee break to ensure a relaxed environment. Ideally the focus group would consist of 2-5 people, but all numbers were appreciated. Unfortunately, only one company out of the group accepted the invite – a technology and home improvement chain. Responses from the remaining companies was that they did not have regularly scheduled breaks in groups and did not have enough time to spare. This proved to be an unexpected limitation. Therefore, as a compliment acquaintance were approached, and one additional focus group was formed as well as one individual longer interview.

Similarly to the shorter interviews the ethical aspects were clearly presented, and the subjects were asked for approval prior to starting. The sessions were sound recorded with the purpose of transcribing them word for word, this ensured full participation in the discussions for all parties involved. One out of three sessions were physical, the remaining two were online on Zoom since the participants lived in another city.

B.1.2.1 Questions

1. Could you briefly tell us about yourselves and what you work with?
2. What does a typical morning look like for you at work?
    a. Where do you enter?
    b. What is the first thing you do?
3. What does it look like during the day?
    a. How do you move around the store?

        i. What does it depend on?
        ii. Is there ever a time it feels unnecessary?
4. Could you describe your routine at closing?
5. Can you describe a task you like and why?
6. Can you describe a task you don't like and why?
7. What is important about the customer's first impression?
    a. How do the doors and entrance play into this?
    b. (Can the doors positively or negatively affect the first impression in any way?)
    c. What role do the doors play at the end of the customer's visit?
8. Have the doors ever malfunctioned?
    a. What happens then?
    b. What do you do to solve the problem?
    c. Does anything with the door ever interrupt you in other tasks? How so?
    d. How does that make you feel?
    e. How do you find out about the problem?
9. Have you seen it malfunction for someone else?
10. What are the stress factors at work?
    a. Anything related to the doors?
11. Have you worked with different types of entrance doors before?
    a. Does it have any impact on the store or on you who work here?
12. If you could think completely freely, how would you like the door to be controlled?
13. What is the biggest challenge at work?
14. Do you have any additional thoughts or reflections you would like to share?
15. Thank you very much for your participation! Please feel free to contact us with questions, or to get clarification about our work and how your participation affects it.

Appendix C Quantitative analysis

C.1 Summarized results from quantitative analysis

All 28 interviews from the retail employees were summarized in an excel-file where their answers regarding certain topics were summarized. The purpose of this file was to gain knowledge into how often something was mentioned and if their answers were similar or not. The topics, answers and the number of interviews if was mentioned was summarized in Table 11. Not all numbers add up to 28 since the question was sometimes skipped during the interview, or they had nothing to say regarding the topic.

Some questions and responses were left out of the quantitative analysis since they could not be divided into clear categories, or they were more suited to be analyzed qualitatively.

Table 11: Results from quantitative analysis.

Topic	*Answers*	*Number*
Type of OMS	Assas with key	15
	Assas with touch	8
	Besam with FAAC button	1
	Geze	1
	Tormax with display	2
	Tormax with LED	4
Type of retail store	Pharmacy	2
	Sport	1
	Shoes	2
	Technology	3
	Clothes	2
	Animal	1
	Food	5
	Toys	1
	Low price	4
	Optician	1
	Furniture and decor	6
	Cars	3
Gender	Male	11
	Female	20

Presumed age range	20-29	10
	30-39	12
	40-49	1
	50-59	7
Time at location	<1 year	6
	1 year	5
	years	12
	6-10 years	4
	>10 years	4
Role at work	Salesperson / regular employee	21
	Store owner or another responsible role	10
Who uses the OMS	Everyone who works there	27
	A select few	4
Learned to use by trial and error	Tried themselves	9
	Learned from someone else	14
Has read the manual	Yes	1
	No	30
Cold	Getting affected by cold weather and want to keep more heat inside of store.	11
Heat	Getting affected by warm weather and want to make it colder inside of store.	10
Wind	Experiences issues with the doors due to strong winds, doors don't close properly.	8
Rain	Having door issues due to rain.	2
Other issues with the sensor	Don't open for kids below 1 m. OR gets negatively affected by power outage. OR opens by itself. OR opens slowly.	17
Functions they use	*Closed*	31
	Auto	31
	Fully open	18
	Partial auto	4
	Only exit	21
Functions they are unsure of	*Fully open*	4
	Partial auto	15
	Only exit	1

Appendix D Qualitative analysis

D.1 Affinity diagramming

D.1.1 Retail employees

When all statements were sorted, 32 groups of themes were created. The 32 groups were then divided into clusters of similar topics. Those clusters were:

1. *Stressful situations, cumbersome, finding out issues, confusion, insecurity, lack of trust.*
2. *Has to work, functionality, kids and sensors.*
3. *Stealing, access, anonymity.*
4. *Time, easy and fast.*
5. *Movement, habits, remote control, automatic.*
6. *Own solutions, trial and error, share knowledge, understanding, effort in thought process, assumptions.*
7. *Customers, welcoming experience, added value.*

When the data had been sorted, another round of sorting was initiated. From the seven clusters of groups, it was easier to find common themes. The method was to go through each cluster again and sort the user statements into new themes. In some cases, statements were moved in between clusters. This sorting round focused more on finding themes beyond the obvious phrasing with the goal to understand and define the needs of the user from the group of user statements.

The second round of sorting statements resulted in 34 new themes. These were grouped into seven new clusters:

A. *Taking up time from work, few steps, low physical effort.*
B. *Confirmation that it works, logical, lacks direct feedback, difficult to understand, communication of problems.*
C. *Clean and tidy, added value, customer contact, first impression, satisfied customers.*
D. *Habits, speed, routines, flexibility, simplify at closing, easily accessible.*
E. *Prevention of theft, not attracting anyone unauthorized, presence, sense of control, fear of losing items.*
F. *Unsure of what to do, trial and error, lack of information, easy to make mistakes, uncomfortable with use, own methods.*

G. *Negative impact on customers and operation, unreliability, trust in that it works how it should.*

The clusters were glued to blank A2 pages and taped onto the wall. This gave a good overview of the clusters and enabled the data to be more easily processed further.

D.1.2 Service technicians

The second round of sorting statements resulted in 21 new themes. These were grouped into three clusters and glued onto A2 papers which were taped to the wall.

H. *Possibility to change mode from the checkout, few options, easy to understand how to use, customer approach, durability, error prevention, easy to read, easy to switch mode, the customer doesn't understand.*
I. *Intermittent errors, self-adjusting, create novelty, offering a relevant service, wanting to know the entire problem upon occurrence, identifying the source of the error.*
J. *Following laws in an easy manner, accessible to solve, access to certificated and measurements, functioning in a risk-free manner, adjustable and visible at different locations, easy installation.*

Appendix E Ideation Workshops

E.1 Scenario-based workshop

The first ideation workshop conducted was a scenario-based workshop (see Table 12) which was formulated to appeal especially to people without a background in design. A conference room was booked which included a large table with chairs around it, a whiteboard, and a projector. A presentation was prepared which was streamed on the projector in front of the table where everyone could see. In the beginning of the workshop the master's thesis, design process, purpose and the guidelines for the workshop were presented.

Table 12: The objectives for the scenario-based workshop.

What	*How*
Timeframe	2,5 hours
Purpose	Increase understanding for the users and their needs. Come up with ideas that meet the users needs.
Goal	>100 ideas
Expectations	The ideas are not final. The ideas are both visual and in text. More complete ideas are gathered towards the end of the workshop.
Participants	Emma, Sofia, Louise (supervisor at Assa) and two other Master's Thesis students.
Material	Post-its in 6 different colors, black markers and one computer.

To get the participants into the correct mindset a short warmup was conducted. The question prompted was "*How can an interface look like that encourages the user to actively make mistakes?*". They had 5 minutes to individually brainstorm ideas, and afterwards they were pasted to the wall in similar clusters and shortly discussed.

Following the warmup the scenarios were presented. This was done one at a time. During all the scenarios the participants followed one fictional user and was asked to design for him. Simple illustrations were added to the presentation to make the users visualize the scenario better (see Figure 57-60).

Scenario 1:

We are at Jysk. Here Max works as a salesperson. It is 10:00 and it is time to open the store. There is a queue outside and people want to come inside.

In what ways can Max change the door settings?

Brainstorm individually for 5 minutes.

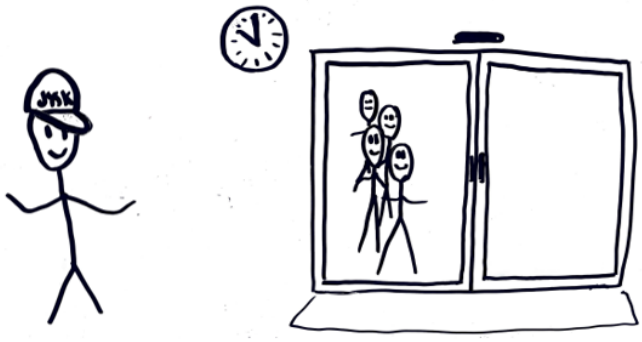


Figure 57: Illustration for scenario 1.

Scenario 2:

Now the store and the doors are open. Max is wondering if he put the door in the correct setting.

How can he get the current setting confirmed?

Brainstorm individually for 5 minutes.

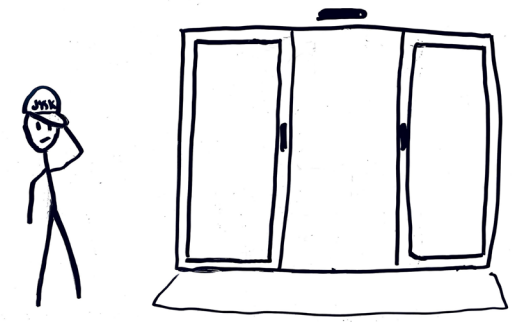


Figure 58: Illustration for scenario 2.

Scenario 3:

Now it is the lunch rush, but the door has seized up.

How does Max find out about this? Keep in mind that he can be anywhere in the store.

Brainstorm individually for 5 minutes.

Figure 59: Illustration for scenario 3.

Scenario 4:

Max has recently found out that the door has seized up. He does not know why or what he can do to fix it.

How does Max receive help to solve the problem?

Brainstorm individually for 5 minutes.

Figure 60: Illustration for scenario 4.

Lastly the participants were asked to choose a post-it from each color that they found interesting. Once they made their choice they were asked to brainstorm individually for 5 minutes to come up with ideas for a solution that was easy and logical.

E.2 Brainwriting workshop

The second ideation workshop conducted was a brainstorming and brainwriting workshop (see Table 13). This session had a more visual focus than the scenario-based one and was conducted with students who have a background in design. The same conference room as from the first workshop was used. In the beginning of the workshop the master's thesis, design process, purpose and the guidelines for the workshop were presented.

Table 13: The objectives for the brainwriting workshop.

What	*How*
Timeframe	2 hours
Purpose	Come up with ideas that meet the users needs. Come up with unexpected concepts. Get ideas on ways to visualize.
Goal	>100 ideas
Expectations	The ideas are not final. The ideas are both visual and in text.
Participants	Emma, Sofia and two other master's thesis students.
Material	Post-its in 6 different colors, black markers, one computer and 12 papers in A3 format.

Initially the same warmup as in workshop one was conducted. Afterwards they were presented with five rounds of individual brainstorming questions:

Round 1:

In what ways can you illustrate the doors different functions (visually)?

- Off
- Auto

Brainstorm individually for 5 minutes.

Round 2:

In what ways can you illustrate the doors different functions (visually)?

- It is cold outside, you want the automatic mode but that the doors open less wide.

Brainstorm individually for 3 minutes.

Round 3:

In what ways can you illustrate the doors different functions (visually)?

- It is warm outside, you want the doors to be wide open.

Brainstorm individually for 3 minutes.

Round 4:

In what ways can you illustrate the doors different functions (visually)?

- You are closing the store in 10 minutes. You want to counteract new customers coming in, but want to enable customers who are inside to leave.

Brainstorm individually for 3 minutes.

Round 5:

How might we enable adjustment of the door both near and far away from it?

Brainstorm individually for 5 minutes.

Following the 5 rounds, they were asked to collect a few post-its that they found particularly interesting from different categories. In front of them on the table they had 3 pieces of paper in A3-format that had been divided into 4 quadrants. Drawing inspiration from their chosen post-its and the question "*How might we make changing the mode on a sliding door easy for a retail employee?*", they were asked to formulate 3 different concepts on each paper in the first quadrant. Once the first 5 minute session was over, they swapped papers with each other anticlockwise and added to the concepts on their new papers in the second quadrant.

This was repeated 4 times until all quadrants were filled out and all 4 participants had added to all 12 concepts. Lastly the concepts were explained in a group discussion.

Appendix F The remaining concepts from the first iteration

During the first iteration 5/12 concepts were chosen for further evaluation. The seven concepts that were rejected are presented below in Figure 61-67.

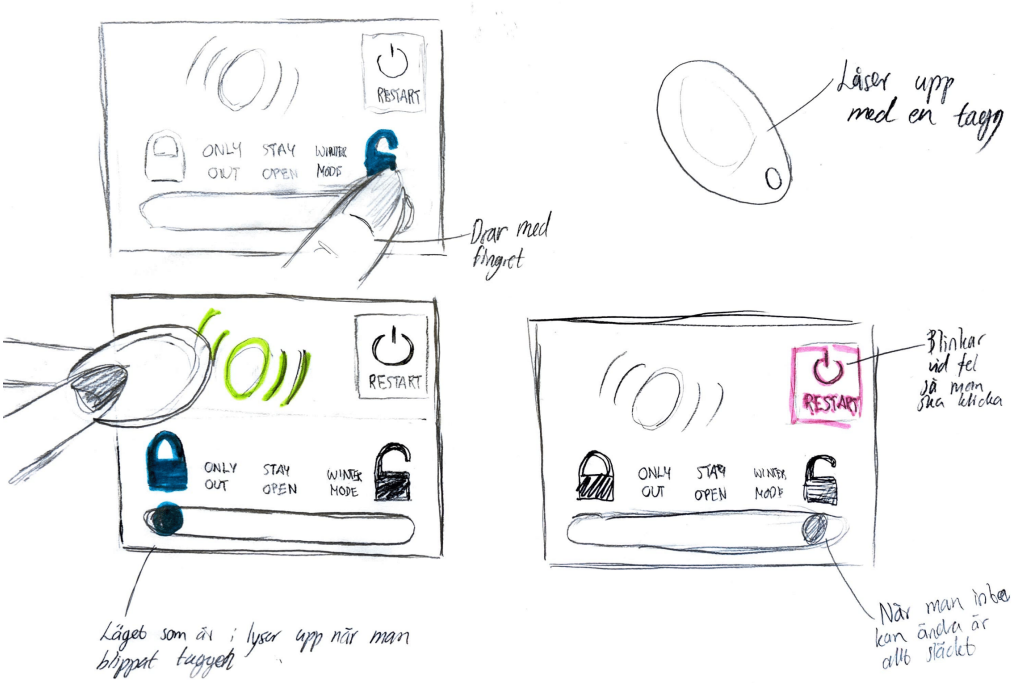


Figure 61: Display with scroll selection, tag activation.

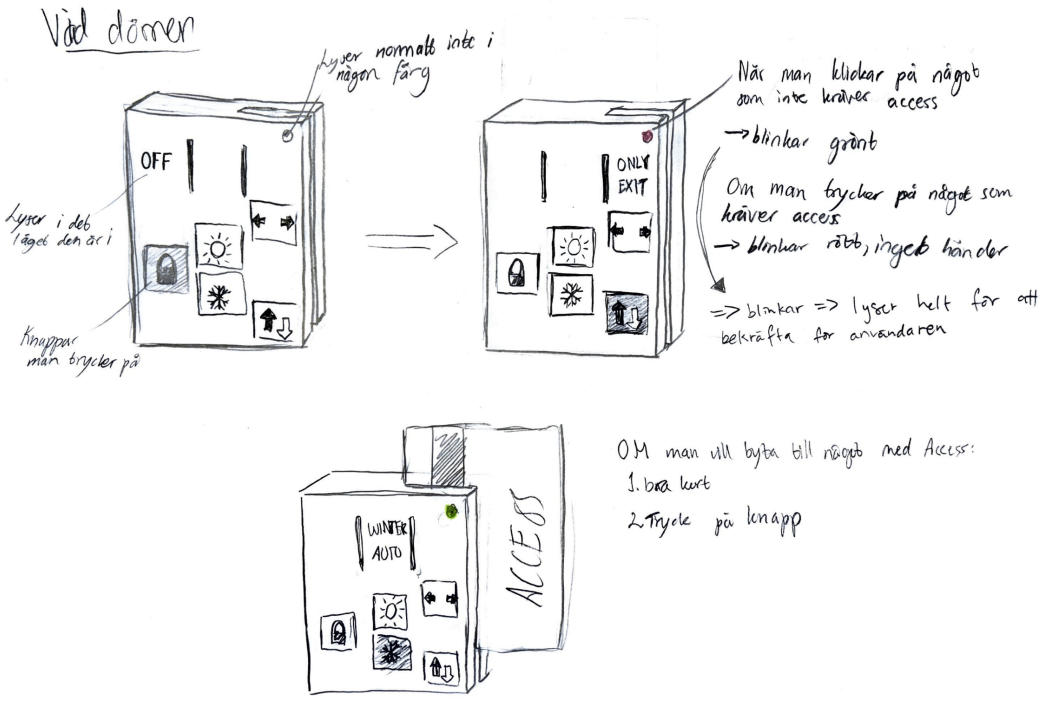


Figure 62: Buttons with symbols on, card activation.

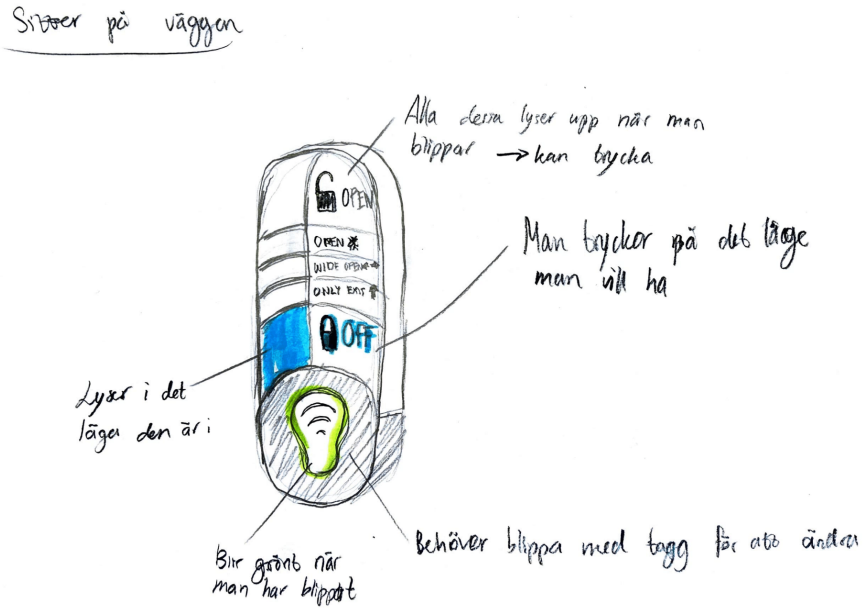


Figure 63: Buttons that lights up when pressed, tag activation.

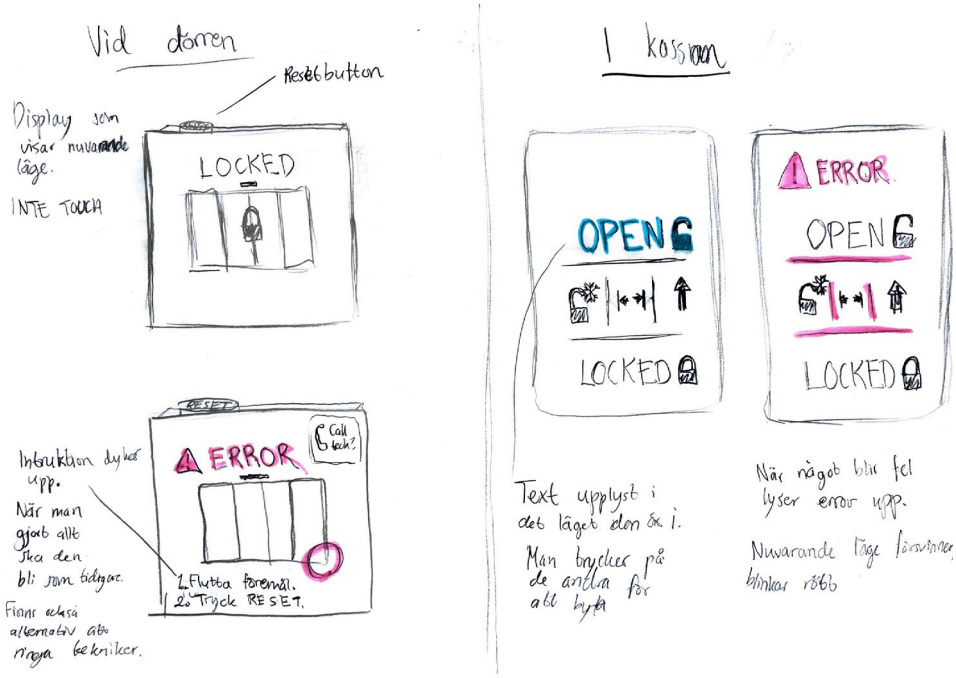


Figure 64: Display by the door and mode selection at the checkout counter.

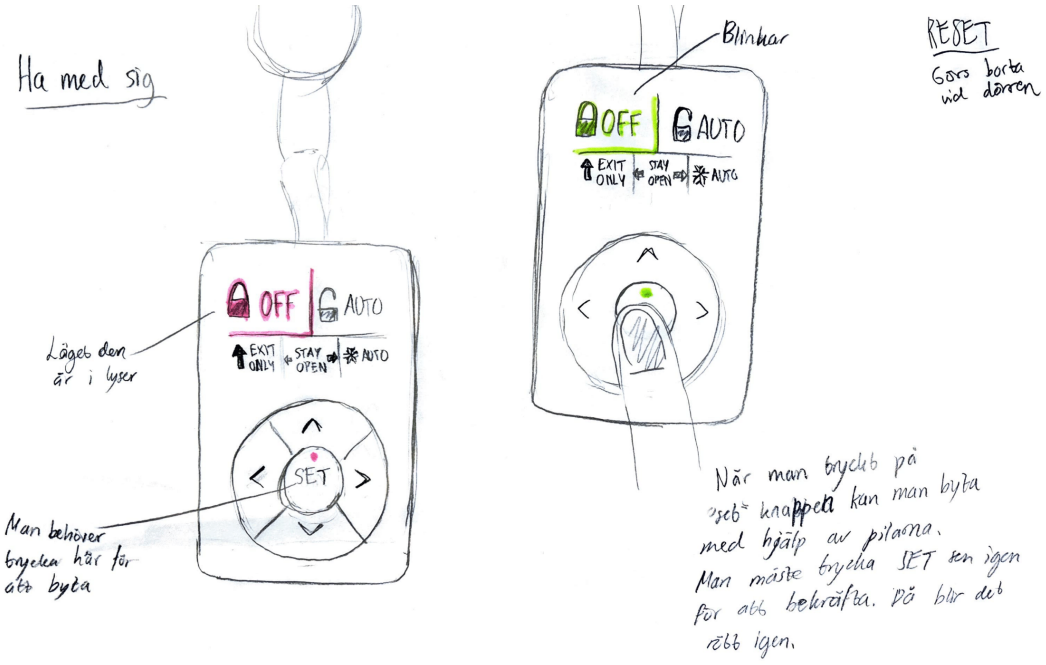


Figure 65: Mobile controller with display and a scrolling function.

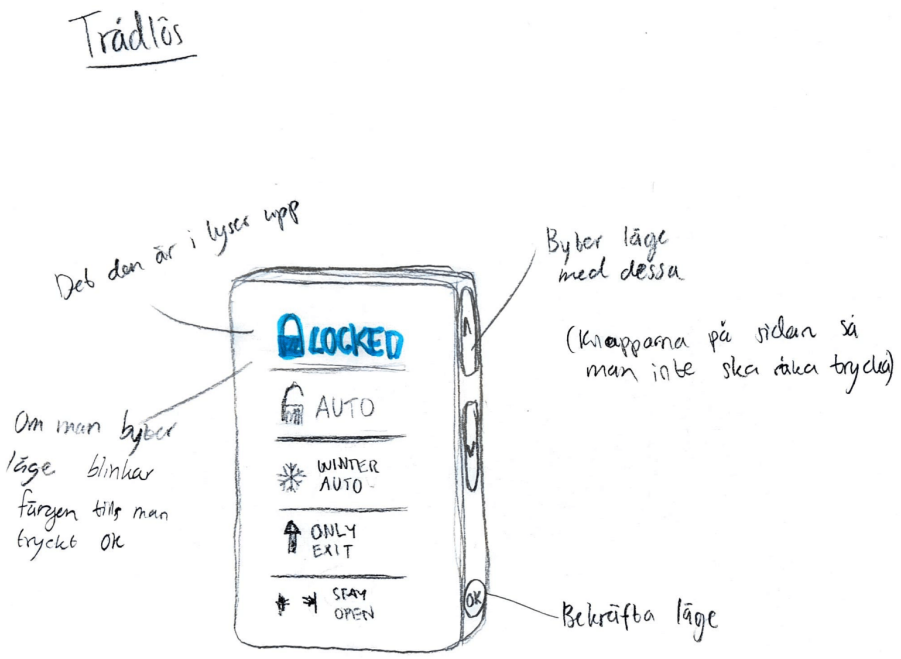


Figure 66: Mobile controller with display and buttons on the side.

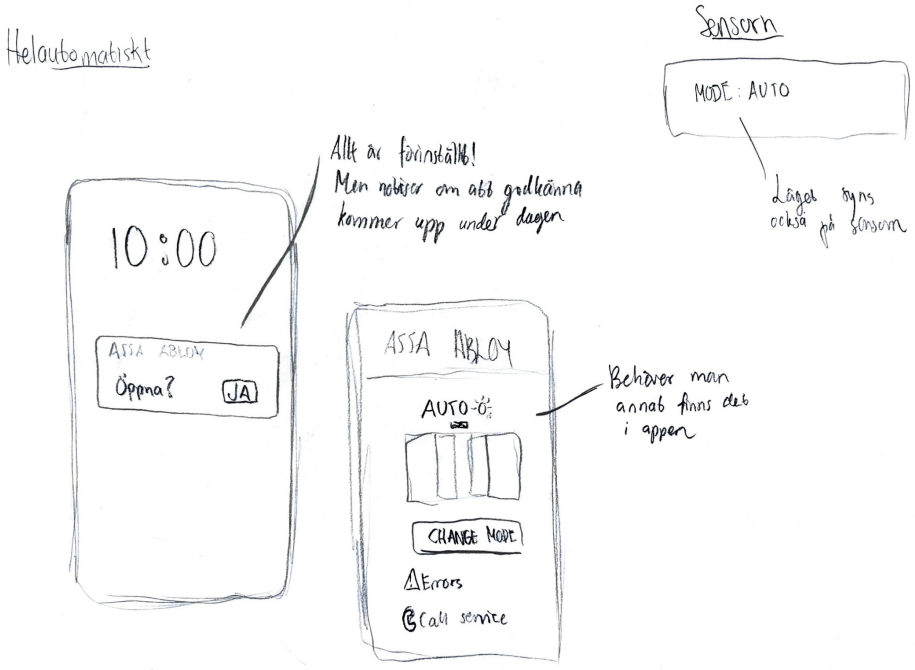
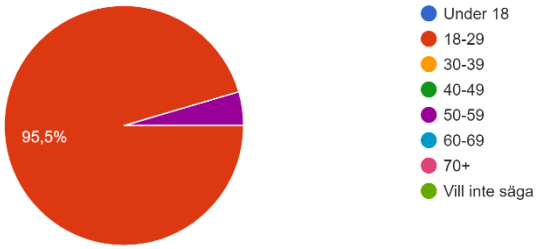


Figure 67: Automatic solution that asks the user to approve its selections.

Appendix G Answers from the symbol survey

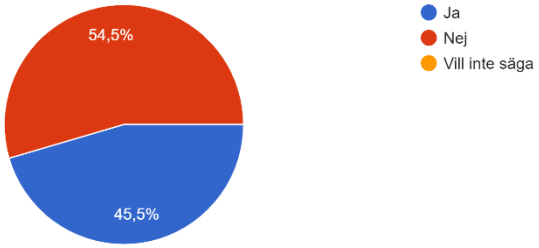
Ålder

22 svar



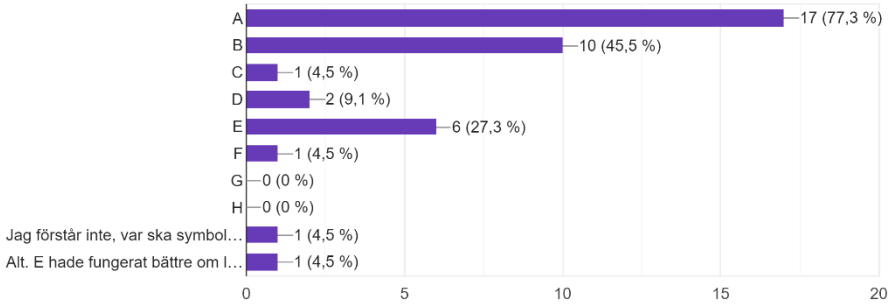
Har du någon gång arbetat i en butik med skjutdörrar?

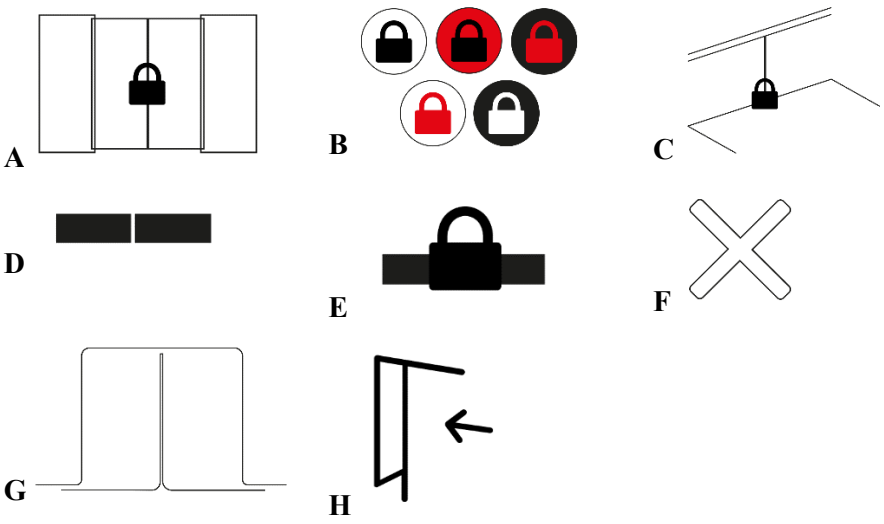
22 svar



Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna är stängda/låsta?

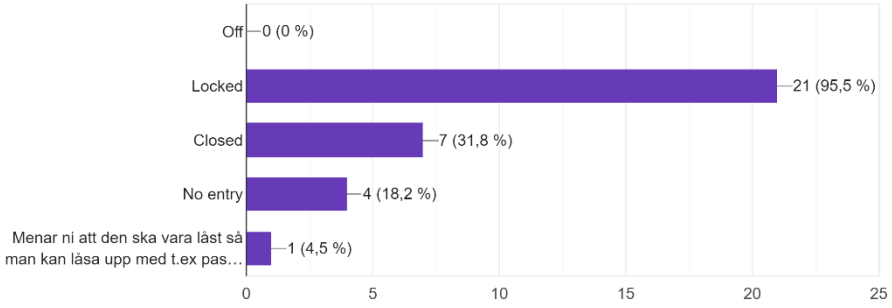
22 svar





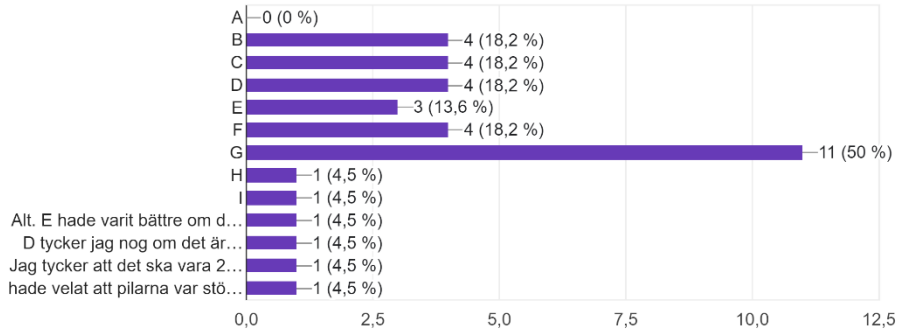
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna är stängda/låsta?

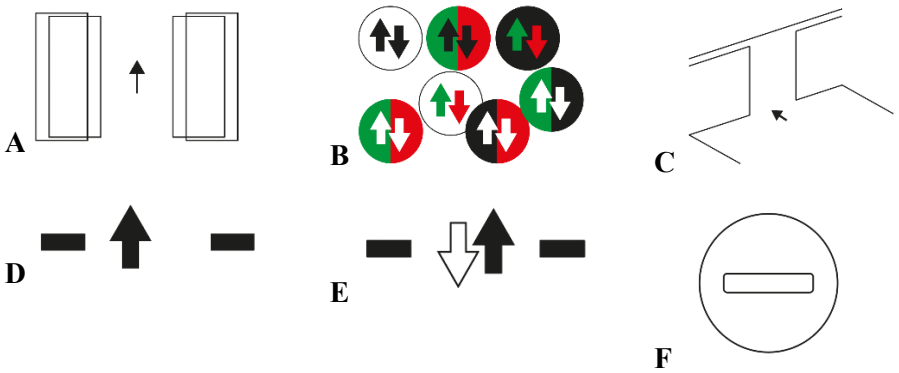
22 svar

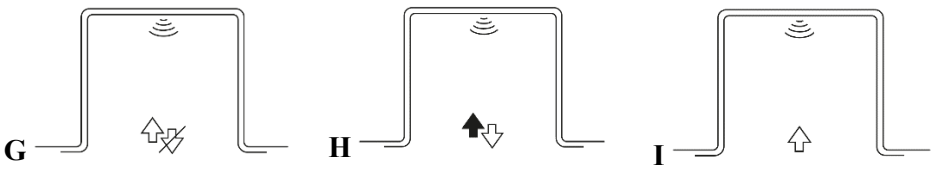


Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna endast öppnas utåt men inte inåt? Denna inställning används ofta de sista minut...kerställa att inga nya kunder kommer in i butiken.

22 svar

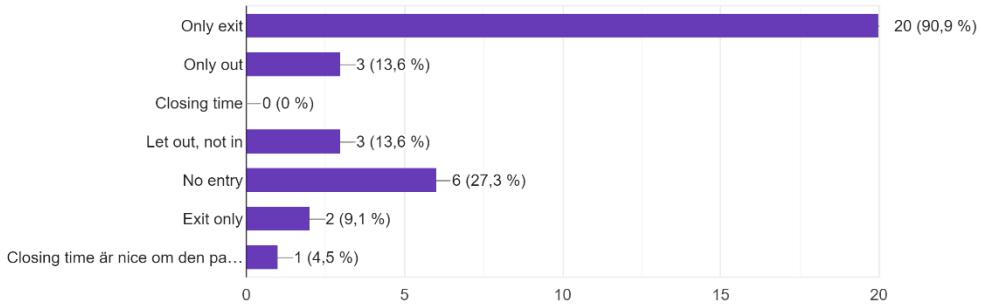






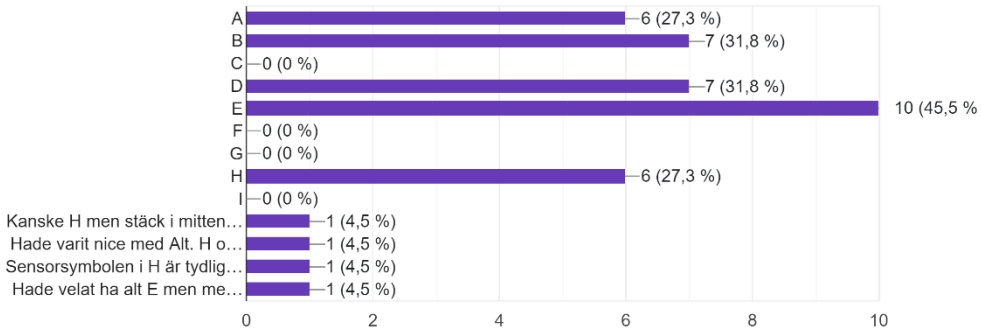
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna endast öppnas utåt men inte inåt? Denna inställning används ofta de sista minuterna i...kerställa att inga nya kunder kommer in i butiken.

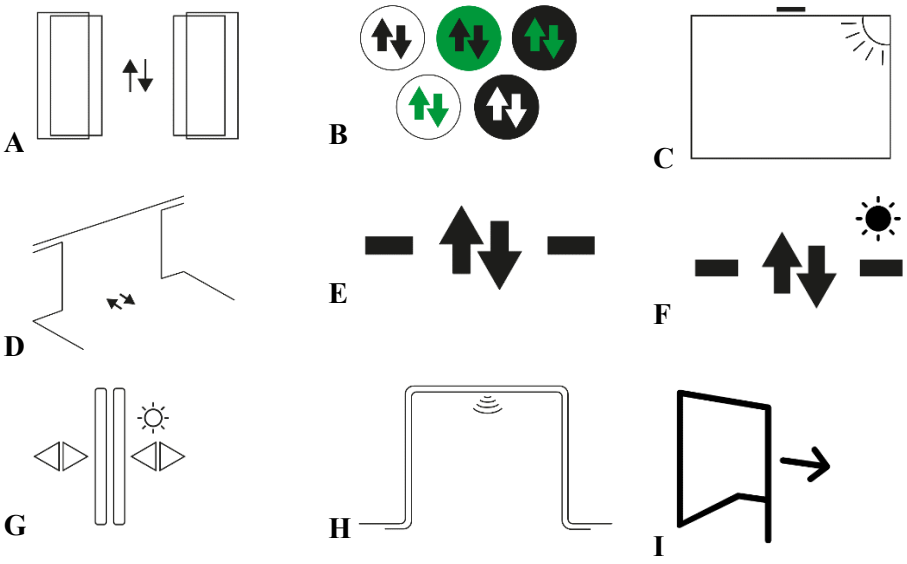
22 svar



Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna öppnas och stängs automatiskt vid detektion av rörelse?

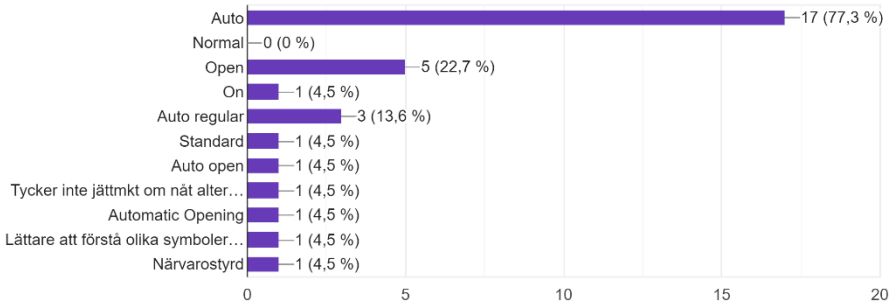
22 svar





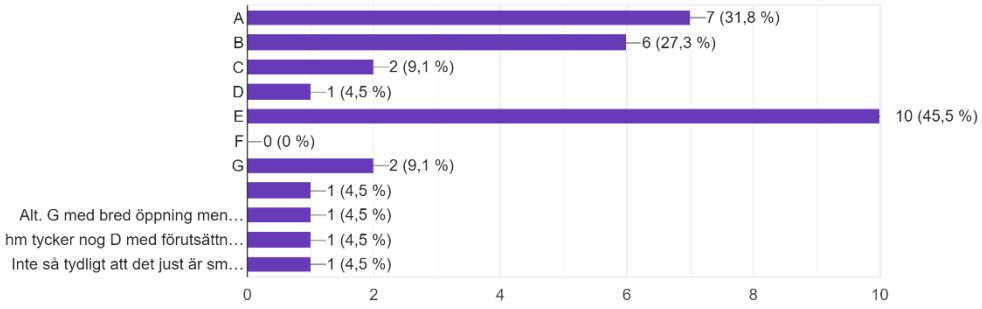
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna öppnas och stängs automatiskt vid detektion av rörelse?

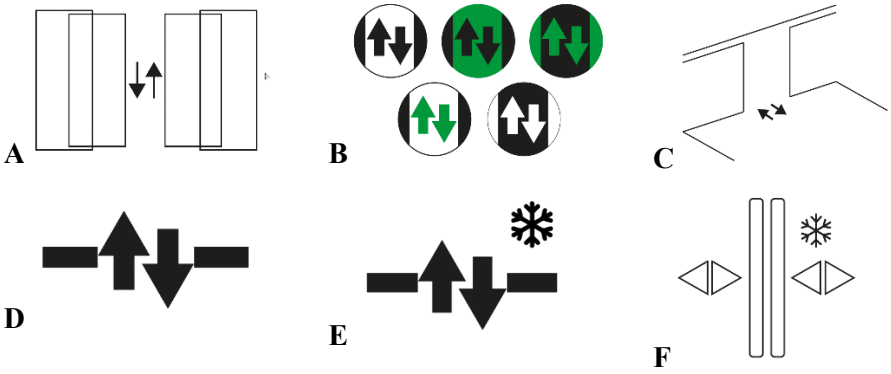
22 svar

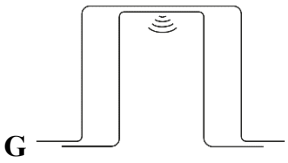


Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna öppnas och stängs automatiskt vid detektion av rörelse, men med mindre öppning. De...r det är kallt ute för att släppa ut mindre värme.

22 svar

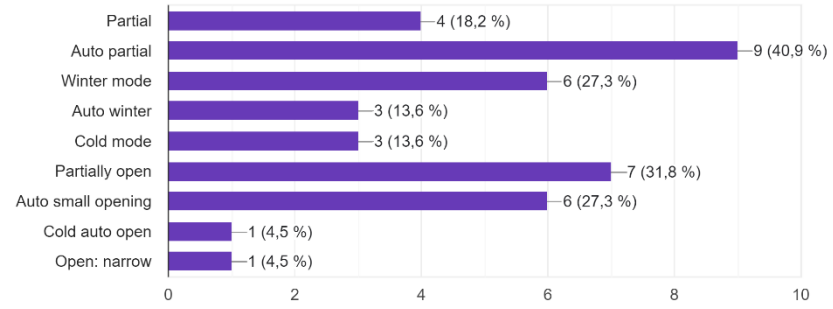






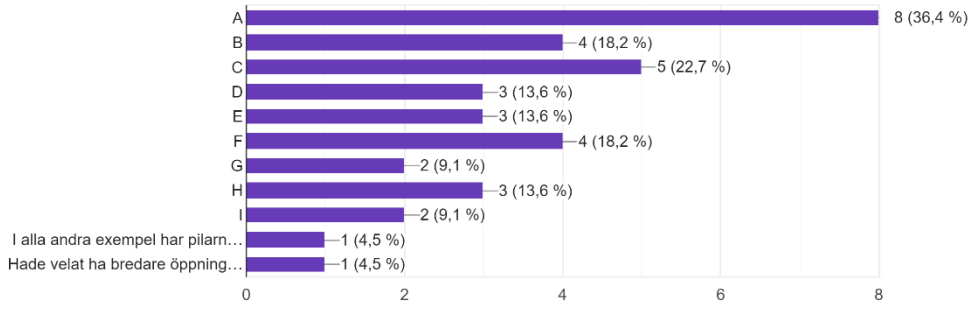
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna öppnas och stängs automatiskt vid detektion av rörelse, men med mindre öppning. De...r det är kallt ute för att släppa ut mindre värme.

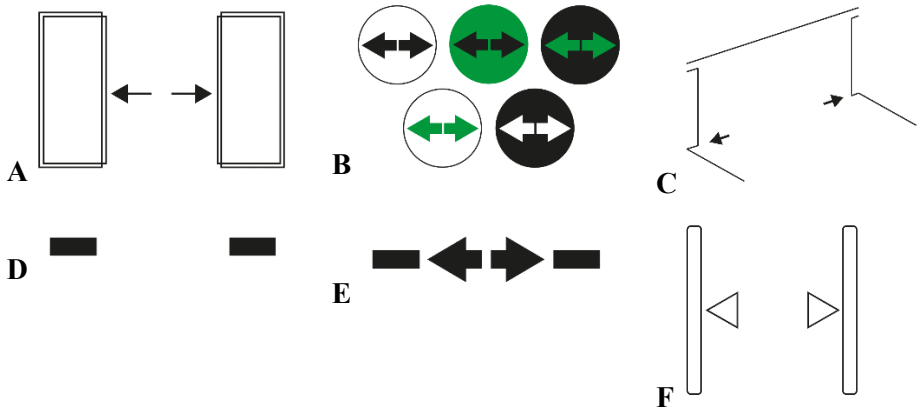
22 svar

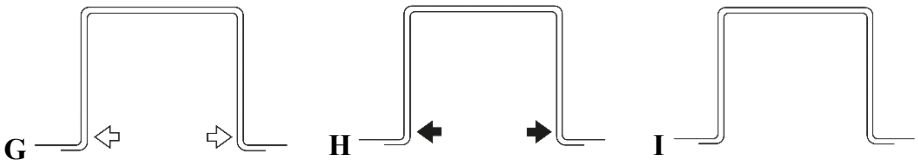


Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna hålls helt öppna?

22 svar

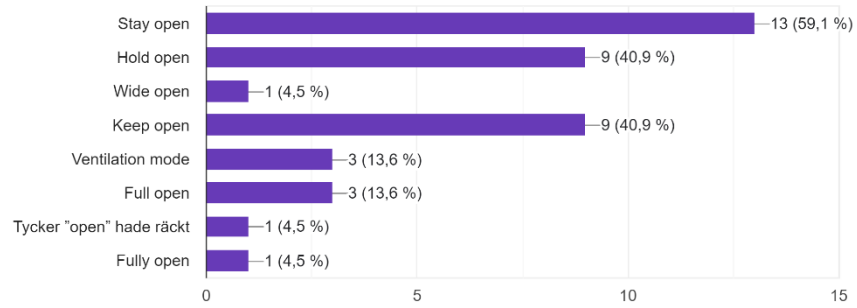






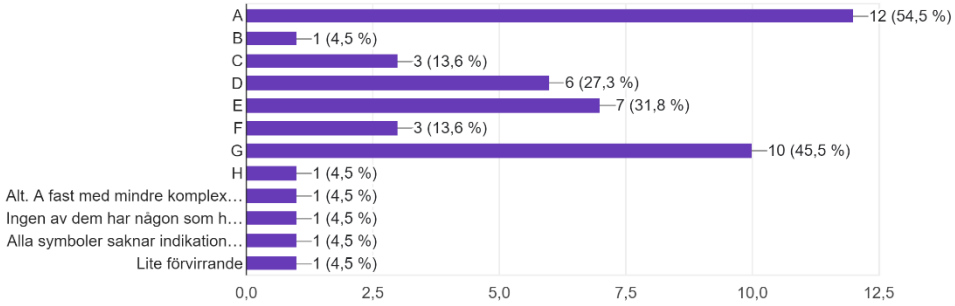
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna hålls helt öppna?

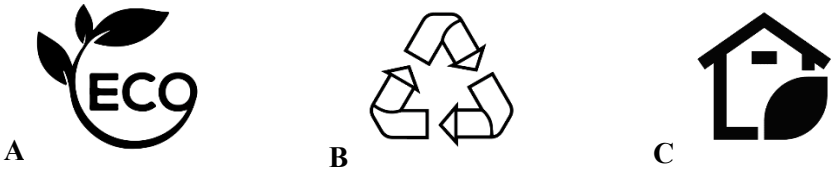
22 svar



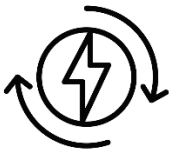
Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna är inställda i eco/smart-mode? Denna inställning innebär att dörrarna är i automatis...erförhållanden vilket bidrar till energibesparingar.

22 svar





D



E

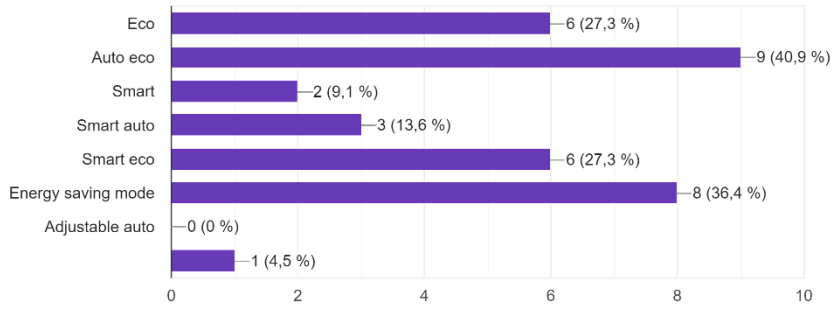
F

G

H

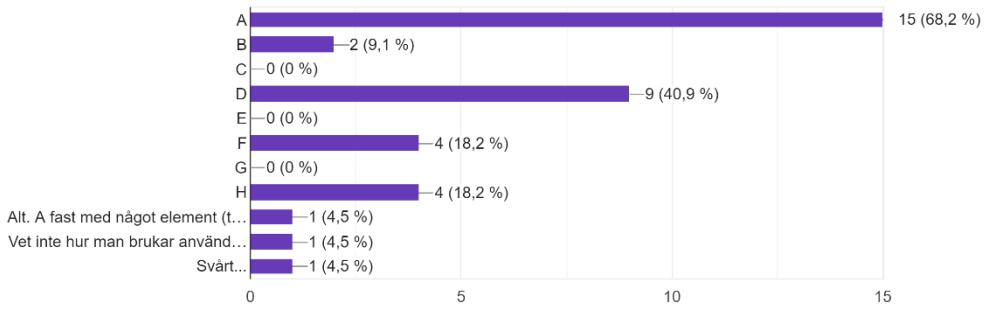
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna är inställda i eco/smart-mode? Denna inställning innebär att dörrarna är i automatis...erförhållanden vilket bidrar till energibesparingar.

22 svar



Vilka av dessa symboler kommunicerar tydligast att skjutdörrarna ändrar läge utefter ett tidsbestämt schema?

22 svar



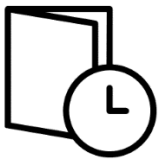
A

B

C

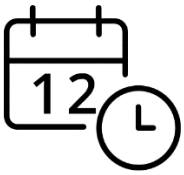
D

E



F

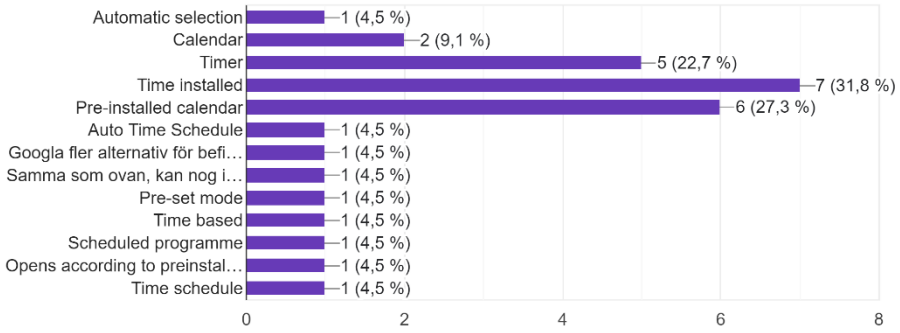
G



H

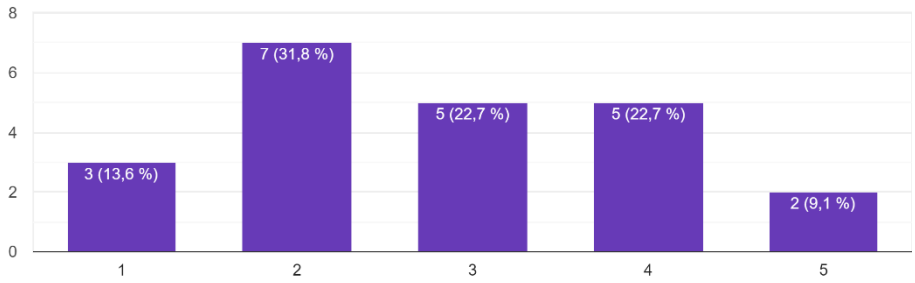
Vilka av dessa begrepp kommunicerar tydligast att skjutdörrarna ändrar läge utefter ett tidsbestämt schema?

22 svar



Vad tycker du är tydligast: endast symbol eller endast text?

22 svar



Endast symbol (only symbol): 1

Endast text (only text): 5
