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Graduation Report

AN IMPROVED REMINDER SYSTEM TO STIMULATE MEDICATION ADHERENCE OF ELDERLY AT HOME AS WELL AS OUTDOORS WITH THE USE OF THE MEDIDO MEDICINE DISPENSER

July 6th, 2018

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Bachelor Creative Technology

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Abstract

This graduation report approaches an improved reminder system to stimulate adherence to medication for elderly with the Medido medicine dispenser at home as well as outdoors. The Medido medicine dispenser offers an audio reminder to its user inside the home to remind them on taking their medication. A functioning reminder in home as well as outdoors is necessary to prevent non-adherence to medication. The user satisfaction of the Medido and requirements for an improved system were researched using an online survey and semi-structured interviews for both elderly and caregivers. The reminder of the Medido was experienced as efficient. However, reminders were missed, because the signal was not heard in every room of the house. As a solution to this problem noise amplifiers can be placed in rooms were the audio signal is missed. Different types of outdoor reminders can be applied, but these reminders should adhere to specific design guidelines based on user requirements of the target group. Outdoor reminding is made possible with the proposed design of a smart pill bottle that was preferred more than a mobile phone or smartwatch by both elderly and caregivers. The smart pill bottle meets the design guidelines and takes over the tasks from the Medido when medication is dispensed in advance for a maximum period of 24 hours.

Acknowledgement

I would like to thank my supervisors and the company Ecare Innovatie for giving me the opportunity to work on this great project, which I believe could be a real addition to stimulate adherence to medication with the use of the Medido medicine dispenser. I would also like to thank them for the support and advice that they gave me during the process.

I want to show my gratitude to Buurtzorg for offering me the opportunity to spread out an online survey for their employees and the search for participants for the interviews. Also to the SmartXP and Ecare TCS for letting me borrow several materials that were needed during this research.

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1. Introduction

The Netherlands counts 3.1 million persons with an age higher than 65 years. This will be a rising number in the upcoming years with 4.7 million elderly older than 65 years in 2040. Of these 4.7 million elderly 43% will be older than 80 years [1]. With the changes in the Dutch welfare state and therefore the disappearance of retirement homes [1], elderly will live for a longer period at home. As a direct result of the accelerating number of elderly people in society, that live longer at home, the demand for care will increase. Of the people older than 65 years 70% has a chronic disease and more than 50% of the people older than 75 years old has more than one chronic disease [2]. Consequently the amount of given care will rise approximately with 4% each year [2].

A part of this care for chronic diseases has to do with medication management. Pérez-Jover et al. [3] state that most elderly people take five or more medications a day and are treated by different physicians. Increasing medication usage leads to a rising health concern, namely medication non-adherence [4]. Schlenk et al. [5] define medication non-adherence as a failure to adopt a medication scheme, stopping or dropping out of a medication treatment and alterations in doses such as increased or decreased, missing or wrongly timed doses.

The therapeutic effect of drug therapy for elderly depends on precise medication dosing, administration and monitoring [6]. The effect becomes unpredictable if these steps are not exactly executed as recommended. Therefore, it is important to prevent for non-adherence in medication management. The causes of medication non-adherence can be unintentional or intentional [7-9]. Physical issues such as impaired vision, loss of fine motor skills, and dysphagia are reasons for unintentional non-adherence [8, 9]. Other examples of unintentional non-adherence are problems with reading and understanding instructions for use, dealing with packaging or preparing medication before use [11]. Lastly, financial constraints are also a form of unintentional non-adherence [7]. Non-adherence to medication increases with 11% if payments are necessary to receive the medication [12]. Next to unintentional reasons for non-adherence there are also intentional reasons that can cause non-adherence. These involve motivational reasons of users to not take in their medication or take it in a different way as prescribed [8]. Motivational reasons for medication non-adherence are caused by various behavioural, attitudinal and socioeconomic motives [7]. Users can choose to stop or alter the prescribed medication therapy, for example when it feels that medication does not increase individual health or when less health risks are involved [12].

Unintentional as well as intentional problems do not only affect the therapeutically effect of the medication, but can also lead to larger problems in the health state of elderly. As an effect of poor medication adherence hospitalizations, adverse clinical outcomes and increased

healthcare costs may occur [13]. According to O'quin et al. [4] 28% of the hospitalizations of elderly are due to medication non-adherence. These hospitalizations are unnecessary and can be prevented if elderly will stick to their medication scheme in the way that it is prescribed by physicians. A way more extreme consequence of non-adherence can be death, which can occur by the use of specific medication, for example medication after a myocardial infarction [14].

By the increase of e-health new devices have been designed and researched with the goal to improve medication adherence in elderly [7]. These devices, called medicine dispensers, help elderly people to manage their medication intake. Appropriate reminders are given and medication is dispensed at the right time. Such dispensers can be deployed in home care, so users become more independent when it comes to daily medication intake. This does not only has advantages for the user, but also for health care organizations who offer home care. When a user becomes more independent with his or her medication, less visits are needed meant for medication intake, and only in a case where problems occur home visits are needed. The workload of home care organizations decreases if less visits are needed. Therefore, the use of a medicine dispenser becomes attractive for such organizations, since it reduces costs. The only costs that must be made are the purchase costs for the medicine dispenser device.

Home care with the help of a medicine dispenser is a turning point within an organization [15]. The usual medication care changes considerably with a medicine dispenser, see figure 1. In usual care, home care is an essential part of the medication intake process. When it comes to applying medicine dispensers in home care, the care of organizations becomes optional and only necessary when problems occur. The dispenser monitors the medication adherence of the patient and informs home care organizations when an error occurs and it is time to intervene. With the use of medicine dispensers, there is often an external company involved. This external company delivers the medication in the desired format that corresponds with the type of medicine dispenser.

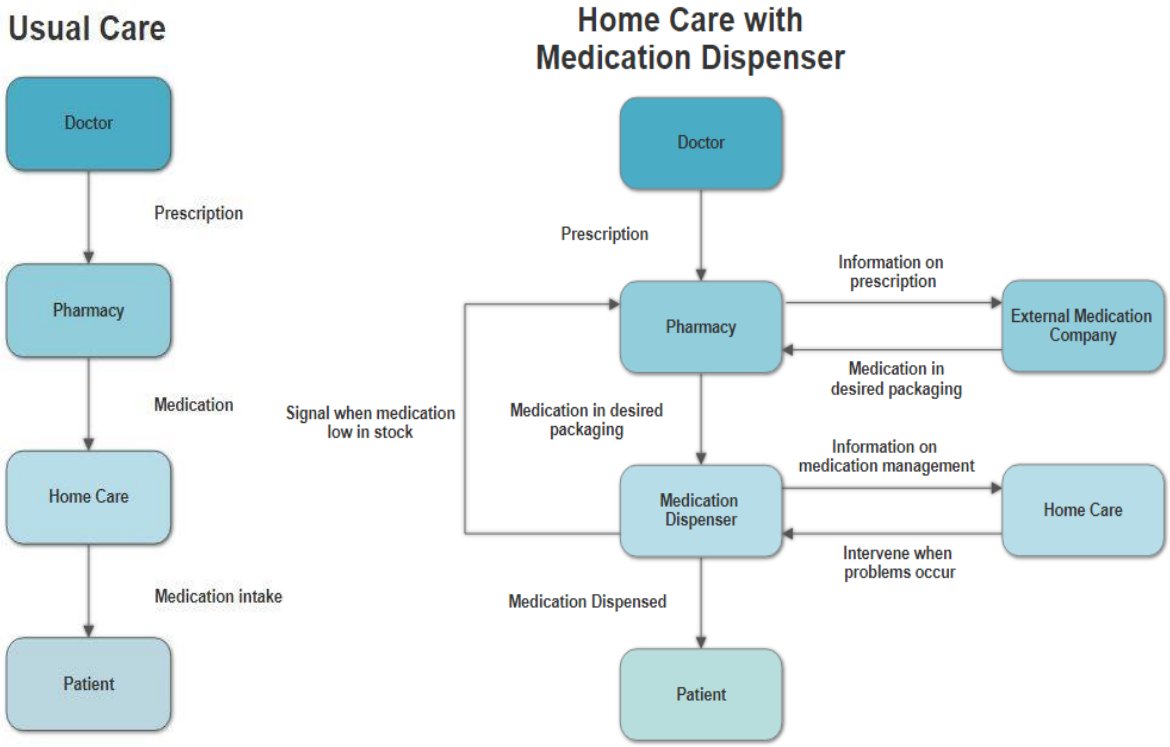

Figure 1: Usual home care versus home care with the help of a medicine dispenser

This Bachelor Thesis is performed on behalf of the company Ecare Innovatie [16]. Ecare Innovatie works on innovative applications in health care. Their largest client is Buurtzorg [17], a home care organisation in the Netherlands. Since 2016 Buurtzorg offers their clients the possibility to use a medicine dispenser within their home care. The medicine dispenser offered by Buurtzorg is the Medido developed by Philips [18]. Trials with the Medido started in 2015 and since 2016 it is approved by all Dutch health insurers. A client qualifies for the Medido if he or she is assigned with help for medication intake and is client of a Dutch homecare organisation. Although these medicine dispensers are upcoming products, it is important to evaluate its functionality and to search for improvements.

1.1 Study objectives

The starting point of this Bachelor Thesis is the Medido dispenser device, since it is used as medication dispenser within Buurtzorg. The main characteristics of the Medido are that it is a clock-based system which makes adherence to medication easier. The Medido can remind the user to take medication and to communicate with the caregiver. At this moment the Medido can only give reminders to the users inside the home. Medication can be taken out of the device in advance for a period of maximum 24 hours. The user will not receive a reminder for medication that is taken out beforehand. Therefore, the aim of this research is to develop an

improved reminder system for the Medido which can also help elderly to remind them on taking their medication outdoors. This leads to the following research question that will be answered within this thesis:

Research question: What type of reminder(s) can be applied to improve and stimulate medication adherence of elderly with the Medido at home as well as outdoors for a maximum period of 24 hours? To solve this research question the following sub questions have been determined:

- How is the user satisfaction of the Medido for elderly?
- How is the user satisfaction of the Medido for caregivers?
- What is the state of the art on medicine dispensers?
- What is the state of the art on reminders systems?
- What are important design features to take into account while designing a reminder system?
- What would be a possible design for a reminder system to improve medication adherence for elderly when they are outdoors?

These research questions are answered by using different methods. One of these methods is a state of the art and literature research. The findings out of this research are described in chapter 2. Besides this research an online survey and interviews with client and caregiver of Buurtzorg are conducted. The different methods used for each part of this research are described in chapter 3. The answers and analysed results of the interviews and online survey are represented in chapter 4.

2. State of the art

In this section the State of the Art on medicine dispensers and its related work is discussed. The first part consists of related work to types of intervention techniques that can be used to improve non-adherence to medication. Secondly different types of reminders used to improve non-adherence to medication are discussed. Thereafter it focusses on the types of reminders that fit the intended end users, namely elderly. This part discusses the use of reminders in home care and the relationship between reminders and elderly with chronic diseases. Lastly important design features of reminders are listed. In the second part smart medicine dispensers which are available on the current market are discussed. At the end of this section an overview of all the dispensers and their characteristics are listed in table 1 at the end of this chapter.

2.1 Related work

2.1.1 Intervention types non-adherence

Authors do not seem to agree on the types of intervention techniques used for modifying medication adherence. Costa et al. [19] state that the main employed interventions to medication adherence are: behavioural , educational, integrated care, self-management and risk communication interventions. Behavioural interventions try to adjust the behaviour of people towards a medical treatment [20]. Educational interventions focus on explaining the process of medication adherence and by discussing their thoughts towards a treatment [21]. Self-management is defined as the ability of the individual, in conjugation with family, community, and health professionals, to manage symptoms, treatments, lifestyle changes, and psychosocial, cultural and spiritual consequences of a chronic disease [22]. During risk communication interventions the user is notified on the risk factors and benefits of their medication use, while integrated care combines all the types of interventions to reach adherence in medication [19].

Lawrenson et al. [23] made a different distinction between interventions meant to decrease non-adherence, namely patient-focussed interventions, provider focussed interventions and system interventions. Where patient focussed interventions are targeting on changing behaviour of people, provider focussed interventions are the same, but they target on the behaviour of caregivers. Lastly system interventions concentrate on telemedicine applications or changes in the way care is organised. George, Elliott and Stewart [24] reviewed methods for changing medication adherence and grouped their results in behavioural, educational and provider focused interventions.

Although authors distinct from each other in the terms they use for interventions techniques the effective methods they found are equal. All the reviews concluded that a combination of interventions where behavioural and educational methods were used improved medication adherence the best, however these interventions do only work if interventions are repeated over time [19, 23, 24]. To change the behaviour of people towards medication adherence educational and behavioural interventions can be used, within these interventions technology reminders can play a role. To create an effective reminder for a medicine dispenser the knowledge on intervention techniques can be applied. With a right application of an intervention technique processed in a reminder design the effectiveness of the reminder can increase sufficiently.

2.1.2 Reminder types non-adherence

This Bachelor Thesis focusses on electronic reminders and therefore the different kinds of them are explored. Fenerty et al. [25] reviewed the following reminders: reminder by phone calls, text messages, pagers, interactive voice response systems, videotelephone calls, and programmed electronic audio-visual reminder devices. In another review automated telephone communication systems are used, such a system can deliver voice messages from heath care provider to patient or the other way around [25]. Other types of reminders that are researched are speech, visual, non-speech audio, touch and smell reminders [26]. Vervloet et al. [27] did a systematic review on the effectiveness of electronic reminders to improve adherence to chronic medication. Three types of electronic reminders were researched, namely SMS reminders, audio/visual reminders from an electronic reminder device (ERD) and a reminder via a pager system.

Of course, not every type of reminder system is as effective in improving non-adherence to medication as the other. Not only there are differences between the effectiveness of reminders, but the content of a specific type of reminder can make it succeed or fail. SMS reminders or voice messages become effective if tailored messages are sent and a reply is requested, less effect was seen when standardized messages were sent [7, 27]. Audio and visual reminders of an ERD are found to be effective and decrease non-adherence to medication, but only if the signal was clear and easy in sight [26, 27]. Pagers are less effective, because it must happen at predetermined times and the ease of use is works not well [27]. Fenerty et al. [25] support the thought of Vervloet et al. [27] that reminder systems which are tailored to a user are way more effective than neutral warnings or statements. Voice-based reminders based on interactive response increased adherence to medication better than text-based reminders via

for example a pager or telephone [25]. Integrated alarms within medication monitoring devices increased the rate of adherence significantly [25].

To decrease non-adherence to medication tailored reminders are more effective than neutral reminders. A disadvantage of the reviews is that there is only focus on the short-term effect of reminders. There is no research done on the effects on the longer run. Effects on the longer run are important as well, since reminders may be used for a longer period. When used for a longer period, the goal must still be the same, namely decrease non-adherence to medication.

2.1.3 Reminders for elderly in home care

Homecare is not a clinical environment and older adults may lack experience, motivation and problem-solving skills to overcome barriers during the use of a medication reminding system [28]. To find an ideal solution for a reminding system for elderly there must be a focus on the needs and desires of the end users. Elderly rather prefer speech or audio reminders than a visual reminder and even though mobile phones are increasingly popular in current population 40% rather receives reminders on their land phone [26]. Both findings were accompanied by the research of Wolters and Mcgee-Lennon [29], in their research elderly were more likely to choose a speech reminder and less likely to choose a visual reminder. Besides this agreement Wolters and Mcgee-Lennon [29] also state that elderly rather received reminders on their landline phones than on their mobile phones.

The design of a reminder system must fit to the need of end users, in this case elderly. Audio reminders, including speech and sound, are preferred by elderly in comparison with visual reminders [26, 29]. These audio reminders must be offered via a medium which is comprehensible for elderly. Mediums such as a land phone are preferred to be used, since elderly are already at ease with the use of such a device.

2.1.4 Reminders for elderly with chronic conditions

There are many different types of reminders, but not every type of reminder is suited for elderly. Elderly do often face chronic, physical or mental conditions that make it harder to react in a proper way to reminders. One of the largest clinical conditions for elderly is cognitive impairment [30]. A systematic evidence-based review and showed that medication adherence for elderly with cognitive impairment becomes better by using human contact as reminding system than nonhuman reminders [30]. Waller et al. [31] suggest that interventions delivered via technology mediums, such as telephone and computer, have the potential to provide information and resources to improve outcomes of caregivers of people with dementia. Korchut et al. [32] did a research in a home care robot for elderly with cognitive

impairments. They interviewed people with mild dementia to find out what way of interaction they prefer, the largest group preferred interacting via simple voice commands, namely 60%. Keyboard and buttons as interface scored very low on preference for people with dementia, namely 3% [32]. Other impairments on human senses such as hearing and vision are increasing in the population of elderly , for this particular group reminders based on smell and touch could be a solution [26].

Not every chronic condition is the same and therefore the efficiency of reminders between them can change. Reminders can be effective for a mental condition such as dementia, but can lack effectiveness for elderly who cope with visual or hearing impairments. It is important to adjust the type of reminder to the type of the chronic condition, so elderly can fit it to their disease and personality.

2.1.5 Design concepts electronic reminder systems

Authors list different concepts to take into account while designing an effective reminder to decrease non-adherence to medication. Paterson, Kinnear, Bond and McKinstry [33] state that electronic reminders in combination with multi compartment medication devices have potential to improve self-adherence of medication for elderly. Although their potential to improve self-adherence for elderly they strongly depend on several concepts. These concepts are the context, usability and medical condition [33]. With the concept context is meant that reminders should fit to the environment they should function in. Of course, the usability of such a reminder should be suitable for the intended end users. Finally, the design should fit to the medical condition of the user, so that impairments do not lead to problems while using the reminder system.

Other authors partly agree on the terms named by Paterson, Kinnear, Bond and McKinstry, but list also different concepts. All reviews name the usability of a reminder as an important design concept [26, 28, 33]. Others agree on the term of context and medical condition [26, 33]. New concepts are introduced as well. In this review a reminder system should be reliable and must be able to assist a user with his or her medication management [26, 28]. Reeder, Demiris and Marek [28] state that a reminder should be able to become a routine task performance and must be acceptable by the type of user. McGee-Lennon, Wolters and Brewster [26] suggests that reminders must be diverse and designed for priorities. A diverse reminder is a one design reminder that can be applied in different ways depending on the priorities of users.

It is important to meet individual abilities of elderly to device controls for medication management systems wherein user centred design plays a large role. Focus points within the process of designing effective reminders are the context of home care, assistance in medication adherence and matching with the individual needs of every user. When these factors are successfully applied the probability of a reminder being effective to decrease non-adherence to medication will increase significantly.

2.2 Medicine Dispensers

In this section medicine dispensers that are available on the current market are discussed. The Medido is chosen as starting point and five other medication dispensers are selected. These five dispensers are selected, because they have their main characteristics in common with the Medido. These main characteristics of the Medido are stated as follows: it is a clock-based system which makes adherence to medication easier, it can remind the user to take medication and to communicate with the caregiver. The section starts with introducing the Medido dispenser. Afterwards the following dispensers are discussed: Pillo, Hero, MedMinder, AdhereTech and the Evondos.

2.2.1 Medido

The Medido [18] is a smart medicine dispenser developed by Innospense and is sold by Philips. The intended end users for the Medido are elderly people who experience difficulties with their medication management and live at home. The Medido is a personal device and can be used by one individual at the time. Medication can be placed in the Medido via a medication roll also called Baxter roll,

Figure 2: Medido from Philips

which is delivered by a pharmacy. A Baxter roll consists of sachets which are linked together in the right order and can be seen in figure 2. Each sachet contains all the medication for a specific date and time. The system is clock based and dispenses the right medicines on the preferred time of the user. Via a signal, a loud buzzer, the user is reminded to take his medication. The user needs to react on the buzzer by pressing the OK button to let the Medido dispense the medication. The sachet with medication is opened by the Medido before it will be dispensed. On the small screen time and explanation about medication can be shown in text.

In the case that a user does not react on the first alert it will repeat itself every 10 minutes for a period of 75 minutes. If after this period there has not been any response by the user

caregivers will be informed. Caregivers will receive a text message with the given problem and will try to call the user, if they fail to contact the user via phone they will visit the user. Communication from Medido to caregiver happens via a General Packet Radio Service (GPRS) network. With this technology mobile data can be send and received in an efficient way. This technology enables the user to take the Medido with him if he is away from home for several days.

Medication such as ointment or eye drops cannot be dispensed by the Medido, but it can give an alert when these medicines must be taken. The Medido can easily adapt itself to a modified medication scheme, this process will be supported by the pharmacy. The pharmacy will also monitor whether the Baxter roll is almost empty and will replace it in time. Sachets with medication can be dispensed before the set time if a user goes away from home, but needs his medication. The Medido will know that these medicines are taken out and will not give an alert, obviously the user will then be responsible for his own medication intake.

2.2.2 Pillo

Pillo [34] is an intelligent home robot who dedicates at the health and wellbeing of families. A Wi-Fi connection is needed to install Pillo and let it work properly. Every family member can be recognized by facial recognition and helps every one of every age to manage their health. Artificial Intelligence is used, so Pillo learns about the people in his environment, by face recognition and a voice interface, and changes its functionality to them. Pillo has an internal cabinet with 28 bins, in each bin is place for approximately 11 pills. Pillo stores and dispenses medication only for the primary user. Medication can be loaded by following a step by step process where pills are put in the correct bin. The info of every type of medication and the time at which it should be taken can be filled in on a mobile application and will be synchronized with Pillo. When the medication settings are set Pillo will dispense the right medication on the right time in a glass at the bottom. The user is reminded to take his medication by the device telling him or notifications from the mobile application. When medication is forgotten other family members will be warned via notifications on their smartphone. Medication that cannot be stored in the cabinets of Pillo cannot be dispensed, but Pillo is able to notify its users about this medication.

Figure 3: Pillo medicine dispenser

The interface of Pillo consists of a round screen with two eyes on it, this gives a personalisation to the device. Users can interact with Pillo via voice commands or the touch screen. Medication is only dispensed for the main user, but all the family members can ask questions about their health and wellbeing. Pillo can connect its users with healthcare professionals and notices when medication becomes out of stock. If a user wants to take medication with him when he leaves home, he can tell Pillo and Pillo will dispense the right medication in advance. Another option is taking the medication out of the bins with the help of the mobile application.

Next to its health management Pillo can be an assistant in keeping up with your agenda and can remind the user of appointments. Via the screen video conversations can be held with family and friends. Pillo can be connected to other devices such as smart watches and smart phones via an application. The mobile application of Pillo can be used to create insight in personal health management which is being displayed in a graphic overview. Caregivers can use the application to monitor the users of Pillo during their health management.

2.2.3 Hero

Hero [35] is a smart medicine dispenser designed for families. It can hold for a month supply for ten different pills. To let Hero work properly a working Wi-Fi connection is needed. The interface consists of a coloured LCD screen with navigation buttons and a select button. Medication can be loaded into Hero by filling a cartridge with pills and register in the name by using the interface. The full cartridge is slide back into Hero and it will automatically store the right order of cartridges and so the medication. The next step is to configure the right medication to the right family member and time, which must also be done via the interface. If all settings are correct Hero can start dispensing medicines. When it is time to take medication, a user is notified via his smartphone. The user needs to fill in his password onto the device if applicable and one press on the button to let Hero dispense his medication. Medication is dispensed into a plastic cup and Hero notices when the cup is tilted and put back in place.

Figure 4: Hero medicine dispenser

Caregivers can be notified via an application about the medication management of the users of Hero. There are both notifications if medication is taken and when it is forgotten. The stock of pills is monitored and users are notified via the application when the stock becomes low. Automatically reordering of medication can be done if approved by the user. This reordering

happens via Amazon, so it is not applicable for medication that can only be received via pharmacies.

The mobile application of Hero is designed to keep track of medication intake for each family member over time. There are private communities in the app where people who take similar medication are connected. Within these communities users can discuss health issues.

2.2.4 MedMinder

MedMinder [36] has several medication boxes with different functionalities. Every box has its own internal cellular modem, so there is no need for an extra communication network. The intended end users for the MedMinder are elderly who live at home and have difficulties with their medication management. The principle of every medication box is the same. Medication for one week and four moments a day can be stored in the box and must be done by user, caregiver or pharmacy. Every compartment contains medication for a specific moment during the day. The Medication schedule of a user can be programmed into the MedMinder via the MedMinder portal.

Figure 5: MedMinder medicine box

A buzzer goes off, the right compartment lights up and the user will receive a reminder on his phone when it is time to take the medication. A user can then open the right medication compartment by opening the lid of the compartment. If a user does not immediately react on the reminders they will continue to occur within 30-minute intervals. If the user still did not take the medication caregivers will be informed via phone, email or text messages. If a user is not home, but needs his medication on the go he can empty the right compartments on beforehand. Another option is to take the MedMinder with him, since it is completely portable and can also run on battery power.

There are medication boxes of MedMinder with extra features. A first extra feature can be that a user receives a signal via a bracelet or necklace if it is time to take medication. These bracelets and necklaces inform the user by vibrating. Secondly there can be chosen for a locking mechanism that opens only the right compartment and locks the other ones. This prevents elderly with a higher risk on wrong adherence from making mistakes. The last extra feature can make it possible that caregivers can record voice messages via a portal. These voice messages can be played via the MedMinder of a user, messages can be used for

reminding users, positive feedback or personalized messages. The MedMinder does not keep track on the stock of medication within itself.

2.2.5 AdhereTech

The AdhereTech [37] is a smart and wireless medicine bottle designed to improve medication adherence for elderly. One bottle can be used for only one type of medication. A user needs to put his pills into the AdhereTech after he receives it from the pharmacy and removed the medication out of the packaging. When different kinds of medicines are taken during the day, more pill bottles are needed to receive reminders for every type of medication. The bottle reminds a user when it is time to take medication by giving light and sound alerts. The process of opening the pill box by the user is registered and notated as an action of medication intake. If non-adherence occurs, so when a user does not open the bottle, caregivers, relatives and the user can be reminded via automated texts messages and phone calls. There is no other device needed for this communication, since the AdhereTech has cellular technology, so it can function on its own. The pill bottle monitors its stock and can give a notification to caregiver and pharmacy when it becomes low. A user can use the pill bottles outside and inside home, since every pill bottle works on batteries and has a battery life of approximately two months. A large advantage of the AdhereTech is that its design and functionality is in no way different than a normal medicine bottle, which causes that elderly do not struggle with its use, because they are already familiar with the design.

Figure 6: AdhereTech medicine bottle

The AdhereTech can collect data about non-adherence of medication. It measures if medication is taken, the dosage that is taken, when medication is taken. This data can be accessed via a webpage where it is displayed in clear graphics.

2.2.6 Evondos

Evondos [38] is a medicine dispenser device designed in Finland specially for people with chronic conditions, dementia or for elderly who receive home care. The Evondos is for individual use and can be placed in a client's home. Its interface consists of a touchscreen and one selecting button. Medication is dispensed via sachets out of a Baxter medication roll. The medication is organised by the pharmacist and will be reordered when it is close to becoming out of stock. If it is time to take in medication the Evondos will give a sign by a buzzer and the button will light up. The sachet will be dispensed if the user clicks on the button on the bottom of the interface. The robot offers clear instructions about medication intake. Information is supported by clear pictograms, so actions are not only substantiated with text. When medication is forgotten and still not taken despite three reminders, the dispenser locks the sachet in a separate chamber, so it is not taken on a wrong time. Caregivers will be informed about the missed medication dose via a text message. Sachets can be dispensed in beforehand if a user goes away from home, but needs his medication. No alerts or notifications will be given for the sachets that are dispensed on beforehand. Taking medication will then become responsibility from the user itself.

Figure 7: Evondos medicine dispenser

Evondos can be used as communication device between caregiver and user. The caregiver can send a text message to the device. The message will be read out loud with the help of a text to speech algorithm. The user can react on the messages by choosing communication symbols on the touch screen. Next to the Evondos there is a Telecare System which allows caregivers to monitor the medication progress of their clients. This Telecare system is connected to the Evondos by an internet connection. If needed family members can have access to the Telecare system.

2.3 State of the art conclusion

Every medicine dispenser out of the state of the art applies a system intervention, since they are all telemedicine devices. The reminders that are applied to change the behaviour of users towards adherence to medication are all repeated over time which make them effective [19, 23, 24]. Next to the reminder the Pillo, AdhereTech and Evondos make use of educational methods where the other devices only apply a behavioural intervention. Tailored reminders are given by the Pillo, MedMinder and Evondos which make them more effective than the other

dispensers that make use of a neutral reminder [25, 27]. The Medido dispenser is designed for elderly and makes use of an audio reminder. Other dispensers that were designed for elderly made use of a light signal or notification on a smartphone besides the audio reminder. None of the researched dispensers were specifically designed for a chronic disease. However, the design and interface of the devices for elderly were kept easy and taking out medication was not a hard task. The Medido and other dispensers do not allow to adapt communication settings for a specific user, where the Pillo device learns about its user and changes its behaviour to them. The AdhereTech and Pillo offer outdoor reminders to their users, while the other dispensers only give indoor reminders.

Table 1: Comparison of characteristics of the researched medicine dispensers

	AdhereTech	Evondos	Hero	Medido	Medminder	Pillo
End users	Elderly people	Elderly or people with chronic diseases	Families	Elderly people	Elderly people	Families
User amount	Single	Single	Multiple	Single	Single	Multiple, but medication management is only for the main user
Medication form	One kind of pill per bottle.	Sachets in Baxter roll.	Single pills can be stored in 10 different cartridges.	Sachets in Baxter roll.	Pills for each moment of the day in one compartment.	Single pills can be stored in 28 cabins, 11 pills per cabinet.
Dispensing technique	User needs to take medication out of bottle.	Sachet is dispensed at right date and time.	Pills are dispensed from cartridges into plastic cup.	Sachet is cut open and dispensed at right date and time.	Lid of compartment must be opened to grab medication.	Pills are dispensed from cabinets into a glass.
Intervention alert	Light signal and Buzzer	Buzzer and light signal on button.	Notification via application on smart phone.	Buzzer as an alert, goes off every 10 minutes for a period of 75 minutes.	Buzzer, compartment lights up and a notification on phone.	Notifications via smartphones or watches. Pillo will talk to its user when he is in the same room.
Exterior device	Normal pill bottle.	Coloured LCD touchscreen and dispensing button below the screen.	Small coloured LCD screen. Navigation through menu with arrow and select buttons.	Small not coloured LCD screen where text can be displayed. Navigation through menu happens with arrow and OK buttons	The interface is a box where compartments can be opened.	Round screen with two eyes. Interaction with the device happens via voice commands or the touch screen.

Communication to caregiver	Text messages or phone calls.	Text message and Telecare system.	Notification to caregiver via mobile application.	Message to caregiver via GPRS network	Phone, email or text message.	Notifications to smart phones and watches.
Info about medication	Not possible.	Is shown on screen and supported by clear icons.	Can be shown in application or on LCD screen.	Can be shown on small LCD screen with text	Not possible.	Is shown on screen and told by the device
Adaptation to modified medication	User needs to put new medication into bottle or must purchase a new bottle.	Pharmacy takes care of modified medication.	It can only store 10 different types of medication.	Pharmacy takes care of modified medication. An alert for medication outside of Baxter roll can be set.	New medication can be put in the compartments.	Every information about medication must be filled in in the mobile application by the user itself
Use outside home	Bottle can be taken everywhere and functionality will not change.	Sachets can be taken out in advance.	Unknown	Device can be taken on a trip by user with requirement that it needs to be plugged in. Number of sachets can be taken for longer period, but user will not receive an alert.	MedMinder can be taken with users or compartments can be emptied on beforehand.	User can take medication out of cabins or can give voice command to the device and the right medications will be dispensed. User will still be reminded via notifications.
Automatically ordering medication by device	Pharmacy is notified when stock of medication becomes low.	Medication is reordered and replaced by pharmacy.	Medication can be reordered via Amazon if possible.	Medication is reordered and replaced by pharmacy.	Does not keep track of medication stock.	Will notify user and if possible order

Data gathering	Unknown	In telecare system data about patient medication and messages is saved.	Unknown	Saves the data about each action.	Does not happen	Gathers data about personality, health and life pattern.
Medication check	Checks whether the pill bottle is opened and medicines are taken out.	Checks whether sachet is taken, but cannot monitor intake process.	Checks whether medication is dispensed and cup with medication is tilted. Cannot monitor intake process.	Checks whether sachet is dispensed, but cannot monitor the intake process.	Checks whether compartment is opened, but not if emptied.	Checks if pills are dispensed and taken via camera.
Connection to other devices	Web page to program the settings of the bottles and have insight in data.	Can be connected to telecare system.	Can be connected to smartphone via applications.	Can be connected to mobile phones via GPRS connection	Connected to smart phones, necklace or bracelet, portal to program and use voice recordings.	Can be connected to smart phones and watches via an application

3. Methods and techniques

This section describes the different methods that were applied to conduct this research to solve the research question as well as its sub questions. The methods that were used were interviews and an online survey. First, the project leader of the Medido within Buurtzorg was interviewed. Secondly, an online survey was spread among Buurtzorg employees. In addition, both Buurtzorg employees and clients using the Medido were interviewed. An overview of the methods can be seen in the flow diagram of figure 8.

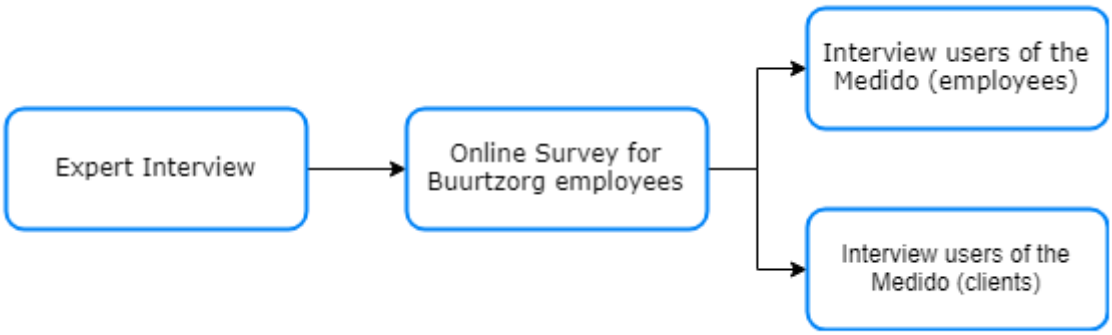

Figure 8: Flow diagram of different methods used during this study

The sections on the interviews with clients and employees of Buurtzorg and survey consist of three parts. In the first part the participants and the selection procedure are discussed. Secondly, the materials and procedure used to conduct the research are described. At last the questions that were determined for the research are motivated.

3.1 Interview Medido Buurtzorg

To get familiar with the Medido and its use within Buurtzorg an interview was conducted with the contact person of Buurtzorg when it comes to the Medido. This person works for Ecare and Buurtzorg and guides the use of the Medido within Buurtzorg. The questions that were asked during this interview are described in the table of Appendix A. Within this table is also explained why these specific questions were asked. The interview was held at the office of Ecare Innovatie and took no longer than one hour.

3.2 Online survey

3.2.1 Participants

The research question describes a target group of elderly who live at home, experience difficulties with their medication and receive home care. This target group are elderly who are clients of Buurtzorg. Asking this target group to fill in an online survey would have led to a bias within the research, since not every elderly is familiar with the use of a computer. Buurtzorg employees face the target group of elderly at least ones a week. They have been trained to

know the critical points of medication intake and adherence. By visiting their clients, they get insight in the demands and needs of every individual client. Besides that, teams of Buurtzorg employees decide whether a Medido can be used by a client. For these reasons, a survey is created for Buurtzorg employees.

At the moment that the survey was published there were 63 Medido devices in use at clients of Buurtzorg, this is only a small part of the clients of Buurtzorg. It is not known why other teams do not commit the Medido for their clients. It could be that their clients are not suited for the use of the Medido or that employees are not familiar enough with the Medido yet. Although employees may not be familiar with the use of the Medido, they can make an estimation based on their knowledge and experiences with medication intake for their clients. The input out of these groups can still be useful, so there was a distinction done between three groups of the survey. The following groups were determined:

1. Employees of Buurtzorg who are familiar with the Medido medicine dispenser and already use it within their work, called group 1 in this report.
2. Employees of Buurtzorg who are familiar with the Medido medicine dispenser, but do not use it within their work, called group 2 in this report.
3. Employees who are not familiar with the Medido medicine dispenser, called group 3 in this report.

The survey was open for all the three groups and distinction between groups is made with an introduction question. Questions between the groups are the same, but some of them are formulated differently.

3.2.2 Materials and procedure

Two weeks before the survey was spread, it was introduced to the employees with a message on Buurtzorgweb[1]. Via a second message, with again a small introduction, the survey was published on Buurtzorgweb. After one week a reminder was published on Buurtzorgweb to receive more responses. The three published messages can be found in Appendix B. The online survey was created with Google Forms[2], an online tool to create and analyse online surveys. The questions determined for this survey were filled in in Google Forms, for the survey lay-out see appendix C. To fill in the survey a device with an active internet connection and browser was needed. Only Buurtzorg employees were able to respond, since a valid Gmail[3]

[1] Online communication platform of Buurtzorg
[2] Google Forms is an online tool to create and analyse surveys https://www.google.com/forms/about/
[3] Gmail is an email service developed by Google

account of Buurtzorg was needed to get access to the survey. It was possible to fill in the survey ones per Gmail account, so there were no chances on double respondents. The survey was open for two weeks in which Buurtzorg employees could respond.

3.2.3 Questions

The questions were divided over six sections in the survey. Every section was displayed on a new page, so respondents were not able to preview questions from upcoming sections. Each section was shortly introduced with text explaining the goal and relevance of the questions. Questions that might be unclear to respondents were explained with extra text. Most of the questions were formulated as statements. Respondents could answer on a 5-point scale to what extent they agreed with the statement. Open questions could be answered with text, the space for an answer was unlimited. It was obligated for every respondent to fill in an answer for every question and statement. In this way respondents were forced to think critically about the Medido.

Questions differed between the three respondent groups (Appendix D). The questions of group 1 were focussed on experiences where the questions of group 2 and 3 focussed more on expectations. Every question was determined to meet the goals of every subpage of the survey. An overview of the questions asked per group with an explanation can be found in the table out of Appendix D. The questions that asked for the ease of use and usability of the Medido were based on the Technology Acceptance Model (TAM) [39]. The TAM has a standard list of questions divided over two categories, namely perceived usefulness and perceived ease of use. The questions have initial scale items for both categories and can be applied to test systems and products. The most important questions out of the TAM regarding to the research question of this report were used in the survey. This came down to a selection of eight statements out of the TAM. Asking every initial scale item out of the TAM would have made the survey too long and would have led to information that was not needed to answer the research question of this report.

3.3 Interview Buurtzorg employees and clients

Both Buurtzorg employees as their clients were interviewed. Only employees and clients who make use of the Medido within Buurtzorg were eligible for an interview. The interviews allowed for a more in-depth analysis in comparison with the online survey.

3.3.1 Participants

The goal of these interviews was to test the effectiveness of the Medido in its current state. The interviews were also used to get insight in the thoughts of employees and clients of Buurtzorg on improvements and new applications for the Medido. Inclusion criteria were that

employee as well as client needed to make use of the Medido at the moment of the interview. This group is interviewed, because their experiences with the Medido allowed for a more in-depth analysis.

3.3.2 Materials and procedure

Teams in the surroundings of Enschede were approached and asked if they wanted to participate in the research. Employees who wanted to participate in the research had informed their clients about the research and asked for their participation. When clients had agreed to cooperate within the research, they have been personally approached by the researcher. The interviews with caregiver and client were held separately from each other and took place at the office of Buurtzorg and at the home of clients. Before the interview started the interviewee was informed about the content and goals of the interview and research via a brochure and oral explanation. As last step the interviewee signed the consent form. During the interviews a semi-structured template was used, and the conversation was recorded in accordance with the interviewee. Pictures of a smartphone, smartwatch and pill bottle have been used during the interviews to explain the ideas for new applications of the Medido. Every interview lasted no longer than 40 minutes in total.

3.3.3 Questions

The questions for the interviews with employees and clients of Buurtzorg have been set up in a semi-structured template. There was overlap in questions between employees and clients, but there were also some differences. An overview of the questions asked per group with an explanation about the reasoning behind the question can be found in the table out of Appendix E.

3.4 Analysing results

Both quantitative and qualitive tools were used to answer the research questions. Quantitative data was gathered via the use of an online survey. The interviews as well as four questions out of the survey consisted of qualitive data. The online survey provided a global view, while the interviews allowed for a more in-depth analysis.

Interview Buurtzorg Medido

The interview was transcribed, and answers given by the interviewee were summarized. The important answers for further research are included in section 4.

Survey

All questions out of the survey were analysed using the analysing tools from google forms and Excel 2016. The survey consisted out of three types of questions, namely statements, multiple choice questions and open questions. The statements in the survey were answered on a 5-

point rating scale. Where 1 was implemented as totally disagree, 2 as disagree, 3 as neutral, 4 as agree and 5 as totally agree. Via this scale a discrete answer was created. The results of every statement were visualized in bar graphs and pie charts, with the percentages shown in numbers. The same applies for the two multiple choice questions. Bar graphs were used to indicate the differences in answers between groups and pie charts to show the difference within groups. The open questions were analysed by using a word cloud. This word cloud was created with the online tool of JasonDavies[4]. Before the word cloud was created, the answers of respondents were summarized in key words. The key words were used as input for the online tool. Out of this input a word cloud was automatically generated.

With this survey a distinction was made between three groups: working with the Medido, familiar and unfamiliar with the Medido. The results were compared within each group to see if there was one line of argumentation, or if there were differences. Next to that a between groups analyse was conducted. With this analysis differences and similarities between groups have been visualized.

Interviews Buurtzorg employees and clients

The interviews with employees and clients of Buurtzorg were analysed equally via a thematic analysis [40]. First, the interviews were transcribed with the help of the sound recording that was made during the interview. After this step the interviews were coded, which meant that terms were linked to the answers of interviewees. These codes were sorted into more general themes and the created themes were reviewed and resigned. Afterwards the final themes were named and described. This description explained the theme and clarified why it was relevant in this research. Five main themes were determined consisting of the subdivided codes for both interviews. With the use of these themes the outcomes of the interviews were described.

Analysing results interviews versus survey

The answers of matching questions out of the interviews and survey were compared with each other. There was looked for similarities and differences between the opinions out of the interviews and survey. Similarity and differences found on the reminding system were highlighted and described. Within chapter 5 the differences and similarities are combined into guidelines for the new designs for the reminder system.

[4] Online word cloud tool by JasonDavies, Retrieved on 11th of May 2018 from https://www.jasondavies.com/wordcloud/

3.5 Ethical Approval

For the interviews that were conducted with employees and clients of Buurtzorg the Ethics Committee of the University of Twente was approached. The committee judged the information brochure, informed consent form and interview checklist. Based on these documents the interviews have been approved by the Ethics Committee of the University of Twente.

4. Results

In this section the results of the interviews and online survey are discussed. In the first section, the results of the interview conducted with the contact person of Buurtzorg are described. Secondly, the results of the online survey are discussed. The third section describes the results out of the interviews with caregivers and clients of Buurtzorg. The last section compares the outcomes out of the online survey and interviews

4.1 Interview Medido Buurtzorg

An interview with the person of Buurtzorg who guide projects such as the Medido is conducted. The goal of the interview was to get insight in the functionality and process of the Medido within Buurtzorg. Some of the predetermined questions could not be answered by the interviewee. These asked for the relation between elderly/employees and the Medido, the usability of the Medido for elderly/employees and the experiences of elderly, informal caregivers and employees with the Medido. These questions were attempted to be answered within the online survey and interviews

The Medido is developed by the company Innospense, Philips bought the licenses of the Medido and brought the developed product 'the Medido' on the market. Buurtzorg was approached by Philips about the existence of the Medido, so no other medicine dispensers were considered. The Medido was used for the first time within Buurtzorg during trials that took place medio 2015. Out of these trials was concluded that the Medido was a valuable addition to the existing services of Buurtzorg. The Medido is not bought by Buurtzorg or its clients, but the device is borrowed from Philips. Buurtzorg strives to more self-reliance for their clients and the Medido is a device that accomplishes this, so this is experienced as a large benefit by Buurtzorg. By increasing the self-reliance costs are reduced, because less visits are needed since clients control their own medication. However, the Medido brought up some disadvantages for Buurtzorg. In March 2018 only 71 clients of Buurtzorg made use of the Medido, so it could be used on a much larger scale. There is no clear explanation for this, maybe they are not familiar with the existence, have lack of time or resources or scared of the technology. Employees of Buurtzorg experienced that not every pharmacy is ready to deliver the right medication packaging for the Medido. The pharmacy must deliver a Baxter role with medication, but it can take up six weeks before they are ready to deliver such a Baxter. This period delays the request of the Medido very much, which led to irritations of employees and clients.

An employee determines if a client meets the medical requirements that allow them to make use of the Medido. Additionally a client needs a WLS or ZVW indication for guiding medication at distance. If the client receives this indication the Medido can be reimbursed via an insurance company, there are no extra costs for the client. When a client has dementia in an advanced stage it could be that he or she would not receive such an indication. Another situation where the Medido cannot be deployed is when a client takes medication where a double check is obligated. This is done by employees via an application for medication were correct a correct dose is essential for vital functions. Another employee checks if the dose and medication is correct and will give approval for administration. Clients with the Medido do not need a double check for their medication, since they manage their own medication and have the right amount already included in the sachets.

If a team starts working with a Medido at least the halve of the team needs to follow an online course about its use. Employees transfer their new knowledge to their clients and can hand out information leaflets additionally. For questions about the Medido employees can contact the Medido helpdesk via phone. The right team receives a signal on their team phone when errors of the Medido occur. It is possible that family members of clients buy the Medido, but in this case the family is responsible and not Buurtzorg. Data about error messages and actions of the Medido are gathered in a database in an online Portal. Buurtzorg and Philips manage this data, but caregivers of Buurtzorg do not have access to it. Out of this data a monthly report is created, which is not shared with clients or their clients. Several problems were experienced by teams that work with the Medido. It occurred that clients forgot their medication even if they were reminded. Another frequent occurring problem were technical issues. For example, the Medido dispenses the sachets wrongly or the Baxter gets stuck in the device. Software problems that have occurred are loss of connection with the Medido device or communication problems between the team telephone and the Medido.

4.2 Online survey Buurtzorg employees

The survey was closed after two and a half week, with 102 responses. One of the responses was incomplete and was filtered out before the results were analysed. This resulted into 101 complete responses. The respondent groups were divided into the following three groups:

1. Employees of Buurtzorg who are familiar with the Medido medicine dispenser and already use it within their work, called group 1 in this section.
2. Employees of Buurtzorg who are familiar with the Medido medicine dispenser, but do not use it within their work, called group 2 in this section.

3. Employees who are not familiar with the Medido medicine dispenser, called group 3 in this section.

These groups might differ fundamentally, because they differ in experiences with clients and experiences with the Medido medicine dispenser. The pie chart out figure 9 shows the group division between the consistent responses. Group 1 consists of 30 respondents, group 2 of 50 respondents and group 3 out of 21 respondents.

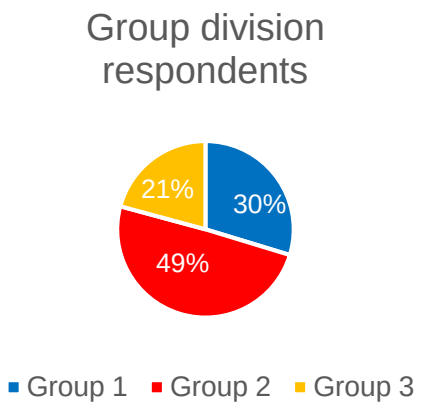

Figure 9: Group division of consistent responses of the online survey

Reasons for (not) deploying the Medido

Group 1 and 2 have been asked why they do (not) make use of the Medido. Mentioned reasons for group 1 can be seen in a word cloud in figure 9 on the left side. The word-cloud for group 2 can be seen in figure 10 on the right sight. The size of the words denotes the frequency of that element as being labelled as reason. The colour and location of the words are random. All reasons were answered as open question.

Figure 10: Left reasons why teams work with the Medido and right Reasons why teams do not work with the Medido (yet) [5]

[5] Created with Wordcloud by JasonDavies. Retrieved on 5th of June 2018 from https://www.jasondavies.com/wordcloud

The Medido is mostly deployed in group 1 to stimulate adherence to medication and self-reliance and to reduce care moments. Group 2 does not deploy the Medido, because of various reasons. The three top reasons are that the team is not well informed about the Medido, that the team does not have appropriate clients for the use of the Medido and lack of time and resources within the team.

Experienced and expected functionality of the Medido

In the second section of the online survey there were questions that asked for the experiences and expectations on the Medido regarding the care that it gives, see figure 11 till 19. Figure 11 shows the experienced difficulties for clients who do not work with the Medido for group 2 and 3. There are significant differences within the groups on the neutral and agree option. Group 2 is divided with a slight difference between those two opinions, while the percentage of group 3 lays higher for neutral (52%) than agree (24%).

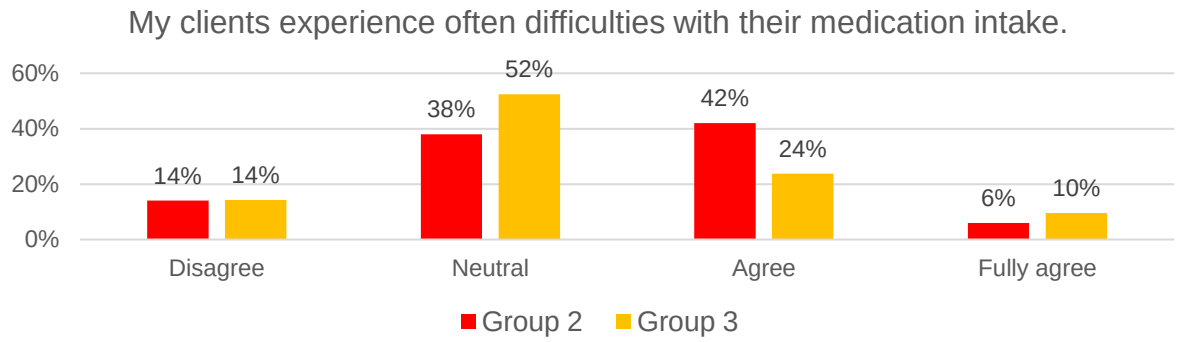

Figure 11: Experienced difficulties during medication intake for clients

Within the rest of the questions of section 2 group 1 is asked for their experience, while group 2 and 3 are asked for their expectations on the Medido. The effect of adherence to the Medido is asked and can be seen in figure 12. No respondent out of group 1 disagreed, where small percentages of group 2 and 3 did so. There are no large differences between group 2 and 3 in answering this question, a slight larger percentage out of group 2 agreed or fully agreed with the statement. Fifty percent out of group 1 fully agreed with the statement, which is way more

than group 2 (16%) and 3 (5%). In contrast to this group 1 scores lower (43%) on agreeing than group 2(46%) and 3 (57%).

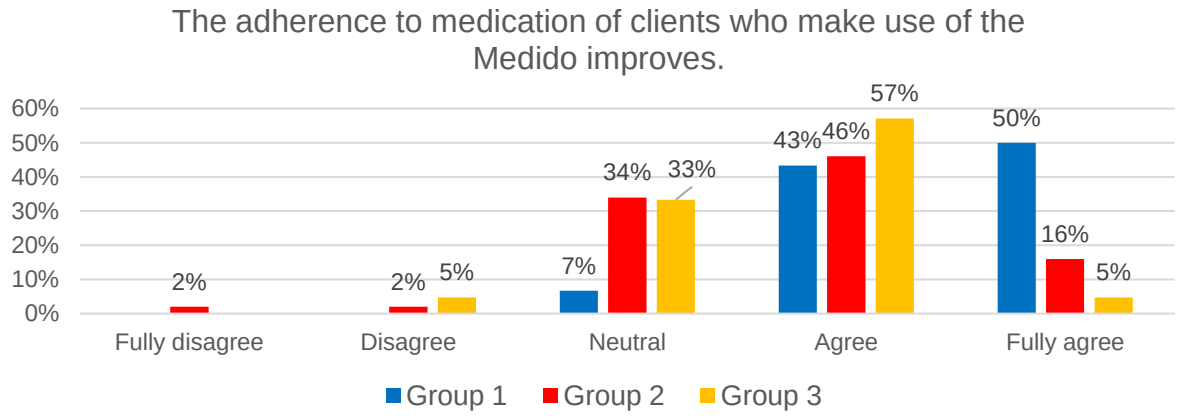

Figure 12: Experienced and expected effect of the Medido on adherence

Group 1 and 2 do not deviate much from each other when it comes to the effect of the Medido on self-reliance of clients, see figure 13. Respectively 58% and 57% agreed and 22% and 24% fully agreed on that the Medido improves the self-reliance of clients. Group 1 deviates strongly from group 2 and 3, 33% out of this group agreed and 60% fully agreed with an improved self-reliance with the use of the Medido.

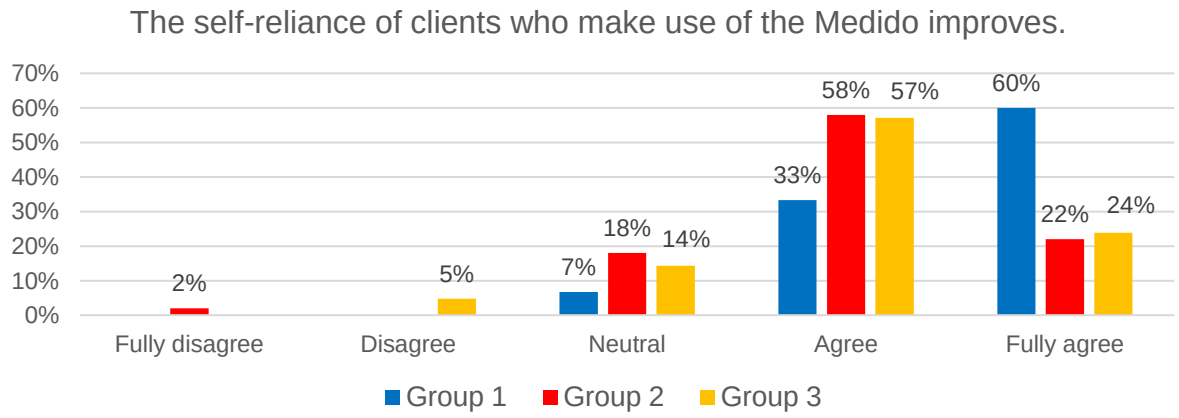

Figure 13: Experienced and expected effect of the Medido on self-reliance

On the statement if the Medido improves the quality of the given care group 2 and 3 score high on neutral (44% and 48%), see figure 14. Small percentages out of these groups (fully) disagree with the statement. Out of group 1 and 2, respectively 30% and 38% agrees with the statement and 22% and 5 % fully agrees. The answers of respondent group 1 are divided over neutral (27%), agreeing (23%) and fully agreeing (50%).

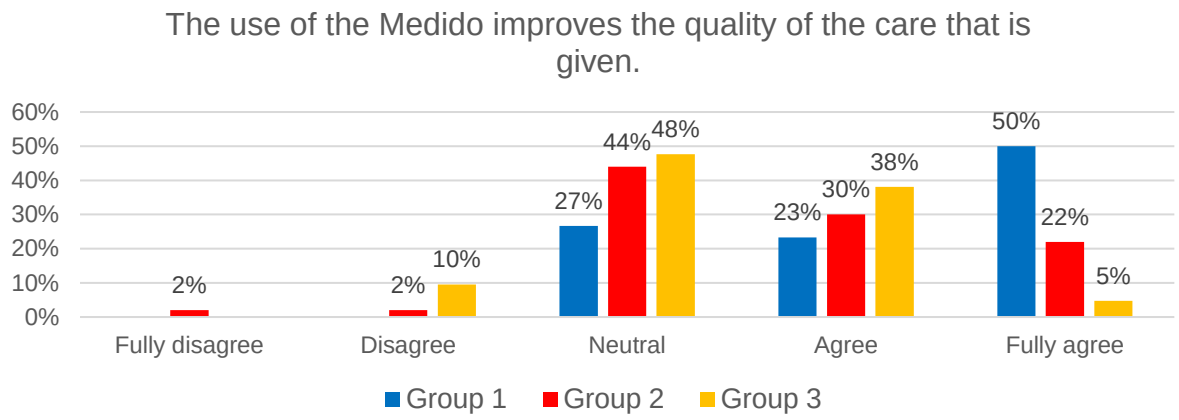

Figure 14: Experienced and expected effect of the Medido on quality of care

The Medido is experienced/expected as a useful system, see figure 15. Only 1 respondent out of group 2 disagreed with that. Out of group 1 60% fully agreed with the usefulness of the Medido, where 34% out of group 2 and 24% out of group 1 had the same opinion. Despite that group 1 and 2 scored less on fully agree, they scored higher on agreeing with the statement, namely 54 and 57% in comparison to 33% of group 1.

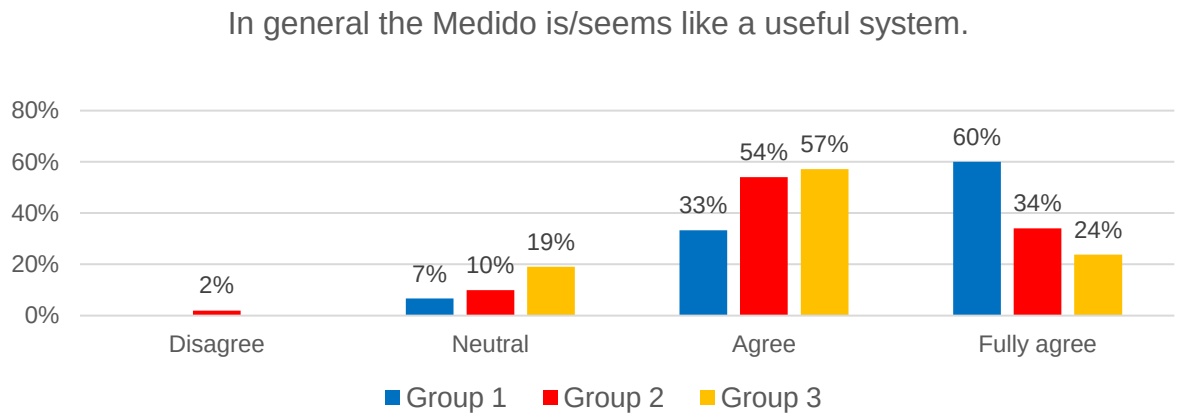

Figure 15: Experienced and expected usability of the Medido

The largest percentages of every group agreed that the Medido is an easy to use device, namely around 50% for every group, see figure 16. In comparison to group 2 and 3 (24% and 14%), a larger part of group 1 fully agreed (37%). Only 1 respondent out of group 2 fully disagreed and 2 respondents out group 3 disagreed.

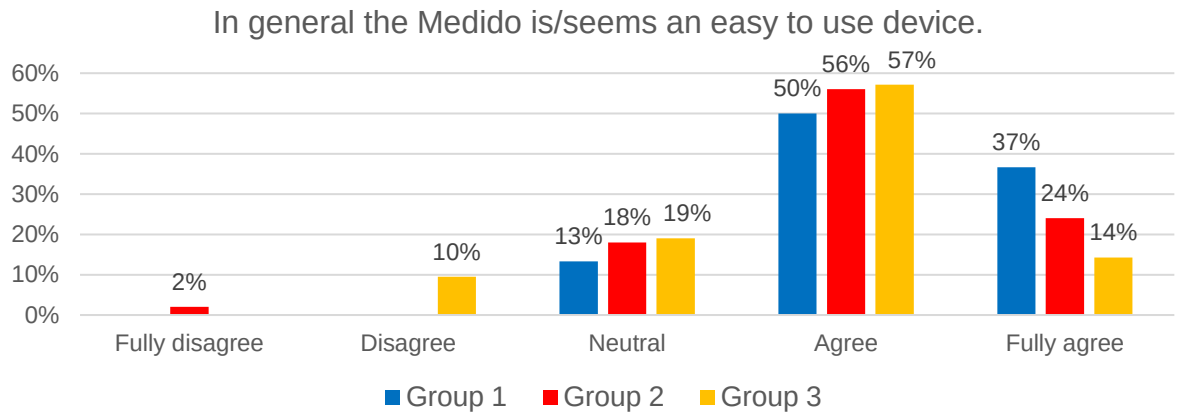

Figure 16: Experienced and expected ease of use of the Medido

All the three groups scored approximately the same percentages on agreeing that the audio reminder of the Medido is efficient, see figure 17. Group 1 scored higher on fully agreeing than group 1 and 2, but lower on the option neutral.

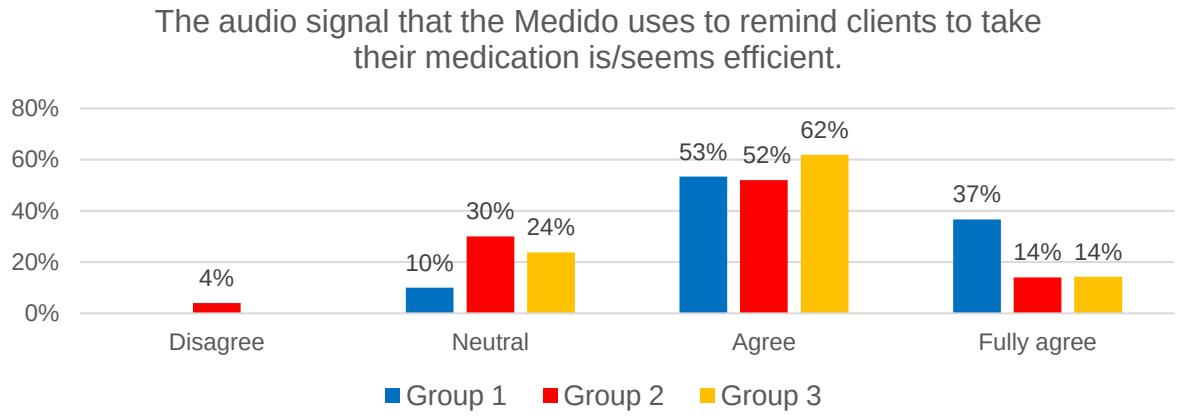

Figure 17: Experienced and expected efficiency of audio signal of the Medido

Group 2 and 3 was asked how important it is that the Medido supports its users during the medication intake, see figure 18. Group 1 was asked to what extent the Medido already supports its clients with their medication intake. Both outcomes can be seen in figure 18. Although it is important according to group 2 and 3 to support clients with their medication intake 77% out of group 1 (fully) agreed that the Medido supports their clients well enough.

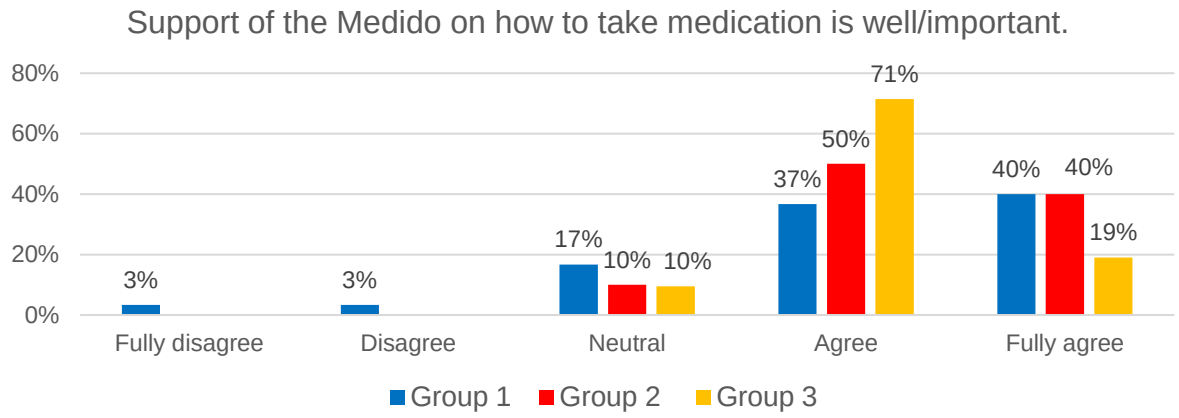

Figure 18: Experienced support and expected importance of support during medication intake

Group 1 and 2 was asked if they were willing to use the Medido in the future as can be seen in figure 19. Both groups did not differ in percentages on disagreeing, but did differ on the other opinions. Half of the respondents (50%) out of group 2 fully agreed, 36% agreed and 8% was neutral. From group 3 14% fully agreed, 52% agreed and 29% was neutral.

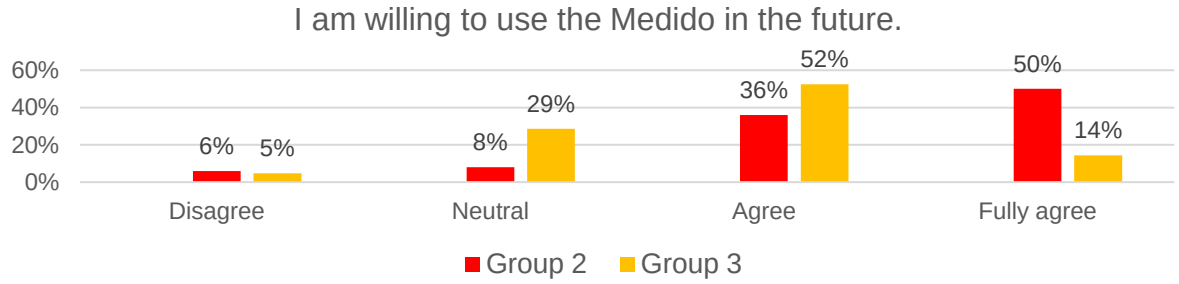

Figure 19: Opinion on use of the Medido in the future of group 1 and 2

Advantages and disadvantages of the Medido

Every respondent group was asked for their experienced or perceived advantages and disadvantages with the Medido. The answers are shown in separate word clouds for advantages (left) and disadvantages (right), see figure 20 till 23. Figure 20 belongs to group 1, figure 21 to group 2 and figure 22 to group 3. The size of the words denotes the frequency of that element as being labelled as (dis)advantage. The colour and location of the words are random. All reasons were answered as open question.

The main advantages why the Medido can be useful are equally for every respondent group. Main advantages are: self-reliance, adherence to medication, less care moments necessary and decrease in costs. For every group the different elements of disadvantages are larger than

the listed advantages. In contrast to the listed advantages the listed disadvantages differ more per group.

Figure 20: Left advantages and right disadvantages of the Medido for respondent group 1 [6]

Figure 21: Left advantages and right disadvantages of the Medido for respondent group 2 [7]

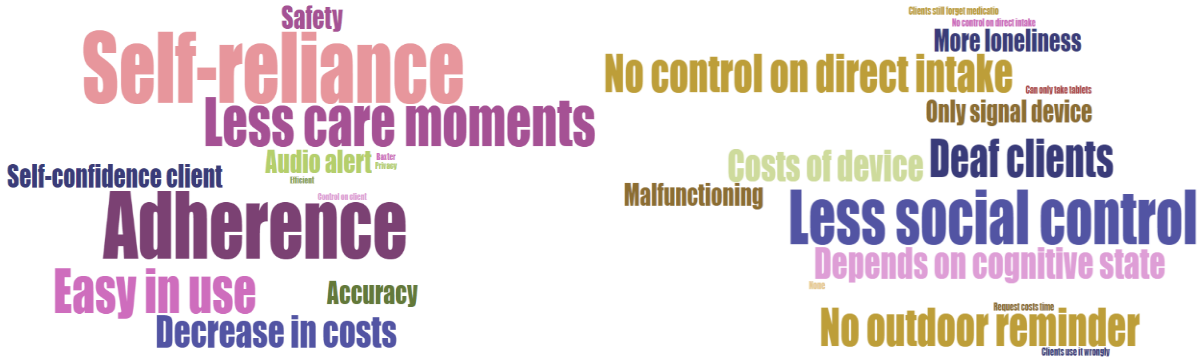

Figure 22: Left advantages and right disadvantages of the Medido for respondent group 3 [8]

[6] Created with Wordcloud by JasonDavies. Retrieved on 5th of June 2018 from https://www.jasondavies.com/wordcloud

[7] Created with Wordcloud by JasonDavies. Retrieved on 5th of June 2018 from https://www.jasondavies.com/wordcloud

[8] Created with Wordcloud by JasonDavies. Retrieved on 5th of June 2018 from https://www.jasondavies.com/wordcloud

New ways of reminding

Different ideas on how a reminder could function differently than the current audio signal in the Medido were asked. Gamification was one of these new ideas, the question asked if gamification would improve the adherence to medication for elderly as can be seen in figure 23. The largest part of the respondents reacted neutral. The percentages of every group choosing disagreeing were significantly higher than the percentages agreeing.

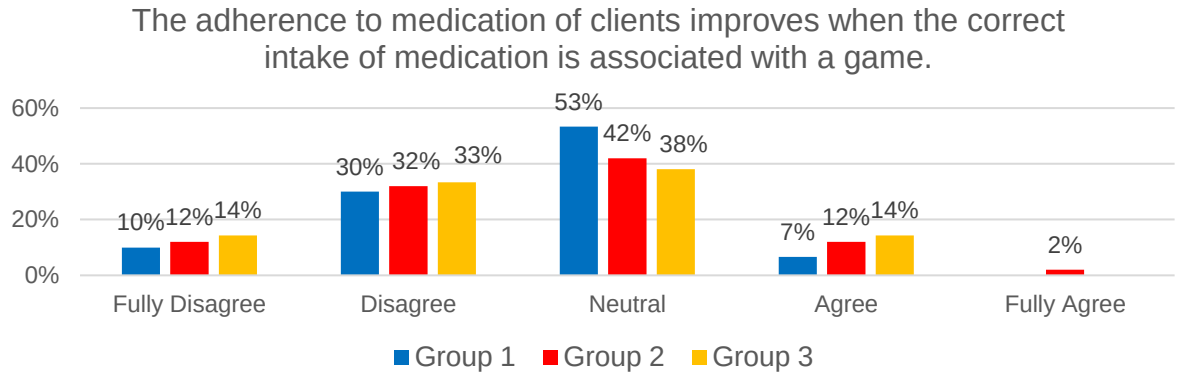

Figure 23: Opinion on gamification of medication intake

Another idea that was asked was if a personal reminder would improve the adherence to medication in comparison with a neutral reminder, see figure 24. The largest percentages from every group agreed with the statement (group 1: 57%, group 2: 56% and group 3: 62%). Small percentages of group 1 (3%) and 3 (5%) in comparison with a larger percentage of group 2 (20%). The percentages that have chosen for fully agree and disagree are very small. Out of group 3 5% fully disagreed and 3% out of group 1 and 2% out of group 2 disagreed.

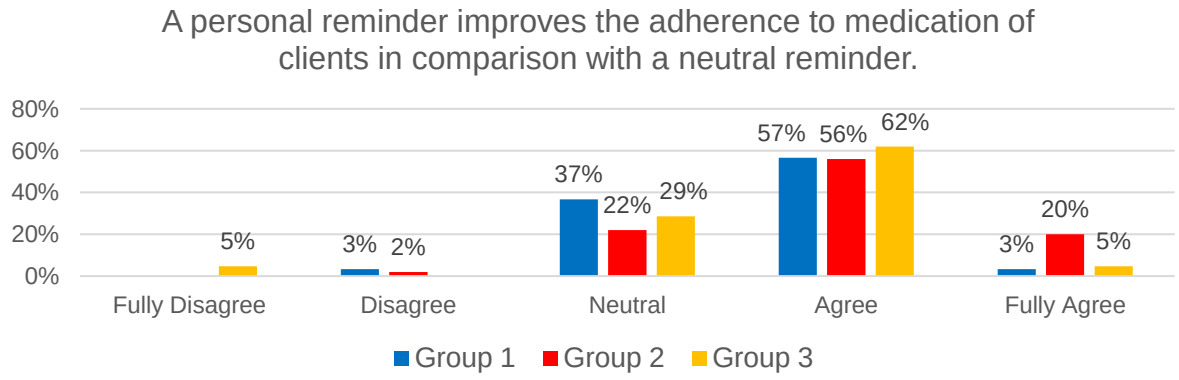

Figure 24: Opinion on a personal reminder in comparison with a neutral reminder

Another statement asked if the adherence to medication would improve if extra information on how medication should be taken was given. The results of this statement are displayed in figure 25. Equal percentages of every respondent group fully agreed and fully disagreed, namely

around 24% and 5%. A significant larger percentage of group 2 (56%) agreed than group 1 (33%) and 2 (43%). In contrast group 2 (16%) scored significantly lower on neutral than group 1 (37%) and 3 (29%).

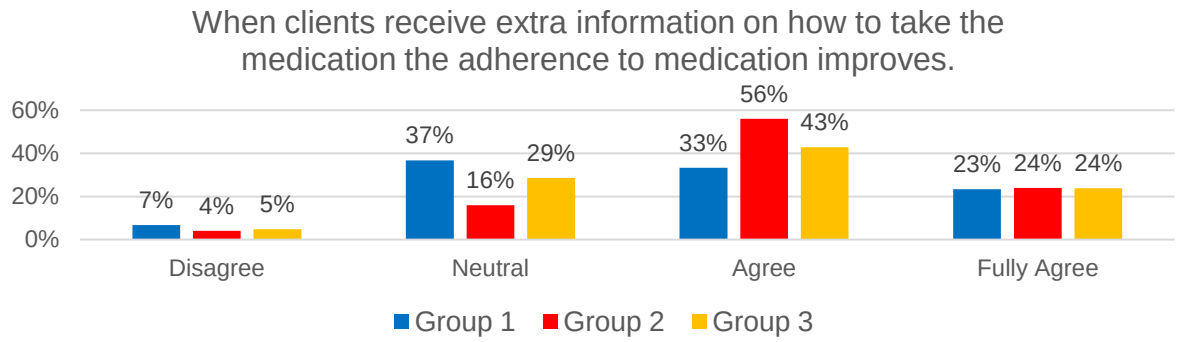

Figure 25: Opinion on receiving extra information on how to take medication

The current reminder of the Medido is an audio signal. Every respondent group was asked if a visual reminder, that made use of light, is a suited reminder. No significant differences were seen in fully agreeing between the three respondent groups, see figure 26. Group 3 (67%) scored higher on agreeing than group 1 (40%) and 2 (48%). The order is the other way around for the neutral opinion, group 1 scored the highest percentage (43%), group 2 (32%) and the smallest percentages was of group 3 (14%).

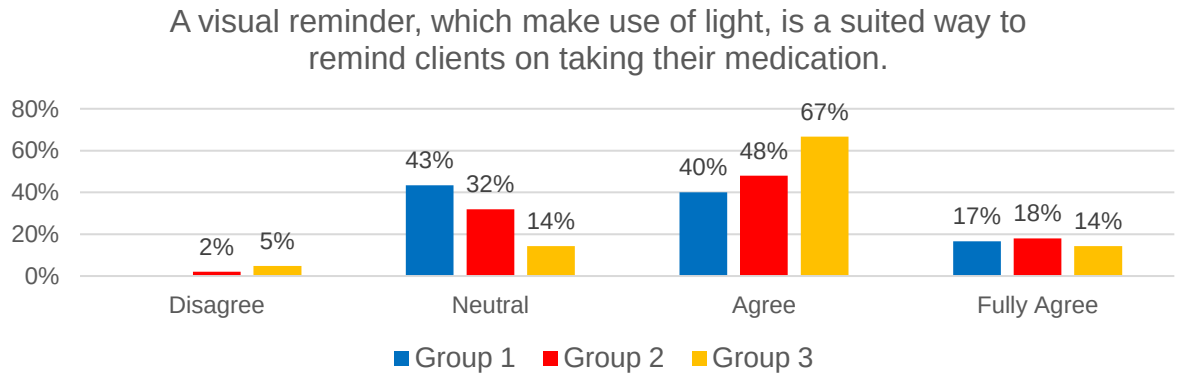

Figure 26: Opinion on a visual reminder for medication

The respondents were also asked for their opinion on a vibrating signal as reminder as can be seen in figure 27. There were no significant large differences between group 1 and 2 except on disagreeing (group 1: 20% and group 2: 2%). Group 3 differs significantly from group 1 and 2, the group scores lower on neutral and higher on agreeing.

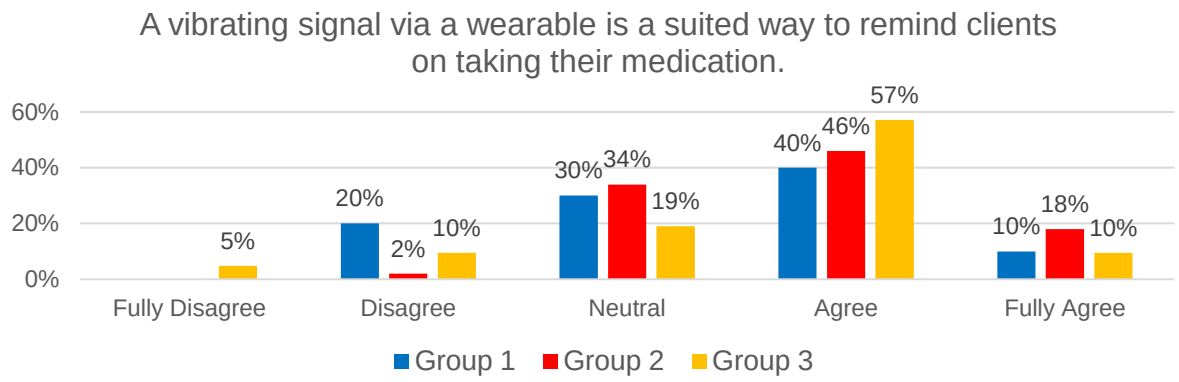

Figure 27: Opinion on a vibrating signal as reminder for medication

Technology mediums for reminding

Ideas on what type of technology mediums could be used for reminding outdoors were asked to the respondent groups. Three different types were asked, namely a smart pill bottle, a smartwatch and a smartphone. The results can be seen in figure 28 till 30. The smart pill bottle scored the best out of the three mediums on fully agreeing and agreeing for every respondent group. The smartwatch scored secondly and a smartphone as medium scored last.

There were no significant differences between group 1 and 2 and two when it comes down to the smart pill bottle. Around 26% fully agreed, 50% agreed, 19% had a neutral opinion and 7% disagreed. Group 3 differed significantly on fully agreeing (10%) and the neutral opinion (33%).

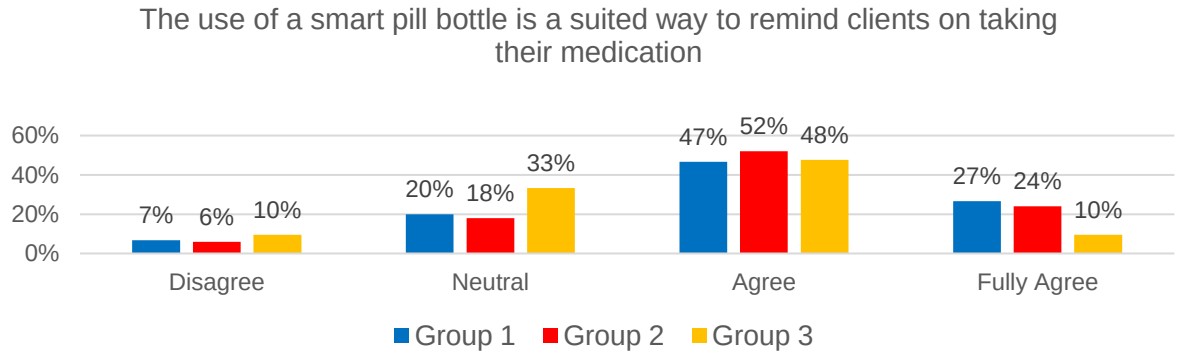

Figure 28: Opinion on using a smart pill bottle as technology medium for reminding on medication

Group 2 scored higher on fully agreeing and lower on the neutral opinion than group 1 and 2 for a smartwatch as suited reminder, as can be seen in figure 28. Within the rest of the answers there were no significant differences.

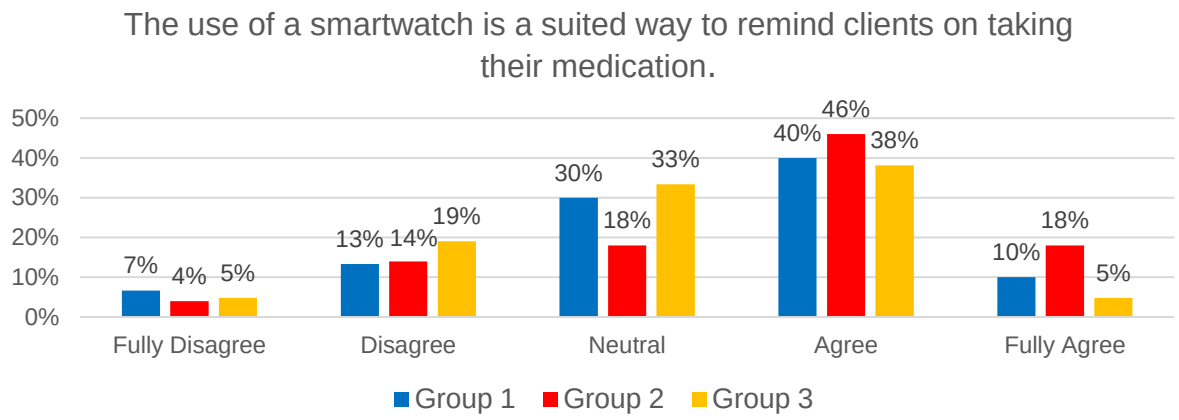

Figure 29: A smartwatch as technology medium for reminding on medication

For a smartphone as suited reminder group 3 scored higher on agreeing (48%) than group 1 (27%) and group 2 (30%), see figure 29. Only group 1 and 2 scored a percentage on fully agreeing, respectively 17 and 14%. A part of every respondent group disagreed with finding a smartphone a suited technology medium (group 1: 30%, group 2 and 3: 24%).

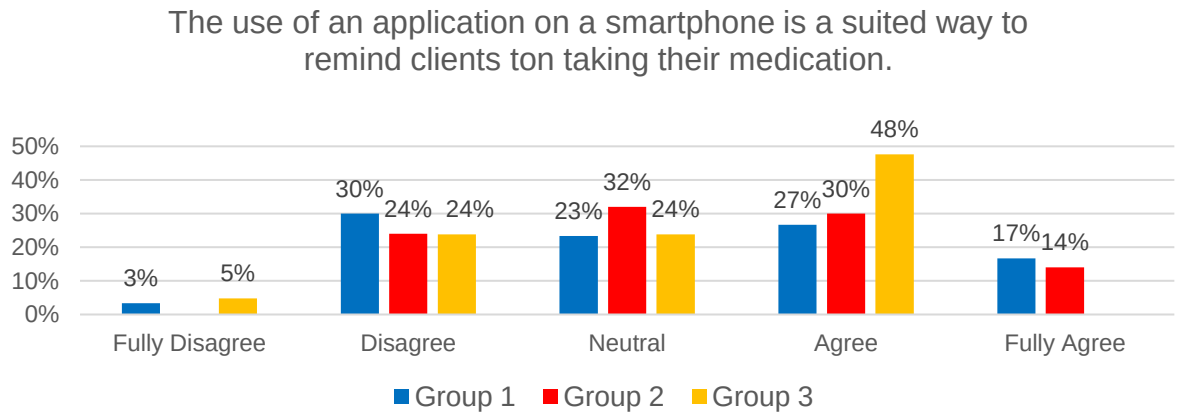

Figure 30: A mobile phone as technology medium for reminding on medication

Every respondent group was asked if their clients made use of a mobile phone and what type of mobile phone is used, as can be seen in figure 31. Only 25% of the clients making use of a mobile phone possess a smartphone and 51% a mobile phone. Of all respondents 35% answered that 25 till 50 percent of their clients make use of a mobile phone. Another 35% said that less than 25% of their clients made use of a mobile phone. The option 50 till 75% of my clients make use of a mobile phone had scored 15%. Eight percent does not know if their clients make use of a mobile phone and 4% stated that none of their clients use a mobile phone.

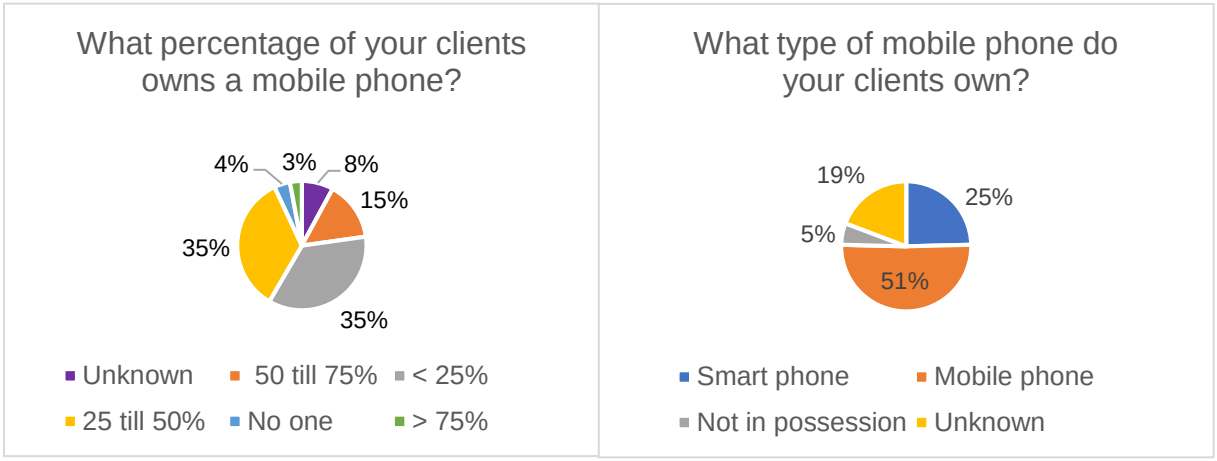

Figure 31: What percentage of clients make use of a mobile phone and what type for every respondent group

4.3 Interview Buurtzorg employees and clients

The interviews were conducted with 3 Buurtzorg employees and 3 clients. All participants finished the interview, so no selection was required because of uncomplete responses. All the participants fulfilled the inclusion criteria, namely employees and clients who make use of the Medido within Buurtzorg.

4.3.1 Interview with clients of Buurtzorg

Three different clients that make use of the Medido have been interviewed. Client 1 was a man with cognitive problems and with the disease of Parkinson. Client 2 was a woman who had just been diagnosed with dementia, she was in a starting stage of the disease. The last client, client 3, was a man with a background in depression. Client 1 lived at home with his wife and the other two both lived in an apartment on their own.

Out of the analysis of the transcribed interviews, 5 main themes were determined, namely (1) effects of the Medido, (2) use of the Medido, (3) current reminder, (4) redesign current reminder and (5) reminder outdoors. Every theme is divided into several subthemes that explain the theme together, for the subthemes see table 2.

Table 2: Main themes with their subthemes out of interviews with Buurtzorg clients

Effects of the Medido	**Use of the Medido**	**Current reminder**	**Redesign current reminder**	**Reminder outdoors**
Medication before Medido	Health condition	Annoyance	Other reminders	Outdoor reminding without Medido
Adherence	Support	Missing reminder	Presenting reminders	Mobile
Acceptance	Problems	Alert for separate medication		Wearable
Care moments/privacy	Usability device			Pill bottle
Self-reliance	Dependency			Desires
	Taking medication			

Effects of Medido

Every respondent easily adapted to using the Medido within their home. Two of them had some doubts on beforehand, but after explanations of their caregivers, they gave the Medido a chance. Client 3 said *"it is a monitoring device, which annoys me, but if you can prevent something from happening you must do it"*. Client 1 had received the Medido from the UMC and needed an organisation to reimburse the use of the Medido. All three clients arranged their medication by themselves before they used the Medido. They all agreed that they kept their self-reliance by using Medido, because the intake process did still lay in their own hands. The adherence to medication drastically improved for all respondents. For two clients a big advantage of the Medido was that they received less care moments, which meant more privacy, because less caregivers visit during the day. Before the Medido was used by the clients, two of them expanded their medication on their own. This meant that they sorted their medication for two weeks. This was a daily task for the wife of client 1 and client 2 did this for herself. Client 3 already received his medication in a Baxter role by the pharmacy before the Medido was introduced to him by Buurtzorg. Although client 2 prepared the medication by herself, she still forgot of her dementia. The Medido took a lot of work over from the wife of

client 1, he is now reminded by the Medido and the pharmacy sorts the medication in a right way. Before the Medido was used by client 1 his wife accompanied the medication intake process every day.

Use of Medido

Every client must take their medication directly after they took it out of the Medido. The Medido does not give a reminder after that the medication is dispensed, so if clients put the medication aside, the chance that medication is forgotten increases. Client 2 mentioned: *"if I do not take my medication directly after the alert, I will forget to take it. Even if Buurtzorg asks me I will say that I took it, because I do not know about it anymore"*. Client 3 mentioned that he was only satisfied with the Medido if the device worked properly. During the first weeks of use sachets were dispensed in an incorrect way. Other clients named problems occurring with the last sachet of the Baxter role or with the cutting mechanism. Another problem that occurred was that all actions needed to be arranged with the helpdesk of the Medido. Two of the clients rather saw that their caregivers were able to change the setting of the Medido.

The usability of the device scored high for all clients. For the client with dementia it was hard to interact with the Medido if the behaviour of the device was different than normally. This client sketched one situation where she missed the reminder. In such a situation the user needs to click on the OK button for five seconds to dispense the medication. She forgot about this necessary action and was not able to dispense the medication. Two of the clients did not stay home for the Medido, but one tried to be at home when the alert of the Medido was close by.

Current reminder

Client 2 and 3 had both medication outside of the Baxter role, namely an inhaler. Client 3 takes this medication on the same time as the alert of the Medido. For client 2 there is a separate alert set for the inhaler. Client 2 also mentioned that she had one kind of medication besides the Baxter role, because the pharmacy did not add this to the Baxter. As a reminding tool she used an agenda where she notated a cross if this medication outside the Baxter was taken. In this way, Buurtzorg was also able to check whether the medication was taken.

The Medido stood on a fixed place in the home of the clients, what led to that the alert was not noticed in every place of the house. Client 2 and 3 said that they could not hear the reminder if they were in the bedroom, for client 1 this occurred when he was sitting in the garden. This led to unnecessary visits of Buurtzorg, because clients did not react on the alert in time. Furthermore, two clients had a hearing aid and the alert is set to a louder volume, so they were able to hear it. The audio alert was experienced as annoying for two clients, but because of that they reacted directly on the alert.

Redesign current reminder

Client 3 suggested a lamp or music in the bedroom to function as reminder, so the alert of the Medido would not be missed anymore. This was also suggested to client 2, she agreed that it could be a solution, but did not find urgently to change. It was not experienced urgently, because she did not missed a reminder very often when she was in another room of her apartment. The first client did not want any change in the way that the reminder was presented. A personal reminder was only received positive for client 2: *"It can help me in understanding it and getting familiar with the device"*. None of the interviewees were enthusiastic about reminding in combination with a game. Alongside gamification, extra support on how to take medication was determined as unnecessary by every client. They all mentioned that the explanation of the pharmacy and Buurtzorg employees was enough to take their medication correctly.

Reminder outdoors

Every client had different experiences with taking medication outdoors. The first client went to day-care during 5 days of the week. The medication for the afternoon was dispensed on beforehand and put into a small pill bottle without reminder. His wife often noticed that medication was not taken at the day-care, because her man is used to the audio alert of the Medido. The second client took medication out on beforehand when she left the house, it was hard for her to take the medication on the right time during trips. For longer trips, such as a holiday she only used the Baxter role without any reminder besides it. The third client claimed that he did not need an outdoor reminder, because he was very little away from home due to having little social contact.

All clients were in possession of a mobile phone, where the phone of client 1 was a smartphone. Both clients did not use their phone frequently, but only for emergencies. The third client did not even possessed a mobile phone. Every client was asked about the use of a pill bottle, (smart) phone or wearable as outdoor reminder and ordered them where choice 1 is the most preferred technology medium, see table 3. The reason for setting a pill bottle as choice 1 was that clients were already familiar with it and there was no difficult technology visible. The positive thing about a wearable and mobile phone were that such devices were always close to yourself but were harder to operate. Two clients indicated that they did not wanted a very notable device as outdoor reminder.

Table 3: Preferences of technology mediums of clients

	Choice 1	Choice 2	Choice 3
Client 1	Pill bottle	Smartphone	Wearable
Client 2	Pill bottle	Wearable	Phone
Client 3	Pill bottle	Wearable	Phone

4.3.2 Interview with Buurtzorg employees

Three different employees of Buurtzorg that make use of the Medido have been interviewed. Employee 1 till 3 are respectively the caregivers of the client's 1 till 3 out of the section before. Employee 1 and 2 had both two clients who made use of the Medido, of their clients only 1 is interviewed. Out of the analysis of the transcribed interviews with employees 5 main themes were determined, namely (1) reasoning behind the Medido, (2) effects of the Medido, (3) problems with the Medido, (4) Medido evaluation, and (5) reminder modifications. Every theme is divided into several subthemes that explain the theme together, for the subthemes see table 4.

Table 4: Main themes with their subthemes out of interviews with Buurtzorg employees

Reasoning behind the Medido	**Effects of the Medido**	**Problems with the Medido**	**Medido evaluation**	**Reminder modifications**
First contact with Medido	Self-reliance	Request	No control	Relevance modifications
When use the Medido for clients?	Adherence	Malfunctioning	Support on medication intake	Presenting reminders
Acceptance	Care moments	Helpdesk	Missing reminder	Mediums
	Quality of care		Efficiency audio reminder	Desires
	Dependency			

Reasoning behind the Medido

The first contact with the Medido differed per employee. Employee 1 was called by a family member from one of her clients. This family member asked if Buurtzorg could help with the reimbursement of the Medido medicine dispenser. The team only knew of its existence, so the employee dived into the Medido and requested the device for the client. Employee 2 saw the Medido for the first time during a Buurtzorg congress two years ago. She was very interested in the device, because she had multiple clients that suited the services of the Medido. One year ago her team was able to deploy the Medido and they directly used it for three of their clients. The third employee encountered the Medido via the Buurtzorgweb. She saw a message about the Medido and started the online course about the device via Buurtzorg. It

took a while before she started to work with the Medido, because there were no clients who were suited for its use. All employees deployed the Medido for clients who tended to forget their medication but were still able to manage the medication on their own.

The first and third employee said that they would not deploy the Medido for clients with dementia. However, employee 2 used the Medido for a client with dementia and it worked well. What made it work was that they started with the Medido in an early stage of the disease. Starting with the Medido in a later stage of dementia would not help the client to take the right medication, because they would forget how to work with the Medido. Employee 3 used a Medido at a client, whose fine motor skills were deteriorated. After a while the client needed help to take the medication out of the sachet and taking the medication in, at that time they stopped the Medido. For all other situations where medication is forgotten every employee would deploy the Medido.

Effects of the Medido

An increasement in self-reliance for clients was named by every employee as large benefit of the Medido. Employee 3 said: *"Buurtzorg strives to self-reliance of their clients and the Medido made this possible".* This increased self-reliance led to less care moments for the clients of all interviewed employees. For employee 1 and 3 the number of visits were reduced from once a day to once per two weeks. This moment was used to change the Baxter role and check upon the clients' health state. The second and first employee called their clients every day to remind them on taking their medication, but with the Medido this was not necessary anymore. The thoughts on if the quality of care improved with the use of the Medido differed per employee. The third employee agreed that the quality of care improved. Her client was used to stay in bed during the mornings, but the Medido works as a stimulant to go out of bed and take the medication on time. The opinion of employee 1 was different*: "The Medido does not improve the quality of the care, but it is a replacement of the care that we gave before".*

Before the Medido was used by clients they experienced several problems with their medication intake. According to the employees the most occurring problems were: missing a dose, incorrect intake of medication on incorrect times or taking too many doses at the same time. Every employee noticed that the adherence to medication for their clients improved with the use of the Medido. Two of the employees said that their clients would stay home for the reminder of the Medido, employee 2 did not agree with that. Her clients would not stay home for the reminder.

Problems with the Medido

Different problems with the Medido have occurred before and during its use. Every employee experienced that it the request of the Medido took too long. In every case this was caused by the pharmacy, since they were not ready to deliver the Baxter role. During the use of the Medido one main error was experienced by all employees, namely correctly placing the Baxter role inside the Medido. This was explained by employee 2: *"placing the Baxter role is a precise task, it asks for some practice to do it right. In the beginning we received a lot of notifications from the Medido caused by misplacing the role"*.

If employees wanted to change settings for the Medido they needed to contact the Medido helpdesk. All employees mentioned that the contact with the Medido helpdesk went easily and that changes were made directly after the call. Disadvantages experienced on the helpdesk were that they were not always reachable. Employee 2 experienced such a situation: *"There was once a situation a client went to the hospital as a matter of urgency and the Medido helpdesk was not reachable. This caused unnecessary consultation between a colleague of my and the Helpdesk, which could have been prevented if one of us was authorized"*.

Medido evaluation

All employees were unsure whether the medication was actually taken by clients. *"Before the Medido was used, we were there when a client took his or her medication, so we were sure that it was taken"*, according to employee 3. Employees must trust on the client that he or she takes the medication when dispensed from the Medido. All employees experienced that reminders were missed and medication was not dispensed on the right time. Missing a reminder could be caused by clients still sleeping, not hearing the reminder or not being at home. When a reminder is missed, employees receive a message on their phone. The follow-up action is to call the client and if no response is received they will visit the clients home. However, the audio reminder was experienced as efficient by every employee. Every employee had clients with hearing impairments and they all still heard the audio signal. Employee 1 thought that a personal reminder would be more effective than a neutral reminder: *"I think that they would accept the technology earlier if the reminder is personally"*. The other two employees disagreed, because clients contact them if a problem would occur.

The Medido in its current state does not give any support on medication intake for its clients. Employees concluded that it could be useful if the Medido explained how to take medication. However, it is unnecessary to explain it every time that medication is dispensed. Clients often know how to take their medication, because it was explained by the pharmacy or by themselves. Besides clients receive package leaflets of their medication, so they can check it

if they are unsure. In the end all employees concluded that it could be useful for new medicines, but other explanations are often clear enough.

Reminder outdoors

An outdoor reminder was experienced as useful by every interviewed employee. Employee 3 mentioned the following: *"a reminder outdoors is especially useful for people who often go outdoors and still have an active life"*. According to employee 1 clients were so used to the audio reminder, that they forgot their medication if they did not receive the audio signal. A SMS via a mobile phone was experienced as a useful medium to present this reminder, but not every client of the interviewed employees possessed one. It was agreed for all the employees that the safest way to use a reminder, is to use a system where elderly are already familiar with. The pill bottle was then chosen as best option, because its use is easy and the technology would not be hard to understand. For such a pill bottle the employees preferred a vibration or audio signal, because these signals were easier to notice than a light signal. A wearable was seen as worst option, because elderly are often unfamiliar with this type of technology. The employees were unsure if gamification would increase the adherence to medication. Employee 2 said: *"maybe it could work for some clients, but I think that most of the do not want that their medication intake is linked to a game"*.

4.4 Comparison online survey and interviews

There were no large differences between the outcomes on the perceived ease of use and usefulness out of the Technology Acceptance Model [39]. Two disadvantages named in the survey by group 1 were not mentioned by during the interviews, namely that the Medido decreased the self-confidence of clients and that they used the device wrongly. In both the survey as well as the interviews employees disagreed or were neutral on applying gamification to medication intake. Employees were more positive about personal reminding and extra support on intake than they were during interviews. In both research methods employees agreed that the best outdoor reminder was a smart pill bottle and mobile phones scored the lowest on average.

5. Ideation

5.1 Current reminder system

The current reminder system of the Medido was experienced as efficient. The audio signal was loud and could even be heard by elderly who had a hearing impairment if they were close to the device. Since the audio signal was experienced as efficient it will not be replaced by another reminding technique or approach. However, there was one drawback experienced: the audio signal was not noticeable in every room of the house by some users. The Medido is often placed in the kitchen or living room and the signal is not heard in places such as the bedroom or garden. This problem is also experienced in another context, namely by the use of doorbells. People with hearing impairments are not able to hear the doorbell in every room of their house. As a solution to this noise amplifiers exist. These devices amplify the noise of a doorbell in rooms where the sound is not noticeable. This principle can also be applied to amplify the audio signal of the Medido. A noise amplifier can be coupled to the Medido and placed in rooms where the reminder cannot be heard. Via these amplifiers users will never miss a reminder in their home again.

An example of such an amplifier can be seen in figure 31. This example costs 59 euros is wireless and must be placed into a wall socket. A doorbell or phone can be connected to it and the device will notice it going off via a noise detector. In this case the sound of the Medido can be coupled as well. There can be chosen to advice Medido users to buy such an amplifier or to deliver it together with the Medido if necessary. Philips can then choose to develop an amplifier on their own or to start cooperation with another party. The advantage of cooperation with another party is that there is no development necessary within Philips, since there already exists many of these types of amplifiers.

Figure 32: Wireless noise amplifier for doorbells [9]

[9] Noise amplifier for doorbells and phones, Retrieved from https://www.bol.com/nl/p/m-e-fg-12-draadloze-deurbel-versterker-set-telefoonbel-versterker-41017/9200000087555269/

5.2 Outdoor reminder system

The design outdoor reminder will be a smart pill bottle that users can take with them when they go outdoors, because this idea was preferred best by the caregivers and clients of Buurtzorg. The data that was gathered from the survey and interviews was processed to create insights about the user requirements for outdoor reminding. Those insights were used to determine a set of 10 guidelines that need to be considered when designing an outdoor reminder. Those 10 guidelines are summarised below.

The design of an outdoor reminder must:

1. Fit medication for a maximum period of 24 hours.
2. Distinguish medication from different moments in an obvious way for its users.
3. Have such a size so that it is easy to take outdoors.
4. Be reliable in communication with the Medido device.
5. Have a reliable battery.
6. Give a clear signal as reminder.
7. Be accessible when malfunctioning of the device occurs.
8. Be easy to use by people with loss of fine motor skills.
9. Notice if medication is taken by the user.
10. Contact caregivers if medication is not taken on the right time.

5.2.1 Proposed design outdoor reminder system

The proposed design of the outdoor reminder was created with the help of the determined guidelines and can be seen in figure 32. The design of the pill bottle was created in SolidWorks 2017.

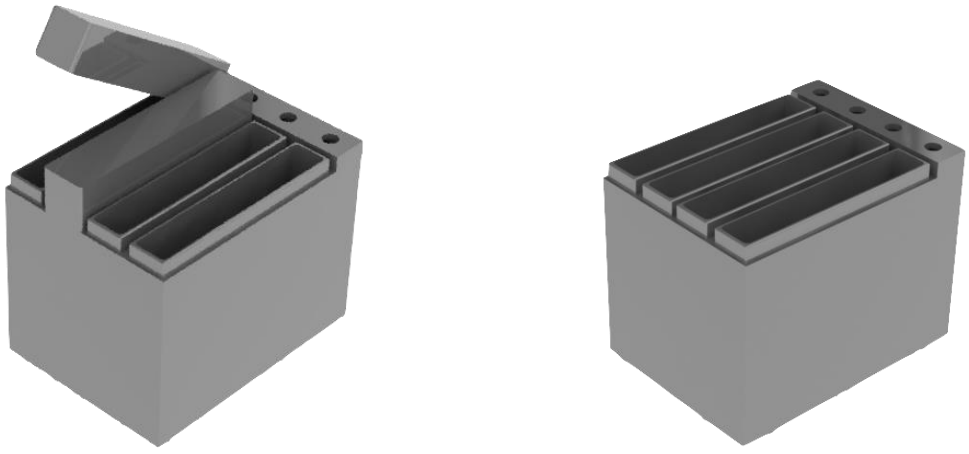

Figure 33: Proposed design of the pill bottle with a base module (left) and three submodules.

The design consists out of several modules. Each module corresponds to one medication moment, so one sachet. In figure 32 four modules can be seen, the module on the left side is the base module. Every pill bottle consists out of a base module and depending on the number of dispensed sachets modules can be clicked on. The number of submodules that can be attached is unlimited. Users can place the sachet inside one module of the bottle if they dispense medication in advance. The sachets can be placed inside the modules on order of dispensing from left to the right, so the first dispensed sachet can be placed inside the base module. The main module will recognize if a submodule is clicked on and powers it. In this way the size of the outdoor reminder can be adjusted to the medication moments that a user has. One module has the following dimensions in centimetres: width 1.7, length 8.2, height with lid 8.3 and height without lid 6.5. The length of module is split up in two parts, one is meant for the sachet and there is 1.3 centimetre reserved for the hardware of the device.

The reminder signal of the pill bottle consists out of three different signals, namely a visual, audio and vibration signal. The noise level of the audio signal can be adjusted by the user, because an audio signal could be disturbing in outdoor situations. However, the vibrating and visual signal cannot be put off, so there is always a reminder present. The visual signal is a light emitting diode (LED) that is located next to the lid of every pill bottle. When it is time to take medication the LED of the corresponding module will flicker and the vibration and audio signal will go off. A user can then easily take out the medication from the right module, since the sachet sticks out for 1.5 centimetres. The different boxes for medication cannot be not locked. This is done to prevent that medication cannot be accessed when malfunctioning of the device occurs. Nevertheless, the device logs if users have taken their medication by measuring the content of the modules. When medication is forgotten a caregiver will be notified via mail and SMS.

Communication of the outdoor device will go via a General Packet Radio Service (GPRS) network, just as happens with the Medido. GPRS is an extension of the GSM network and offers a service where data can be sent efficiently, cheap and fast [41]. There is chosen for a GPRS connection, since this connection is always accessible with a SIM card. Wi-Fi for example would need connection to a Wi-Fi network, which is often not accessible outdoors. In consultation with Philips [18] there has been chosen to let this communication go via the online platform Salesforce[10]. The Medido and the outdoor reminder are linked to this online platform. User device interactions are send and stored inside the Salesforce environment. A roadmap

[10] Online platform where follow up actions after specific events happening on devices can be arranged. https://www.salesforce.com/nl/

of actions that need to be taken after specific events was written down in this program. The environment of the Medido and outdoor reminder has been setup in Salesforce. Both devices can be linked to a specific client of Buurtzorg and caregivers can be connected as well. Follow up actions as texting and mailing caregivers are arranged if the outdoor reminder notices that medication is not taken on time. The outdoor reminder can be connected to Salesforce via a GPRS module that functions as client and connects to the online platform. The Salesforce environment makes it possible that the outdoor reminder can be used together with other medicine dispensers. Instead of the Medido, the outdoor reminder can be linked to another IoT medicine dispenser within Salesforce. The same Salesforce environment can be used to determine follow up actions and to log medication intake of users.

5.2.3 First prototype outdoor reminder

A prototype that has been designed for this project can be seen in figure 33. The prototype consisted of two modules: the base module and one submodule. Not all the functions out of the proposed design were implemented within this prototype. For some implementations further research is necessary. The prototype had the original dimensions, noticed when medication was inside or outside the module and could give a visual, audio and vibration signal. A GSM shield was placed on top of the Arduino, this shield made it possible to let the Arduino function as client and to communicate via a GPRS network. A simulation of the salesforce environment was created with an entry for both the Medido and outdoor reminder, possibilities to connect clients and caregivers and determine follow up actions. The connection between the GSM shield and Salesforce was not developed.

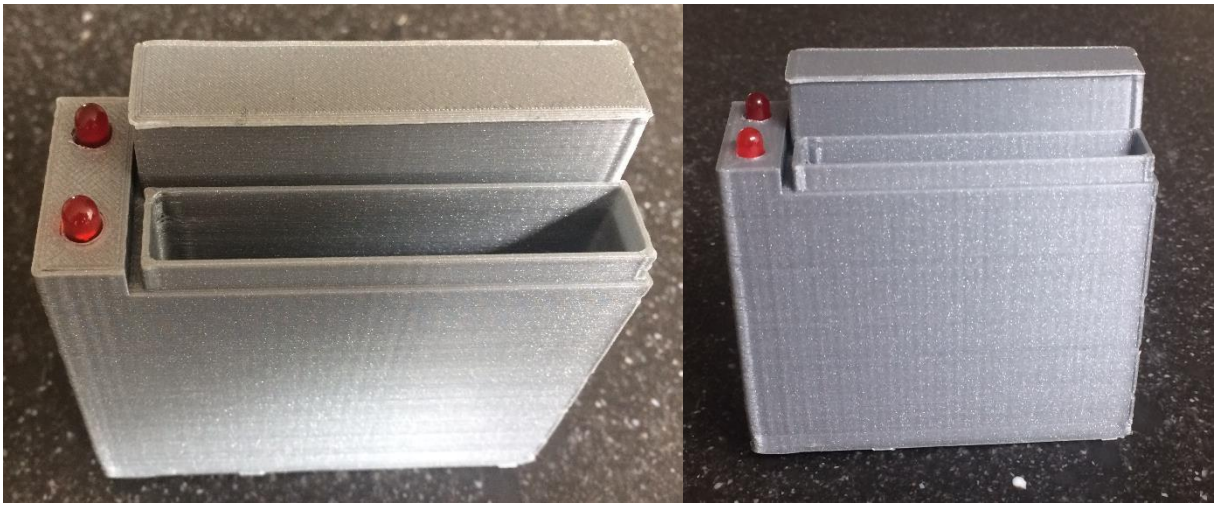

Figure 34: Prototype of outdoor reminder with two modules

The following materials were used for the prototype:

- 3D printed design of 2 modules with original dimensions.
- Arduino UNO
- Arduino GSM shield 2
- Breadboard
- Wires
- Piezo buzzer
- Resistors: one 33Ω, two 330 Ω, one 1 kΩ, one 10 kΩ
- Vibrating mini motor disk ada1201-300
- Capacitor 10 µFarad
- Diode 1N4001
- Transistor NPN
- LED red
- Reflective sensor

The hardware design of the prototype can be seen in figure 34 and was created in Fritzing 2016.

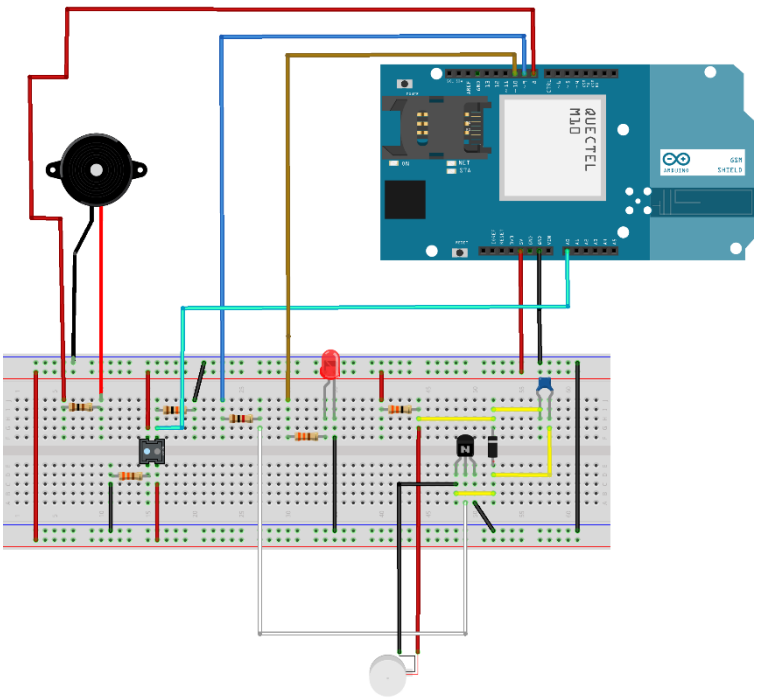

Figure 35: Hardware setup of prototype

6. Discussion

Two solutions to stimulate and improve adherence to medication with the use of the Medido were created during this research. An outdoor reminder system, which was not possible before, was designed. Besides important guidelines were set that could be used to create other outdoor reminder systems. These guidelines make that the design fits with the target group of elderly. The outdoor reminder that was designed cannot only be used together with the Medido, but it can also be linked to other medicine dispensers that are currently on the market. These results, which are described in more detail in the previous two chapters, have several implications that are discussed within this chapter. First, the striking results of the survey and interviews are discussed. During the second section the study and proposed design limitations are listed. In the last section the recommendations for future research are described.

6.1 Online survey and interviews

There were differences between the groups that filled in the survey. Group 2 was the largest group (50 respondents) followed by group 1 (30 respondents) and group 3 (21 respondents). An explanation for these differences could be that employees who are familiar with the Medido were motivated higher to fill in the survey. The difference between group 1 and 2 could then be explained by that there are more employees who are familiar with the Medido than employees who work with the Medido.

Each respondent group thought equally on why the Medido should be deployed at clients. The main advantages listed were that the clients self-reliance increases and that non-adherence to medication is prevented. The Medido was not always deployed, because of several reasons. It could be that employees did not determine one of their clients suited for the use of the Medido, but there was also lack of knowledge and time. Nevertheless, employees who did not work with the Medido yet experienced that a part of their clients perceive difficulties during their medication intake, so here does lay an opportunity for the Medido medicine dispenser to grow within the organisation of Buurtzorg.

The questions based on the Technology Acceptance model scored higher on (fully) agreeing when employees were already working with the Medido, so for respondent group 1. A difference could also be seen between respondent group 2 and 3. In general group 2 had a more positive view on the Medido than group 3. It can be concluded that when employees are familiar with the Medido they become more positive about its use and functionality. This conclusion was supported by the question if group 2 or 3 were willing to use the Medido in the future. Group 2 scored significantly higher on this question than group 3. The positivity even increased more when employees have deployed the Medido at their clients. Only a small percentage of Buurtzorg employees make use of the Medido, so when the goal is to scale up

the deployment of the Medido within Buurtzorg critical information on the Medido is necessary. When employees are well informed about the use and functionality of the Medido their opinion on it will become more positive. A positive viewpoint of employees is necessary, because they choose if the Medido will be deployed at clients.

Gamification used in combination with medication intake was not received well in both the interviews as well as in the online survey. In both methods respondents and interviewees did not experience any type of gamification. Therefore it could be that experiencing gamification is necessary to see whether such a solution is suitable. A systematic evidence-based review and showed that medication adherence for elderly with cognitive impairment becomes better by using human contact as reminding system than nonhuman reminders [30]. However, one interviewee who suffered from dementia agreed upon this while the other interviewees with chronic impairments disagreed. It can be concluded that personal reminders can have effect on the adherence if a client has a well relationship with his or her caregiver and cares for face-to-face and personal contact.

The fair and ignorance about technology on elderly made that the best option for an outdoor reminder system is currently a smart pill bottle. The largest part of the elderly generation is not used to make use of a smartphone or wearable and controlling those devices can already be perceived as a difficult task. Where elderly are often not familiar with a wearable or smartphone, they know how a pill bottle works. Therefore a smart pill bottle with the appearance of a standard bottle feels the most trustable medium for this generation. Within ten or fifteen years this view on technology mediums will shift. People will then be more acquainted with the use of wearables and smartphones, so a safe choice for a pill bottle will not be necessary anymore.

6.2 Limitations study and proposed design

There were some limitations to this research because of constraints in time, resources and target group. One of the limitations of this research is that only three employees and three clients of Buurtzorg have been interviewed. Since this is such a low number the outcomes cannot be generalized over all clients of Buurtzorg with a high degree of certainty. Besides the interviewees all made use of the Medido within Buurtzorg. Interviewing non-users would give inside in if the answers would also be true for this group. Research is only done within one care organisation, namely Buurtzorg. Within the Netherlands there are many more care organisations that make use of the Medido medicine dispenser. The results out of this research are specified on the needs of the employees and clients of Buurtzorg. It is not proven that

these results are also applicable to other care organisations. A bigger sample size of interviewees and of more care organisations might had given better results.

Age, gender and chronic conditions were taken into account during the interviews with clients, but were not used for determining correlations. With a higher sample size this can be taken into account and might give more insights into the individual needs of elderly. Age and gender were not measured in the survey, perhaps this data could give more insight into what group of employees prefers working with the Medido the most.

The online survey was evaluated as “clear” and “not too long” by many respondents. It is believed that the results have not been influenced by unclear or too many questions. Caregivers and their clients are interviewed separately. Therefore it is concluded that the answers were not influenced to prevent influencing the relationship between caregiver and client.

During this research a design for an outdoor reminder was proposed. However, not every feature of this system was fully worked out. There is no design to let the clicking of modules to each other function properly. A design of a functioning lid for the modules is also missing. Besides there is no advice on what type of battery should be used. The outdoor reminder was not linked to the Salesforce environment that was set up. The proposed design was created based on the needs of the target group. However, the design was not tested with this group. User tests would have given insights in if the design really fits the individual needs of this target group.

6.3 Recommendations for future research

The design of the outdoor reminder must be further researched to create a fully functioning prototype. Solutions for adding modules to each other and opening and closing the lid of a module can be researched. The online platform Salesforce must be designed to the needs of care organisations. Besides, software needs to be developed to connect the device with the Salesforce environment. Possibilities of the appearance and material choices of the device need to be explored. As last step choices on hardware must be made. A microchip can be used instead of using the Arduino Uno and GSM shield, so that it would need less space within the outdoor reminder.

Other features of the outdoor reminder and Medido can also be further researched. The proposed design does not see if the right sachet is placed in the right module. If this could be said with certainty mistakes would be prevented and adherence to medication will improve. Every sachet has a Barcode, so there can be investigated how to use this barcode to be sure

that the right sachet is taken on the right time. With the use of the Medido and outdoor reminder it is unclear if medication is actually taken by the user. Caregivers must trust on their clients that they take their medication when the medication is dispensed. The discovery of a technique, for example with the use of cameras and machine learning, that ensures that medication is really taken on the right time would drastically decrease the chance on non-adherence. Focus can also be shifted towards developing smart medicines, that send out signals if the medication is taken in by humans. The relation between adherence and gamification for elderly can also be researched, to see whether this would help to stimulate the adherence to medication.

Further research in the options on how to apply a noise amplifier for the Medido in practice is needed. There can be chosen to make use of an existing amplifier or to build one specially for the Medido. Market research is needed to show what option would be done to create an appropriate financial model for the supplier Philips. The development of a financial model is also important for the outdoor reminder system.

If both products are fully functioning and adopted into a financial plan user tests are needed to see if the products fit the individual needs of the target group. A user test reveals problems that can occur if users interact with a device. These problems can then be solved and tested again to prevent that the errors occur when the product is on the market. A medical product is not easily brought to the market. Guidelines for such products exists and must be met. Research is needed in what these guidelines precisely hold.

7. Conclusion

This researched investigated what type of reminders could stimulate adherence to medication of elderly with the Medido medicine dispenser in the home as well as outdoors for a maximum period of 24 hours. The target group were elderly who receive home care and need help with their medication intake to prevent non-adherence to medication. The state-of-the-art research determined that there were different types of reminding, different types of reminding mediums and that there are different functionalities for in home and outdoor reminding. It also showed that elderly often face chronic conditions that obstruct them to understand and adopt properly to reminders that are given for medication.

To improve the current reminder system of the Medido it was important to test the user satisfaction of the Medido and the user requirements of the target group and their caregivers. It was also necessary to test the opinion on other ways of reminding for medication. This was done with an online survey filled in by 101 Buurtzorg employees and semi-structured interviews with 3 employees and 3 clients of Buurtzorg. Employees were only asked to fill in the survey, because asking the target group would have led to a bias. Employees face the target group often and are educated to know the critical points of medication intake and adherence.

The data gathered from the survey and interviews was processed to get insights into the user requirements for reminding systems. These insights were used to propose two designs to improve and stimulate adherence to medication. The proposed design to improve indoor reminding with the Medido is the use of a noise amplifier. The amplifier makes it possible that the reminder of the signal will not be missed within the home of elderly. The research insights were also used to determine a set of 10 guidelines that need to be considered when designing an outdoor reminder system. In this research the smart pill bottle was preferred most as outdoor reminder medium. With the help of the determined guidelines a design of a smart pill bottle was proposed. This smart pill bottle stimulates the adherence to medication for elderly while they are outdoors by taking over the functionalities of the Medido.

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9. Appendix

A: Interview Questions Medido Buurtzorg

	Main questions (numbers) **with sub questions** (letters)	**Explanation of question**
1	How did Buurtzorg got acquainted with the Medido?	To get insight in the process of how Buurtzorg started to offer the Medido in their services.
a	How did the Medido become a part of the services of Buurtzorg?	“
b	When did the Medido became a part of the services of Buurtzorg?	“
c	Why was there the choice for the Medido as medicine dispenser?	Why does Buurtzorg work with the Medido and not with another medicine dispenser that is available on the market.
d	Have there been any other devices considered next to the Medido?	“
e	What are the pros and cons for Buurtzorg by using the Medido?	What is the consideration for Buurtzorg to offer the Medido in their care services.
2	Have there been trials with the Medido within Buurtzorg?	To get insight in the starting process of the Medido in practice.
a	When did the first trials started?	“
b	How are teams selected to join the trials?	“
c	Is there data available about the trials? Or other research?	“
3	Which client is eligible for the use of a Medido?	What clients are eligible for the Medido? And how do they come in contact with the Medido?
a	What are inclusion criteria? What are exclusion criteria?	“
b	Other ways how clients come in touch with the Medido?	“
4	How do nurses learn to work with the Medido?	How does Buurtzorg take care that the Medido is deployed within its teams and that the Medido is well applied.
a	Where do they retrieve the information from?	“
b	Does the caregiver have the choice if a Medido is used?	“

c	How do caregivers think of the use of the Medido?	“
d	Are caregivers open for this kind of innovative developments?	“
5	What is the double check that is sometimes obligated?	Employees of Buurtzorg check on medication intake, how does this work normally and what role plays the Medido in this process?
a	How is this double check organized? Who is responsible for this? For which medicines or patient is this needed?	“
b	How does the double check work for clients with a Medido?	“
6	Who buys the Medido? Client, nurse, caregiver, others?	How is the payment of the Medido arranged within Buurtzorg?
a	With or without insurances? Can the Medido also be applied within Buurtzorg without any reimbursements of the insurances?	“
7	How is the relation between elderly and the Medido?	How does Buurtzorg arranges that their clients accept the use of the Medido and what obstacles are there in this process. These obstacles can be taken into account while making a new design for the reminder system.
a	Are elderly willing to purchase the Medido? If yes, how are they stimulated? If no, what are the problems?	“
b	Do elderly accept the use of the Medido within home care?	“
8	How well is the usability of the Medido for elderly?	How do the clients of Buurtzorg cope with new technologies in their daily life, in this case the Medido medicine dispenser. How does the Medido change their daily life? To check if things are open for change in a future design.
a	Is the use of the Medido easy to understand for elderly? How do they learn how the Medido works?	“

b	How do elderly cope with occurring mistakes of the Medido?	“
c	How do elderly take their medication when the Medido is not available? What does this change on their adherence to medication?	“
d	Outstanding’s on usability of Medido and elderly?	“
9	Does the Medido gather data? What is this data mean?	There is asked for data to get insight in what might be used in a prototype in the future of this research.
a	Who manages this data?	“
b	Who has access to this data?	“
c	What is done with this data regarding: family, (informal) caregiver, elderly?	“
10	What are the experiences of the Medido of elderly?	To see how clients experience the use of the Medido.
a	Does the Medido improve their adherence to medication?	“
b	Do they experience any disadvantages?	“
c	Are there any other advantages regarding the use of the Medido for clients?	“
d	Any other experiences regarding the use of the Medido for clients?	“
11	What are the experiences of the Medido of caregivers?	To see how caregivers experience the use of the Medido.
a	Does it decrease the workload and moments of care?	“
b	Does it increase the quality of the care?	“

c	Do they receive signals of the Medido? Which, when and what do they do with them?	“
d	Any other experiences regarding the use of the Medido for caregivers?	
12	What are the experiences of informal caregivers with the Medido?	To see how informal caregivers experience the use of the Medido.
a	Does it decrease the workload and moments of care?	“
b	Does it increase the quality of the care?	“
c	Do they receive signals of the Medido? Which, when and what do they do with them?	“
d	Any other experiences regarding the use of the Medido for caregivers?	“
13	Do problems occur with the use of the Medido? Communication, offline, forget medication problems?	To find out if there are possibilities for improvement, because problems occur frequently.
a	Do other problems occur with the use of the Medido?	“

B: Messages on Buurtzorgweb Survey

Laura van der Neut | 06 april 2018 | 11:28 uur | Hulpmiddelen en materialen

8

Afstudeeronderzoek Medido

Beste buurtzorgmedewerker,

Ik ben Laura van der Neut en zit momenteel in mijn laatste jaar van de studie Creative Technology. Als laatste deel van mijn studie ben ik nu bezig met mijn afstudeeropdracht bij het bedrijf Ecare. Tijdens deze opdracht doe ik onderzoek naar medicijndispensers in de thuiszorg. Als uitgangspunt gebruik ik de Medido, welke al binnen Buurtzorg wordt ingezet. Het doel is om nieuwe toepassingen te creëren voor de Medido om de zorg te verbeteren.

Binnenkort zet ik een korte enquête uit om inzicht te krijgen over de kennis en ervaringen met betrekking tot de Medido binnen Buurtzorg. Ik neem graag jouw input mee in mijn onderzoek!

Je kunt de uitkomsten van mijn onderzoek volgen via deze website: https://sites.google.com/student.utwente.nl/medido-buurtzorg/home. Wanneer er vragen of opmerkingen zijn over het onderzoek, kun je reageren op dit bericht of een e-mail sturen naar l.vanderneut@student.utwente.nl.

Groeten,

Laura van der Neut

Laura van der Neut | 08 mei 2018 | 23:18 uur | Hulpmiddelen en materialen

2

Enquête Medido

Beste Buurtzorgmedewerker,

In april heb ik op Buurtzorgweb mijn onderzoek naar de Medido medicijn dispenser van Philips aangekondigd. Op dit moment ben ik bezig met het verzamelen van data en ik neem graag jouw input mee in mijn onderzoek! Daarvoor heb ik een enquête uitgezet voor alle Buurtzorg medewerkers, het maakt niet uit of je wel of niet bekend bent met de Medido. Het invullen van de enquête kost ongeveer 7 minuten. Via de volgende link kan je de enquête starten: https://docs.google.com/forms/d/e/1FAIpQLSd3Yo0tbudBLWjFm7z1YWLMR2XqURPn9d1zELdKXL5t-lQ-Ew/viewform?usp=sf_link

Wanneer er vragen of opmerkingen zijn over het onderzoek, kun je reageren op dit bericht of een e-mail sturen naar: l.vanderneut@student.utwente.nl. Je kunt de uitkomsten van mijn onderzoek volgen via deze website: https://sites.google.com/student.utwente.nl/medido-buurtzorg/home.

Bij voorbaat dank voor je medewerking!

Groeten,

Laura van der Neut

Laura van der Neut | 18 mei 2018 | 15:49 uur | Hulpmiddelen en materialen

3

Afstudeeronderzoek Medido

Beste Buurtzorgmedewerker,

Vorige week heb ik een enquête uitgezet via Buurtzorgweb. Op dit moment heb ik al aardig wat reacties ontvangen, maar hoe meer input hoe beter! Het maakt niet uit of je wel of niet bekend bent met de Medido en het invullen van de enquête kost ongeveer 7 minuten. Mocht je de enquête nog niet ingevuld hebben, maar wel mee willen werken aan mijn onderzoek dan kan dit via de volgende link: https://docs.google.com/forms/d/e/1FAIpQLSd3Yo0tbudBLWjFm7z1YWLMR2XqURPn9d1zELdKXL5t-lQ-Ew/viewform?usp=sf_link

Wanneer er vragen of opmerkingen zijn over het onderzoek, kun je reageren op dit bericht of een e-mail sturen naar: l.vanderneut@student.utwente.nl. Je kunt de uitkomsten van mijn onderzoek volgen via deze website: https://sites.google.com/student.utwente.nl/medido-buurtzorg/home.

Groeten,

Laura van der Neut

2416 keer gelezen

0 Reacties

C: Online survey lay-out

Onderzoek Medido Medicijn dispenser

Beste Buurtzorgmedewerker,

Deze vragenlijst is bedoeld voor onderzoek over de Medido, medicijn dispenser van Philips, een apparaat dat mensen kan helpen bij het nemen van medicatie. Dit onderzoek wordt uitgevoerd aan de Universiteit Twent. Voor vragen kun je contact opnemen met: Laura van der Neut (l.vanderneut@student.utwente.nl).

De vragenlijst is anoniem en zal enkel gebruikt worden voor wetenschappelijke doeleinden. De vragenlijst bestaat uit totaal 25 vragen, waarvan 20 stellingen waarop je kan aangeven in hoeverre je het eens bent met de stelling. Daarnaast zijn er 5 open vragen. Alle vragen zijn verdeeld over 6 pagina's. Onderaan de pagina kun je op de voortgangsbalk zien hoe ver je bent. Je kan op ieder gewenst moment stoppen met de vragenlijst.

*Vereist

1. **1. Bent u bekend met de Medido medicijn dispenser van Philips?** *
   Markeer slechts één ovaal.
   - ◯ Ja, ik gebruik de Medido binnen Buurtzorg *Ga naar vraag 2.*
   - ◯ Ja, maar ik gebruik deze (nog) niet binnen Buurtzorg *Ga naar vraag 13.*
   - ◯ Nee, ik ben niet bekend met de Medido *Ga naar vraag 23.*

Medido Gebruik binnen Buurtzorg

Deze vragen zijn gericht op de ervaringen met de Medido in de thuiszorg.

2. **2. Waarom heeft jouw team er voor gekozen de Medido in te zetten bij cliënt(en)?** *

3. **3. De therapietrouw van cliënten die de Medido gebruiken is verbetert.**
   Markeer slechts één ovaal.

	1	2	3	4	5	
Helemaal mee oneens	◯	◯	◯	◯	◯	Helemaal mee eens

D: Online survey questions per respondent group with explanation

Question with Category and section number	**Different participant groups of caregivers** (C1= works with Medido, C2= familiar with Medido, C3= unfamiliar with Medido)			**Type of question with explanation**
	C1	**C2**	**C3**	
1. Introduction				
Are you familiar with the Medido of Philips?	X	X	X	Question to differentiate between respondent groups.
2. Medido employability				
Why did your team choose to work with the Medido?	X			Open question, asks for a qualitive answer. This is asked to create insight in why caregivers chose to work with the Medido.
Why didn't your team choose to work with the Medido (yet)?		X		Open question, asks for a qualitive answer. This is asked to get insight in why caregivers chose to not work with the Medido.
My clients experience often difficulties with their medication intake.		X	X	Statement, respond on a 5-point scale. To get insight in whether support is necessary to prevent non-adherence to medication.
TAM perceived Usefulness				
The adherence to medication of clients who make use of the Medido improves.	X	X	X	Statement, respond on a 5-point scale. Based on initial scale item of the category perceived usefulness of the TAM.
The self-reliance of clients who make use of the Medido improves.	X	X	X	Statement, respond on a 5-point scale. Based on initial scale item of the category perceived usefulness of the TAM.
The use of the Medido improves the quality of the care that is given.	X	X	X	Statement, respond on a 5-point scale. Based on initial scale item of the category perceived usefulness of the TAM.
In general the Medido is/seems like a useful system.	X	X	X	Statement, respond on a 5-point scale. Based on initial scale item of the category perceived usefulness of the TAM.
TAM perceived Ease of Use				
Clients do often not react on the reminder that they receive from the Medido.	X			Statement, respond on a 5-point scale. Based on the initial scale item of the category perceived ease of use of the TAM.

In general the Medido is/seems an easy to use device.	X	X	X	Statement, respond on a 5-point scale. Based on the initial scale item of the category perceived ease of use of the TAM.
The audio signal that the Medido uses to remind clients to take their medication is/seems efficient.	X	X	X	Statement, respond on a 5-point scale. Based on the initial scale item of the category perceived ease of use of the TAM. Besides that, it checks if the research question is relevant.
The Medido supports users well enough on how to take their medication	X			Statement, respond on a 5-point scale. Based on the initial scale item of the category perceived ease of use of the TAM to look if clients know how to take their medication.
It is important that the Medido supports users in how they should take their medication.		X	X	Statement, respond on a 5-point scale. Based on the initial scale item of the category perceived ease of use of the TAM.
I am willing to use the Medido in the future.		X	X	Statement, respond on a 5-point scale.
3. Advantages and disadvantages Medido				
List the three most important advantages of the use of the Medido.	X	X	X	Open question, to get insight into the advantages of the Medido. Asks for three points, so caregivers are forced to come with concrete solutions.
List the three most important disadvantages of the use of the Medido.	X	X	X	Open question, asks for a qualitive answer. To get insight into the disadvantages of the Medido. Asks for three points, so caregivers are forced to come with concrete solutions.
4. Reminding outdoors				
It is useful to remind clients on taking their medication when they are outdoors.	X	X	X	Statement, respond on a 5-point scale. To get insight if the research question is relevant according to Buurtzorg employees.
Do you have ideas on how clients can be reminded on their medication when they are outdoors?	X	X	X	Open question, aims to receive input from employees about their ideas on how to remind elderly outdoors. This question can give new insights in how to create an efficient reminder system for elderly for outdoor use.
5. New solutions for reminders				
The adherence to medication of clients improves when the correct intake of medication is associated with a game.	X	X	X	Statement, respond on a 5-point scale. To see how caregivers think about this approach of reminding.

A personal reminder improves the adherence to medication of clients in comparison with a neutral reminder.	X	X	X	Statement, respond on a 5-point scale. To see how caregivers think about this approach of reminding.
When clients receive extra information on how to take the medication the adherence to medication improves.	X	X	X	Statement, respond on a 5-point scale. To see how caregivers think about this approach of reminding.
A visual reminder, which make use of light, is a suited way to remind clients on taking their medication.	X	X	X	Statement, respond on a 5-point scale. To see how caregivers think about this approach of reminding.
A vibrating signal via a wearable is a suited way to remind clients on taking their medication.	X	X	X	Statement, respond on a 5-point scale. To see how caregivers think about this approach of reminding.
6. New technology medium solutions				
What percentage of your clients has a mobile phone?	X	X	X	Multiple choice question, aims to indicate to what extent clients of Buurtzorg make use of a mobile phone.
What type of mobile phone do your clients own?	X	X	X	Multiple choice question, aims to indicate what type of mobile phone is used by Buurtzorg clients.
The use of an application on a smartphone is a suited way to remind clients ton taking their medication	X	X	X	Statement, respond on a 5-point scale. To indicate how effective caregivers find this technology medium.
The use of a smartwatch is a suited way to remind clients on taking their medication.	X	X	X	Statement, respond on a 5-point scale. To indicate how effective caregivers find this technology medium.
The use of a smart pill bottle is a suited way to remind clients on taking their medication.	X	X	X	Statement, respond on a 5-point scale. To indicate how effective caregivers find this technology medium.
Do you have additional comments?	X	X	X	Open question, not obligated to be answered. Gives respondents the opportunity to comment on questions or thoughts about the survey and mention ideas that have been gained throughout filling in the survey.

E: Questions interviews Buurtzorg employees and clients

Questions with category	Interviewed groups (Ca= caregiver, Cl = client)		Why is this question asked
	Ca	Cl	
General			
Why did you choose to work with the Medido?	X	X	This is asked to create insight in why caregivers and clients chose to work with the Medido.
Did you have doubts on the Medido on beforehand? About what?		X	Indicate problems of clients on beforehand of the Medido.
Does the Medido supports you? Is it better with the Medido than without?		X	Indicate if clients are satisfied with the Medido and if it relieves them during daily life.
How was your (clients) medication organised before the Medido?	X	X	Find the differences in the process with and without the Medido
Why did you/your team deploy the Medido at these specific clients?	X		Indicate for what group the Medido is suited according to caregivers?
When would you (not) deploy the Medido at clients? Why?	X		"
For the group who is not suitable for the Medido, is it possible to fit the Medido to them with small adjustments?	X		Do caregivers have thoughts for small adjustments, so the Medido can be applied more often.
Can you list some advantages of the Medido?	X	X	What do the interviewees like about the Medido.
Can you list some disadvantages of the Medido?	X	X	What do interviewees dislike about the Medido.
Do you see any improvements possible for the Medido which make the use of it easier?	X	X	Indicate if interviewees prefer other settings of the Medido.
Perceived Usefulness TAM			
Does the Medido improves the quality of the care? Why and in which way?	X		Indicate if the Medido influences the quality of the care that is given.
Does the Medido improve the adherence to medication for clients/yourself? How do you notice this? To what extent is it improved?	X	X	Indicate if the Medido influences adherence to medication.
Does the Medido improve the self-reliance of clients/yourself?	X	X	Indicate if the Medido influences self-reliance.
Do you visit clients less and do clients appreciate this?	X		Indicate if care moments change with the use of the Medido and is this received positively.
Do error messages occur frequently? How do you solve them?	X		Indicate the presence of errors occurring with the Medido.

To what extent do you find the Medido a useful device?	X	X	Indicate how the usefulness of the Medido is experienced by interviewees.
Perceived Ease of Use TAM			
Do problems occur when the medication is taken out of the Medido? What exactly goes wrong and how do you try to prevent this?		X	Indicate errors that clients experience with the Medido.
Is medication forgotten despite the audio signal of the Medido? When does this happen? How often does this happen?	X	X	Suggest efficiency of the current reminder system indoors.
Do you think that the audio signal is efficient? Would you rather see this differently?	X	X	Asks directly for efficiency and changes of the Medido.
Do you need to concentrate when you take medication out of the Medido? Which task is hard to perform?		X	Tries to find difficulties in the process of the medication intake with the Medido.
Is it always clear how medication should be taken in? How do you/your clients know this? Would you like to receive/offer extra information?	X	X	Indicates if the Medido lacks in giving information and if this is wishful.
Do you always hear the audio reminder? Are there places where you miss the reminder?		X	Tests effectiveness of audio reminder out of the Medido.
New ideas for reminder system			
How do you think of a visual reminder? Where should the light burn? Would you rather see a combination of audio and light?	X	X	To see how interviewees think about this approach of reminding.
Would you/your clients prefer a personal reminder rather than a neutral reminder? Why (not)?	X	X	To see how interviewees think about this approach of reminding.
Would you/your clients like to receive more information on how medication should be taken from the Medido? Why (not)? How would present this (audio, video)?	X	X	To see how interviewees think about this approach of reminding.
How do you think about gamification in combination with medication intake?	X	X	To see how interviewees think about this approach of reminding.
Indoor Reminder versus Outdoor reminder			
The Medido only reminds indoors and not outdoors, do you/your clients experience this as difficult? Why (not)?	X	X	Tests relevance of the research question.

Do you/your clients stay home for the reminder of the Medido?	X	X	Tests relevance and consequences of the research question.
Do you/your clients forget the medication without the reminder of the Medido? How do you prevent this?	X	X	Tests relevance and consequences of the research question.
How do you feel about a reminder system outdoors?	X	X	Tests relevance of the research question.
New ideas on reminding outside			
Do you have any ideas on reminding outside?	X	X	Question is there to receive blank input about reminding outdoors.
Do you/your clients have a mobile phone? Do you/they always take it with you/them? Is it a smart phone?	X	X	Indicates whether a mobile phone could be used for a reminder system.
Is a reminder via a mobile (smart) phone useful for your clients? Why (not)?	X		Learn about thoughts of caregivers on mobile phone reminding.
Would you like to receive a reminder via your mobile phone? Why (not)? What type do you prefer: audio, light or vibration?		X	Learn about thoughts of clients on mobile phone reminding.
Is a reminder via a smartwatch useful for your clients? Why (not)?	X		Learn about thoughts of caregivers on smartwatch reminding.
Would you like to receive a reminder via a smart watch? Why (not)? Would you use and wear it? What type do you prefer: audio, light or vibration?		X	Learn about thoughts of clients on smartwatch reminding.
Is a reminder via a smart pill bottle useful for your clients? Why (not)?	X		Learn about thoughts of caregivers on smart pill bottle reminding.
Would you like to receive a reminder via a smart pill bottle? Why (not)? Would you take it with you? What type do you prefer: audio, light or vibration?		X	Learn about thoughts of clients on smart pill bottle reminding.
General end question			
Do you have any remarks on this interview or about your experiences with the Medido medicine dispenser?	X	X	Gives interviewees the opportunity to comment on questions or thoughts about the interview and mention ideas that have been gained throughout the interview.