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Investigating the design factors for a voice UI in a Workforce Management software

Master's thesis in Interaction Design and Technologies

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Master's Thesis 2019
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Typeset in LaTeX
Gothenburg, Sweden 2019

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Abstract

This thesis explored design factors for implementing a Voice User Interface (VUI) in the use scenario of a food retail Workforce Management (WFM) software. The research focused on design considerations for introducing a VUI, and had the ambition to identify the benefits of introducing a VUI for two user groups of the WFM software, i.e. supermarket employees and managers.
While following the User-Centered Design process, the VUI's effectiveness of supporting user's work by enabling hands-free interactions with the WFM software was examined in the industrial use case. The directions of the iterations were informed by user feedback and the results obtained in previous iterations. The iterative method also allowed for keeping the process of prototype design flexible.
A set of design factors was derived from the executed design process where it was found that managers were the user group that could immediately benefit from introducing the VUI in the industrial scenario. Specifically, design guidelines for the industrial use case suggest how a Voice User Interface (VUI) can be implemented to allow hands-free interactions while on the move.

Keywords: voice user interface, voice UI, VUI, voice, speech, Workforce Management, software, WFM software, UCD, design guidelines.

Acknowledgements

I would like to thank my academic supervisor Tomasz Kosiński of the Interaction Design division at Chalmers University of Technology. He was always there whenever I had troubles or needed advise and gave constructive feedback.

I would also like to thank Ronald Spruijtenburg from R&R WFM who helped me while writing the thesis and approached customers to be able to do user tests with real users. Additionally, I would like to thank Bart Bijl from InfoSupport who helped me during the process and everyone at R&R WFM who read my master thesis and gave constructive feedback.

Likewise, I want to thank my family for their support and understanding throughout the thesis project.

Wiebke Meyer, Gothenburg, May 2019

Contents

Abbreviations

ACD Activity-centered Design. 12, 13
API Application Programming Interface. *Glossary:* API
ASK Alexa Skills Kit. 7

GUI Graphical User Interface. 5, 19, 49–51, 56, 64

HCD Human-centered Design. 15
HTML Hypertext Markup Language. VII, 40

SaaS Software as a Service. VII–X, 3, 4, 33, 44, *Glossary:* SaaS
SDK Software Development Kit. 7, *Glossary:* SDK

TTS Text-To-Speech. 42

UCD User-centered Design. XVII, 13, 47, 59, 61, 63
UI User Interface. 5, 41
UX User Experience. XI, XII, XVIII, 28, 34, 36, 50

VUI Voice User Interface. v, I, III, VI, XIII, XIV, XVI, XVIII, XIX, 1–6, 8–11, 16–19, 21, 25–28, 30–45, 47–61, 63, 64

WCAG Web Content Accessibility Guidelines. 18, *Glossary:* WCAG
WFM Workforce Management. IX–XII, XIV, XVII, XVIII, 1–4, 10, 28, 39–41, 44, 47–53, 55, 57, 59, 63, 64
WOZ Wizard of Oz. XIX, 39–42

Glossary

Marginal employment A marginal employment can also be called a mini job and the employee only gets a wage of max. 450 € that is tax-free. VII

SaaS Software as a Service is a license model where customers can access the software via the browser, have a monthly subscription and the product is centrally hosted. 3

SDK A Software Development Kit is a set of tools that can be used during software development. 7

WCAG The Web Content Accessibility Guidelines have the goal to provide universal guidelines to meet the needs of people with disabilities. 18

List of Figures

1
Introduction

This thesis aims to examine the use scenarios that can benefit from introducing a voice interface in the food retail support setting. By the end of the thesis, it should be understandable how the VUI should be implemented within the industrial use case to provide an added value to the users.
All of the above will be investigated based on interviews and questionnaires conducted with real users of the currently deployed software version. These users have the best insight into their work and complex actions since they use the system as a support tool on a daily basis. Afterwards, the data will be analyzed to identify the design factors. This conclusion and insight will be further taken into account while designing and evaluating the VUI with regard to users' expectations and requirements expressed during the design iterations. Out of this design process, the final design factors for VUIs for a food retail Workforce Management (WFM) software will be derived and concluded with the design guidelines on how to address them in the considered use case.

1.1 Aim

The aim of this Master thesis is to explore the design factors for implementing a VUI for the users of a food retail support software. Additionally, the added value of introducing a VUI will be assessed by exploring whether and how the hands-free interaction might benefit the users of this kind of software.
This thesis will provide a set of design guidelines for the implementation of VUIs in a food retail WFM software. These design guidelines contribute to the knowledge on how a VUI can be implemented in such a system and what to pay attention to while implementing it.

1.2 Research Question

Which design factors should be considered while introducing a VUI for food retail Workforce Management software users?

The research question intends to explore the design factors for the introduction of a VUI in the specific scenario the thesis focuses on.
This specific thesis scenario will focus on the food retail WFM software for an industrial use case. It will explain the process and involves a qualitative research (described in chapter 4.1.2) to identify the design factors for introducing a VUI.

1.3 Stakeholders

The stakeholders of the thesis project are:

- Chalmers University of Technology
- R&R WFM - providing the industrial use case and hosting the thesis
- Wiebke Meyer - thesis writer
- Current and future R&R WFM clients / software users

2
Background

The project explores the introduction of a VUI to the existing WFM software which is hosted centrally as a Software as a Service (SaaS) solution. It involves understanding the added value a VUI might offer and the different tools that are available on the market to implement it.

2.1 Industrial Use Case

The particular case of this Master thesis will be analyzed in collaboration with the company R&R WFM. One of the company products is a SaaS product offered as a planning solution for food retailers in the Netherlands and Germany. It gives an insight into the productivity and labour costs of the supermarket. The manager primarily works with this service using a web browser interface and can forecast the workload based on earlier data, plan the working hours of the employees, gain insight into the worked hours and arrange the payments. The software also has to take the specific requirements of employees into account. Some of the employees, especially in the Netherlands, are still going to school and are only available in the evenings, weekends and school vacations. Other employees are only allowed to work for a couple of hours per week due to reduced ability to work or other reasons. All the employees of the supermarket have access to parts of the service relevant for their work tasks via a mobile app. The Job App can be used to view the current working schedule, add and edit the availability time in general as well as per day, and manage leave requests. Figure 2.1 shows the current home screen of the Job App for the supermarket employee.

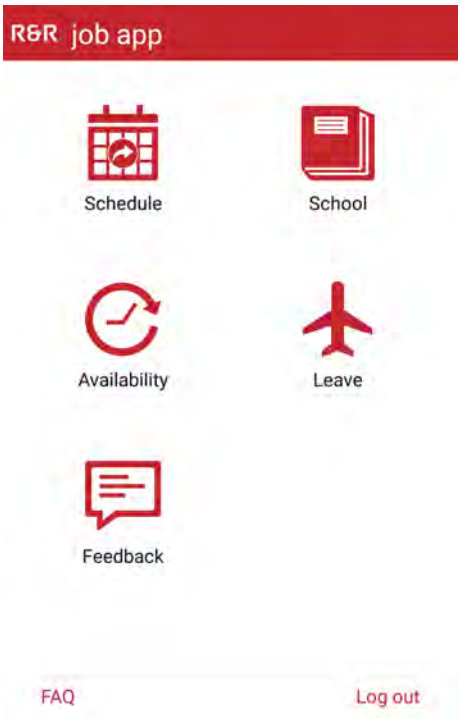

Figure 2.1: R&R Job App home screen

At the beginning of the software development process, the focus lied on optimizing the employee productivity against labor costs. Over the last few years, the importance of employee well being increased. This factor was brought to the attention by

customers as it is difficult for them to find new employees and therefore the person well being is important to keep the employee. Nowadays, it is possible to see this shift in the design. For example, German customers have the option to add the 'Freizeit' function where the employees can schedule times when they would like to be free. Another change of requirements resulted in a new Job App feature where employees can see their worked hours. This is necessary as employees were unsure about their worked hours and wanted to get a better overview of it.

2.1.1 Scenarios

Usually, a supermarket is really busy and the employees together with the managers are occupied and information has to be retrieved quickly.
A manager has a separate office where he/she has access to a computer. If a manager has to open the computer and click through several screens to find an answer to a simple question, it is a good use case for a VUI that can retrieve this information more efficiently. Additionally, the manager might want to spend more time in the workplace with the other employees and at the same time wants to be informed about important messages immediately. Moreover, it could be valuable for the manager to get to know who is working today or at what time the next employee is arriving while on the move. As an extra factor, a manager might want to issue voice commands to the software to retrieve specific information while moving between different locations.
The employees can also benefit from the hands-free interaction with the SaaS product via the Job App. The Job App provides easy access to the work schedules and other services. From the comfort of their homes, they could access these services via devices such as Google Home or Amazon Alexa without even the need of reaching for their smartphone.

2.1.2 Specific requirements

The industrial case is limited to software for the food retail market. Additionally, the customers of the R&R WFM company are located in the Netherlands and Germany. This means that the VUI has to be available in Dutch and German to be useful to all customers.

2.2 Voice User Interfaces

According to Clark et al. [11] the popularity of conversational UIs is growing and voice is becoming more prominent as a mode of interaction with software systems. Presently, a voice assistant can do many things, but there are also many tasks it cannot do, like continuing a conversation [16]. For example, voice assistants are not designed for complex conversations and have significant difficulties with many routines and critical aspects of these conversations [44].
Since 2012 conversational interfaces are available on the commercial markets [32]. For example, people are using tools like Apple's Siri, Google Assistant or Amazon's Alexa in their daily routine. According to Zue and Glass [60], the past decade has shown that there is a progress in the development of conversational interfaces that enable humans to communicate with computers using spoken dialogues.
In general, the interaction with VUIs is different than with Graphical User Interfaces (GUIs). The two major requirements are that it should be easy to learn, and the interaction should be natural [51].

2.2.1 VUI vs. GUI

Using a VUI has a few advantages over a GUI. As stated by Dasgupta [16], a voice interface is intuitive, hands-free and faster in many cases.
If an employee is working in the supermarket, the person mostly needs both hands and is busy during the shift. The hands-free affordance of the VUI is a big advantage to get the information the employee needs while he/she is still able to work at the same time.
The VUI provides convenience by eliminating the need of manual or physical interaction with software and its interfaces [16]. However, to date, it still requires learning the commands a VUI supports [16]. Brown et al. [7] agree with Dasgupta that more interfaces supporting natural interaction are needed.
Additionally, the advantage of a VUI lies in the efficiency of information input/output, as a simple sentence can contain multiple actions for the system. Commanding a set of actions while using a GUI would require multiple manual actions in order to be able to achieve the same effect. Of course there is a learning period for how the VUI works and the current VUIs are not all robust yet.

2.3 Multimodal Interfaces

A multimodal interface provides the user with multiple modes of interaction to accomplish the same task, for example by combining speech, gesture, pen input, or other modalities [5]. This implementation gives the freedom of choice for an interaction to the user and can also be used to promote accessibility.
As a whole, multimodal interfaces have the benefit of a greater input and output flexibility and support user preferences by offering more alternatives and naturalness in the interaction [7].
This kind of interface could be used in the transition period between GUI only and the VUI interfaces. If users are still able to use multiple modes to interact with

the system, they can slowly get used to the new type of interaction, i.e. to voice or speech.

2.4 Comparison of the voice assistants

In this section an overview of existing voice assistant technologies that can be used for a VUI implementation are provided. Voice assistants are used to add natural language capabilities to a software system. Figure 2.2 shows where the US general population uses these voice assistants in different areas of their daily life's.

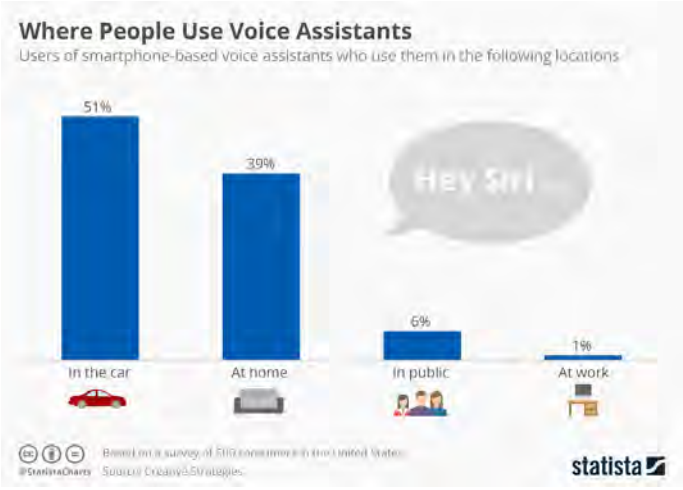

Figure 2.2: Where People Use Voice Assistants[1]

At the moment, there are different voice assistants on the market like Google Assistant, Amazon Alexa, Apple Siri, and Microsoft Cortana. Figure 2.3 shows the voice assistant market share in 2017 and the expected share in 2020. Amazon Alexa had a market share of about 62% in 2017 and is expected to have a decreased share of 34% in 2020. Google Assistant on the other side is expected to increase its market share until 2020 from 25% to 43%.

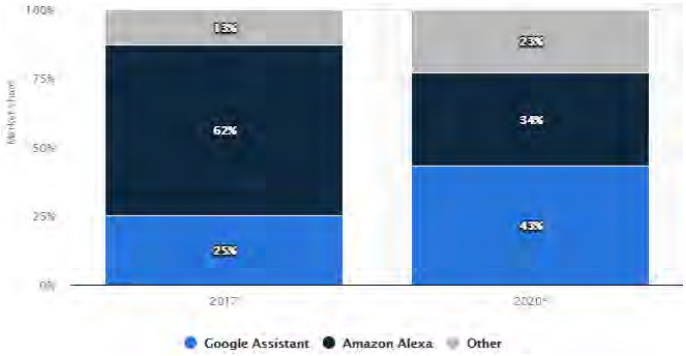

Figure 2.3: Voice assistant market share in 2017 and 2020, by product[2]

[1]https://www.statista.com/chart/7841/where-people-use-voice-assistants/
[2]https://www.statista.com/statistics/789633/worldwide-digital-assistant-market-share/

2.4.1 The voice assistant available on the market

The voice assistant tools that are available on the market and that were considered in this work at the stage of writing are described in this chapter.

2.4.1.1 Google Assistant

Google Assistant uses Google's vast knowledge base to retrieve information. It can be used for entertainment, managing tasks and answering questions. As Google is the world's most used search engine [42], Google Assistant can take advantage of it and retrieve quickly the relevant information to the question. The assistant can be installed on iPhones (with some disabled functions) and is integrated into Android phones [25].
The voice assistant can be integrated with an existing app using a Google Software Development Kit (SDK) for developing the app. Another option is Google Actions [28] that allows third-party developers and services to use the voice assistant.
Google Assistant is available in English, German, Dutch and other languages. Powered by Google Assistant, Google Home can be used as an additional interface.

2.4.1.2 Apple Siri

Apple Siri is the voice assistant for Apple devices and can be used the same way as the Google Assistant or Amazon Alexa. Siri can be extended with the SiriKit [15] to enable additional apps to work with voice. Siri is available in multiple languages like English, German and Dutch. It can be used on all Apple devices with the iOS system, but it is not possible to use the assistant with an Android device. Apple has an additional device - the Apple Home Pod. It is a speaker, but it can also help with everyday tasks and controlling the smart home through voice.

2.4.1.3 Amazon Alexa

Amazon Alexa is a virtual assistant from Amazon. Alexa is responsible for the voice assistance and Amazon Echo is the device that can be used as a Wi-Fi speaker. Using the Alexa Skills Kit (ASK), developers have the possibility to develop third-party apps [15]. Amazon Alexa can speak English and German among other languages, but is not able to speak Dutch. Additionally, it can be used on Android and iOS.

2.4.1.4 Microsoft Cortana

Microsoft Cortana is a voice assistant and can be used for different tasks like setting reminders by voice [33]. Cortana can be extended with the Cortana Skills Kit. The kit enables developers to develop skills for Cortana and connects users to the custom service [28]. The assistant is available in English, German and other languages, but not in Dutch. It can be used on Windows, Android and iOS operating systems.

2.4.2 Comparison of the Voice Assistants

Figure 2.4 shows an overview of all features of the different voice assistants. For example, all voice assistants support the languages required in the industrial scenario, except Amazon Alexa and Microsoft Cortana. Also, all of them are extendable with own voice features and commands and are available on iOS devices. Apple Siri is not available on Android devices, but the others are also running on those devices. Microsoft Cortana has no physical device. However, Google Assistant is available through the Google Home speaker, Apple Siri through the Apple Home Pod, and Amazon Alexa can be used with a range of physical speaker devices including those with screens.

Voice assistant	English	German	Dutch	Extendable	Android	iOS	Physical device
Google Assistant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Amazon Alexa	Yes	Yes	No	Yes	Yes	Yes	Yes
Apple Siri	Yes	Yes	Yes	Yes	No	Yes	Yes
Microsoft Cortana	Yes	Yes	No	Yes	Yes	Yes	No

Figure 2.4: The summary of voice assistants with regard to the industrial use case's requirements

The available voice assistant tools at the stage of writing were compared to indicate which available voice assistants fulfill the system requirements and could be used to implement the VUI in the industrial use case.

3
Related work

This section describes methods and work related to this Master thesis project. The different projects are described in respective sections.

3.1 Designing a Conversational Agent

Kocielnik et al. [29] designed a chat and voice-based conversational agent that combines a slack bot as a chat-based communication and a custom Amazon Alexa Skill for a voice interaction. The goal of the project was to understand how to design for the text and voice channel of this conversational agent that supports workers' activity journaling and self-learning through reflection. The conclusion of the project is that workers can benefit from the added communication tool as the chat makes it easily readable for non-native English speakers and the voice option is more engaging and personal and therefore better for complaining. This Master thesis aims to implement the same principle like adding voice to a system that should benefit by introducing a VUI for the managers and employees in the supermarket.

3.2 Introducing a Virtual Assistant to the Lab

Austerjost et al. [4] tested a VUI in a lab environment for controlling and reading out specific device data from laboratory instruments. A laboratory can be a noisy environment where the sound level is equivalent to a normal conversation. The findings of this work can help to relate it to the food retail market as it typically is a noisy environment as well. An accuracy of 95% was the outcome of the speech command recognition performance and shows a high potential of VUIs in noisy environments as the one analyzed in this work.

3.3 Conversational Interfaces in Public Spaces

Candello et al. [8] investigated the user experience of conversational interfaces in public spaces, like hotel lobbies, store showrooms, car dashboards, or home devices, and the effect on the audiences. Their work resulted in several design recommendations, e.g. that designers should take into consideration the previous content knowledge of the user as it can affect the social interaction with machines. Especially if an audience is present, the effects of the social interactions are boosted. These recommendations relate to the food retail market as they inform the design of interactions with chat-bots in physical spaces and can also inform the design of a VUI for a food retail WFM software.

3.4 Visual Feedback for Mobile Voice Assistants

Hou and Yang [24] analyzed the role and characteristics of visual feedback in voice interfaces. Siri was used as a case study and the project goal was to improve the reliability of the voice assistant by optimizing the voice interaction feedback interface in mobile devices. The paper summarizes the task mode of language interaction, discusses the voice interaction principles with relevant theories, and elaborates on the problems of mobile voice assistants. The results of this research project were improved design principles to solve the drawbacks of the current voice interaction. This Master thesis investigates similar considerations, however for the implementation of a VUI in the industrial use case.

4

Design Theory

The project confronts a wicked problem [46] of investigating the design factors of introducing a VUI into the industrial use case. Gaver [20] discusses in the paper 'Research through design' different theories that can help to solve this kind of problem. Various theories and frameworks are chosen for this project and are, as well as voice interface design principles, discussed in this chapter.

4.1 Design Research

In general, this research project constitutes a participatory action research [55] as it involves the participation of people in the design process and the effectiveness of the design increases based on this input. The participatory action research method is based on the action research. According to Wadsworth [55], it is generally used for observation and reflection and explicitly uses the action component.
In the following section, the exploratory research, qualitative research and research quality criteria are described that are also part of the action research.

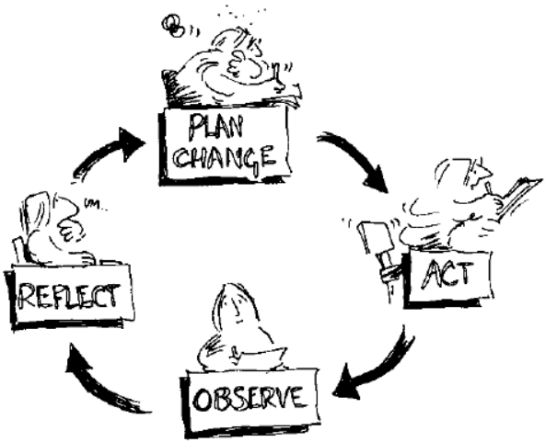

Figure 4.1: The basic elements of action research [55]

4.1.1 Exploratory Research

An exploratory research study, also called formulative research study, is used to gain new insights into a phenomenon, and to get familiar with it [30]. The research must be flexible to consider the many different phenomenon aspects [30] and is a prestudy of an unfamiliar problem of which the researcher has no or little knowledge about [50]. Herewith, the problem wasn't already solved by someone else and the researcher also checked the literature before starting the prestudy. In order to solve the existing problem, the researcher answers a set of questions through this research and uses it at the initial stage of the research process [52].
Moreover, a formative research refers to an exploratory research and states that there is no clear set of outcome for the study [19]. It has guiding questions about

what theory improvements can be made, and what methods did and did not work well [19].
The thesis project is an example of such a research study.

4.1.2 Qualitative vs. Quantitative Research

A qualitative research has the aim of developing a theory that explains what was experienced and is used when observing and interpreting reality. Contrarily, a quantitative research is used when the researcher begins with a theory (or hypothesis) and tests it for confirmation or disconfirmation [38].
The thesis project makes use of the qualitative research and is an example of such a study.

4.1.3 Research Quality Criteria

In this section, two research quality criteria are discussed: reliability and validity.
Reliability describes the extent to which the study is reproducible with a similar methodology, if the results are consistent over time, and if the study contains an accurate representation of the total population [22].
Another criteria is the validity, that is, whether the study can accomplish to answer the research question and can test the hypotheses in an accurate and trustworthy way [26]. The validity of a research can be divided into internal and external validity. The internal validity relates to results that are only obtained due to the manipulated independent variable, whereas the external validity describes if the results are generalizable to environments, groups, and contexts outside of the experimental setting [40].
The thesis project has to have a certain quality to justify that the research is valid and reliable. These criteria are used to assess research projects and are described to understand what they mean.

4.2 Design Paradigms

Design frameworks are an important part of the design process. To be able to design the right system for the right purpose, it is important to choose the best suitable design framework. In the following, four design frameworks will be explained and discussed where one of the design frameworks is also used for the thesis project.

4.2.1 Activity-Centered Design

The Activity-centered Design (ACD) process has an activity-centered focus on high-level human activities [34]. It also considers the knowledge of the technology, tools and activity reasons [39].
The focus of the ACD process lies on the activity whereas the focus of the Master thesis lies on the user. It is still important to have a look at this paradigm as it is an iterative process that also examines the requirements and parts of it can be used for the chosen design framework.

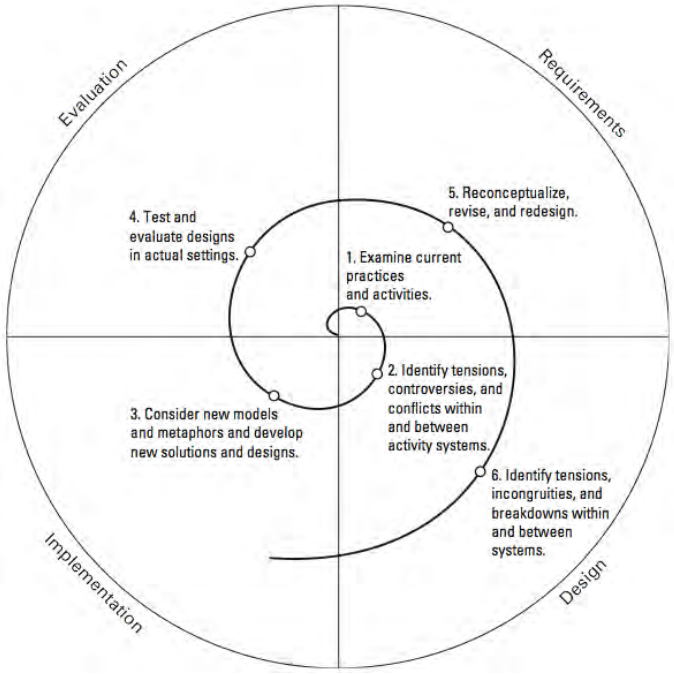

Figure 4.2: Iterative ACD design cycle [21]

4.2.2 User-Centered Design

The UCD process is an iterative design process where users influence the design [1]. Throughout the design process users are completely involved to ensure a user friendly, accessible and usable product. This approach contains four iterative steps shown in figure 4.3. For the thesis project, the UCD process was chosen, as the industrial use case centers on the users and their needs. The users influence the design and are the focus of this design paradigm [1]. These phases use multiple design theories to support the process iterations and consist of the user research, concept development, prototype and evaluation.

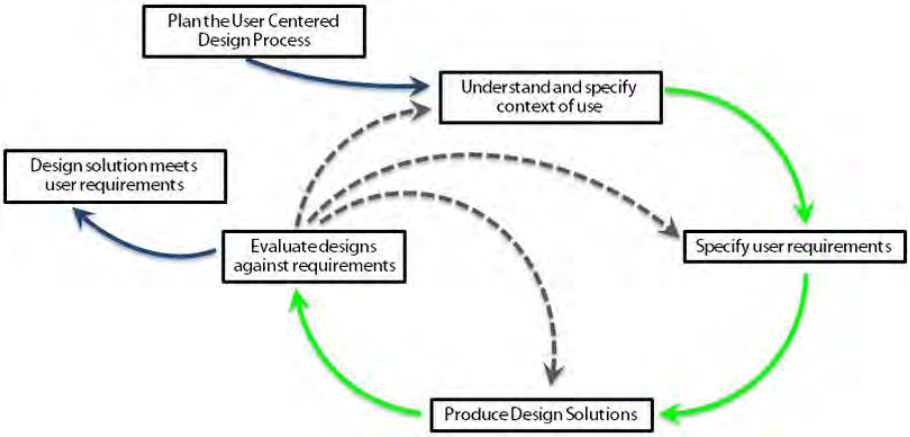

Figure 4.3: User-centered Design (UCD) process [47]

4.2.3 Goal-Directed Design

The Goal-Directed Design process is developed by Cooper et al. [14] and consists of the following six phases:

1. Research
   The Research phase gathers information about the users and investigates the domain.
2. Modeling
   The Modeling phase places the users in the context based on Personas and other effective methods.
3. Requirements Definition
   The Requirements Definition phase defines the requirements and creates a vision, for example based on scenarios.
4. Design Framework
   The Design Framework phase defines the design structure and the interaction framework based on form factor, posture, data elements, functional groups, sketches, key path scenarios and validation scenarios.
5. Design Refinement
   The Design Refinement phase refines the behaviour, form and content.
6. Validation and Testing
   The last phase is about validating and testing the design, for example with usability tests.

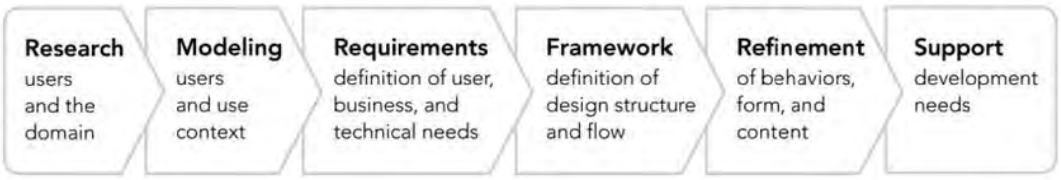

Figure 4.4: Goal-Directed Design process [48]

The Goal-Directed Design process focuses on the goal, but it is still user-centered. It is not used for the thesis project, but has elements that can be used while following the chosen design framework.

4.2.4 Human-Centered Design

The Human-centered Design (HCD) process designs a solution for people and puts the emphasize on different stakeholders and their needs [58]. This process also aims to get a better match with the real world and its future [31].

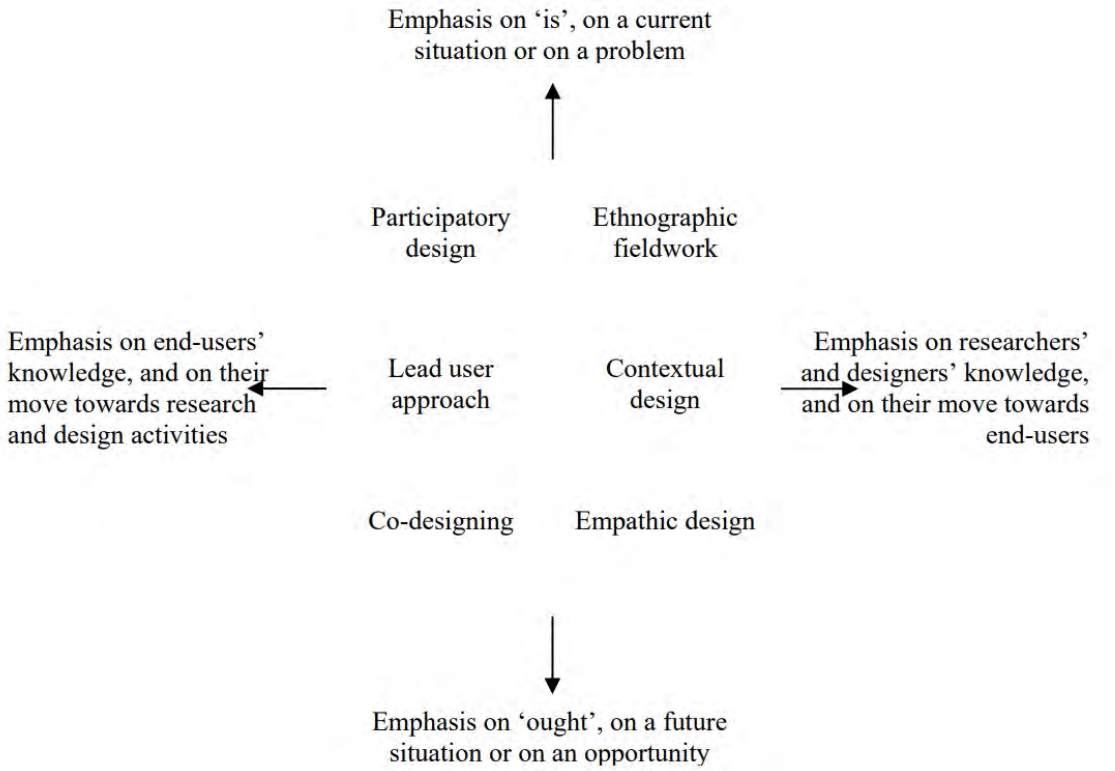

Figure 4.5: Different HCD methods and practices [53]

In comparison with the other design frameworks, the HCD process is focused on the human. It could also be used for the thesis project, but as it centers on the multiple stakeholders as humans, another design framework is a better fit. The HCD process still has elements that can enrich the chosen design framework.

4.3 Voice Interface Design Principles

A VUI allows people to use voice when interacting with mobile devices and PCs. But to be able to design for VUIs, it is important to understand the basic voice interaction flow and other VUI design principles that are introduced in the following section.

4.3.1 Basic Voice Interaction Flow

Generally, for effective voice design a script has to be prepared that enables smooth messages within the context [13]. This should be based on a basic voice interaction flow as shown in figure 4.6. A voice interaction needs a trigger to start the device/-conversation. Once the device is triggered, feedback will be given to the user in the form of a leading cue. For example, this leading cue can be visual or auditory and the device is actively listening afterwards. When the user stops talking, the device gives realtime feedback to the user and ends with an ending cue. This ending cue can be the same as the leading cue. Then the device processes the request and performs the action. This can be switching on or off the lights or playing music.

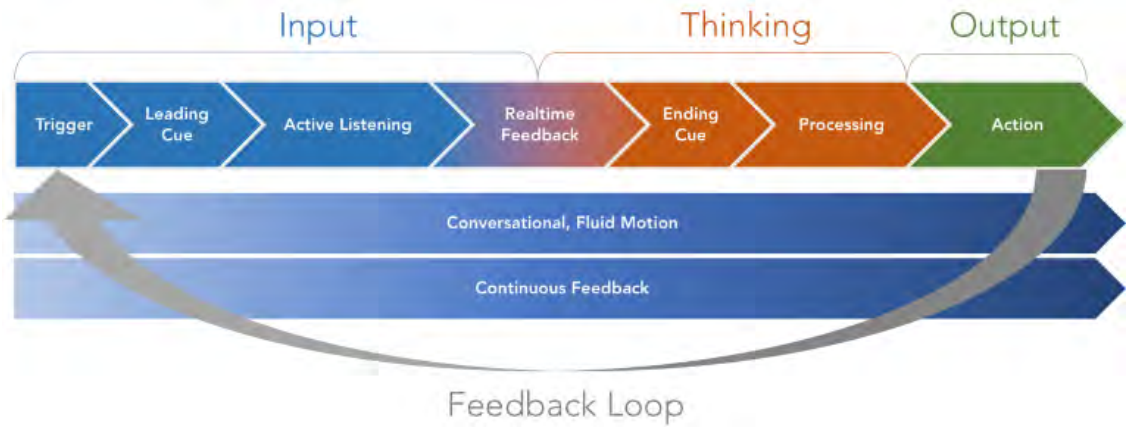

Figure 4.6: Basic Voice Flow [1]

[1] https://medium.muz.li/voice-user-interfaces-vui-the-ultimate-designers-guide-8756cb2578a1

4.3.2 Sample Dialog

A sample dialog is an exemplary interaction between the VUI and the user and has the form of a dialog [41]. It is a good idea to write multiple sample dialogs for the most common use cases of the VUI to design natural-sounding conversations.

USER
Ok Google. Who was the 16th president of the United States?

GOOGLE
Abraham Lincoln was the 16th president of the United States.

USER
How old was he when he died?

GOOGLE
Abraham Lincoln died at the age of 56.

USER
Where was he born?

GOOGLE
Hodgenville, KY

Figure 4.7: Google Sample Dialog [41]

4.3.3 VUI Interaction Flow

After creating sample dialogs, the next step is to sketch flows of the interactions supported by the VUI. All possible paths that the system can take are illustrated in a flow diagram [41].

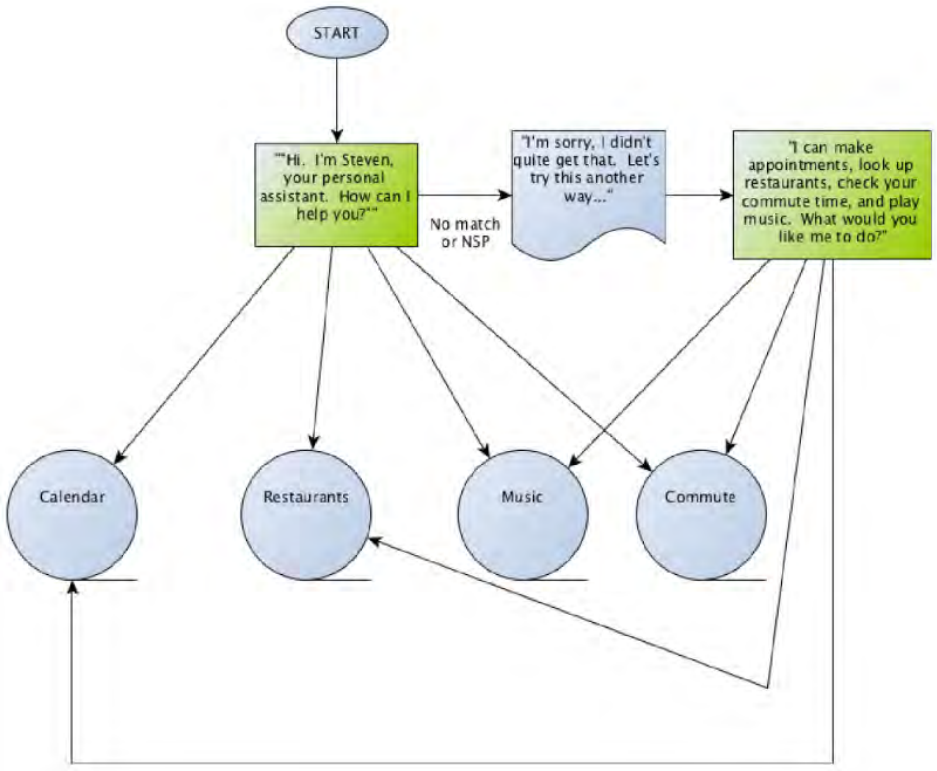

Figure 4.8: Sample VUI Interaction Flow [41]

4.3.4 Acknowledgement of understanding the input

The user should get a confirmation that the VUI received the input in the form of a blocking or non-blocking confirmation.
For a blocking or explicit confirmation the user is forced to confirm the information [41]. For example, 'I think you want to add paper towels to the shopping list. Is that correct?'. A non-blocking or implicit confirmation is not asking the user to confirm the information and just let them know what was understood [41]. For example, 'OK, adding paper towels to the shopping list'.

4.3.5 Error Handling

A VUI needs to consider how to handle errors. If an error is handled poorly, users are unlikely to complete their tasks and won't consider to come back. If the error is handled well, the user will be able to complete the task.
Pearl [41] discusses four errors a VUI can make:

- No speech detected
- Speech detected, but nothing recognized
- Something was recognized correctly, but the system does the wrong thing with it
- Something was recognized incorrectly

It will be considered in the design process how the VUI should react in these cases.

4.3.6 Accessibility

Accessibility is an important aspect of designing for VUIs. Web Content Accessibility Guidelines (WCAG) [2] are also developed for voice recognition and users with disabilities. The content has to be designed in a way that makes it clear how the VUI works and how it can be controlled.

[2]https://www.w3.org/WAI/standards-guidelines/wcag/

4.4 Multimodal Interface Design

Multimodal interfaces should also follow design guidelines to ensure a good and valid design. Reeves et al. [43] suggest the following categories of guidelines that should be considered during the design process:

- Requirements Specification
- Designing Multimodal Input and Output
- Adaptivity
- Consistency
- Feedback
- Error Prevention / Handling

Additionally, multimodal interfaces should be tested with a high-fidelity prototype as the user interacts according to their beliefs with a fully functional system [27]. This gives a better insight of the users and their reactions to the real system.
All in all, it has to be decided whether a multimodal interface is necessary for the system. For data-rich environments it might be unavoidable to use multiple modalities to support a given task [49].
As a multimodal interface design could be used in the transition period between GUI only and the VUI interface, it is important to consider the design implications and principles for this system as well.

5

Methodology and process

The project uses various methodologies to support the design process. The book 'Universal methods of design' by Hanington and Martin [23] contains multiple methods that can be used during the process to approach the problem this thesis aims to solve. Besides that, Wadsworth discusses in the book 'Do It Yourself Social Research' [55] different methods for an effective research that informed the process followed in the thesis.

5.1 User Research

The user research inspected users' needs and motivations by evaluating existing knowledge about voice assistants, and conducting qualitative research. These methods allow for gaining insights into VUI users' needs and expectations. Individual interviews were used as the users can directly explain their work environment and circumstances to the interviewer. The questionnaire results are useful to examine how representative the participants are of the general population of voice assistant users. The outcome of the interviews and questionnaires were then used to inform the design of VUI prototypes.
For the questionnaire as well as the individual interviews, a pilot study was executed. Pilot studies were conducted in order to tackle issues and to be able to redefine the questions. A pilot study basically pretests the study and is a mini-research with a few people to illuminate problems [55].
To analyze the outcome of the user research, the grounded theory approach was used. It is an approach which leads to knowledge that is grounded in data [54] and it is a method of the qualitative content analysis to examine the data systematically [36].

5.1.1 Overview of voice assistants market share

The questionnaire consisted of questions about the phone operating system, the voice assistant use, how often it is used and for which purpose. To retrieve this general data for the two different countries, Germany and the Netherlands, information from respective market research providers were used.
The following chart combines the market share data for Android and iOS from Germany and the Netherlands in 2018.

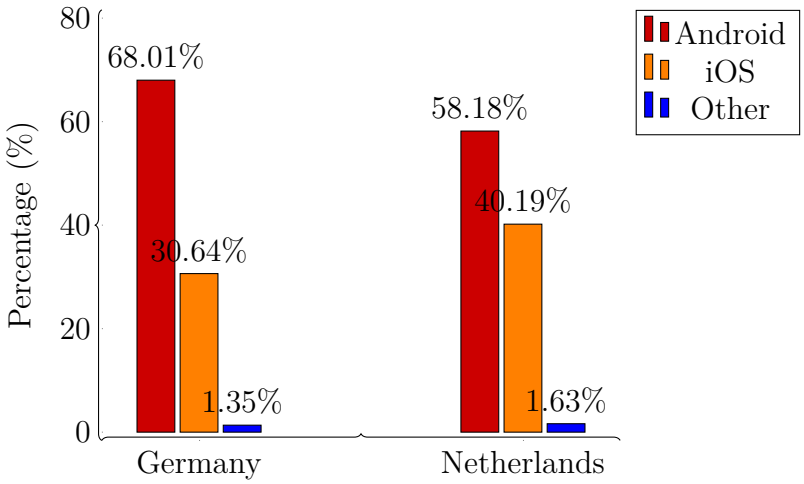

Figure 5.1: Mobile Operating System Market Share Germany[1]and the Netherlands[2]in 2018

Figure 5.2 shows how the voice assistants are used in Germany. The questionnaire from Spendid Research was filled out by 1024 Germans between 18 and 69 years and 37% of them are currently using a voice assistant. In November 2017, Google Assistant was the most used voice assistant in Germany, followed by Siri, Cortana and Amazon Alexa. Most of the people use a voice assistant for messages (67%), searches (65%) and music (62%).

Figure 5.2: The use of voice assistants in Germany - November 2017 [3]

[2]http://gs.statcounter.com/os-market-share/mobile/germany/#monthly-201801-201812-bar
[2]http://gs.statcounter.com/os-market-share/mobile/netherlands/#monthly-201801-201812-bar
[3]https://www.splendid-research.com/de/statistiken/item/studie-nutzung-digitale-sprachassistenten.html

Figure 5.3 shows how the voice assistants are used in the Netherlands. In October 2018, Apple Siri was the most popular voice assistant in the Netherlands, followed by Google Assistant and Amazon Alexa. It is also mentioned that Google Assistant was recently launched in the Dutch language and it might change the market share of the different voice assistants. Until now, only 19% of the Dutch people are using voice assistants.

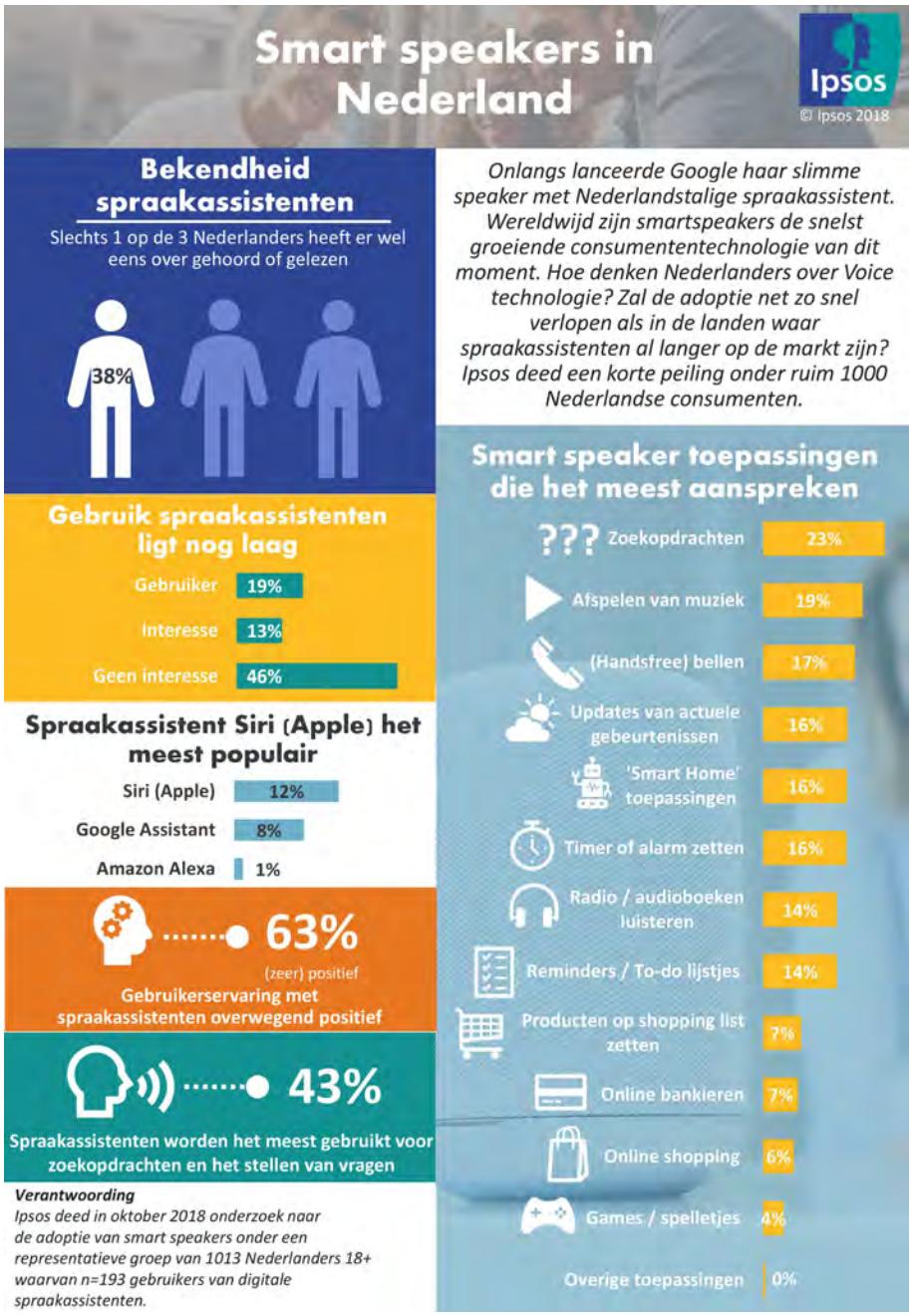

Figure 5.3: Smart speakers in the Netherlands - October 2018 [4]

[4]https://www.marketingtribune.nl/bureaus/nieuws/2018/11/ipsos-adoptie-digitale-spraakassistent-nog-pril/SmartSpeakersNederland.pdf

5.1.2 Questionnaire

Questionnaires can be used to get to know a general overview of the study sample. In this case, it was used to understand the users experience with the different voice assistants. Questions as 'Which voice assistant do you use?', 'How often do you use the voice assistant?', and 'For which tasks are you using a voice assistant?' were asked. The form had only one early exit point where users could directly submit the form if they answer 'no' as it made no sense to ask the rest of the question. The participation was voluntary and the participants could withdraw at any time without explicit reason and no further consequences. The participants also agreed in the consent form that the data will be subject to anonymous scientific analysis and publication. The whole questionnaire can be found in appendix A.1.

5.1.2.1 Pilot questionnaire

During the pilot study, three people filled out the questionnaire. All questions were clear and the users didn't report issues with understanding them. There was one user who used a voice assistant once, but wasn't able to find a fitting answer for question 10: 'For how long do you use voice assistants?'. As users who only used a voice assistant once should still be able to answer the questionnaire, the answer 'only one time' was added for this question.

5.1.2.2 The questionnaire

During the pilot study, a demographic question about the age was included in the questionnaire. The different statistics about voice assistants include no information about the age of the different users. As this is the case, the representativeness of study participants compared to the general population with regard to age could not be assessed. Additionally, some people might consider this demographic question as sensitive and if the question is asked, some sources suggest to keep it optional [2]. Due to this, the demographic question about the age was removed from the questionnaire.

5.1.3 Individual Interviews

Apart from the questionnaire, individual interviews were used to retrieve more information about the user needs. It is a qualitative research method [23] and can retrieve explicit user information. According to Wadsworth [55], an individual interview is a conversation of two people as a simple face-to-face meeting. Consequently, interviews with supermarket managers and employees were set up to get to know their needs and requirements for a VUI. All interview questions can be found in appendix A.2.1.

5.1.3.1 Consent form

A consent form was used to make sure that the user gives consent to take part in the research study. Furthermore, the user got informed about the purpose of the research study and that the participation was completely voluntary. The consent form audio recording of the individual interview as the study was performed by only one person. For one person it is difficult to have the full attention on the interviewee while taking notes at the same time, which might result in the loss of data from the study session. The full consent form can be found in appendix A.2.2.

5.1.3.2 Pilot individual interviews

During the pilot study of the individual interviews, three people were interviewed. One of the interviewees was a manager and the other two were general employees. They understood the questions, but most of them didn't have a lot of experience with voice assistants. As it turned out that the study participants often did not have prior experience with voice interfaces, more examples of possible connections with the R&R software were given. Through these examples, the user was able to imagine how voice interfaces could be used. This has been improved with the real user studies as the user is not always able to follow the different thoughts about how the voice assistant could make the processes more efficient.

5.1.3.3 The individual interviews

After the pilot study, the conclusion was made that it might be helpful to have an interview script to be able to focus on the most important parts during the interview and to have enough examples of a VUI. This interview script can be found in appendix A.2.3.
As a whole, the users were able to understand the interview questions. On the one hand, some users were really busy at work and were not able to give extensive answers to the questions. On the other hand, some users were really open and gave a lot of information as answer to the questions. System functionalities that were not working as the users would have wanted them were collected in the mind map (appendix A.2.4).
Altogether, it was difficult to schedule all the interviews with the supermarket employees as they were not always available and it turned out to take longer than expected.

5.1.4 Qualitative Content Analysis

A qualitative content analysis has the goal to gain insights on what the content describes and the idea is to maintain the systematic nature for the various stages of a qualitative analysis [36]. According to Zhang et al. [59] a qualitative content analysis follows the process of preparing the data, develop and evaluate a coding scheme, code all the text, and draw conclusions from the coded data.

5.1.4.1 Grounded Theory

Grounded Theory is a data collection and analysis approach where flexible guidelines are provided and which leads to a theory that is grounded in data [54]. The analytic process consists of writing analytic narratives throughout inquiry, coding data, and developing, checking, and integrating theoretical categories [10]. When the grounded theory talks about coding, it means how the data is processed. Coding means categorizing data segments and shows how the data is selected, separated, and sorted [9].

5.1.4.2 Data Analysis

For the qualitative content analysis of the individual interviews, no hypothesis was formulated in advance of applying the grounded theory approach. The data set analyzed at this stage consisted of only the data collected during the interviews. For the particular set of requirements in this project, such as using specific languages, the author did not find literature studies explicitly informing the design process.
In specific, the interview transcripts were coded with the codebook tool and in that sense categorized and sorted into themes. Afterwards the retrieved data was analyzed and evaluated. This grounded theory method gave the possibility to extract a set of user requirements and expectations towards a VUI.

The QDA Miner software[5] offers a free version to analyze the qualitative data according to the grounded theory approach. This software was used in which the interview transcripts were coded. The academic supervisor was the 2nd coder. At the beginning, each coder came up independently with their codebooks by coding two employee and one manager transcript. The codes for the codebook emerged from the data in the transcripts. After setting up these codebooks, there was a meeting to refine them up to the point where both coders agreed upon and it was clear. Finally, the codebooks were merged to the initial codebook version (shown in figure 5.4).
Some employees are also working as other employees' supervisors and have more responsibilities than others. As this is the case, not everything for these employees would be covered by the employee codebook and therefore the decision was made to only have one codebook for managers as well as employees.
The initial codebook version was then used to code all the remaining transcripts. At the end of coding of all the interview transcripts, the codebooks were compared and finalized for the concluding step as shown in figure 5.5. When a coder found an

[5]https://provalisresearch.com/products/qualitative-data-analysis-software/

instance of a code not present in the codebook, it was added and later discussed and resolved with the other coder. The inter-rated reliability score measure, Cohen's Kappa, measures the agreements on a categorical scale between two raters [57]. In this case, the Cohen's Kappa was tracked at the value of 0.98.
The result is a codebook that includes the structural codes as well as the hierarchies and gives more insight about the different views on the work day of the users and their experiences with VUIs.

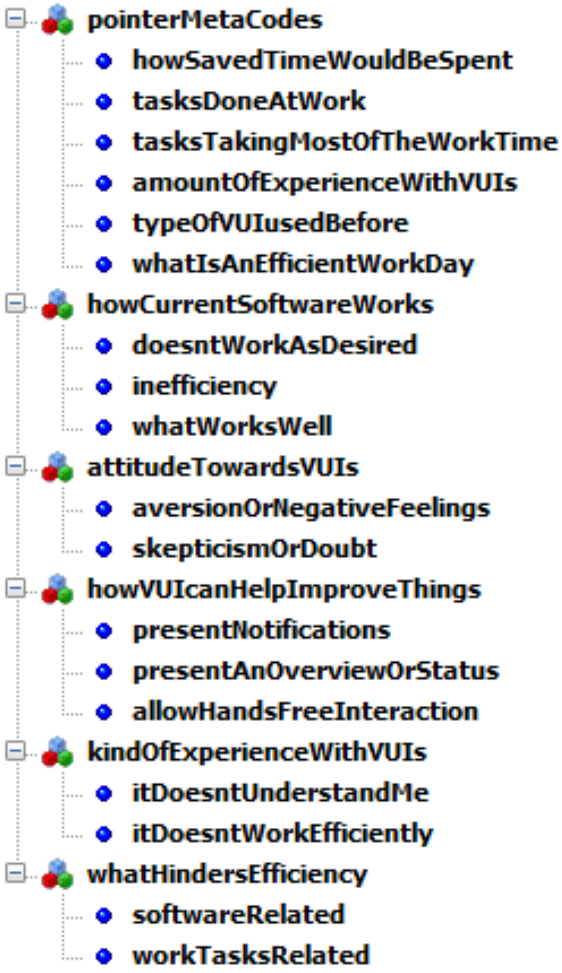

Figure 5.4: Initial Codebook

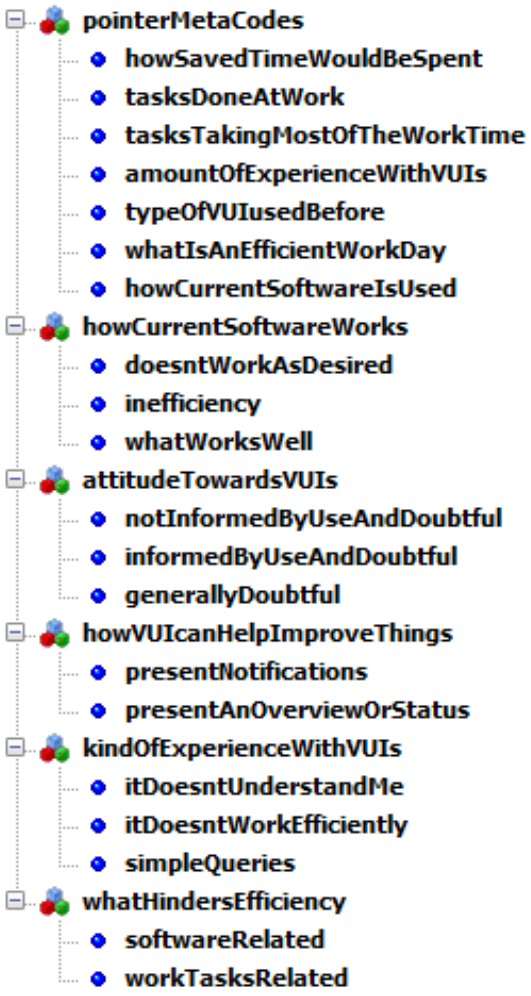

Figure 5.5: Final Codebook

5.2 Concept Development

The concept development phase used the input from the user research to create the first concept of a VUI. Therefore, scenarios [23] were constructed based on the designed personas [23]. Out of the scenarios, sample dialogs were created. These sample dialogs describe the interaction between the user and the VUI [41]. The next step in the concept development phase was to sketch VUI flows that illustrate all possible paths that the system can take [41].
According to Pearl [41], sample dialogs and flows describe the VUI context. The context itself is important for the user to understand the circumstances and to be able to interact with the VUI. Before this context of the interaction between the user and the VUI could be analyzed, the personas and scenarios were developed. The scenario method explores the product use from the users perspective [23]. To characterize the users perspective, personas were defined based on the outcome of the user research. This method is used to identify the user's behavioral patterns and to present it in a user profile [23].

5.2.1 Personas

The two UX Designers, working for the company R&R WFM, already created five Dutch and four German manager personas for the other design implementations. It is important to reuse the same personas as the VUI should be suitable for the same kind of users. As an example, a German and Dutch manager persona can be found in appendix A.4.
All of the personas created by the two R&R WFM UX Designers are managers from the Netherlands and Germany. No personas for supermarket employees were created so far and therefore only one of the manager personas is reused for this Master thesis.
The reused persona is the persona called 'Johan Oostdam' (appendix A.3) and contains general background information about the manager and his store. It is also registered how many hours per day he is using the internet and how much experience he has with the R&R solution. Nevertheless, the persona doesn't contain the number of tasks or interactions a person has with the R&R solution and which of these tasks take the most of his time. Furthermore, it doesn't include the type and extent of experience with voice assistants. This knowledge was obtained during the user research and added to the persona for a more complete overview of the users.

Figure 5.6: Additional information for the persona manager 'Johan Oostdam'

Figure 5.7: Persona employee Maartje de Jong

Figure 5.8: Persona employee Daan de Vries

All personas were created online using the web-based tool 'HubSpot'[6].

5.2.2 Use scenarios

A scenario is a tool that verifies the preliminary analysis of user needs and expectations. The method also elicits further feedback and expectations from the users while they have the opportunity to engage with the prototype.

5.2.2.1 Scenario 1

You are a manager in a supermarket. While driving, you would like to get a summary about the current store in Veenendaal (the Netherlands). Therefore you ask the VUI to give a summary.

5.2.2.2 Scenario 2

You are a manager in a supermarket. While driving, you would like to get more information about the store. Therefore you ask the VUI to give you more information about the revenue stream of the store in Veenendaal (the Netherlands). Afterwards you would like to get to know how many employees are sick today.

[6]https://www.hubspot.com/make-my-persona

5.2.2.3 Scenario 3

You are an employee in a supermarket. Currently, you are sitting at home on the couch, but you would like to get to know at what time you have to work again. Therefore you ask the R&R Job App. The VUI responds with a time and date of your next work shift. You realize that you are not available at that time and ask the VUI to send a shift replacement request, because your university schedule changed and you have a class.

5.2.3 Sample Dialogs

Sample Dialogs give a better insight on how the interaction between the user and VUI might flow. To come up with authentic sample dialogs, Google Assistant was tested and its answers were used for inspiration. For example, Google Assistant gives short answers and it sounds like a computer in the way the answers are given. It is important that the VUI in the sample dialogs also sounds like a computer to provide the same type of user experience to the user. This is in line with the work of Clark et al.[12] who found that voice assistants can be inspired by human interactions, but a conversation between a human and voice assistant is a new type of interaction that has to be explored.

5.2.3.1 Sample dialog for scenario 1

USER
Ok VUI. Tell me a summary.
VUI
Okay, from which shop do you want the summary?
USER
The shop in Veenendaal.
VUI
Yesterday, the revenue stream for the shop in Veenendaal was 30.794,98 €. The total revenue stream for this week is 92.384,91 €. 3 employees called in sick today. You didn't use the payment function for last week.

5.2.3.2 Sample dialog for scenario 2

USER
Ok VUI. Tell me the revenue stream.
VUI
Okay, from which shop do you want to know the revenue stream?
USER
The shop in Veenendaal.
VUI
Yesterday, the revenue stream for the shop in Veenendaal was 30.794,98 €. The total revenue stream for this week is 92.384,91 €.
USER
How many employees are sick today?
VUI
3 employees called in sick today.

5.2.3.3 Sample dialog for scenario 3

USER
Ok VUI. At what time do I have to work?
VUI
Next work you have on Monday at 9am at the cheese department.
USER
Send a shift replacement request.
VUI
Alright, when is the shift?
USER
On Monday, 25th of March at 9 o'clock.
VUI
Okay, shift replacement request on Monday at 9AM. Do you want to add a reason?
USER
Yes, university class.
VUI
Okay, shift replacement request on Monday at 9AM, university class. Do you want to send that?
USER
Yes.
VUI
Okay, I send your shift replacement request.

5.2.4 VUI Interaction Flow

The VUI flow chart in figure 5.9 describes the different control flow paths within the VUI that can be taken by the user. In this example, the user has five main options to ask for the work time, revenue stream, shift replacement request, sick employees, or a shop summary. The options to ask for the work time and shift replacement request were derived from the Job App functions being most popular among employees based on the qualitative study. The other three options are intended for the manager who could ask for these general information as they required a lot of clicks within the SaaS web interface otherwise.

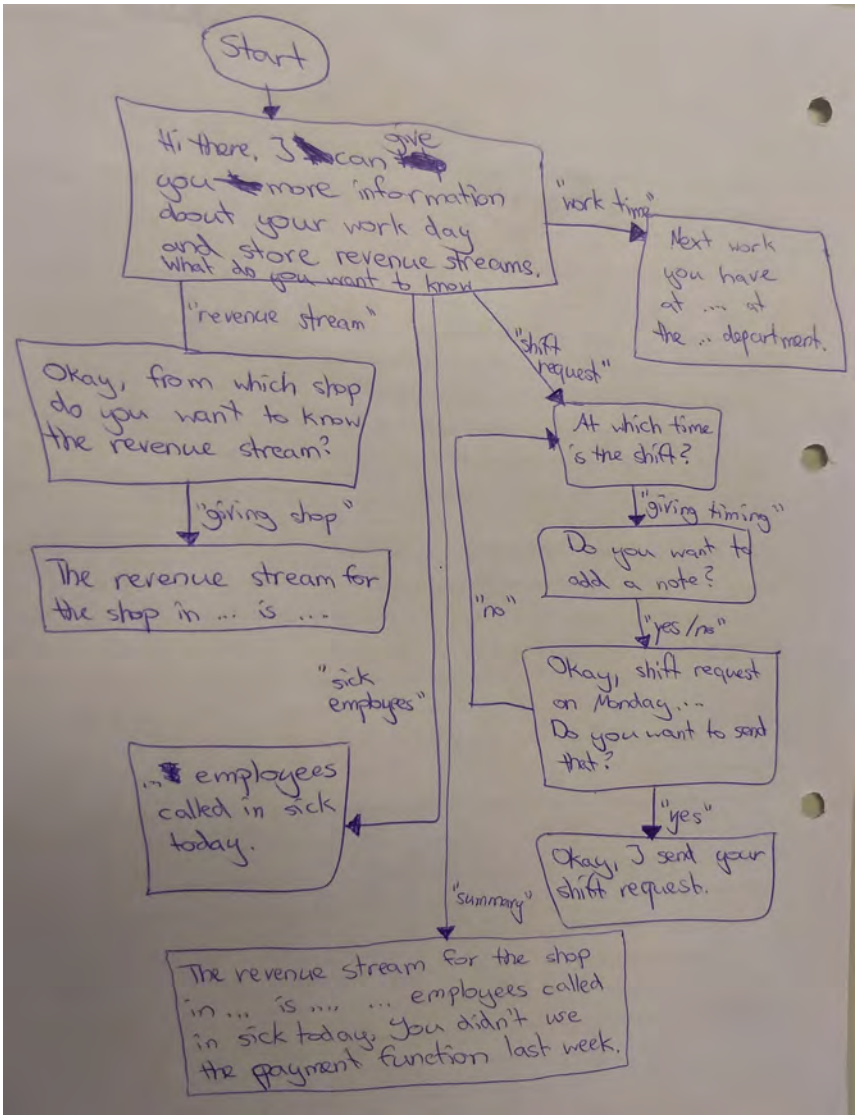

Figure 5.9: The sketch of possible interactions with the VUI

5.3 Iterating on the concept

The first concept was improved by iterating it with other UX designers with the cognitive walkthrough method to gather feedback and to make sure that the concept is understandable by the real users. The cognitive walkthrough method evaluated whether the system accounted for the users task order and the ease of use [23]. This evaluation led to updated scenarios, sample dialogs, and VUI flows.

5.3.1 Scenarios

All in all, the feedback from the other UX Designers was positive and the scenarios were found to be understandable and clear.

5.3.1.1 Scenario 1

One comment was that scenario 1 is nearly the same as scenario 2, except that the user asks for a different kind of information. Due to that, scenario 1 will not be used for the following iterations and merged with scenario 2. A new scenario for the manager was defined:
You are a manager in a supermarket. While driving, you would like to get more information about the store. Therefore you ask the VUI to give you more information about the revenue stream of the store in Veenendaal (the Netherlands) and how many employees are sick today. In case you need everything quickly, you are also able to ask for a summary.

5.3.1.2 Scenario 3

One of the designers was questioning if it is possible to access the calendar using the voice assistant in scenario 3 and if it recognizes colliding events. As it wasn't experienced before, it was tried to enter two events at the same time to a calendar with Google Assistant. This is actually possible, but the voice assistant doesn't let the user know that there is another event at that time already in the calendar.
One other comment is that scenario 3 is narrowed down too much due to the employee being at home on the couch. In general, a VUI allows for hands-free interaction and the employee could be at home and busy with anything that requires the use of both hands such as taking care of a baby or cooking. The scenario is changed accordingly:
You are an employee in a supermarket. Currently, you are at home and busy with your hands, but you would like to get to know at what time you have to work again. Therefore you ask the R&R Job App. The VUI responds with a time and date of your next work shift. You realize that you are not available at that time and ask the VUI to send a shift replacement request, because your university schedule changed and you have a class.

5.3.2 Sample Dialogs

Apart from the scenarios, the sample dialogs were discussed. One person found it weird that the voice assistant doesn't reply with the exact date and only mentions the day of the week when the question was asked to send a shift replacement request for a specific day. This is specific to Google Assistant and corresponds to the responses given in cases when the event added to the calendar are up to 7 days ahead of the current date. This will be changed in the sample dialog for scenario 3 to keep it consistent.

5.3.2.1 Sample dialog for scenario 3

USER
Ok VUI. At what time do I have to work?
VUI
Next work you have on Monday (or April 8) at 9am at the cheese department.
USER
Send a shift replacement request.
VUI
Alright, when is the shift?
USER
On Monday, 8th of April at 9 o'clock.
VUI
Okay, shift replacement request on Monday (or April 8) at 9AM. Do you want to add a reason?
USER
Yes, university class.
VUI
Okay, shift replacement request on Monday (or April 8) at 9AM, university class. Do you want to send that?
USER
Yes.
VUI
Okay, I send your shift replacement request.

5.3.3 R&R Job App calendar

The option to ask at what time the employee has to work was removed from the VUI flow chart. Currently, it is possible to synchronize the calendar with the work schedule from the R&R Job App into the users own calendar as shown in figure 5.10. While discussing the scenarios and sample dialogs, it was discovered that if the synchronize option is used, it is already possible to ask the different voice assistants at what time he/she has to work. As this option is available, the option was omitted in the further design process iterations.

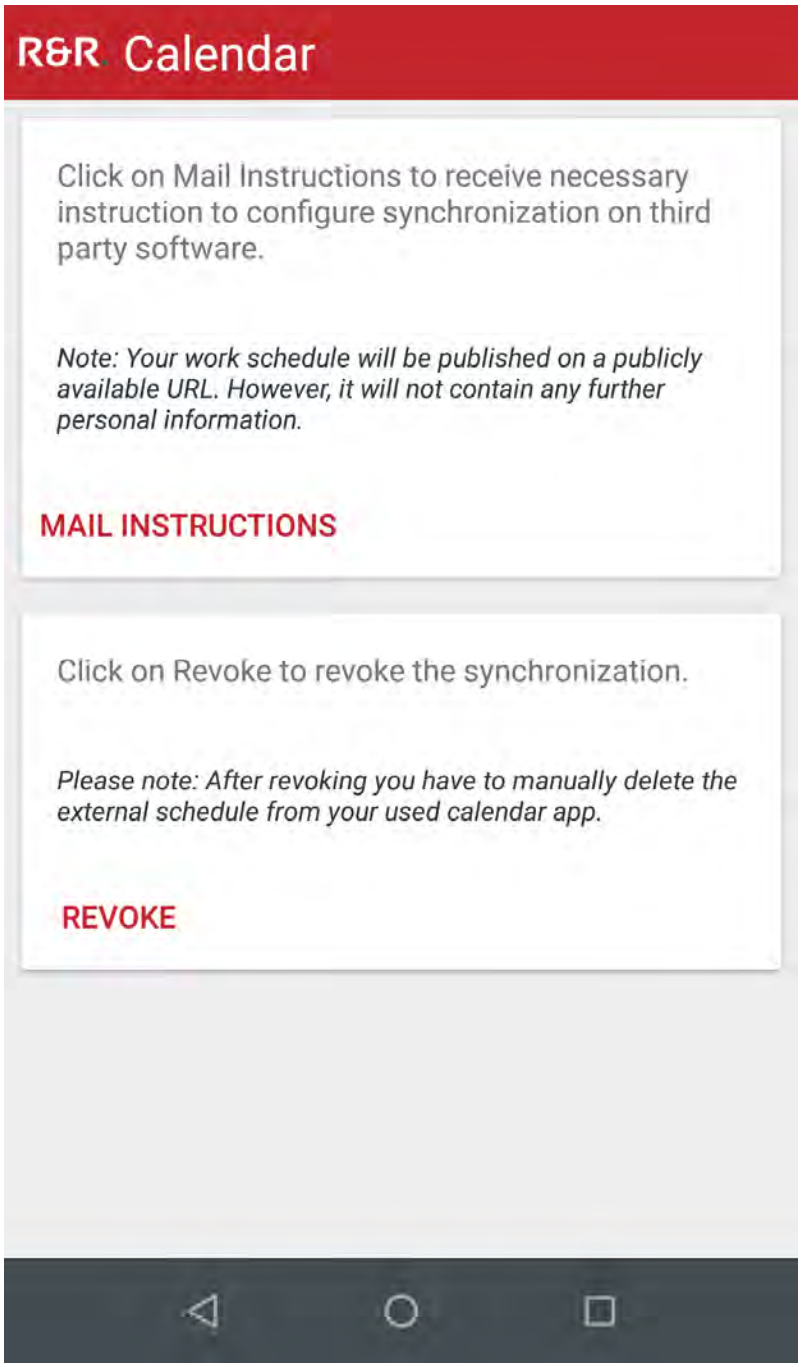

Figure 5.10: R&R Job App calendar synchronization option

5.3.4 VUI Interaction Flow

The other UX designers also provided feedback on the VUI interaction flow (shown in figure 5.9). One comment was that the flow mentions at the beginning a number of possibilities suggesting these are the only ones available via the VUI. However, it is also possible to obtain other types of information, for instance, ask for employees who called in sick. The suggestion was made to, instead of enumerating all of the options, provide a general prompting sentence.

Additionally, it was questioned if it makes sense to go back to the beginning if the user decides not to send the shift replacement request in the way the VUI created it. This could lead to endless loops which means that the employee would have to tell the VUI to stop before the assistant can be used for another assignment. As a Google Assistant as well as an Apple Siri device were available, it was tried to send a general message via both voice assistants in order to check what they do if the user decides not to send the message. Both voice assistants just stop the action and the user has the possibility to still confirm the message by clicking the confirmation button. Apple Siri also informs the user that the message is not sent, but Google Assistant isn't doing that.
The decision was made to create one VUI interaction flow for the managers and one for the employees. The VUI interaction flows were updated according to the comments. The yellow blocks show the user actions and the green blocks show the VUI answers.

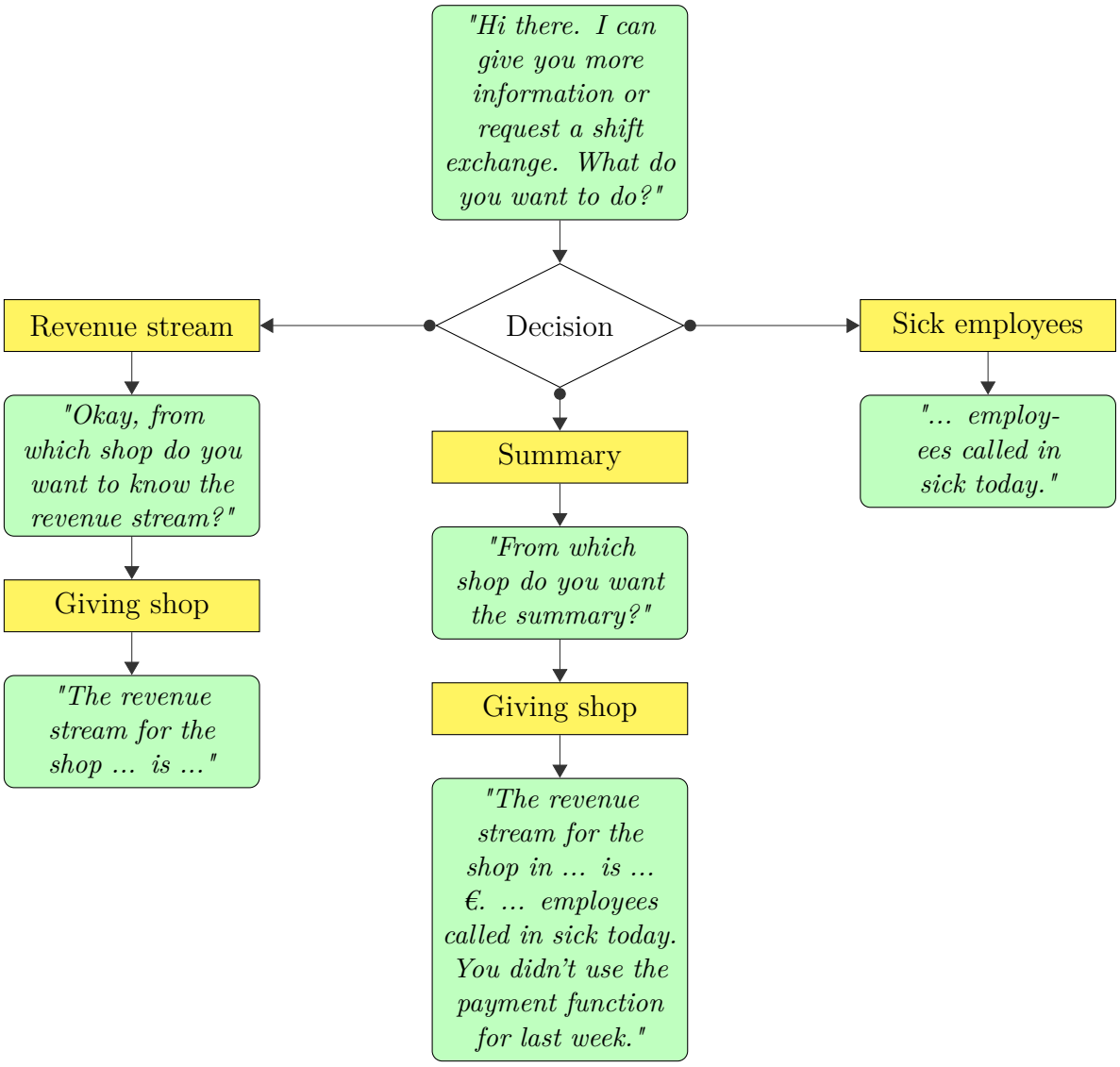

Figure 5.11: Updated VUI interaction flow chart for the managers

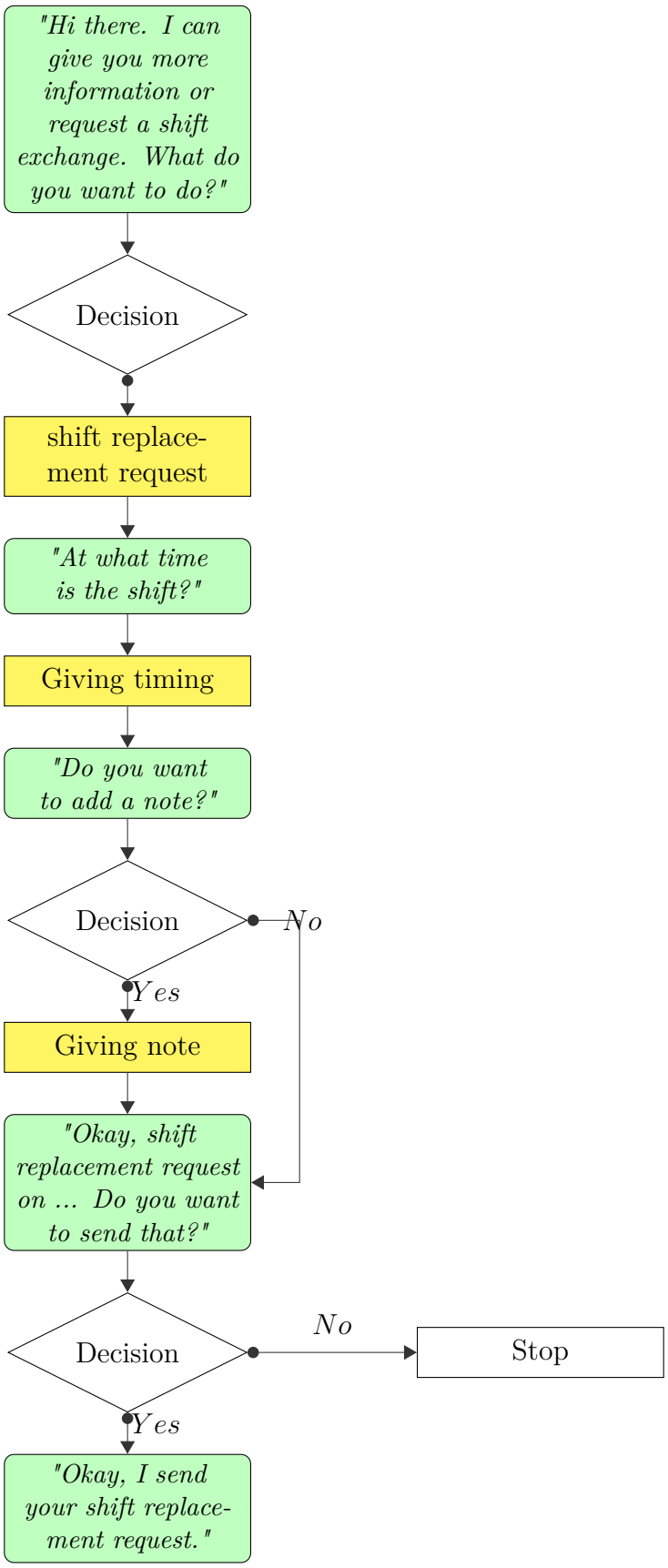

Figure 5.12: Updated VUI interaction flow chart for the employees

5.4 Low-fidelity prototype

The first prototype was a low-fidelity prototype to give the possibility to test the design quickly and change it rapidly. As a paper prototype was not a possible option for a VUI, a Wizard of Oz (WOZ) study with sound files was created. A user interacts with a system that is stimulated as a working product during the WOZ method [23]. The WOZ voice prototype was described by Brandt [6] and can be performed with a wizard who reads sentences as a voice assistant. Company colleagues who have worked in a supermarket and know the food retail WFM software, evaluated the prototype with the usability testing method. The method focuses on the tasks and people and evaluates how to improve the interface usability [23].

5.4.1 VUI Prototype

When designing for an app or website, it is easy to create a paper version as a low-fidelity prototype and a look & feel wireframe as a high-fidelity prototype. This procedure is not possible for a VUI as voice cannot be demonstrated on a paper or in a wireframe. Therefore, Brandt [6] introduces four different voice prototyping methods with an increasing level of fidelity: WOZ, WOZ with sound files, a functional prototype, and beta code on a production platform.
A WOZ study simulates scenarios that cannot be tested in a different way and it has three main components: a human wizard, an interface, and a subject (user) [35]. The setup is detailed in figure 5.13.

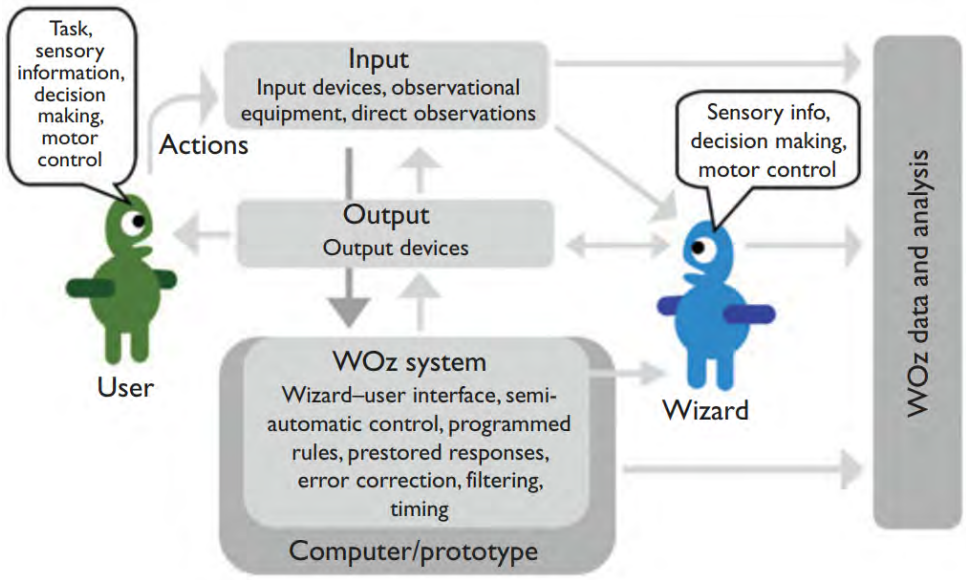

Figure 5.13: WOZ setup [35]

While a WOZ study can be performed with a wizard who reads out sentences as if being a voice assistant, a WOZ study with sound files makes it already more realistic for the user [6]. This is an improved version of the WOZ-only method.
According to Brandt [6], to allow a user to test the prototype without an intervention from a wizard or another person, a functional prototype gives the opportunity to

the user to experience the design on their own. This functional prototype can be written in a scripting language or HTML and ties sound files to the users actions [6].
A high-fidelity prototype would be to run a beta code on a production platform [6]. In that case, the user uses real data and can access the system the same way as if it would be completely developed.

5.4.2 Prototype environment

For the prototype, the text from the VUI, as used in the sample dialogs, was translated and sound files were created as suggested by the prototyping approach for VUIs by Brandt [6]. These sound files were generated by the text-to-speech program 'text2speech' [7]. As the users of the first prototype test were located in the Netherlands and speak Dutch, a Dutch voice was chosen for the sound files. The program offered two voices, the man voice 'Ruben' and the female voice 'Lotte'. The decision was made to use the man voice 'Ruben' as the female voice had an accentuation that was not that close to Dutch and difficult to understand. These sound files were played during the prototype testing.

5.4.3 Testing environment

Figure 5.14 shows how the low-fidelity prototype testing environment was set up. This picture was taken at the R&R WFM company office, but it was the same setup in the supermarket. The user got a paper with the scenarios to read through it and they always had the possibility to ask questions if something was unclear. On the other side of the table there was a laptop that was providing the WOZ sound files and the notepad was there to be able to take notes about the comments the user made. A phone was centered on the table, currently not in the figure, so that it looked like they talk to an actual VUI.

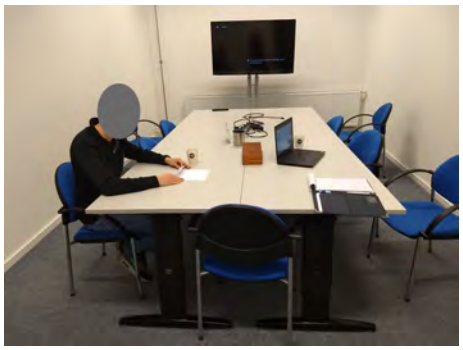

Figure 5.14: Low-fidelity prototype testing environment

[7] https://text2speech.us/

5.4.4 Prototype evaluation

To gather design information and test the concept before the prototype was shown to the real supermarket users, it was tested with the Usability Testing method through company colleagues who had experience working in a supermarket and know the food retail WFM software. A few of these company colleagues already had an experience with a voice assistant and a few didn't have an experience with it before. The Usability Testing method focuses on the users and their tasks, and explores any clues on how to improve the interface usability [23].

This turned out to be a good choice as the feedback from the participants was useful. On one hand, they didn't expect that the VUI would actually react to their commands, but really appreciated this way of interaction. On the other hand, the WOZ prototype needs to be improved and more convincing. The users had trouble to talk to the VUI like it is an actual voice assistant as this type of UI was a new situation for them. This scenario setup has also made the testing of the prototype less authentic and this setup would have led to misleading results while testing it with the real users in the supermarket.
Therefore it was decided to create a more advanced prototype for testing it with the supermarkets. It is believed that this will lead to more valid testing results and valuable feedback from the real supermarket users.

5.4.4.1 Scenarios

While testing the prototype, the question emerged as to why the manager has to specify the store and the employee doesn't have to. Earlier, this decision was made as the manager in the scenario is responsible for multiple stores. As this fact was left out of in the scenario before, it was added now to create a better understanding for the situation of the manager:
You are a manager for multiple supermarkets. While driving, you would like to get more information about the store. Therefore you ask the VUI to give you more information about the revenue stream of the store in Veenendaal (the Netherlands) and how many employees are sick today. In case you need everything quickly, you are also able to ask for a summary.

5.5 High-fidelity prototype

Usability issues of the low-fidelity prototype were addressed while developing the high-fidelity prototype. It was a WOZ system that could interact with the user without an intervention from a wizard or another person. The first test was performed at the company with colleagues. The evaluation method think-aloud protocol [23] gave insights about the users' thoughts while testing the prototype. All in all, the test showed that the prototype was ready to be tested with the real supermarket users.

5.5.1 Prototype

In this case, it was decided to create a partially functional prototype with the Tortu[8] tool for designing VUI software. The use of a Text-To-Speech (TTS) software, which could have allowed for more flexibility in emulating a VUI while using the WOZ method, was not possible to apply in the project setting. The reason was that the author was the only person available to run the study and thus this would, in the best case, confuse the participant that the researcher is simply typing the answers before they are spoken.
The Tortu tool is a platform for VUI design prototyping. Within the tool, it is possible to add a VUI flow in form of a sample dialog. Figure 5.15 shows the manager scenario created using Tortu. In the beginning, the manager has five choices to retrieve different kind of information, either the manager can ask what the revenue stream is in general or from a specific shop, a summary in general or from a specific shop, or how many employees are sick. Based on what the user would click on while prototyping, the voice assistant gives the requested information. The same situation is also implemented for the employee scenario.

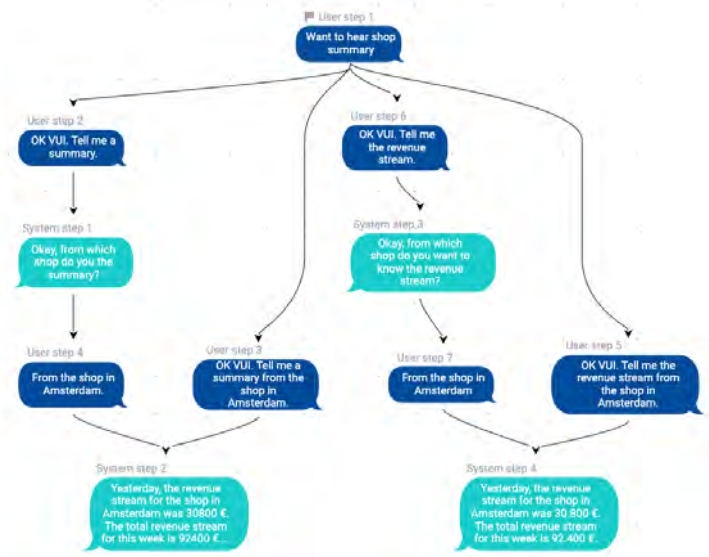

Figure 5.15: Manager scenario created using Tortu

[8]https://tortu.io/

While prototyping the VUI flows with Tortu, the user can either speak, write, or click on an answer (shown in figure 5.16). If the user chooses to talk to the prototype, it offers the same experience as a real VUI and the user can work without an intervention from a wizard.

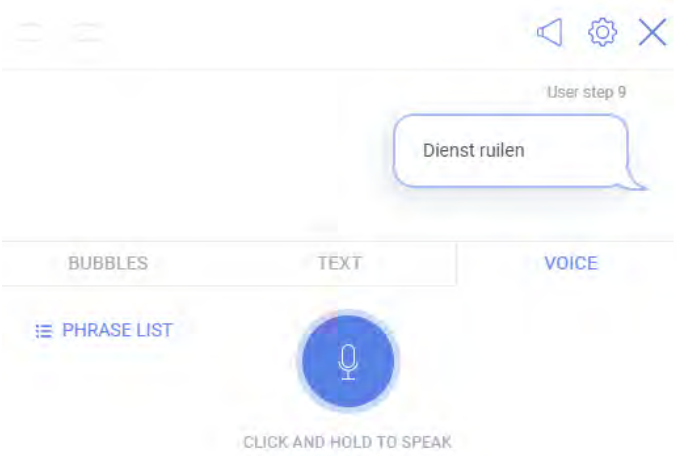

Figure 5.16: Tortu tool - prototyping mode

5.5.2 Testing environment

Before this new prototype was tested with real users at the supermarket, it was tested internally with colleagues at R&R WFM to check if everything works and the required interactions are possible to execute for the participants. Figure 5.17 shows how the testing environment looked like. The user got the two scenarios: the manager and the employee scenario. The speaker was placed in the center of the table and acted as a voice assistant. As the Tortu tool requires the user to click and hold the button to be able to speak to the voice assistant, this case was simulated by the laptop.

Figure 5.17: Functional prototype testing environment at R&R WFM

Figure 5.17 shows a huge speaker in comparison to a real Google Home or Amazon Alexa speaker. This was the only speaker that was available for this test scenario. Before the test was carried out, it was attempted to set up the environment with an available Google Home Mini to make it more realistic. Unfortunately, this was not possible as the Google Home Mini requires WiFi to be able to react as a simple speaker. WiFi is available at the company office, but won't be available at the supermarket itself. This makes it more difficult and it was decided to use a simple speaker for this testing scenario.

5.5.3 Prototype evaluation

The second prototype was also tested internally with company colleagues who have worked in a supermarket before and know the food retail WFM software. A few of these company colleagues already had an experience with a voice assistant and a few didn't have a prior experience. During the process, the Think-aloud Protocol was used to test if the prototype is understandable and works according to the plan. The Think-aloud Protocol required users to verbalize their thoughts and tasks and through this they can reveal flaws and strengths of the interface [23].
While testing this prototype, the test users had no difficulty to talk to the VUI as if it was a real voice assistant and could interact with it accordingly. Besides that, the employee and manager scenario were understandable and clear. According to the test users, especially the summary for the manager was a really useful function and could be of an added value for a real manager.
During the test, the speaker didn't work according to plan. It was connected to the laptop and somehow always started to speak a bit late so that parts of the VUI text was missing. As this was not a good situation, the speaker was removed to continue with a more understandable prototype.
While examining the summary option for the manager, the question arose as to which parts of the information offered by the SaaS software to a manager should be summarized. The ideal situation would be that the manager can decide for himself/herself how his/her summary will look like and therefore create their own voice assistant routine. For this prototype, it was decided to give the information on how many employees are sick, what the revenue stream of the shop is, and if the payment function was used, based on the most used functions in the SaaS web interface. During the user research, it was discovered that certain actions required of the manager that pertained to employee payments were not executed on time in Germany. This can be remedied by implementing as a reminder and for that reason was added to the summary. The option to get the revenue stream of a shop is information that is often requested from the software. Apart from that, it can have a big impact on the supermarket if too many employees are sick on the same day. Consequently, this information is valuable and was added to the summary for quick access as well.

5.6 Iterative design of the high-fidelity prototype

The last test with the high-fidelity prototype suggested that the prototype was ready to be tested with the real supermarket users. Accordingly, a user test with the supermarket employees was set up and they evaluated the prototype based on the evaluative research method. Basically, the method involves the real potential users by testing prototypes [23].

5.6.1 Testing environment

The setup in the supermarket was the same as at the premises of the R&R WFM company while testing the high-fidelity prototype iteration as described in section 5.5.2. The only difference was that no speaker was used for the prototype test. For the real supermarkets, a smartphone was used and the prototype was running on that device.

5.6.2 Prototype testing

The prototype test at the supermarket used the Evaluative Research method that engages real potential users for testing prototypes, or interfaces during the design process [23]. In total, six employees and two managers from two different supermarkets tested the high-fidelity prototype. During the user tests, it was discovered that none of the participants worked with a voice assistant prior to the study.
Before the test started, the users were briefed about the goal of the test. Earlier interviews have shown that a VUI can have an added value for the employees and managers. To evaluate whether this is actually the case, prototype tests with real users have been set up. Therefore, the participants were presented with a scenario and then interacted with the prototype via a smartphone. Afterwards, the participants were asked questions aimed at eliciting their feedback on the prototype use:

- Which information from the VUI has an added value for you?
- Is there something missing that you would like to be able to do with the VUI and that creates an added value for you?

Additionally, all users were asked about their opinion if a VUI should give feedback to the users of web and smartphone interfaces and react on demand only or if it should also notify whenever. This feedback is valuable to improve the participants general attitude towards VUIs.

To complement the study debriefing of how the prototype could work in real life, two video for the scenarios of the manager and employee were prepared.

Figure 5.18: Thumbnail of the employee Vimeo video

https://vimeo.com/332626076

Figure 5.19: Thumbnail of the manager Vimeo video

https://vimeo.com/332626076

6
Results

An iterative design process was followed for this thesis project which consisted of four phases within the UCD process. The different phases had multiple results and lead to the knowledge on the design factors that should be taken into account when implementing a VUI in the explored industrial use case.

6.1 Qualitative analysis

According to the interviews and questionnaires, managers and employees mostly use a voice assistant to ask simple questions, e.g. about the weather or other simple queries. This suggests that especially the first version of the VUI should be simple in a way that the users can understand the functions and get used to this new way of interacting with the WFM software. Simple tasks that can be implemented are, for example, requesting the leave balance, asking at what time the employee has to work or to send shift replacement requests. Another simple task that could be meaningful for managers is presenting information at the beginning of each workday or while driving.

6.1.1 Participants' experience with voice assistants

The participants' experience with voice assistants are described in this section. The questionnaire was answered by 10 participants, including managers and employees. Only six of them had used a voice assistant before. Background information on the participants' experience with voice assistants are pictured below.

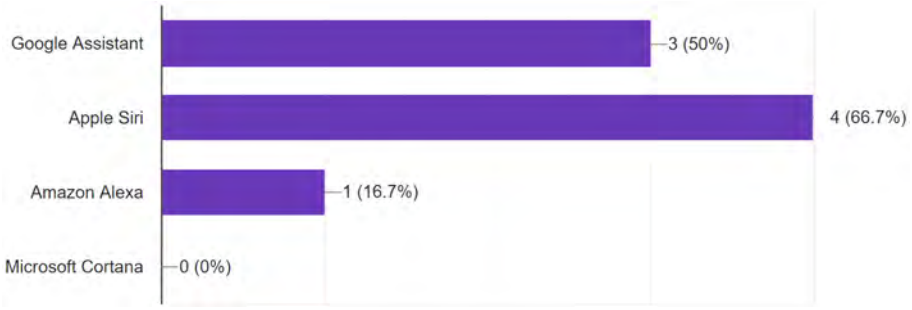

Figure 6.1: The types of voice assistants used by the participants of the initial qualitative user study

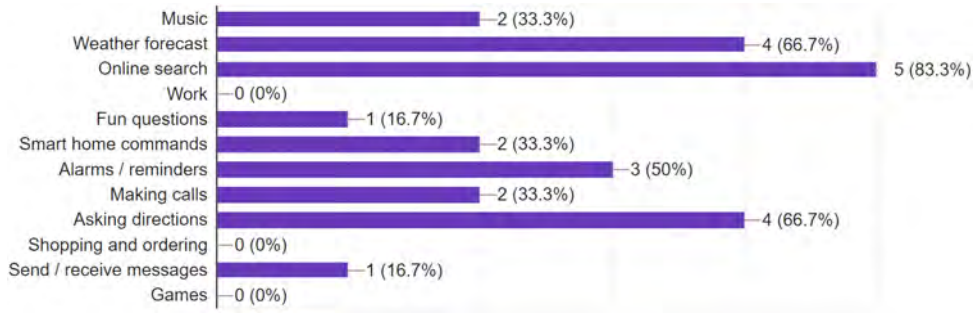

Figure 6.2: Purposes of voice assistant use by the initial qualitative study participants

According to Splendid Research[1], Google Assistant is the most widely adopted voice assistant in Germany. In the Netherlands, people are mostly using Apple Siri (12%) or Google Assistant (8%)[2]. The study participants turned out to be mostly using Apple Siri (66,7%) or Google Assistant (50%) as shown in figure 6.1. The purposes the participants use voice assistants for match these declared by users in Germany[1] and the Netherlands[2], i.e. to play music, check the weather, message people, or online searches.
The user research revealed that the users would like to have the possibility of hands-free interaction with the WFM software at home as well as while driving.

6.1.2 Work environment of the managers and employees

The individual interviews gave an insight into the work environment of the managers and employees. These insights give an idea on where a VUI can bring an added value. Managers are for example more busy with meeting and facilitation work of the employees, and solving problems with customers. Employees on the other hand have different tasks that are centered around the goods like checking the quality of the goods, and restocking and cleaning shelves. A more extensive description containing all the results can be found in appendix A.3.1.

6.1.3 Current R&R WFM software system

During the qualitative content analysis, certain codes pertaining to the existing software system emerged. Therefore, a few of the codebook codes were used to establish how the current software system is working and what are the factors hindering the efficiency of the software for the users.
On the one hand, the managers and employees mentioned in their interviews that parts of the software didn't work as desired. For example, managers desire a fully working message function in which they can send and receive messages. On the other hand, the employees would like to see their registered hours in the Job App

[1]https://www.splendid-research.com/de/statistiken/item/studie-nutzung-digitale-sprachassistenten.html
[2]https://www.marketingtribune.nl/bureaus/nieuws/2018/11/ipsos-adoptie-digitale-spraakassistent-nog-pril/SmartSpeakersNederland.pdf

and not only their scheduled hours. This means that the employees are not able to see how much they actually worked at the moment.
This knowledge was used to identify the first interactions where a VUIcan bring added value to the WFM software users. The full description of this phase's results can be found in the appendix A.3.2.

6.1.4 Suggestions for VUI usages

The qualitative analysis also give a lot of different insights about the points on where to implement the VUI in the software. For example, a VUI can be used to ask at what time the employee has to work, to send shift replacement requests, to request their leave balance, or to retrieve information while driving to different stores. These scenarios can also be fulfilled by using a GUI, but a VUI has the advantage that it can be used in the car while driving and that it allows hands-free interaction at home, for example while cooking.
All the above named functions are expected to be available to the users on demand, i.e. providing information once the user asks about them. It is also possible that the VUI tells the user information based on specific events like that the employee forgot to check in or out, or that their work schedule changed. In this case, a GUI is not the perfect solution as notifications on the phone can be missed or not seen on time. A VUI has the advantage that it can directly speak to the user and the information arrives directly.

6.1.5 Unprompted feedback from a VUI

Only a few of the interviewees mentioned that they can imagine unprompted feedback from a VUI. Under normal conditions, users don't desire that the VUI gives general messages or notifications especially when the user didn't ask for it. For example, the VUI should not interrupt when other people can listen, like roommates or even when an employee tries to make a baby asleep. In these cases, users understandably don't want the VUI to begin a voice communication with them. Furthermore, if the VUI speak important or sensitive information out loud, it can violate users' privacy and might stress or even scare them, especially if they are not used to the VUI yet. It will be more desired if the VUI will wake up based on the keyword, for example 'Okay, VUI'. Another option is to mute the voice channel and only allow it to activate in the morning after asking for general feedback or in situations where users want to unmute it. In that case, the VUI is allowed to answer questions or present information but otherwise the VUI should not be enabled and should fall back to GUI notifications.

6.2 Concept development

The results of the user research informed the concept development phase where the personas, scenarios, sample dialogs, and VUI flow charts were created. The scenarios are based on the created personas and were used while testing the prototype at a later stage. The sample dialogs constructed in this phase of the project and the VUI

interaction flow make the interaction between the voice assistant and the user more clear and give a necessary example for the first prototype. After creating a first concept, it was iterated and further improved with the help of feedback from other UX designers obtained through the Cognitive Walkthrough method. For example, scenario 1 and 3 were merged so that there is only one scenario for the employee and one for the manager. Furthermore, it was discovered that, in case the employee synchronized the calendar, it is already possible to ask a voice assistant at what time the employee has to work. That is the reason why this function is not further analyzed as it is offered by the existing general-purpose software and assistants. As a consequence, the VUI interaction flow was also updated and benefited for the prototyping phase.

6.3 Prototyping phase

The low-fidelity prototype was designed and pilot tested with company colleagues who provided valuable feedback before the prototype was tested with real supermarket users. The feedback on the low-fidelity prototype was used to develop a high-fidelity prototype that was tested with the supermarket users. Most of the employees found it entertaining to talk to a VUI but overall they found it unnecessary to really use the VUI. Moreover, they found it hard to imagine at what time they would use it, as many users said that they would just wait until their hands are free and then use the app via the GUI. Another argument was that they don't have to know this information immediately and can wait until they have the time to look it up manually. All in all, the employees are not yet used to VUIs and may, most probably due to this fact, find it hard to envision their added value. This suggests that the function can be entertaining for young employees, where the novelty effect can play a non-negligible role, but it is not an essential feature that would bring a considerable added value to the employee.

However, the VUI implemented in the WFM software is not expected to provide the functionality to ask at what time the employee has to work. Any VUI can provide this information as long as it has access to the employee's calendar.

To the contrary of supermarket employees, the managers were enthusiastic about the summary and revenue stream functionality and had many ideas on which other information would be valuable to them. For example, one suggestion is to get to know about the revenue stream compared to last year in the VUI summary.

The other presented feature, allowing to ask how many employees are sick today, was not appreciated as the managers mentioned that this data is not relevant to them and that it is important to know for the department supervisor. These supervisors are also supermarket employees, who have the responsibility for a specific department and has to take action in case another employee is sick. Nevertheless, these department supervisors are considered to be part of the supermarket employees user group as they aren't working with the WFM web interface but only use the mobile app.

Preference for on-demand assistance

In line with what the initial qualitative research has shown, participants of the user tests of the high-fidelity prototype have also preferred an on-demand assistance. None of the users can imagine to have a VUI that will notify the user whenever it considers it is a good idea. The users just want to use the on-demand feature in which they have to activate the voice assistant to retrieve information. The participants mentioned that they don't want the VUI to talk to them spontaneously in any situation, even at home. An exception to this VUI behaviour would be if the users have the mobile app in the foreground of their phone and their screen is on. In that case, the users won't mind if the VUI starts talking to them as they expect specific information from the app unless they would be in a public space and the VUI would start talking out loud about some details of their work or any information they would consider sensitive.

6.4 Design factors

The identified design factors are based on the qualitative and quantitative data obtained from the questionnaire and individual interviews as well as an evaluation of the VUI prototypes, which was informed by the initial qualitative research phase.

1. **Customizability of the VUI features offered to the users**
2. **Assistant proactiveness**
3. **Preferred implementation platform**
4. **Preferred user authorization mechanism**

6.5 Design guidelines

Based on the design factors, the design guidelines for the specific use scenario were determined. A VUI can enables hands-free interaction for the manager, for instance while driving or when it requires to perform multiple manual actions in order to retrieve the information needed at a given moment. At the same time, supermarket employees did not find a VUI to be essential for the improvement of their usage of the WFM software. The following design guidelines should be taken into consideration while introducing a VUI in a food retail WFM software.

1. **The VUI should offer a mechanism for the users to customize its features.**

   In the particular industrial scenario, there are several managers with different functions within a supermarket, e.g. a store manager, department manager, or region manager who is responsible for all supermarkets within the region. According to the manager's purpose, they need different information that is important to obtain while on the go or in an efficient manner. This VUI functionality allows for requesting the desired information in a simple, hands-free way, eliminating the need for a manual interaction with the software via a GUI. It ensures that the managers can decide which information is important for them and what they would like to be presented

with via the VUI.

2. **The VUI should not interact with the user unprompted.**
   Users don't want the VUI to activate and interact with them without their explicit approval or command. It is preferred to have an on-demand feature for the voice assistance that presents information after the user activated the VUI. The functionality of unprompted voice interaction initiated by the VUI was highly undesired by the study participants.
3. **The VUI should be implemented on a mobile platform.**
   The suggestion is to implement the VUI in the app as the users of the WFM software are already used to it.
   Additionally, the voice assistants supporting the requirements as described in chapter 2.1.2 should be used for the use case considered in this work. Currently, the voice assistants that are available on the market and fulfill these requirements, are Apple Siri and Google Assistant.
4. **The authorization of the VUI use should be based on the users' account within the WFM software platform.**
   All in all, the VUI shouldn't be accessed by any person without authorization, for instance someone who is not an employee. If the user has to log in to the app to access the VUI, the user would already be authorized and the app would know which information the user is allowed to have access to. Moreover, the mobile app could require the user to log in again after a certain time to prevent unauthorized people from using the app. An additional setup could force the user to introduce a two-factor authentication method, like a fingerprint of face ID, before the VUI can be used in general. Other than that, an authorization mechanism could be that, once the user is logged into the mobile app, the voice recognition could be used to make sure that only the employee him/herself can issue commands to the VUI and therefore has access to the company information.
   Nevertheless, Hoy [25] states that before the voice assistants would be used for confidential applications, the privacy and security controls need to be improved. However, if the VUI should be mostly used in public spaces, it might not be appropriate to implement it in an app [41].
5. **The VUI should not interfere with other mobile apps that can be navigated by the default phone voice assistant.**
   Once the mobile app will be opened by the default phone voice assistant, it could interfere with other mobile apps in case they would also use the same wake-word to get activated. In the particular industrial scenario, the wake-word for the VUI could be the default wake-word of the phone voice assistant and 'launch the R&R Job App' will be added to it. These additional words would make sure that only the specific mobile app will be launched. Once the mobile app is launched and the authorization is accepted, the default phone voice assistant can be used to retrieve information from the specific mobile app by using the wake-work and adding 'R&R Job App' to the beginning of the request.

The presented design guidelines will be discussed in the context of the industrial use case in the following section.

7
Discussion

By following the exploratory research approach, this thesis has identified a set of design factors and guidelines for the analyzed industrial use case. The contribution can also be seen as all steps within the iterative design process, as all findings lead to different conclusions for the next step.

7.1 Design Factors

The identified design factors can be seen as considerations for the future work or implementation of the prototype in the real software. The design factors offered by this work can be a stepping stone for introducing a VUI in the industrial cases such as considered in this thesis.
By looking at the research quality criteria such as reliability and validity, the study can be reproduced with a similar methodology. However, there are threats to the reproducibility of the project as other study participants with more or less experience with voice assistants can change the outcome of the study. Furthermore, other methods can explore different VUI design parts and therefore come up with other design factors.

7.2 Design Guidelines

The established design guidelines are based on the identified design factors. They are specific for the industrial use scenario and can be seen as considerations for the implementation of a VUI in a food retail WFM software.
It is suggested to implement the VUI on a mobile platform. Before investigating a VUI implementation, managers did not use the mobile platform and it was only used by the employees. If the VUI will be integrated in the mobile platform, the managers would also start using it and additional features could be launched.
Besides, if the mobile platform can be opened by the default phone voice assistant, it could interfere with other applications. This situation can be prevented when the default voice assistant receives a command to start the mobile app and directly checks if the user is logged into the app. Likewise, the mobile app should also check whether the user's voice can be recognized. Only if the user is logged in and can be identified, the mobile app is allowed to receive voice commands via the default phone voice assistant and give out information.
Furthermore, if the mobile app will be opened by the default phone voice assistant, the wake-word has to be specified to make sure that the correct mobile app will

be used to retrieve the information. Moreover, the mobile app should not interfere with other mobile apps that can be navigated by the default phone voice assistant. Therefore, additional words will be added to the wake-word to make it more specific and clear from which mobile app the information has to be retrieved. This use case prevents the interference when there are multiple apps running on the phone that could be directed by the default phone voice assistant.

During the thesis project, it was not evaluated if managers require the VUI to work on a desktop computer as all managers have access to a work smartphone. The different voice assistants are not all available for a desktop computer, but Amazon Alexa launched recently an app for Windows 10[1]. Unfortunately, Amazon Alexa does not fulfill the requirements for a voice assistant in the given industrial case, i.e. it is not available in the Dutch language (as described in chapter 2.4.2). As only Google Assistant and Apple Siri fulfill the language requirements, it was decided that it is the best decision to integrate the VUI in the existing mobile app.

7.3 Identified benefits of introducing a VUI

During the design process of the project, it became more and more clear that the benefit for employees in the use cases examined in this project were scarce, but that it can have a positive effect on the managers productivity if he/she can use the VUI while driving or when multiple manual actions are required to retrieve the information needed. The kind of information managers need from a hands-free system were explored. For example while driving, a VUI summary is more efficient and productive to already retrieve some store information and then go to the store prepared.
A first indicator that the employees don't find an added value in a VUI appeared during the individual interviews. Employees were generally interested in the interaction modality but couldn't imagine that they would use it in their work flow. Only the owners of a voice assistant were able to find a use case for the VUI but not those who did not own and use a voice assistant. This means that users who already use a voice assistant can imagine to use it for their work flow as well but users who don't like voice assistants and are not using them at home, cannot imagine to use it at work.
The user test of the high-fidelity prototype involved the supermarket employees asking at what time they have to work or to send a shift replacement request. The prototype test confirmed that the users are interested in the voice interaction modality, but cannot imaging to use it in their work flow. During the user tests, it was identified that none of the test users worked with a voice assistant before nor would like to use it. It might be that another result could have been concluded in case the test employees would already have been using voice assistants at home.
Another question that arises is what data is actually valuable for the users. There are lots of options and a few answers were given during the final high-fidelity prototype test. Nevertheless, to find out the exact information that managers would like to

[1]https://www.theverge.com/2018/11/8/18075450/amazon-alexa-windows-10-app-download-features

know is an interesting direction for the future work to explore as there was not enough time to study and test this data to a sufficient extent.

7.4 Preference for on-demand assistance

The participants of the high-fidelity VUI prototype assessment tested their preference for an on-demand feature or getting notified at any point of time. Earlier, it was hypothesized that the users don't want to be notified at any point of time and this initial assumption was indeed proven correct by the study results. This resulted in recommending against the implementation of such a feature. Reis et al. [45] found that users stop completely with their voice interaction in public spaces as they are embarrassed about talking to their device. This also implies that getting notified by a VUI at any point of time is not desired as the user would feel uncomfortable if this happens in a public space.

7.5 Developed prototypes

During the project process, a low-fidelity and a high-fidelity prototype were developed and can be seen as implementation examples. These prototypes are simulating the VUI functions for the manager and employee. Furthermore, two example videos of how the users can interact with the prototypes show how it could work in real life. Based on this prototype, a VUI functionality could be implemented into the existing software and would already provide an added value to the managers.

7.6 Implementation considerations

If one of the popular voice assistants will be used as a basis for implementing the VUI there is no way of preventing the data of company clients to be send to third-party servers. This privacy and security risk can only be mitigated by the R&R WFM company if they develop their own assistant based on publicity available voice datasets such as the one shared by Mozilla Common Voice project[2] or use one of the open source voice assistants, i.e. Mycroft[3]. These assistants allow for hosting the service in their own premises which means that only the company will have access to and be in full control of the clients data and the storage. Another advantage is that there will be no additional third-party involved.
The procedure to interact with an open source voice assistant like Mycroft is the same as for the popular voice assistants like Apple Siri or Google Assistant. All of the assistants use an identifiable wake-word after which the user can speak a command. Furthermore, it is possible to add commands to the system by creating new skills. These skills are new commands that the users can use to get some information. According to the author's knowledge, there are no usability differences between the open source and popular voice assistant that could be used for implementing the

[2]https://voice.mozilla.org/en
[3]https://mycroft.ai/

VUI. In relation to the threads of a third-party application, it is more desirable to host an open source voice assistant on the company's servers to remedy privacy issues.

7.7 Ethical considerations

In general, a VUI can be confusing to the user as it contains no proof or feedback that the interaction took place whereas a GUI gives the user permanent feedback. One example of a VUI is the recent introduction of Google's Duplex that has a human sounding voice and speaks to the user[4].
A voice assistant has to listen continuously to provide on-demand assistance to the users. As the study participants prefer this on-demand assistance, it is crucial to consider the upcoming privacy threats that this kind of technology entails. Another concern is the user's privacy and the final aspect of this work is to contain informed consent from the participants of the user study.

7.7.1 Continuously listening voice assistants

Another aspect is that the voice assistants have to listen at all time to be able to respond to the users [25]. Although all voice assistant companies insist that the devices are not recording everything except when a user is waking up the voice assistant, there has been at least one case where the recorded data at all times was send back to the Google servers [25]. Another case was a false Alexa activation that recorded a coulpe's conversation and send the sound file to a random contact of theirs[5].

7.7.2 User privacy

Moreover, privacy of users' interactions with the VUI is a concern, as it can't be assured that only the user will hear the VUI's speech output. It is important to protect the privacy of the user. Therefore, Google Assistant has been equipped with a feature to identify each user by their voice and only present information if the specific user voice can be recognized [25]. A study performed by Reis et al. [45] found that users stop completely with their voice interaction in case they are surrounded by more people, because of their embarrassment of speaking to a device. Easwara Moorthy and Vu [18] agree in their paper that users prefer another type of interaction than voice in public spaces.
The VUI access should be controlled via the mobile app authorization. A second security step can be a speaker verification where the user voice can be identified. In case someone else will try to use the function, the VUI won't present the information as the voice is not recognized. This assures that not everyone can retrieve the information but at the time the manager is asking for the data and someone else sits with him/her in the car, the information will still be presented.

[4]https://www.androidauthority.com/what-is-google-duplex-869476/

[5]https://www.theguardian.com/technology/2018/may/24/amazon-alexa-recorded-conversation

7.7.3 Obtaining an informed consent of study participants

While conducting user studies like questionnaires and interviews, it is fundamental to consider the consent of the participant. Before the user study begins, the person has to give a fully informed consent for the participation.
A person in the Netherlands has to be at least of the age of 16 to be allowed to give consent without the parents and the age of 18 if it involves pornography or prostitution [56]. In Germany, the age of consent for each person is 14 at which the person is allowed to give consent without parents [56].
The ethical and legal rules were followed during all of the user studies in this project.

7.8 Future Work

While testing the high-fidelity prototype at the supermarkets, it turned out that introducing a VUI for the industrial use case would be valuable for supermarket managers. Unfortunately, it was not possible to test the current prototype more extensively with managers, but this should be done to test and further verify the introduction of a VUI to bring an added value to them.
Besides testing the prototype with a bigger and more diverse sample of managers, it should be analyzed which kind of information is interesting to them. It might be that not all the information that the managers would like to have is actually available in the software and that it has to be added to the WFM software as an additional feature supporting managers' work.
Additionally, the employee scenario was tested with participants who don't have any experience with voice assistants. As all participants mentioned that younger colleagues would like this feature, it is necessary to test if that is actually the case. Therefore, user studies with the younger generation who already use voice assistants in their daily life's is advisable. Besides that, the VUI should be tailored to the users' previous experience with VUIs by age as the various ages can have an impact on the VUI interaction as well as the design factors for voice assistants non-users.

7.8.1 Gender of a VUI

Overall, it is difficult to consider which kind of gender the VUI should have. Should it be a female or a male voice? Should the type of voice be decided by the system or can every user choose their own voice? If the voice matches the gender, according to Almeida et al. [3] it might enhance user engagement and enable social-identification, but it can have a negative impact if a female voice sounds too masculine or vice versa. A female or male voice can be modified in a way that it sounds more like the other gender [37]. In general, Nass and Brave [37] state that males prefer male voices and females prefer female voices, even when these voices are machine-generated. The best option would be that each user can choose which kind of voice they prefer.
The voice for the VUI can be adapted to any possible voice that is available through the voice assistants. As the assistants for the specific smartphones within the app should be used, there are already female and male voices available that can be setup by the user. If users can setup their own preferred voice for the VUI, it makes it user specific. Therefore, it creates a general VUI that can adapt to different circumstances.

8

Reflections on the research process

The iterative UCD process was influenced by the users and flexibility was the biggest aspect that this design method offered. In general, a specific area was explored throughout the project. Although the original time plan couldn't be followed at all times, it was possible to finish the project on time. The UCD process helped to focus on the important project parts as it has small iterations.

8.1 Executed design process

The design process followed the UCD method as described in chapter 4.2.2. It is an iterative design process that influences the design through the users [1]. The user research was intended to understand the users' needs and requirements. This process was supported by the literature review carried out earlier that also allowed for a better understanding of the benefits a VUI can bring to the industrial use case studied in this project. Besides that, the user research itself influenced the VUI concept development.
The most extensive phase of the UCD process was the user research. At first the questionnaire and individual interviews were set up and prepared. Due to difficulties while organizing appointments at the supermarkets, this phase took seven weeks and therefore longer than the initially planned three weeks. On the one hand, it took a while to run the pilot study and get the answers from the real study. On the other hand, the qualitative content analysis was an extensive investigation where together with the academic supervisor the codebook based on the grounded theory approach was created. The codebook has led to understanding the work environment of the managers and employees, the current R&R software system, and suggestions for VUI usages from the real users. Eventually, this step provided the preliminary guidelines for the VUI implementation under the industrial use case.

All in all, this process resulted in the outcome that can be adopted for the managers and employees using a food retail WFM software. It was also beneficial to have tried different evaluation methods as they all approached the evaluation a bit different and made it possible to always have a look at the design factors from a different perspective.
However, as the user research and evaluation phase were depending on the supermarkets, it was not always running smoothly. For the user research, it took some time to arrange appointments with the supermarkets. Once these appointments were established, it took about two weeks before the user study could be performed. How the supermarkets were approached was changed for the evaluation phase by

approaching them ahead of time. The original time plan was used to estimate at what time a user study should be set up and the supermarkets were contacted before the first low-fidelity prototype even existed. This turned out to be a good choice as the appointment could be planned on time and the high-fidelity prototype that should be tested together with the real users was ready at the same time.

8.2 Process iterations

The process of the project is a general process with multiple iterations to improve the concept and design. Likewise, the process can also be splitted into smaller steps than during this project. It was easier to work on a small step before working on a new step. The project had a limited time frame and at the beginning the amount of work seemed immense. By breaking the work into smaller steps, it was easier to create a time plan and work on the different parts to achieve the goal. This can be freely adapted and depends on the project. It should then be identified which steps are critical for the given project and how the iterations should be divided.
Another aspect is to always check the outcome of the iteration or phase and how it can help to establish the next iteration result. These small outcomes were valuable in this project as they let the process focus on the important findings and improved these results with every iteration. This cycle is also described by Wadsworth [55] where he states that the participatory action research observes and reflects on the results to plan and take actions for the next step.
By going through the executed process during the thesis work, one of the most important aspects is the flexibility that was offered. The iterative design process produced incremental results that could be tested with users early on in the process and improved the design. Potential issues were discovered in advance and could be enhanced before the next iteration started. Another step that led to improved prototypes was testing these with the internal team of designers in the company that is developing the software to be adapted with the VUI. This boosts the prototype development and reveals early the parts that real test users could have difficulties with. It can also be that the test users do not perceive the prototype as fully functional. This situation can already be identified during the tests conducted with the company colleagues and an improved prototype that leads to a better user interaction can be developed. This flexibility allowed for a more stable and usable prototype design for the study participants.

8.3 Applied design methods

In the course of the project, multiple design methods were used. The methods that were chosen for the design process could have been exchanged with other design methods. In specific, a new evaluation method for the prototype assessments was used each time. This was done as each method has a different approach on how to examine the prototype and gives new inputs to the design. Generally, there are lots of prototyping evaluation methods that can be used and not only the chosen methods, such as Usability Testing, Think-aloud Protocol, or Evaluative Research.

8.4 Generalizability

The project is limited to the context of the industrial use case. It is not possible to generalize all results and easily adapt it to another case in a different industry. This means that a specific area was explored in this exploratory research and only a following summative research can lead to a general theory.

8.5 Time management

The project was planned for 20 weeks as part of the Chalmers University of Technology Master programme 'Interaction Design and Technologies'. During the project, supervision was planned with the academic supervisor as well as industrial advisor to ensure a high quality process and to make sure that the project goal would be achieved. The original and the updated time plan can be found in appendix A.5.

Reflection on the time management

The original time plan had different amount of weeks planned for the different steps in the UCD process. This was done as the prototyping and evaluation phase was expected to take longer than the user research and concept development phase. However, after starting the project it was realized that time plan couldn't be followed and that user studies should be planned ahead as the users are mostly not quickly available when they are needed in the process.
Additionally, it showed that test users aren't always available at the time they are needed. This will happen at other projects too and can be prevented if the user studies are planned ahead of time. These takeaways are important and will be valuable lessons while working on other projects in the future.
If the project would have allowed for more time, more iterations would have been carried out. Specifically, at least one more iteration would have helped to explore the exact information the managers would like to know in their VUI summary.

9
Conclusions

This project aimed to examine the design factors for implementing a VUI for employees and managers in the use scenario of a food retail WFM support software. Additionally, it had the ambition to evaluate the interface type. While following the UCD process, the effectiveness of a VUI and its hands-free design was examined based on the industrial use case.

The research question was:
Which design factors should be considered while introducing a VUI for food retail Workforce Management software users?

The project aimed to develop a set of design guidelines and investigate the design factors for the use of VUIs in the industrial use case. The investigated design factors were identified for introducing a VUI for food retail WFM software users.

1. Customizability of the VUI features offered to the users
2. Assistant pro activeness
3. Preferred implementation platform
4. Preferred user authorization mechanism

The resulting design guidelines were constructed in the form of considerations based on the findings of the process and state how a VUI can be implemented in a WFM software system.

1. The VUI should offer a mechanism for the users to customize its features.
2. The VUI should not interact with the user unprompted.
3. The VUI should be implemented on a mobile platform.
4. The authorization of the VUI use should be based on the users' account within the WFM software platform.
5. The VUI should not interfere with other mobile apps that can be navigated by the default phone voice assistant.

The design guidelines include that the VUI for the managers should be implemented on a mobile platform as the users of the WFM software are already used to it. Additionally, the WFM software platform should directly authorize the users based on their account. Specifically, the manager can use the VUI while driving or when it requires to perform multiple manual actions in order to retrieve the information needed at a given moment. This VUI should offer a mechanism for the users to customize its features. All in all, the feature customization should be adjustable in a way that the manager can decide individually what information is valuable and should be presented.

In addition, the results of the design process suggest that a VUI has an added value for the managers of a food retail WFM support software. The user tests showed that managers have an interest to bundle the store information in a VUI summary. This summary can then be requested while driving and in this way the manager prepares for upcoming meetings or situations he/she is driving to. Further, it is also possible to access this information while being in a meeting where the managers don't have the time to go through the WFM software's GUI controls and find the information. In these cases, the VUI is quicker in retrieving the data.
As for the employees, they already have the possibility to ask a voice assistant at what time they have to work. Therefore, they just have to synchronize the work schedule with their own calendar and give access to this one to their voice assistant. Currently, they can use this functionality without the need of implementing an additional feature in the WFM software. The user study also showed that employees think that the voice function would be entertaining to use but it doesn't have an added value that could be identified in the executed process with the available participants sample and the number of process iterations that could be realized in the thesis project time line.

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A

Appendix

A.1 Questionnaire

1. Which phone do you use?
   - ☐ Android
   - ☐ iPhones
   - ☐ Other _____
2. Employee: Where is the R&R software useful for you?
3. Manager: Are you responsible for more than one store?
   - Yes
   - No
4. Manager: How many types of tasks do you perform daily?
5. Manager: How much time per day/week do you spend with the R&R software?
6. Do you know what a voice assistant is, for example Google Assistant, Apple Siri or Amazon Alexa?
   - Yes
   - No
7. Have you ever used or interacted with a VUI?
   - Yes
   - No ($\rightarrow$ submit the form)
8. Which voice assistant do you use?
   - ☐ Google Assistant
   - ☐ Amazon Alexa
   - ☐ Microsoft Cortana
   - ☐ Apple Siri
   - ☐ Other _____
9. For how long do you use voice assistants?
   - Only one time
   - A few days
   - A few weeks
   - A few months
   - Half a year
   - One year
   - More than one year

10. How often do you use the voice assistant?
    - Less than once a month
    - At least monthly
    - At least weekly
    - Times per day _____
11. For which purposes are you using a voice assistant?
    - ☐ Music
    - ☐ Weather forecast
    - ☐ Online search
    - ☐ Work
    - ☐ Fun questions
    - ☐ Smart home commands
    - ☐ Alarms / reminders
    - ☐ Making calls
    - ☐ Asking directions
    - ☐ Shopping and ordering
    - ☐ Send / receive messages
    - ☐ Games
    - ☐ Other _____
12. How are you using or have you used the voice assistant?
    - ☐ On a speaker
    - ☐ With a smartphone
    - ☐ Other _____

A.2 Individual Interviews

A.2.1 Interview questions

Employee:

1. Describe your daily work/tasks.
2. Which tasks take the most of your time?
3. Which work tasks make you interact the most with the software?
4. Are there elements of the software that could be improved?
5. Are there tasks where a VUI (or voice-based interaction in general) could help you?

Manager:

1. Where do you spend most of your time with while using with the R&R software?
2. Are there tasks involving the software that take a lot of time and where you think a VUI could help you?
3. Could voice interaction help you with a certain task?
4. How much time on average do you spend in the workplace with the other employees?
5. If you would have less work tasks to perform, where would you invest this time?
6. How often do you interact with shift/shop assistants/employees?
7. What do you consider an efficient work day?
8. In general, what hinders your efficiency? And how about when you use the software?

A.2.2 Interview consent form

Information about the Participation in a Research Study

Please read the following information carefully.
Study: Benefits of a Voice User Interfaces for the R&R WFM software solution
Conductors: Wiebke Meyer
Organization: Chalmers University of Technology
Contact: wiebkem@student.chalmers.se

Description: You are invited to participate in a research study that serves the R&R WFM software solution for an anonymous analysis and to investigate the benefits of a Voice User Interface for this software.
In this study, you will be asked to respond to a questionnaire and to take part in an individual interview. The research study is conducted while sitting and does not require exerting activities. There is no requirement for the participants. The exact procedure will be explained to you in the beginning of the session.
Your participation in this research is voluntary. You may choose to participate or to withdraw your participation at any time without any penalty. You have the right to refuse to answer particular questions. Your individual data will be kept private. Please do not hesitate to let the conductor know if you have any questions, or would like to take a break at any time.

Risks and Benefits: There are no known risks involved in this procedure. However, your participation does benefit the research study about the benefits of a Voice User Interface for the R&R WFM software solution.

Duration: Your participation will take approximately 15 minutes.

Audio recordings: Separately from your consent to participate in the study, you may optionally provide me with your consent to use the audio recordings for scientific analysis and citations. The cited information will be anonymous and no names or other personally identifiable information will be used while analyzing or publishing the study results. Moreover, the audio files will be stored on a password-protected computer and will never be sent over any network. All in all, the audio files will be deleted after the defence of the Master thesis.

I sincerely appreciate your involvement and valuable feedback, and I thank you for your participation.

Please sign the attached form on "Consent for Participation in a Research Experiment" to indicate your agreement to these terms and conditions.

Consent to Participate in a Research Experiment

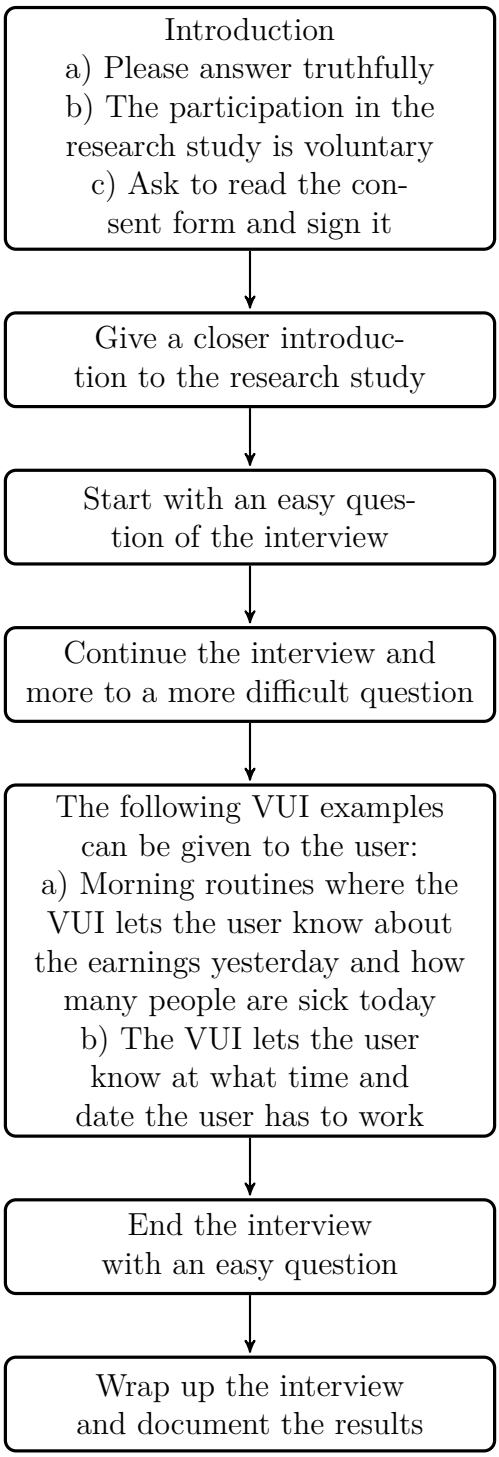
With my signature below, I certify that I have read the attached document *"Information about the Participation in a Research Study"* and am well informed about the motivation and procedure of this research study on *"Benefits of a Voice User Interface for the R&R WFM software solution"*.
I am aware that my participation in this study is voluntary and that I may withdraw from participation at any time without explicit reason and with no further consequences.
I agree that the data resulting from my participation in this experiment will be subject to anonymous scientific analysis and publication.

Please tick the boxes if you agree:
[ ] **I agree to participate in this research study under the conditions described above and in the attached document.**
[ ] **I agree to being recorded with an AUDIO recorder for the purpose of anonymized analysis.**

First and last name: _____

Place and Date: _____ Signature: _____

A.2.3 Interview script



A.2.4 Mind Map

Mind Mapping is used to better understand and organizing the problem when many pieces are unclear as well as to develop concepts and to generate ideas [23]. It has no limits and contains no ideal structure or format [17]. All in all, it is a useful method to generate idea and concepts or to organize a problem space.
The goal of the interviews were to better understand how the users interact with the software. The mind map shows the identified points the participants explicitly mentioned where the software is not working according to their wishes.

Worked hours
The manager has to check all worked hours and has difficulties to find this function within the R&R software. In general, the worked hours function is based on weeks and not on days which makes it even more complicated for the manager.

New employee
If a new employee is added to the SaaS product, the contract starting date is entered. At the same time, the date when the employee should be scheduled for work has to be entered. This date always has to be a Monday to make sure that the manager is able to choose this employee during the scheduling of the work. The SaaS product doesn't allow any other date than a Monday, but this can lead to troubles for the manager.

Check in / out
Employees forget to check in/out when the enter for/leave from work. Afterwards, the manager has to adjust the registered employee work times manually.

Flex hours
In Germany, managers can hire an employee as a Marginal employment. The SaaS product allows the manager to enter flex hours per employee. These hours will also be paid at the end of the month and don't count as overtime. As employees with a marginal employment are not allowed to have flex hours, it is necessary to pay attention to it. This goes wrong a lot of times and the manager has to change it manually for each employee.

Shift replacement request
Currently, the R&R Job App allows the users to request a replacement for their shift, but it is not possible to request a replacement for only a few hours of the shift.

Message function
The message function within the R&R software is based on HTML and not user friendly. The manager is just able to send messages and no images and an employee is not able to react on a message.

Completing payment
The SaaS product has a payment function. This means that all hours should be correct and a payslip for each employee will be created together with the overtime. In the Netherlands, this function is used and the money on the payslip will be transferred to the employee. In Germany, employees have a fixed monthly salary and the payslip is not used to pay the employees. Regularly, the managers in Germany forget to use the payment function. This means when employees look at their overtime, an incorrect number is shown. As a conclusion, employees get frustrated as they know that the overtime is incorrect.

Figure A.1: Mind map for R&R SaaS solution issues

A.3 Qualitative Content Analysis

A.3.1 Work environment of the managers and employees

The individual interviews gave an insight into the work environment of the managers and employees. Managers are more busy with meeting and facilitating employees, solve problems with customers, and have other appointments. Employees on the other hand have different tasks that are centered around the goods like checking the quality of the goods, removing items that are not good anymore, and preparing the goods for the customers like baking bread or cutting cheese. Furthermore, employees also have to clean and restock the shelves. In addition to the different tasks, one supermarket had a daily stand-up to talk about what happened yesterday and what are they planning to do today.

In all of the interviewed supermarkets, the R&R WFM software solution is used. The SaaS solution is used to check and correct the registered hours for each employee, schedule the work, sending messages to the employees, and check the numbers from the previous day. In general, all module of the SaaS solution are used by the managers. In contrast, employees are just using the R&R Job App to check the work schedule, the worked hours, and the leave balance. Moreover, employees can also request replacement or leave, and enter the times they cannot work due to school or the university.

The work environment of managers as well as employees is not always ideal. Their efficiency during a work day is for example hindered by a theft, defect things, or unpredictable events like meetings with employees due to something that happened or a customers who wants something in specific. These unexpected things take a lot of time and energy of the managers and employees.

A.3.2 Current R&R software system

As part of the qualitative content analysis the current software system was researched. Therefore, a few of the codebook codes were used to establish how the current software system is working and what the efficiency of the software hinders.

Currently, the R&R WFM software system has two interfaces, a smartphone app and a SaaS web interface. Generally, the users like that it is easy to access the worked hours, ask for leave, and exchange shifts via the R&R Job App.

Contrarily, the managers and employees mentioned in their interviews that parts of the software didn't work as desired. For example, managers desire a fully working message function in which they can send and receive messages. This is not implemented in the software and while discussing this with the company mentor, it was clear that the so called message function is more like a notification function in which managers can just inform employees. The software won't implement a message function in which employees and managers can talk to each other as this is not the main function of the software system.
Additionally to the manager, the employees would like to see their registered hours in the Job App and not only their scheduled hours. This means that the employees are not able to see how much they actually worked at the moment.
Another insight is that employees forget from time to time to check in our out while entering or leaving from work. In that case a manager has to correct the registered hours for the specific employee.
Furthermore, employees would also like to be able to send a replacement request for a few hours of a shift instead of the whole shift. This is not implemented in the Job App right now.
Another aspect in Germany is that the payment function is not used for paying the employees, but while using the module, the registered hours are getting checked and the employees receive their correct overtime balance. As managers forget to use this function, the employees don't always see their correct overtime balance.
Besides that other employees mentioned that they have a supervisor function in which they also have to check other employee schedules. This is not possible within the app and these employees would like to have more possibilities to view all schedules or view even more from different departments in the Job App.

A.4 Personas

Figure A.2: German Manager Persona from the UX Designers at R&R WFM

Figure A.3: Dutch Manager Persona from the UX Designers at R&R WFM

A.5 Time Plan

A.5.1 Original time plan

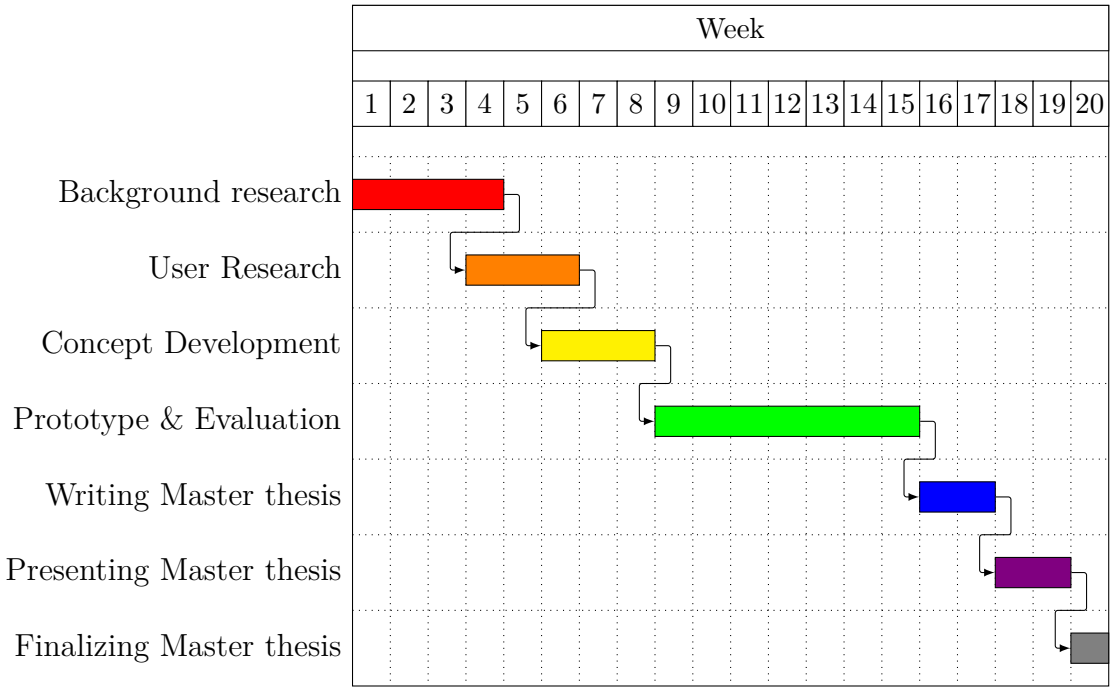


Figure A.4: Gantt chart of the original time plan

Week 1: 21-01-2019 - 25-01-2019

- Getting to know the company and the industrial use case
- Setting up the planning report
- Working on the introduction, aim and research question
- Background research about VUIs and voice assistants
- Research about design frameworks and VUI design principles

Week 2: 28-01-2019 - 01-02-2019

- Background research about related work
- Theory research about design frameworks
- Theory research about voice interface design principles
- Theory research about basic voice interaction
- Setting up methods to be used during the design process

Week 3: 04-02-2019 - 08-02-2019

- Planning report review
- Rewriting the planning report based on the feedback from the academic supervisor
- Meeting with company employees to get a better understanding of the current software product

Week 4: 11-02-2019 - 15-02-2019
- Rewriting the planning report based on feedback from the academic supervisor
- Setting up the questionnaire for the user research
- Spreading the questionnaire in different channels
- Setting up interview questions

Week 5: 18-02-2019 - 22-02-2019
- Conducting interviews with real users
- Evaluating the questionnaire responses
- Gathering and analyzing the current food retail WFM software problems

Week 6: 25-02-2019 - 01-03-2019
- Writing personas based on the interviews and questionnaires
- Writing about the process of the interviews, questionnaire and personas in the Master thesis document
- Setting up a VUI use case and flow

Week 7: 04-03-2019 - 08-03-2019
- Evaluating the VUI use case and flows
- Defining sample dialogs for the VUI
- Evaluating these VUI flows and sample dialogs with users

Week 8: 11-03-2019 - 15-03-2019
- Drawing a conclusion of the evaluation of the VUI flows and sample dialogs
- Iterate on these flows and dialogs

Week 9: 18-03-2019 - 22-03-2019
- Creating a low-fidelity prototype of a VUI

Week 10: 25-03-2019 - 29-03-2019
- Testing the VUI prototype with real users
- Evaluate these tests

Week 11: 01-04-2019 - 05-04-2019
- Editing the prototype based on the evaluation
- Testing the VUI prototype with other real users

Week 12: 08-04-2019 - 12-04-2019
- Drawing conclusion for design factors from the evaluation
- Applying these design factors in the prototype
- Deciding for a specific voice assistant for the VUI

Week 13: 15-04-2019 - 19-04-2019
- Creating a high-fidelity prototype

Week 14: 22-04-2019 - 26-04-2019
- Testing the high-fidelity prototype
- Evaluating the high-fidelity prototype

Week 15: 29-04-2019 - 03-05-2019
- Drawing further conclusions for the design factors

Week 16: 06-05-2019 - 10-05-2019
- Writing the Master thesis report

Week 17: 13-05-2019 - 17-05-2019
- Continuing to write the Master thesis report

Week 18: 20-05-2019 - 24-05-2019
- Preparing the presentation

Week 19: 27-05-2019 - 31-05-2019
- Present the Master thesis
- Attend two other Master thesis presentations
- Be an opponent for one other Master thesis presentation

Week 20: 03-06-2019 - 07-06-2019
- Rewrite and finish the Master thesis based on the given feedback

A.5.2 Updated time plan

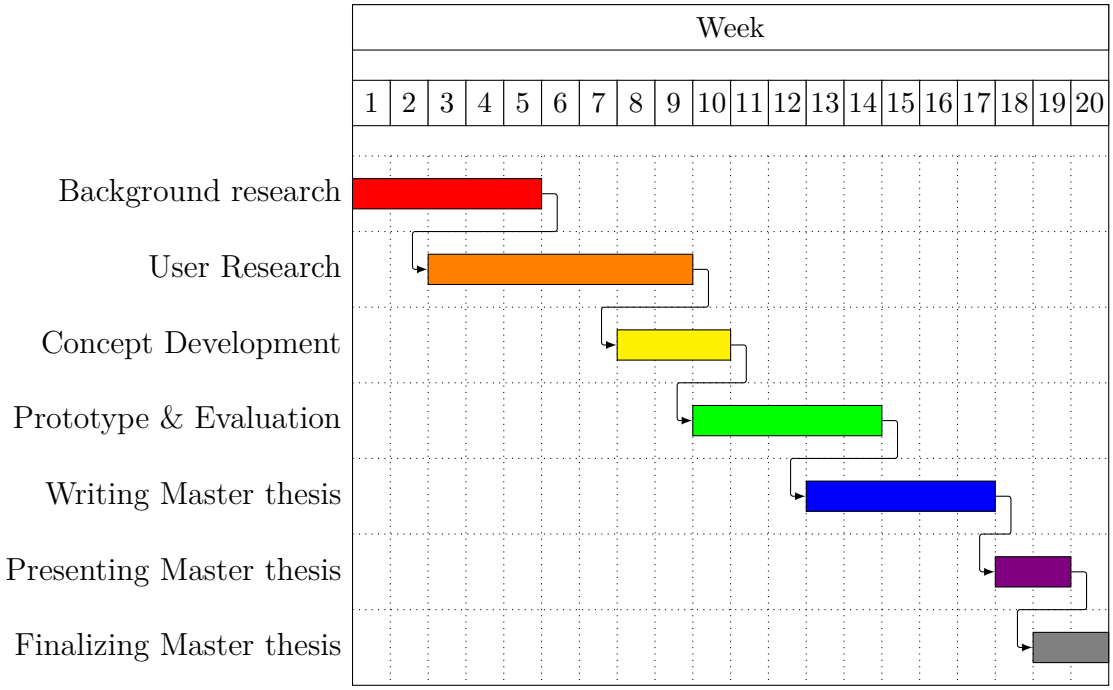


Figure A.5: Gantt chart of the updated time plan

Week 1: 21-01-2019 - 25-01-2019

- Getting to know the company and the industrial use case
- Setting up the planning report
- Working on the introduction, aim and research question
- Background research about VUIs and voice assistants

Week 2: 28-01-2019 - 01-02-2019

- Background research about related work
- Theory research about design frameworks
- Theory research about voice interface design principles
- Theory research about basic voice interaction
- Setting up methods to be used during the design process

Week 3: 04-02-2019 - 08-02-2019

- Planning report review
- Rewriting the planning report based on the feedback from the academic supervisor
- Meeting with company employees to get a better understanding of the current software product
- Setting up the questionnaire for the user research
- Rewriting the planning report based on feedback from the academic supervisor

Week 4: 11-02-2019 - 15-02-2019

- Setting up the questionnaire for the user research
- Setting up interview questions for the user research
- Rewriting the planning report based on feedback from the academic supervisor

Week 5: 18-02-2019 - 22-02-2019

- Finalize planning report
- Reviewing the interview questions
- Conducting a pilot study with the interviews
- Writing about GDPR, pilot studies, sample size and UCD design in the process of the Master thesis document

Week 6: 25-02-2019 - 01-03-2019

- Evaluating the pilot study
- Reviewing the questionnaire and interview questions
- Writing about the pilot study, voice assistant statistics, user requirements, personas, mind mapping, and prototypes in the process of the Master thesis document
- Writing about the voice gender in the ethical considerations
- Creating a draft of the UCD process
- Creating an interview script
- Writing and evaluating the consent form for the individual interviews

Week 7: 04-03-2019 - 08-03-2019

- Writing about prototypes in the methodology of the Master thesis document
- Conducting individual interviews with real user
- Call with German supermarket manager for an interview
- Writing the transcripts from the interviews with real users
- Adding an example of a manager and employee interview as a transcript in the appendix
- Writing about the real individual interviews in the process of the Master thesis document
- Writing the transcripts from the interviews with real users
- Adding a mind map in the process of the Master thesis document with the current food retail WFM software problems according to the managers and employees
- Adding a description to the different mind map items in the process of the Master thesis document
- Writing about the demographic question about the users age in the process
- Deleting the age question from the questionnaire
- Writing about experimental research and internal, and external validity in the methodology
- Writing about the research question and experimental research in the introduction

Week 8: 11-03-2019 - 15-03-2019

- Redefining the research question
- Conducting individual interviews with real users
- Writing the transcripts from the interviews with real users
- Writing about the questionnaire outcome in the process
- Evaluating the questionnaire responses in relation to the statistics
- Finishing the mind map with the current food retail WFM software problems according to the managers and employees
- Updated the Master thesis template
- Writing about exploratory and formative research in the methodology chapter
- Writing and comparing qualitative and quantitative research in the methodology chapter
- Writing about research quality criteria in the methodology chapter
- Adding the codebook method with references and a short description to the list of methods
- Reading about the qualitative content analysis
- Writing about Qualitative Content Analysis including Thematic Analysis and Grounded Theory in the methodology chapter

Week 9: 18-03-2019 - 22-03-2019

- Creating the QDE minor file with two employees and one manager interview transcript
- Fixing references for the methodology chapter
- Evaluating the individual interview responses by creating the initial codebook
- Writing about personas in the process
- Adding gantt charts to the planning chapter for the original and updated time plan
- Writing about hypotheses for an exploratory research
- Creating an example flow chart in LATEX
- Finalizing the initial codebook
- Evaluating all individual interview responses with the codebook
- Writing about the qualitative content analysis in the process chapter
- Evaluating the persona for the manager and improving the information based on the interviews and questionnaires
- Creating new personas for two employees based on the interviews and questionnaires
- Writing about personas in the process chapter

Week 10: 25-03-2019 - 29-03-2019

- Writing and improving the Master thesis document
- Writing in the qualitative content analysis about the final codebook
- Analyzing the final codebook result
- Creating scenarios for the VUI
- Defining VUI sample dialogs for the scenarios
- Setting up VUI flows for the scenarios
- Evaluating the concept with other UX Designers
- Iterate on these VUI flows and sample dialogs

Week 11: 01-04-2019 - 05-04-2019
- Creating a low-fidelity prototype of a VUI with the WOZ method
- Testing the VUI prototype with real users
- Rewriting the document based on the feedback from the academic supervisor
- Evaluate these prototype tests
- Drawing conclusions of the low-fidelity prototype

Week 12: 08-04-2019 - 12-04-2019
- Preparing new and more realistic prototype in high-fidelity
- Writing about the high-fidelity prototype in the iteration 3 section
- Testing high-fidelity prototype with company colleagues
- Evaluating high-fidelity prototype
- Writing about the high-fidelity prototype evaluation in the document
- Adding related work to the background section
- Deciding for a specific voice assistant for the VUI in the considerations
- Writing first considerations for introducing a VUI in the industrial use case
- Figure out the respective added value for the managers and/or employees

Week 13: 15-04-2019 - 19-04-2019
- Writing the Master thesis report
- Preparing the test of the high-fidelity prototype
- Testing the high-fidelity prototype
- Evaluating the high-fidelity prototype

Week 14: 22-04-2019 - 26-04-2019
- Figure out the respective added value for the managers and/or employees
- Generating guidelines in the form of considerations to bring an added value for managers and/or employees
- Writing the Master thesis report
- Restructuring the chapters
- Filming the video for the prototype demo
- Editing the video for the prototype demo
- Uploading the prototype videos on Vimeo

Week 15: 29-04-2019 - 03-05-2019
- Write the discussion chapter of the report
- Write the conclusion chapter of the report
- Write the abstract of the report
- Continuing to write the Master thesis report

Week 16: 06-05-2019 - 10-05-2019
- Restructuring the Master thesis report
- Improving the Master thesis report

Week 17: 13-05-2019 - 17-05-2019
- Improving the Master thesis report

Week 18: 20-05-2019 - 24-05-2019

- Read the Master thesis from the opponents
- Prepare questions for the Master thesis presentation from the opponents
- Preparing the presentation
- Present the result of the Master thesis to the company

Week 19: 27-05-2019 - 31-05-2019

- Present the Master thesis
- Attend two other Master thesis presentations
- Be an opponent for one other Master thesis presentation
- Rewrite and finish the Master thesis based on the given feedback

Week 20: 03-06-2019 - 07-06-2019

- Rewrite and finish the Master thesis based on the given feedback