U-Med

A mobile application and a reverse vending machine for individuals to reduce unused medication waste

Ecenur Bacaksızlar

Interaction Design
Two-year Master’s Programme
15 Credits
2nd Semester/2022
Supervisor: Jens Pedersen
Abstract

Medication waste, both packaging and actual drug waste, has been having a tremendous impact on the environment and healthcare budget. However, this is even more concerning after Covid-19 affects the drug purchasing behaviours and causes potentially more unused medications while many people are not able to access healthcare. Some of the main challenges of lack of contribution to the life after the purchase of unused medicine are the patient's lack of knowledge of how to dispose of them, the medication distribution, the legislation and not having an encouraging sustainable system to reduce medication waste on a bigger scale.

This project focused on understanding medicine usage behaviours in Turkish society and developing a circular model called U-Med (Unused Medications). The model has a mobile application and reverse vending machines which are linked with e-Nabız (e-Heartbeat, an application that Turkish citizens and health professionals access to health data collected from health institutions) to reduce medication waste by providing individuals to dispose of or share their unused medicines with the healthcare system or the other industries that can reuse. The concept also aims to show a sustainable approach which can influence decision-making in legislation on medication distribution. This project includes face-to-face, semi-structured interviews in a neighbourhood in Sarıyer, Istanbul Turkey with 5 patients, 3 doctors, 3 nurses and 5 pharmacists along with the health director in the municipality of Sarıyer. Additionally, remote interviews were organised with a non-profit organisation in Greece called GIVMED which has similar concerns. Apart from these, a Turkish survey among 88 Turkish citizens about medication usage behaviour was conducted.

Keywords: Medication waste, circular economy, participatory design, sustainability, medicine sharing, unused medication, reverse vending machine, smart bins, interaction design
Table of contents

1. INTRODUCTION: AIM AND RESEARCH QUESTION 5
2. BACKGROUND 5
   2.1 Medication waste 6
   2.2 Circular economy 7
   2.3 Participatory design 8
   2.4 State of art 9
      2.4.1 Medicine sharing 9
      2.4.2 Smart bins and reverse vending machines 10
3. METHOD 13
   3.1 Project plan 13
   3.2 Design process 14
   3.3 Design methods 15
      3.3.1 Exploration phase 15
      3.3.2 Synthesis phase 18
      3.3.3 Ideation and concept phase 18
      3.3.4 Prototyping and testing phase 19
4. DESIGN PROCESS 21
   4.1 Exploration 21
      4.1.1 Trust 21
      4.1.2 Altruism 23
      4.1.3 Alternative use 24
      4.1.4 Legislation 24
   4.2 Synthesis 25
   4.3 Ideation and concept 26
      4.3.1 Preparation 26
      4.3.2 Activities and learnings 28
         4.3.2.1 Trust 28
1. INTRODUCTION: AIM AND RESEARCH QUESTION

The Circular Economy (CE) has become a subject that many have discussed and worked on over the past years. Especially, systems around recycling end-products along with production wastes, upcycling suggestions to develop more sustainable systems have been hot topics. However, concentrating on medical waste in this field has room for development and discovery. According to one of the latest research studies about sustainable chemistry and pharmacy, a high impact on the environment and healthcare budget can be achieved by sustainable approaches to reducing medication waste, which can be defined as any leftover or not fully used pharmaceutical item throughout the pharmaceutical supply and use chain (Smale et al, 2021). Additionally, these researchers address this problem as a joint responsibility and invite all stakeholders from the manufacturers, distributors, prescribers, and pharmacists to patients to minimise the waste.

This thesis particularly explores with a user-centred design and participatory design approaches, the medication usage behaviours of individuals, the notions of health professionals and patients towards donating medications to prevent increasing medication waste and suggesting a more sustainable system which has positive impacts on both the environment and the society in Turkey. Therefore following research question is formulated:

- How can a platform/model in Turkish society encourage individuals to share their unused and unexpired medicines, and health professionals to prescribe these medicines to people in need to decrease medication waste and ensure a more just healthcare system for all?

This project will focus on developing a platform with reverse vending machines (RVMs) to share unused and unexpired medications, both the normal and the cold-chain ones (the ones that require special storage conditions), with the healthcare system to be used in poor neighbourhoods. While medicine sharing has many limitations around safety and legislation, potentially, this thesis and the outcome of this research can influence decision-making in legislation on medication distribution for a more sustainable society both in economic and environmental aspects.

During this project, some doctors in a community health centre in Sarıyer district in Istanbul, some of their patients and some pharmacists nearby along with the health director in the municipality, were collaborated. Additionally, a remote interview was organised with a non-profit organisation called GIVMED in Greece which has similar concerns about medication waste. Apart from these, a Turkish survey among Turkish citizens to investigate the medication usage and sharing behaviour of individuals was conducted.

2. BACKGROUND

This section describes the major topics of this thesis: Medication waste, Circular economy, Participatory design, Medicine sharing and Reverse vending machines.
2.1 Medication waste

According to Andeobu et al. (2022) waste generated from the diagnosis, treatment or immunization of humans and animals is defined as medical waste and contacting medical waste poses a significant danger to the health of a person. In their research, they stated needles and syringes, soiled dressings, body parts, diagnostic samples, blood, chemicals, medications, medical devices, and radioactive materials are all examples of medical waste generated by healthcare activities.

Based on the research from Andeobu et al. (2022) while public awareness and consciousness towards medical waste are lacking, prior to the pandemic the medical community was the targeted group of policymakers and their medical waste management policies. According to them, with the current COVID-19 pandemic and the ways of preventing its transmission, the need for public awareness of any kind of medical waste along with the consciousness of its separation from the general waste is now more visible. They also stated, that since the outbreak, the estimated amount of waste generated only from COVID-19 is 2.6 million tons/day worldwide.

Based on recent research about waste minimising measures in medication, wasting potentially usable medications is also endangering the budget of pharmaceuticals (Smale et al., 2021). In the literature review they made, the annual loss of up to $5.4 B in the United States, around £300 M in the United Kingdom and at least €100 M in the Netherlands can be observed. Additionally, based on the research, destructive effects to the ecosystem are caused by the pollution of the aqueous environments with medication wastes, for example through the ignorant disposals in drains. According to the researchers, although the pollution is mainly caused by human excreta because of the medication usage, the effect of unconscious disposal of unused medication on the environment should not be underrated.

According to Smale et al. (2021) the numerous stakeholders involved in the pharmaceutical chain, including end-users, the patients, can all contribute to medication waste. Based on their research, for instance, early termination in the treatment can be seen due to adverse events, lack of efficacy or resolution of the condition of the patient and because of these reasons patients may not use all of the medication prescribed to them. Additionally, they also state, that patients can also contribute to medication waste by over-ordering, abandoning or not using the medications according to their treatments. If these unused medications are returned to the pharmacy unopened, they are usually discarded for incineration, resulting in the waste of potentially valuable medication (Smale et al., 2021).

Based on the research from Smale et al. (2021) a move to a sustainable practice of manufacturing, distributing, prescribing, dispensing, and using medication is required to address the problem of medication waste. According to them, at least the strategies of reducing, reusing and recycling waste with a prior focus on waste minimisation should be included in processes.

Minimising medication waste is a joint responsibility of health authorities, manufacturers, distributors, prescribers, pharmacists and patients (Smale et al., 2021). This thesis concentrates on exploring waste-reduction strategies by mainly focusing on the two actors, the prescribers and the patients and three themes, sharing, reusing and disposing of.
2.2 Circular economy

According to research from Nautiyal and Goel (2021), a Circular economy (CE) can be defined as an economic closed-loop cycled model which aims to reduce wastefulness and consumption of resources. Based on their research, it concentrates on recycling and reusing the resources and seeks to reduce waste flows and emissions in the atmosphere. According to them, in this way, the outputs of any activity become inputs for other processes rather than waste. The circular economy idea provides a closed economic model in which products and services are produced in a sustainable way by reducing resource use and waste, while the linear economy is neither focusing on the progress of the efficiency at all stages of the product life nor ensuring environmental protection (Nautiyal & Goel, 2021).

Based on the recent study from Kampelmann et al. (2021) implementing such circular models frequently necessitates novel types of coordination across processes, players, and scales. They state that such shifts have been difficult to grasp in the value chain literature. According to them, recent contributions have argued that, rather than traditional value chains, circular economy projects create new value systems.

Several different approaches to CE from different industries can be encountered around the globe. An energy company located in Stockholm called Stockholm Exergi aims to make Stockholm become the world’s first climate-positive capital city, presenting a system which treats wastewater and sludge (Cirkulär Ekonomi Minskar Koldioxidutsläppen, n.d.). The sludge contains an excessive amount of substances along with many toxins and heavy metals which should not blend with the environment. According to them, toxins can be eliminated from the cycle by combustion. For the nutrients remaining after the incineration, they developed a technique for treating the sewage sludge and explored the possibilities to return nutrients to the ecosystem. Another recent approach to CE towards minimizing food waste can be seen in Löfberg’s and Circle K’s project called Räddat Kaffe, which can be translated as “saved coffee” (Räddat kaffe - med Löfbergs | Circle K, n.d.). This coffee is created from three different coffee types that are otherwise being wasted during production. According to them, this investment saves 60 tonnes of CO2 during the first year. Cooperation between a Finish oil refining company Neste, transportation, logistics and storage company HAVI and Mc Donald’s, the global fast-food chain can give another perspective towards reducing and reusing food waste (Turning Fries into Miles – How McDonald’s, Neste, and HAVI Create a Circular Economy That Uses Cooking Oil to Fuel Logistics, 2020). In the scope of this project, they used the vegetable cooking oil from McDonald’s in the Netherlands and turned it into a fuel called Neste MY Renewable Diesel to be used for McDonald’s own logistics provided by HAVI.

According to the recent research from MacNeill et al. (2020), some medical tools are ideally suited for single use. Based on this research, intravenous catheters, tubing, syringes, and needles are examples of those low-complexity tools that are difficult to clean. They also state recycling to restore the base components may be the best choice for these items. According to their research, high-complexity devices, such as medical imaging equipment, are on the other end of the spectrum, built for lengthy lifespans and maintained through maintenance, repair, and refurbishment cycles. MacNeill et al. also indicate, that in the middle, there are devices for which circular design combined with reprocessing methods allows for product integrity—that is, keeping the device in use as near to its original state as feasible for as long as possible. According to their research, the greater the economic and environmental benefits
of maintaining product integrity, the more advanced the device. Based on their research, the development of long-lasting products that are simple to disassemble and repair is supported by a servitization model. They also argue that the circular design is known for its modularity, flexibility, and diversity. In their research it is also mentioned since the original manufacturer is responsible for product performance and safety, it is in the original manufacturer’s best interest to provide reprocessing processes that are safe, effective, and simple to follow. When considering these, in their research, they also manifest that the diverse stakeholder groups must work together to achieve a common aim of systemic transformation to circular systems in medical fields.

However, according to the recent research from Alshemari et al. (2020) currently, because of the quality and the safety concerns, circularity strategies for pharmaceuticals are not seen in many countries but environmentally-friendly management towards reducing waste, cost and usage disposal of the elements of a pharmaceutical product or medicines can be performed. Based on their research, the best methods for minimizing pharmaceutical waste when considering the implementing CE in the pharmaceutical supply chain (PSC) are the three Rs, reducing, reusing and recycling disposable elements, 9Rs which are refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover. Based on the examples from the table called Current Pharmacy Medicines Waste Management Practice That Endorses the CE Ethos in their research, some of the practices are drug donations, providing more environmentally friendly inhalers while recycling the packaging for reuse, arranging medication dosings and prescribing in specific quantities, supplying return schemes for safe reuse and disposal of medications to patients and API (extracting, purifying and repacking) recovery for reuse which is using green engineering methodologies to recover and reuse medications.

One of the purposes of this thesis is that explore, refine and redefine the meaning of medical waste, mainly pharmaceutical waste, and what we can do with them.

### 2.3 Participatory design

According to Hanington and Martin (2017), Participatory Design is a human-centred approach to research and design that encourages active user and stakeholder participation at all stages of the process, including co-design events. They also state that Participatory Design’s origin is widely attributed to Scandinavian initiatives in the 1970s, particularly in Norway, where computer specialists collaborated closely with ironworker and metalworker union leaders and members on the integration of new technology into the workplace.

A recent study by Bødker et al. (2022), looks into the impact of Participatory Design on the development of future technologies. Participation is stressed as a means for people to influence digital technologies that will affect their work practices or daily lives. According to them, other approaches, similar to Participatory Design, include components of participation, such as user-centred design, co-design, user-experience design, or experience-based design. Based on their research, people are involved in designing their future technology through Participatory Design not as ‘users,’ but as human beings with all of the faculties of skillfulness, emotions, concerns, beliefs, and anchoring values that make us human. It is a method of debating prospective futures and personal or societal values, and then developing new digital technologies to serve human lives (Bødker et al., 2022).
There have been several studies regarding health care and the public sector using a Participatory Design approach by focusing on boundaries between citizens and these sectors. In a literature review on Participatory Design in relation to these topics, some of the projects are about registration of moving of residence, application of various subsidiaries, patient record system and handover, coordination and knowledge sharing in hospitals wards and emergency medical services (Bødker et al., 2022, p.45).

Engaging with a specific community in a process of mutual learning and empowerment also entails introducing alternatives from which the user's current practice may progress in different ways (Bødker et al., 2022, p.6). According to Bødker et al. (2022), Participatory Design embraces methods of collaborating with individuals who will be the end-users of the proposed alternative. Based on their study, Participatory Design leverages the expertise of representatives of certain groups with a special interest or specialised knowledge as a contribution to the project’s outcome.

In this thesis, mostly in the exploration and the ideation and concept phases, a Participatory Design approach is used with stakeholders such as doctors, nurses, pharmacists and patients in order to integrate them into the process since they will be affected by the proposal. Another critical reason to collaborate with them is to create better solutions together through their experience and knowledge.

### 2.4 State of art

#### 2.4.1 Medicine sharing

The lending (providing prescription medications to someone else) or borrowing (being given and using a medication prescribed for another person) of medications has been defined as prescription medicine sharing by the researchers who had studied non-recreational medicine sharing behaviours of the patients, negative experiences from shared medications and influencing factors to share in New Zealand (Beyene et al., 2016). According to their research, while non-recreational sharing means sharing any prescribed medication for its therapeutic effect, recreational sharing is sharing abusable prescription drugs for feeling good or ‘getting high’. Some of the negative experiences they stressed in their research are around possible unsafe and ineffective treatment, risk to public health and risk of drug dependence. Altruism, having limited access to medicine and health services, sociocultural differences and having leftover/unused prescription medicines are the influential factors on medicine sharing that they discovered and elaborated on in their study.

Although there are some projects around reducing medicine leftovers through medicine sharing or donation, there are not very common. Some of them are GIVMED (2022), Sirum (SIRUM – Saving Medicine : Saving Lives, 2022) and a terminated project in Sariyer, Istanbul called “Ücretsiz İlaç Desteği” (appendix 2) which can be translated as “Free Medication Support” are some of them.

While Image 1 shows the application of GIVMED, an NGO in Greece that helps people donate their unused medications to people in need through a platform called MEDforALL where users can scan their medication, and find donation points along with shortages of the medications in these points (GIVMED, 2022). During the exploration phase of this thesis, an
interview was conducted with GIVMED. Therefore further insights will be shared under 4.1 Exploration and 4.2 Synthesis.

Another rare example of medication donation is from the United States, an organisation called Sirum (SIRUM – Saving Medicine : Saving Lives, 2022). In this organisation, national drug donation law experts empower health facilities and pharmacies to share their unused drugs along with enabling individuals to join the movement by either donating money or their unused medicine.

Free Medication Support Project was a project that was carried out in Sarıyer municipality in Istanbul from 2009 to 2017 where individuals can donate their unused and unexpired medicines and the municipality gives these medications to people in need under doctors' supervision (appendix 2). For this project, as Image 2 displays, they had built a pharmacy located in the municipality. During the exploration phase of this thesis, an interview was organised with Dr Armağan Eren who took part in this project. Therefore further insights will be discussed under 4.1 Exploration and 4.2 Synthesis as well.

2.4.2 Smart bins and reverse vending machines

According to Sarc et al. (2019), the term "digitalisation" refers to the incorporation of digital technology into daily lives. Based on their research, since digitalisation represents the fourth
industrial revolution, this integration is known as "Industry 4.0.". The terminology "Internet of Things" (IoT) is broken down into two parts: "Industrial Internet of Things" and "Consumer Internet of Things." (Sarc et al., 2019).

Based on the research from Sarc et al. (2019) Industry 4.0 refers to the broad use of information and communication technology (ICT) and its integration with the IoTs, Services, and Data, with the objective of achieving real-time management of production and value chain networks. According to them, autonomous objects such as workpieces, storage and conveyor systems, robots, machinery and equipment, mobile communication, real-time sensors/actuators, and information and communication technology (ICT) empower a massive change from previously centralised controls to decentralised, adaptable coordination of self-controlling systems. They also argue, as a consequence, responding flexibly to user requirements rapidly and decentrally, manufacturing a large number of variations with low batch sizes at the same time, implementing new user-oriented business models and increasing competitiveness are feasible.

Several approaches, designs and concepts toward “smart bins”, which can be categorised as IoTs, can be found in the field of waste management. According to Sarc et al. (2019), one of the pioneer autonomous robotic solutions in the field of waste management was a project called DustBot project which was conducted between 2006 and 2009 to improve European capitals’ urban hygiene and waste management. In partially unstructured surroundings such as squares, streets and parks, the DustBots are able to function and vacuum-clean around (Dustbot, 2020). Next to that, citizens can have DustBots delivered to their homes to dispose of small amounts of domestic rubbish and transfer them to appropriate waste collection centres. With the help of preloaded information such as a map of the area, the robots are able to work with a certain amount of autonomy. Encouragingly, this project has been restarted in late 2020 (Dustbot, 2020). While Image 3 shows the concept, a French industrial company which designs and develops innovative waste sorting and recovery solutions, Green Creative, proposed R3D3, a smart bin which automatically sorts and compacts recyclable beverage cups and packaging (Green Creative, n.d.). Another smart bin example from Finland can be seen in Image 4, called City Solar by Finbin which can be used in public environments such as city centres, airports, amusement parks and etc., is a compressing smart rubbish bin which functions with solar power (FINBIN CitySolar - Smart Waste Management, 2020). According to FINBIN, since the bins are connected and send the level of the garbage to the collection teams and the waste compression, it optimises emptying and saves costs and the environment.
While Image 5 displays a reverse vending machine example for recycling bottles in Sweden, according to Rana et al. (2022), a Reverse Vending Machine (RVM) is a system where individuals can give their recyclable items such as plastic bottles, used cans etc. and earn rewards in return such as cash, coupons or points. According to them, these machines can be used for identifying, sorting, collecting and processing such items. Based on a survey they shared which was carried out in 2014, 41% of respondents agree that reward or cash would be a motivational factor for encouraging their recycling tendencies. Based on a technical paper from Kim et al. (2021), by using barcode, vision and infrared sensors which are located near, RVM systems can sort recyclable items. Many countries have been concentrating on waste management by implementing IoT technologies where they could efficiently engage people and cities in waste management exercises (Rana et al., 2022). For instance, according to Rana et al. to track the waste level in dustbins, several sensors were used to notify the authorities whenever the bin is full to provide a solution to the leakage problem.
In their research Rana et al. (2022) proposed recycling aluminium with RVM. They have proposed recycling aluminium since it is more valuable than either plastic or glass. According to their research, this RVM attempts to encourage Malaysians to live more environmentally friendly lives by rewarding them with virtual points when they recycle. With this machine, the public will be able to recycle the aluminium can and gain virtual points while tracing the recycling history and its commonness. Moreover, they argue that it will help the aluminium scrap industry to decrease the workload of segregating aluminium, monitor the machines when their container is full and learn about RVM’s location.

Using RVMs in the medical field to collect and manage medical waste is not a completely unorthodox approach. A renal machine by Barts Health NHS is one of the first attempts based on an RVM around the renal field (Use Reverse Vending with Medical Waste, n.d.). According to them, with these RVMs, the empty virgin bottles from patients’ renal dialysis can be crushed and recycled by the renal team.

Similarly, in this project, it is attempted to explore a system around RVMs and its rewarding aspects where the medication leftovers are collected to be reused or disposed of for more sustainable futures.

3. METHOD

Under this section the project plan, design methods and the design process will be mentioned and situated briefly, later they will be discussed more in detail in the 4. Design Process section.

3.1 Project plan

The 10-week project is planned by using the GANTT Chart which can be seen in Image 6 which displays the overview of the project plan and its phases. The plan with the overseen design activities for each phase while showing overlapping exercises can be seen in appendix 13.
Because of the shortness of the project, the double-diamond model illuminated the project plan. Due to the nature and the uniqueness of the design processes, the time limitation, ongoing findings and developments the planned design activities along with the applied time needed to be adaptable to change during the process. The processes needed to be flexible enough to adapt to certain circumstances such as stakeholders’ availability and the dynamic nature of the field, the health centre in Sarıyer, Istanbul Turkey, where the most of the exploration, the synthesis, the ideation and concept phases had been conducted.

### 3.2 Design process

The initial design opportunity, reducing medication waste, had been discovered, developed and iterated several times during the process. While Figure 1 shows the detailed journey of the design process and the Figure 2 illustrates the overview of it, to discover the potential in this opportunity in Turkey, several stakeholders from the field of medicine and patients in Turkey and the individuals working in the related fields had been collaborated during the exploration, the synthesis and the ideation phases. Because of the nature of the participatory design approach in the health centre and its dynamic nature, and the chosen methods for exploration and ideation, the synthesis and the Ideation and Concept phases were intertwined. After the end of the synthesis phase, the final concept was developed to be prototyped and tested. The detailed model with reasonings behind will be discussed under the 4. Design Process section.

---

**Figure 1. Detailed Journey of the Design Process**
3.3 Design methods

To have an effective design process, several design and research methods to explore medicine usage behaviours and sharing, donating or disposing of medications stakeholders were practised with stakeholders. In this section, the methods of each phase and the reasons to use them will be presented.

3.3.1 Exploration phase

For the exploration phase, desk and literature research, observation method (Hanington & Martin, 2017), several face-to-face interviews with stakeholders (Snyder, 1996) from doctors, pharmacists to patients, and questionnaires were conducted to discover the stakeholders’ current behaviours toward medication usage from prescribing to disposal, sharing and their current practises towards medication. As Image 7 and Figure 3 show some flow diagrams (Hanington & Martin, 2017) used during these interviews to understand the current systems and facilitate and discuss new ideas, the current model of the system was shown to the interviewee as well. The models evolved after interviews with the insights gained.
As IDEO.org (2015) states, with expert interviews, designers can gain information about the subject directly while having key insights into relevant history, context and innovations. In the first days of this project, to gather insights of GIVMED regarding medication waste, donation and user behaviours, Thanasis Vratimos, the co-founder and business developer of GIVMED was contacted. Later, as Image 8 displays, expert interviews with 3 doctors and 3 nurses in the health centre, 3 pharmacists working around this health centre, and a health director in Sarıyer were organised in their workplaces. Additionally, expert interviews with other 2 pharmacists were also executed. These expert interviews were performed to gain key insights quickly into the field of medication waste and sharing possibilities along with understanding the patients' behaviours from health specialists’ perspectives. Since sharing, donating and disposing of medication are critical and require professional knowledge, interview with the experts in the field was an effective method to gain knowledge quickly.

According to Hanington and Martin (2017), people, objects, the environment, events, behaviours, and interactions can be documented through observation to distinguish between observed behaviours and inferences, guessing the meaning and intentions of acts. In the health centre in Sarıyer, Istanbul, this method had been conducted in and around the health centre before and after interviews and brainstorming sessions to have a better understanding of stakeholders' behaviours.
Since observing intended users or stakeholders may not be enough to gather critical information to have an understanding of the topic, interviews are an effective method to be used during the discovery phases of the design projects. They are face-to-face dialogues which can be helpful for in-depth interpretation of the perceptions, thoughts, motivations and behaviours of the users (Zijlstra, 2020). While Image 9 shows some of the scenes from the fieldwork, with 6 patients in the mentioned health centre in Istanbul, face-to-face interviews were conducted to understand their behaviours concerning medication usage and possible motivations regarding the subject of sharing or donating unused and unexpired medications. Interviews were started with introducing the project and the interviewer herself, followed by some ice-breaker dialogues. Also because of the nature of the place, interviews took around 10 minutes depending on the interviewee’s time while waiting in their queue to see their doctor or after their appointments and willingness.

Image 9. The scenes from the fieldwork

Questionnaires can be used as a research tool when needing quantitative information about users’ opinions, beliefs and needs from a large number of people rather than a limited group of people with similar mindsets (Zijlstra, 2020). A questionnaire among Turkish citizens about medication usage behaviours was executed to have a better understanding of the topic and the users’ decision-making process when it comes to donating, sharing or obtaining unused and unexpired medications. The questionnaire was open to all citizens who are older than 13 and regardless of the fact that the respondent is a specialist in health or chemistry areas and was not aimed to take more than 10 minutes.

Naturally, some challenges were encountered during this process. One of the main problems in interviews is the trust issue between the interviewer and the interviewees when they are not acquainted (Myers, 2013). For this project’s expert interviews only, this trust issue was not experienced since the parties were acquaintances. However, the interviews with the patients needed additional effort to build trust. After interviewing the first patient, the questionnaire was kindly introduced to the participant to fill out if they wish either from their own mobile phone or the interviewer’s. The help was also offered if needed. Confidentiality of the questionnaire was also assured. However, the participant expressed her extreme fear and untrust in the questionnaires and shared previous bad experiences with them. This fear of questionnaires may have happened for several reasons starting from undoubtedly the ill will of the interviewers to the educational level and technology literacy of the participants. After this instance, the interviewer decided not to mention the questionnaire and continue with informal face-to-face interviews.
3.3.2 Synthesis phase

During the synthesis phase, the affinity diagramming method had been applied which is a method used for meaningfully clustering and expressing observations and insights from the exploration phase (Hanington & Martin, 2017).

Affinity diagrams for the insights from doctors, pharmacists, a health director, patients and a business person from GIVMED and the questionnaire were made on a Miro board and then summarised into main insights.

While Figure 4 shows the mapping of the insights of the questionnaire which was conducted for this project to explore medication usage behaviours of Turkish citizens, one of the underestimated aspects of this process was synthesising insights in Turkish and translating them to English. For the sake of time efficiency, grouping and summarising the insights in English were the used approaches instead of translating each insight for the time efficiency.

![Figure 4. Mapping of the Insights of the Turkish Survey](image)

3.3.3 Ideation and concept phase

During the ideation and concept phase, informal brainstorming workshops with flow diagrams from brainstorming graphic organisers (Hanington & Martin, 2017) with 2 doctors and 3 nurses who are working in the community health centre were conducted in different sessions because of their availability. Later the idea was discussed in different sessions with a doctor and 2 pharmacists who are working in different locations to gain different perspectives. The objectives of these sessions were ideating a platform/system where citizens can donate their unused medication to be used by someone else again and exploring the incentives of the stakeholders around the platform/system of this project from their perspective.

According to Hanington and Martin (2017), the brainstorm graphic organisers are aiding people to create new ideas and concepts by structuring problem space visually. Based on their research, the flow diagram method which is a type of brainstorming graphic organisers can
be used for describing events which are in sequence, illustrating actions and processes of different actors in a system or giving cause and effect of these interrelated components.

During these ideation workshops, the design researcher pointed out some pre-selected questions from the Circular Designs Ideation Pack from the Use2Use design toolkit for initiating and generating ideas and discussing the possible obstacles (The Use2Use Design Toolkit – USE2USE – Circularity from a User Perspective, n.d.). The questions have been selected from the Design for Exchange and Design for Circular Match-Making sections of the toolkit. The Design for Exchange section addresses design challenges related to people’s obtainment and clearance processes and the latter deals with the interaction between two subsequent users while focusing on communication and trust. After the selection of the questions, they were adapted to the concept by the design researcher (appendix 7). The questions were not printed out since they were in English and the sessions were informal without having defined time due to their work environment. For these reasons, the adapted questions were asked by the researcher during the sessions. Discussions were carried out with the aid of the diagrams drawn during the synthesis phase which can be seen in Figures 6 and 7 in English under 4.3.1 Preparation. The mentioned figures can be found in Turkish in Appendix 11. Sometimes, during these ideation sessions, in order to create a better understanding, the instinctive use of the role-playing method by the participants where participants act as users in realistic scenarios (Hanington & Martin, 2017) was also observed.

3.3.4 Prototyping and testing phase

In the prototyping phase, the prototypes of the mobile application and the reverse vending machine were designed to be tried sequentially by the users in Experience Prototyping sessions aided by the methods of Usability Testing and the Wizard of Oz technique (Hanington & Martin, 2017) as they were truly experiencing this system during the testing phase. Additionally, possible integration with the existing e-Nabız application and the U-Med proposal was discussed after the introduction of e-Nabız to the ones who are not familiar with it. To have their final insights, the prototypes were also evaluated by a doctor and a pharmacist who participated in the design process previously. Throughout the testing phase, improvements to the prototypes were made according to users’ comments and feedback. The testing sessions took approximately 45 minutes with the discussions.

Usability Testing enables designers to concentrate on users and their tasks to enhance the usability of an interface while seeking empirical evidence during those tasks (Hanington & Martin, 2017). In these sessions, users were encouraged to think out loud for the researcher to observe their interactions, pain points, frustrations and the points they find useful while they were performing the given tasks according to the scenario. The scenario will be explained in detail under the 4.4 Prototyping and testing section.

For investigating and evaluating the physical touchpoints of a system over time and space with users, such as with low-fidelity mock-ups portraying information kiosks, mobile devices and apps, and key personal roles engaged in the service, the Experience Prototyping is a powerful technique to perform (Hanington & Martin, 2017). Since this project has many touchpoints such as the mobile application and the reverse vending machine, the Experience Prototyping method was used to both understand the individual touchpoints and also the sequence of them as a whole.
KULTUR OCH SAMHÄLLE

In the prototyping phase, the interface of the application which can be downloaded by the citizens to check their medications, find donation spots and create appointments for their cold-chain medications and the interface of the reverse vending machine where users can dispose of or donate their leftover medications were designed. As Image 10 shows the connections between the screens, the interfaces were linked to each other according to the user tasks that would be examined during the testing sessions. To prototype these interfaces, the prototyping tool called Figma was used.

![Image 10. Linked interfaces according to the user tasks](image10)

Additionally, as Image 11 displays, the low-fidelity prototype of the reverse vending machine was made to be used during the testing sessions with the aid of the Wizard of Oz technique which encourages designers to mimic system responses from behind the scenes during users interacting with the system (Hanington & Martin, 2017). This prototype was done to simulate the reverse vending machine’s sorting function, to examine the interactions with the participants and to observe their reactions.

![Image 11. Low-fidelity prototypes of reverse vending machine](image11)

The language barrier was also one of the challenges faced during the testing phase. Because of the time limitation, the prototypes were designed only in English for the audiences of this thesis. Also, since the reverse vending machine prototype needed to be tested physically, the majority of the participants were based in Malmö from different nationalities although 2
Turkish participants who live in Malmö partook in testing. Engaging with individuals from different nationalities did not necessarily mean a downside of the testing sessions since it allows to gather varied perspectives.

It goes without saying that, without facilitating the system in real life, expecting to tackle every aspect from each stakeholder of this system would be a naive expectation. In the process, many problems therefore opportunities may arise for further developments.

4. DESIGN PROCESS

In this project the medication usage behaviours of patients and the notions of health professionals and patients towards sharing and disposing of medications were explored with a user-centred design and participatory design approaches, to prevent increasing medication waste and suggest a more sustainable system which has positive impacts on both the environment and the society in Turkey. Therefore the collaborations with the doctors in a community health centre in the Sarıyer district in Istanbul, some of their patients and some pharmacists nearby were established during this project to gain insights from the stakeholders and create a solution with them.

In this section, the applied design process and its findings will be discussed more in detail. The reasoning behind the decisions, the obstacles and challenges faced and how they all inspired the process will be shared.

4.1 Exploration

In this section, the findings of the exploration process from participants in Turkey and Greece along with the desk research around medicine usage and sharing in order to reduce medication waste will be discussed under 4 sub-themes: Trust, Altruism, Alternative Use and Legislation.

4.1.1 Trust

One definition of trust is a belief that one can depend on someone or something, according to the Cambridge Dictionary. For participants, one of the main motivators observed to share and encourage people to obtain unused or donated medications is to ensure this belief.

According to the questionnaire while its findings can be found in appendix 12, and the interviews conducted with patients, the encouraging experiences of acquaintances such as friends and family members with the medications, and the giver and the receiver having good knowledge regarding the medication are influencing the trust to share and obtain unused medications. Around 60% of the respondents of the questionnaire who would not prefer using unused and donated medications reported that they would prefer taking the donated unused medications from their doctors if they have to instead of their pharmacists or acquaintances. One of the critical findings from the interviews which also supports the questionnaire’s findings was that borrowing medication from different people along with health specialists was an actual practice while consisting of trust issues. Another interesting insight observed was that some of the patients knew what they want or need in terms of medication and ask specifically for those medications from their doctors and the doctors also have some level of trust in their regular patients in these cases.
While the majority stated positive comments and trust towards the idea of sharing or donating their unused and unexpired medications to a safe place that takes care of the medications and donates them to people in need, some still showed concerns about misuse and storage history of medications. Trust towards the system seemed the most crucial concern according to the open-ended answers in both questionnaires and interviews. While the respondents of the questionnaire support the idea of having a safe place to donate unexpired and unused medication and the need for it, the indispensable role of the doctors in this project of sharing and obtaining unused and unexpired medication once again was testified with this questionnaire. Due to the participants’ trust in doctors in this field, it was supportive data that the places where the donated medications will be distributed in this project should be the places where the doctors are.

Although the necessary storage conditions and temperatures of some medications are in wide ranges, some of the primary conditions for health professionals to trust the unused medications are that they comply with storage conditions and being able to trust the effectiveness and sanitariness of these medications due to their storage and usage history. According to the interview with Thanasis Vratimos, the co-founder and business developer of GIVMED, in order to overcome the storage issue, GIVMED accepts the medicines which are unexpired except the open creams, drops, syrups, inhalers and medicines that need to be stored in the fridge and donate them to the institutions called Social Pharmacy and some other organisations in Greece. The most critical aspect for this system to work efficiently is these trusted places, Social Pharmacies’ existence in Greece. Currently, in 2022, they are located around 120 different spots, where medications and pharmaceutical products are provided free of charge to the people who are in need and have limited access to the health system such as the unemployed, elderly people, and homeless people and migrants. Additionally, they have been operating for around 7 years now and no side effects have been reported. Based on the interview with, Dr Armağan Eren, the health director in Saryer municipality, during Ücretsiz İlaç Desteği (Free Medication Support) project, they had been mostly accepting the unopened medications from people who had changed doses to the relatives of deceased people who had their unopened medications to avoid storage issues and prevent tampering. They had been collecting the unopened cold-chain medications from the patients’ houses in order to avoid the disruption of the cooling process. While these concerns are in mind, according to the doctors interviewed, to minimise any possible side effects and build trust in a system where donated medications are distributed, patients need to be monitored after taking unused donated medications.

During the online meeting with Thanasis Vratimos, while the initial idea was medication sharing between patients in close neighbourhoods back then, he shared their previous experiences that their initial idea around medicine sharing was also designing a process between patients. Although after their initial research with the specialists, they decided to create a system around Social Pharmacies due to the trust and health concerns, different medication usage and legal issues. Especially this learning helped to shape the initial idea into a more defined one until the next interviews with the specialists in Turkey.

Overall, the discussions with the health specialists, Thanasis Vratimos and the questionnaire conducted in Turkey helped shape the idea of this thesis around the unopened medications, doctors and additional monitoring to endorse trust.
4.1.2 Altruism

Based on the questionnaire and interviews conducted, another factor influencing medicine sharing is helping others and the sense of community. Supportively, according to the similar research held in New Zealand regarding medicine sharing by Beyene et al. (2016), one of the main motivators for individuals who state sharing medicines with others is usually helping them, in other words, altruism as well.

Also according to the observations held in and around the health centre in Sarıyer, it was once again noted that there is cooperation between people in many ways. Since it is a health centre and welcomes people in need, health specialists collect baby food, cloth and other items to donate to people in need from their acquaintances or other patients in the health centre. As Image 12 shows some altruistic examples from the field, they are also working on creating newborn boxes that include leaflets to educate mothers, diapers, lotions, creams, cloths etc. too. Additionally, there are donation boxes for clothes located close to the health centre for people to donate their unused clothes to the municipalities as well.

![Image 12. Altruism examples in Turkey](image)

*Image 12. Altruism examples in Turkey (Left: Items from the newborn box Right: Donation box for clothes)*

As Image 13 shows the collected unused medications by doctors, according to the interviews with health professionals, sharing unused medication is an applied practice even though it is not supported openly by the authorities. Sample medications from companies, vitamin Ds and some other drugs are given to patients for several reasons such as helping people who cannot afford or access medications, reducing the rate of child-mother death and advertisement reasons. Once they receive unused medications from a patient or someone else, the first thing they do is to sanitise them with sprays. Also, some doctors stated they used to send medications to war zones where they even sent the expired ones.
Based on the activity report of the Ücretsiz İlaç Desteği (Free Medication Support) project, between 2009 and 2017, they reached 11960 patients and donated 27897 packages of medication which would make 2.3 packages per patient overall (appendix 2). Additionally, according to Dr Armağan Eren, the main target group of this project was the citizens who are not able to pay their premiums due to financial reasons and therefore cannot be able to obtain their medications from pharmacies because of the Turkish legislation even though they are insured. Items like prostheses, orthosis, oxygen tubes and baby food were also attained for these people under the project.

4.1.3 Alternative use

According to the interviews conducted with the patients and the questionnaire, the awareness towards disposal of medication is poor. The majority throw the medications into the regular bins. Some mentioned giving them back to pharmacies or their doctors if they have not used them. One interviewee stated that she never thought of throwing the medications away and said that she keeps all of the medications in a drawer.

However, there are alternative ways of handling unused or expired medications for different cases too. Some health specialists mentioned they have been using kidney medications for flowers and birth control pills for their hair. Some pharmacists mentioned a WhatsApp group chat of doctors, pharmacists, veterinarians and pharmaceutical representatives where they collect expired medications and items like eye drops, cleaning solutions, baby food, and antibiotics and use them in animal shelters under a veterinarian's supervision. They give unexpired and suitable ones to the ones in need under doctors' supervision. Medications are controlled by doctors and pharmacists in this group and pharmaceutical representatives are responsible for the delivery.

These insights along with the experiences of field experts showed that alternative ways of handling medication waste have great potential.

4.1.4 Legislation

Based on the interviews with health professionals, distributing unused medications in places other than pharmacies is strictly forbidden in Turkey for many reasons such as medications being personal, individually prescribed and easy to tamper with. Based on the Cumhuriyet’s
news, according to the statement made by the Turkish Ministry of Health, access to 2303 websites that were found to be selling and promoting drugs over the internet in 2020 was completely blocked, and criminal complaints were filed with the Chief Public Prosecutor's Office for the purpose of establishing legal action against 608 websites (“İnternetten ‘ikinci el’ ilaç satışı! Sağlık Bakanlığı harekete geçti,” 2020). It was stated that the necessary actions were meticulously carried out for the ‘second hand’ concept website, social media account and mobile applications where the sale of drugs was detected, the accounts where the sale of drugs was blocked, and a criminal complaint was filed with the prosecutor's office for the judicial process facility. In addition, it was noted that the risks brought by the purchase of non-pharmacy drugs were emphasised on the official social media accounts of the ministry, and informative and warning posts were made regularly.

According to the activity report of Ücretsiz İlaç Desteği (Free Medication Support) (appendix 2), after operating for around 7 years, this service, which has become an indispensable public service for the patients who are insecure and cannot reach medicine and medical supplies, has been terminated as of August 2017 as a result of the Ministry of Health legislation and the notification of the Istanbul Provincial Health Directorate.

According to the interview with Thanasis Vratimos, in Greece, even though Social Pharmacy’s foundation was supported by the Government of Greece back in the days, right now they are facing some legislation problems with the government as well. One of the reasons these problems have been occurring is the concern of the profit from the medication.

The harms and dangerous consequences of unconscious drug distribution made beyond the control of experts in this field cannot be denied. Considering these matters, this thesis is trying to explore a system around sharing and obtaining unused medications which are controlled by the authorities of the field to create more environmentally friendly, economical and social solutions to medical wastes. Discussed issues along with possible political concerns and disagreements, motivated to develop this system among wider masses and cross-neighbourhoods governed by different political parties to create a solution to a common problem together while aiming to create a sense of community.

4.2 Synthesis

As Figure 5 shows, the synthesis process had been done with affinity diagrams for the insights from doctors, pharmacists, a health director and a business person from a field-related NGO and the questionnaire was made on a Miro board.
Later, the insights from the interviews and questionnaire were summarised into 9 main insights. The order of the list does not show any importance:

- **Trust**: For this system to work, both patients, doctors and pharmacists need to trust the quality of the medications.
- **Storage**: The storage history of the medications is critical and important for them to be reused.
- **Altruism**: People are used to helping each other in Turkey and they are willing to do it when they can. E.g: cloth donation, unused items donations etc.
- **Quick disposal**: Users of the GIVMED platform are mainly looking for a place to dispose of their medications quickly rather than helping others.
- **Sharing, an applied practice**: Giving unused and unexpired medications under doctors' supervision is an applied practice in certain cases. E.g: to people in need, war zones, advertisements etc.
- **Monitoring**: Patients need to be monitored after taking unused donated medications
- **Sense of community**: Health professionals have informal communication channels where they share unused, unexpired or expired medications depending on the use case between each other.
- **Incentives**: Different stakeholders have various incentives to participate in this service. Apart from the most common one, altruism, doctors would like to be encouraged to use these medications and patients are interested in gaining extra services.
- **Alternative use**: Medications are being used for alternative cases such as kidney medications for flowers, birth control pills for hair or certain medications for animals in the animal shelters.
- **Legislation**: Currently, it is not legal to share used medications and it is a must to be supported by the Turkish Health Ministry. But there have been instances where new legislation made for exceptional services.

### 4.3 Ideation and concept

As a matter of fact, the ideation phase co-existed during the whole period of interviews and brainstorming sessions with the experts. Under this section the preparation for this phase, the activities and learnings will be shared.

#### 4.3.1 Preparation

After the discussions with the health director, the target group of the receiver of these medications has developed and focused on the ones who cannot pay their premiums and therefore cannot obtain medications from pharmacies. The model was first drawn in a notebook in Turkish during a discussion with a doctor and a pharmacist which can be seen in Image 6 and later translated into English for the audience of this thesis as can be seen in Figure 3 under 3.3.1 Exploration phase. Discussed issues, also for political concerns, led to designing this system among wider masses and cross-neighbourhoods governed by different political parties to create a solution to a common problem together while aiming to create a sense of community.

Improved diagrams of the system were drawn by the design researcher in line with the other previous research outputs and insights to support the ideation and concept with the experts.
While Figure 6 (appendix 11) illustrates the diagram for the normal medications which do not need certain storage conditions as the cold-chain ones, citizens in different neighbourhoods governed by different municipalities find the nearest collection points through a mobile application where they can dispose of their medications to be checked by the pharmacists. After the examination, medications which pass the test are sent to Family Health Centres (FHC) in the low-income neighbourhoods to be prescribed by the doctors to the patients in need who are not able to obtain medications from pharmacies. As Figure 7 illustrates (appendix 11), a similar process is followed for cold-chain medications, except for the collection phase. During the collection, collection teams come to collect the cold-chain medications from the citizens when the citizens are convenient. Citizens can create appointments for their cold-chain medications through the mobile application.

Figure 6. Improved diagram of the system for normal medications

Figure 7. Improved diagram of the system for cold-chain medications
4.3.2 Activities and learnings

During the brainstorming workshop with the health specialists, while discussing the improved diagrams, to assist this ideation process, some questions from the Circular Designs Ideation Pack (appendix 7) from the Use2Use design toolkit (The Use2Use Design Toolkit – USE2USE – Circularity from a User Perspective, n.d.) were used to initiate and generate ideas, and discuss the possible obstacles. The selected and adapted questions were set around trust-building between everyone involved in the medication sharing, making medication sharing and disposal accessible, activations to circulate unused, unexpired or expired medications and facilitation of the cleaning of the packages. Based on these questions, activities and learnings will be shared under 3 sub-themes: Trust, Accessibility and functionality and Activation.

4.3.2.1 Trust

According to brainstorming workshops with the experts, the trust in the system can only be done by collaboration with the Ministry of Health and their support which is the crucial factor for this system to work. To reinforce trust, donations should only be accepted by citizens with IDs. This would also help the system to assess whether the medications are safe since the medications are assigned to individuals and can be tracked. Furthermore, to avoid abuse and intrusions, the collection of normal medications should be done in trusted places such as large hospitals, health centres and places like supermarkets. During the distribution of these unused donated medications, synchronisation with the pharmacists’ systems is also vital to avoid misuse and multiple purchases from these distribution places and pharmacies. When it comes to reusing and collecting unused cold-chain medications, it is reported once again that it is critical and can be dangerous since they may lose their effects or get harmful to patients. Taking these concerns into account, the collection and the reuse of these medications can be still considered if it includes dedicated collection teams and examiners. The control of the medications can be done by a group of allocated pharmacists in the neighbourhoods. When in need of further examinations, sending the medications to their production sites can be considered. Still, gaining everyone’s trust and making them contribute to the system seems impossible. For that, experts suggest leaving the decision to take the donated medications or not to the patients after their doctors’ recommendations. To minimise the possible side effects and ensure trust in the system and these donated medications, patients need to be monitored after taking unused donated medications.

4.3.2.2 Accessibility and functionality

Based on the sessions, equipping accessibility can be done by providing convenient collection points and an application which can be downloaded by citizens. The collection request for cold-chain medications can be facilitated through the application according to the provider’s availability. The collection of normal medicines can be done with reverse vending machines at these points where the sanitization can also be undertaken. Reverse vending machines have been considered since they are convenient to use, sustain labour-saving and are able to undertake the sanitisation process. Those who do not have smartphones can check their medications at the collection points and can also create appointments for their cold-chain ones at a call centre.
4.3.2.3 Activation

Activating users to contribute to the system can be done by providing them motivation next the sake of altruism. According to the sessions, to motivate citizens to donate their unused, unexpired or expired medications, points or a certain amount of money can be defined to their ID for each medication they donate which eventually can enable them to get ahead in the health system in terms of setting appointments and having discounts in pharmacies etc. These points can be assigned to the e-Nabız application (e-Heartbeat, an application that Turkish citizens and health professionals access to health data collected from health institutions) after the donated medications pass the controls done by the pharmacists. For pharmacists, controlling these medications will be another branch of work. Motivating doctors to prescribe donated medications, and defining positive performance for the ones who prescribe those drugs can be considered. Additionally, a certain amount of money for each prescribed donated medicine can be allocated to the health centre to be used for the needs of this health centre such as utility bills.

4.4 Prototyping and testing

4.4.1 Prototyping and the scenario of the testing session

In order to support the scenario of the testing session which will be explained in the following paragraphs, the interfaces of both the mobile app and the RVM were designed accordingly in Figma. As Image 14 shows, the RVM’s physical prototype was first sketched on a tablet and then built with affordable materials such as mock-up cardboards, paper plates and paper. The choice of the materials was indeed the affordability but also testing the critical elements quickly while making sure the participants got the main idea.

Image 14. Reverse vending machine (RVM) sketches

In the testing sessions, the schedule of the sessions along with 4 different leftover medications was given to the participants. They were asked to imagine having these medications at their home and how they would like to handle them. These medication states were chosen to test possible scenarios. The medications’ states were:
Later, as Images 15 and 16 show instances of users engaging with the mobile application prototype and the RVM prototype, they were first asked to explore the mobile app prototype, check their given leftover medications through it and find a way to deal with their medications. After this session, in line with the scenario, they were accompanied to the RVM prototype to complete the donation and disposal of their leftover medications. While Image 17 displays the current state of e-Nabız and the possible integration, at the end of these sessions, the e-Nabız application as well as a mock-up of a possible integration were shown to discuss a potential integration of the U-Med into the existing e-Nabız application. Participants were asked what kind of potentials and risks they would see with these kinds of interactions with the touchpoints and the possible integration with the existing application. Some participants were introduced to e-Nabız since they were not familiar with it. Throughout all of the sessions, users were asked to think out loud.

Sometimes during and sometimes after the testing sessions depending on the level of work, improvements such as wording changes and implementation of more explanations were made on the prototypes to be tested at the next sessions according to the feedback of the participants and the researcher's observations.

![Image 15. Instances of users engaging with the mobile application prototype](image15.jpg)

![Image 16. Wizard of Oz with the low-fidelity prototype of the RVM and a user engaging with it](image16.jpg)
4.4.1 Insights

In this section, the insights from the testing phase will be shared under 4 sub-themes: Information, Privacy and safety, Integration and Flow.

4.4.1.1 Information

During the beginning of the testing session with the mobile application, some of the participants struggled with which medications to scan and how to scan their medications. One was concerned if they should have scanned the expired medication too while also considering unpacking the unopened medications to scan the medications inside. Some had difficulties understanding the difference between the terms like normal and cold-chain medications and the potential and earned points, although some discovered the differences once they proceeded and some needed further explanation made by the design researcher. Some also mentioned the need of having reminders like notifications about the set appointments for their medications. These all show the need of educating users about the system with a comprehensive and well-designed onboarding session along with providing them with the necessary information when relevant.

Although the design has the statuses of the medications like disposed of, under examination and shared, one suggested seeing the journey of the donated or disposed of medications. Another supported the idea since this would mean a confirmation that the system is doing what it claims for many people while mentioning they would not need to know this journey to continue contributing themselves.

4.4.1.2 Privacy and safety

Some participants were critical about having their IDs exposed. While Image 18 displays the early version of the profile page of the app, one of the participants was analytic when they saw a name and a picture on the profile page of the mobile app, then referred to preferring
having a dummy name and representative avatar on the language learning platforms. Also shared their disquietude about the government receiving all information. Another user expressed discomfort while sharing their ID during interacting with the reverse vending machine prototype. All are convinced once the importance and reasoning of the ID sharing are expressed, which is that medicine sharing is diligent practice, requires trust and accountability and the medications are already assigned to individuals when they are first acquired, therefore also for the safety reasons, sharing ID during these experiences is advised by the health professionals.

Additionally, some users expressed contentment with the interaction with the RVM after asking if they would prefer to have this experience with someone who is delegated or something else. One stated that they found the interaction with the RVM fun and declared since the medications are personal and can be private, they would not prefer to interact with another person. Some other participants also shared these comments and found the familiarity with the machine and its attributes useful to recognize and interact with since they are used to engaging with reverse vending machines to recycle in their home country. These insights support providing the sharing or disposing of medications interactions with the RVM rather than with something completely novel or someone who can criticise.

Many participants assumed these RVMs would be in the hospitals and in the pharmacies, or maybe the supermarkets. One participant specifically stated that these places need to have a serious impression and be safe while being in public places in order to be accessible by many. Therefore according to the testing sessions, equipping these machines in proposed places was found relevant and accessible by the participants.
4.4.1.3 Integration

In general, the possible integration with the existing application e-Nabız which can be seen in Image 16 under 4.4.1 Prototyping and the scenario of the testing session section, approached differently by participants.

Some found the potential integration with an existing application useful to access many users of the existing one while some declared having a stand-alone application is functional to focus on a single theme which is reducing medication waste by sharing or disposing of them. Some expressed frustrations of having many applications on their smart devices and therefore found the integration sensible to reduce their memory usage on their smart devices while some were sharing that they do not check every feature of the existing applications they have, for not being missed out they were preferring having a stand-alone application. One participant shared that having integrations with applications of established organisations or governments may be difficult and shared one of their acquaintance’s struggles with unmet integration proposal about body weight and scales with e-Nabız. This participant also found having a stand-alone application useful and imagined having additional features and discounts in other sectors such as cosmetics with the U-Med application.

Overall, about this matter, a consensus about users’ preferences has not been established yet but having the function in these different applications may be considered.

4.4.1.4 Flow

In general, along with the improvement areas mentioned previously, the flow of the system between the mobile application and the RVM was found functional, clear and useful. The given feedforward and feedback were found relevant and helped users to engage with the system.

Mostly, the information given on the mobile application had been iterated during the testing sessions with feedback from the users rather than the RMV design. This may have happened since the mobile application is the first place where the users are informed about and engaged with the system. The RVM was found engaging and fun. While users were inserting their medications, the sound and physical effects were done by the researcher with the aid of the Wizard of Oz method. This method was found effective and made the experience with the machine more fun.

5. MAIN RESULTS AND FINAL DESIGN

A model in Turkish society which is supported by the Health Ministry can encourage individuals to share their unused and unexpired safe medications and to dispose of expired or opened ones, as well as health professionals to prescribe these safe medications to those in need of reducing pharmaceutical waste and ensuring a more equitable healthcare system for all. In this section first, the U-Med model (U: Unused, Med: Medications) will be explained. Then the U-Med mobile application and the U-Med RVM designs will be shared. The Turkish name of the platform is called KİT (Kullanılmamış İlaç Toplama) which can be translated as “Collection of unused medications”.
5.1 U-Med model

The concept of U-Med is a non-profit platform supported by the Ministry of Health where Turkish citizens can give their unused medications which are either expired, unexpired, opened or unopened. After the examinations, the people in need access the safe medications. For the other medications, they are either sent to dispose of or to be used in other industries.

![Figure 8. The Unused Medications’ Journey in U-Med System](image)

While Figure 8 shows the unused medications’ journey in the U-Med system, citizens with unused medicine first enter their leftover medicines on the U-Med mobile application and list nearby collection points for normal medicines. In the collection points which are health centres, hospitals, pharmacies, supermarkets and municipalities, medications are collected...
by RVMs by the citizens. RVMs are provided to reduce the workload and labour costs and to enable accessibility and privacy.

The RVMs accept all kinds of medications to reuse or dispose of. In order to be reused for human care, the medications must be unopened and unexpired and also must pass the inspections carried out by pharmacists in the relevant municipalities. The expired medications and the medications which do not pass examinations for human reuse can either be sent to disposal sites or to other industries such as plant irrigation or facilities such as animal shelters depending on the need and type of the medication.

If the drugs pass the inspection carried by pharmacists under the relevant municipalities, points are defined both to the e-Nabız application of the citizen and U-Med. These points can be used in the health centres (hospitals, pharmacies etc.). Some medications can be considered to be examined more in their production sites before taking them back into the system. After the examinations, safe medications are sent to the Family Health Centres (FHC) in the low-income neighbourhoods to be prescribed by the doctors to the patients in need who are not able to obtain medications from pharmacies. Doctors present the possibility of obtaining these donated medications and the option of attaining them from the pharmacies. The final decision will be on the patient whether she or he prefers using these donated free medications. The patients who prefer taking these medications are monitored by their doctors for minimising the side effects of these medications. To motivate doctors to prescribe donated medications, positive performance is defined once they prescribe those drugs. Additionally, a certain amount of point for each prescribed donated medicine is allocated to the health centre to be used for financing its needs such as utility bills.

Proposing a sharing system for cold-chain medications has been considered critical and potentially dangerous because of the uncertainty of their previous storage history. Yet a system which tries to find ways to include these medications can be still considered while taking into account the risks. For the cold-chain medications, a similar process as normal medications is followed for cold chain drugs, except for the collection phase. During the collection, collection teams come to collect the cold-chain medications from the citizens when the citizens are convenient. If they have cold-chain medications, citizens make appointments for the teams to pick up their cold chain medicines from their homes through the U-Med application. The further steps are carried out as the normal medication flow.

The U-Med system’s applications, which are the mobile application and the RVM, and the users are communicating through feedforward and feedback elements on the interfaces and the user’s interpretation of these. The style of the interaction proposed with these applications has the qualities of turn-taking, directness and simplicity and it is dialogue-based. Hornbæk and Oulasvirta (2017) define the dialogue concept as “a cycle of communication acts channelled through input/output from the machine perspective, or perception/action from the human perspective.”.

According to Hornbæk and Oulasvirta (2017), optimal behaviour interaction appears when the rewards, costs (or utilities), actions and constraints posed by the tasks or the environment are included in the system. They state that the goal is to adapt the behaviour to maximise the utility according to the user’s capabilities. In light of these, it can be argued that the role of the U-Med system has some aspects of optimal behaviour change interaction. The whole U-Med system is built around changing behaviours of current use ways of unused medication by offering incentives such as rewards and points and transforming it into reusing or properly
disposing of the medication. Currently, there is no established and well-functioning system around these concerns in Turkey.

5.2 U-Med mobile application

As Image 19 displays the main screens of the U-Med mobile application, the clickable prototype of the mobile application and the RVM can be reached in Appendix 9. The U-Med mobile application enables Turkish citizens to check their leftover medications to dispose of or to share with others, find the nearest drop-off points to leave these medications, create appointments for collection teams to pick up their cold-chain medications and collect points with each contribution to be used in the Turkish health system.

Users are encouraged to take part in the system with the points assigned to them after each contribution along with the data shared by the platform on the Home screen varying from how many people accessed the medications to what kind of services they can get with their points.
According to research from Chakrabarti and Luger (2012), a conversational user interface (CUI) is software that performs simple and fundamentally repeated activities inside a messaging feature in a natural way. As Image 20 shows the flow, after the onboarding about how to donate or dispose of the leftover medications, on the Donate screen users are accompanied by CUI to check and find a way to handle their medications. They can register their leftover medications to the application by either scanning or typing the code on the package. After they check the medications that they registered. If they have cold-chain medications, they create an appointment for the collection team to collect their medication. For the normal medications, they can find the nearest drop-off points.

Image 20. The flow of checking medications, finding drop-off points and creating appointments

On their profile, users can follow their upcoming appointments and the medications to drop off along with the medications that they have already donated or disposed of. Users can keep track of their points on their profiles. They can earn points with every donation of their unexpired leftover medications and disposal of their expired or opened ones. Points are assigned after the examinations for safety, done by the pharmacists after users leave their medications at drop-off points or collection teams collect their cold-chain medications.
5.3 U-Med RVM

The U-Med RVMs (appendix 9) are located in drop-off points such as hospitals, health centres, pharmacies and supermarkets for Turkish citizens to share or dispose of their unused medications.

While Image 21 displays the main screens of U-Med RVM, citizens with unused medicine identify their IDs on these RVMs to start the process. They can either scan and read their IDs or log in with their e-Devlet (e-Government) credentials. E-Devlet is a resource that enables fast and secure access to Turkish government services (Hakkımızda, 2022).

Then they start to insert the medications into the tunnel of the machine. In the tunnel, the medications are sanitised and sorted by the sensors by checking the QR of the medication and the condition of the package. The users are assisted to insert their medications by the illustration as a feedforward, on the screen pointing to the tunnel. After every medication intake, users are informed about the medication’s name, its expiry date and its status assessed by the RVM. These statuses can be as follows:

- Under Examination: If the medications are unexpired and unopened
- Opened Package / Disposal: If the medication’s package is open
- Expired / Disposal: If the medication is expired

According to the statuses, users can see the potential points that they can earn or the points that they already earn. If the status contains the term “Disposal”, they directly earn 1 point. If it is “Under Examination”, they can earn 5 points after the medications pass the...
examinations. If the medication cannot pass the examinations, users get 1 point as Disposal statuses.

After completing the interaction with the RVMs, users are logged out from the system automatically for safety reasons.

Since the RVMs are connected to the system and send the amount and the type of the medications gathered, the collection of these medications by the authorities for disposal, examinations and then their distribution can be managed effectively.

**6. EVALUATION/DISCUSSION**

The concept of U-Med explores reducing medication waste in Turkey by focusing on reusing the shared leftover medications. The idea is woven around two digital entities, the U-Med mobile application and the U-Med RVM. The main human actors involved are the patients who share or dispose of their unused medications, the dedicated pharmacists who examine the medications, the doctors who work in the low-income neighbourhoods who can prescribe these medications, and lastly, the patients who receive these medications since they cannot obtain their medication from pharmacies due to financial reasons. Some of the other players in this system are the veterinarians who work in animal shelters and the animals who need medications and the individuals working in irrigation industries and the plants which are irrigated by them.

The topic of the reuse of normal and cold-chain medications after the purchase was chosen because of its potential to have an impact on the environment and the behavioural change of the actors. It was chosen over the topic of changing the production or prescription methods as the changes in these fields would be lengthy processes and connected to the changes at the system and the governmental levels. Additionally focusing on post-purchase and working around this topic were more accessible during this thesis’ process.

As mentioned before, suggesting a reuse system for cold-chain medications is considered critical and potentially dangerous. While taking these concerns into account, the U-Med suggests including these medications in the system for several reasons while providing additional examinations for these medications. If these medications are found to be unsuitable for human care, they can be considered to be profited by non-human actors or safely disposed of. Furthermore, in the future, the technologies and further developments around these medications might allow us to understand more about their previous storage histories and safeties which may open the possibilities for safe reuse.

Findings of the exploration process about the medication usage behaviour and sharing motivations were underpinning some of the previous research done in the field, such as the one by Beyene et al. (2016). Reducing medication waste around sharing has previously been studied and currently been carried on by some organisations around the globe as mentioned in 2.4.1 Medicine sharing and elaborated in 4.1 Exploration too. While the concept of U-Med surely supports these formations and shares some similarities with the mentioned similar works like GIVMED (2022), Sirum (SIRUM – Saving Medicine : Saving Lives, 2022) and Ücretsiz İlaç Desteği (appendix 2), it has certain deviations from these projects. Firstly, it can be argued that this process differentiates from its correlates in Greece and the United
States since the regulations, cultures, behaviours and practices around medication usage are diverse in different countries. Additionally, Sirum focuses on empowering organisations to share medications with their law experts along with enabling the public to donate their unused medications (SIRUM – Saving Medicine : Saving Lives, 2022). GIVMED concentrates on the donation of unused medications and enables individuals to access donation points by its provided application (GIVMED, 2022). While these are in mind, U-Med encourages the public to dispose of their leftover medications through the mobile application and the RVMs along with sharing the good ones. This circular concept is also supported by the rewards which are defined to the patients who dispose of or share their leftover medications and to doctors at the health centres where these medications are to be distributed. It utilises the trust between the doctors and the patients and suggests doctors distribute the appropriate medications in the low-income neighbourhoods to the ones in need. It also opens the path to explore the alternative reuse of leftover medications by different sectors such as irrigation and animal care.

This study had a limited number of stakeholders. Mainly, the health specialists in the health centre, the patients there and pharmacists around this health centre were collaborated with. Additionally, the health director in Sarıyer and co-founder of GIVMED were interviewed to acquire learnings from their experiences. This project’s stakeholders were chosen because of the practical reasons for gaining knowledge in the field and the feasible access due to having acquaintances with most of the specialists. Even though the insights and ideas gathered from the stakeholders were useful and invaluable and the collaborations with them were satisfactory and productive, the findings may not be representative of the whole Turkish society. For this, a more elaborated study with the involvement of a diverse selection of medical specialists from different fields along with involving a broad range of patients from different neighbourhoods and backgrounds would represent the diverse population of the Republic of Turkey. In order to discover the other alternative uses of leftover medications in different industries, further research and collaborations should be established. Additionally, to realise this proposal and reconsider the legislation, further cooperation with the Ministry of Health, the Ministry of Environment, Urbanisation and Climate Change and the Ministry of Agriculture and Forestry must be established since it is a joint responsibility to reduce waste and create more sustainable futures.

During the ideation and the concept sessions, semi-structured and adaptable methods like expert interviews (IDEO.org, 2015) were conducted due to the health centre and pharmacies’ dynamic environment and the health specialists’ availability. These sessions were mostly organised during their short breaks. Therefore in these sessions, mostly the design researcher was active in terms of documenting and visualising the ideas. Even though these quick sessions with smaller groups of 2 or 3 health specialists provided valuable insights, having longer and scheduled sessions with many of them together after work or during lunchtime might have given more insights, ideas and extracted engaging discussions.

The design was created in English and the one particular focus of the testing was on investigating the physical interaction with the RVMs, therefore further online tests with people based in Turkey were not feasible. Although, this would have enabled tests with the people who are familiar with the Turkish Health System. For the mentioned reasons, the testing sessions were conducted in person in Malmö to test the physical interactions with the RVMs along with the mobile application. People who have tested the prototypes were coming from different cultural backgrounds, they might have different experiences and concerns with
health care, medication usage, medication sharing and recycling. This quality of the testing session may not have a negative impact on testing results since the physical interaction with RVMs are relatable and it provided additional perspectives due to the multicultural experiences towards medical and recycling systems.

This thesis proposal goes beyond interaction design and includes aspects of service design as well. This circular system moves around rethinking the medication distribution, prescription, usage and disposal after the purchase with the safety and the legislation limitations in mind. As discussed in the 5.1 U-Med model, designing this concept by benefiting from reusing and sharing possibilities allows the system to have several types of interactions between different actors and elements such as patients, doctors, pharmacists, and individuals in different industries, connected with familiar elements like mobile application and RVMs. The familiarity of these elements and interactions is feasible for the sake of simplicity, accessibility, functionality and environmental impact.

7. CONCLUSION

This thesis concentrated on developing a circular model in Turkey for reducing medication waste by focusing on encouraging individuals to share and dispose of their leftover medications while being aware of the safety and legislation limitations. The safe and shared medications are to be distributed by doctors to people in need who cannot access medications. It also discovers the alternative reuse possibilities of leftover medications such as reuse in animal care and irrigation industries.

The U-Med model is structured around dialogue-based interactions with the mobile application and reverse vending machines. The system has several stakeholders that contribute to the system and gain rewards from their actions along with humanistic incentives such as altruism. The current main stakeholders of the U-Med are the patients who share or dispose of their leftover medications, the dedicated pharmacists who inspect the medications, the doctors who prescribe these medications, and lastly, the patients who obtain these medications since they cannot obtain their medication from pharmacies due to financial reasons. Some other players in this system can be the veterinarians who work in animal shelters and the animals who need medications, the individuals working in irrigation industries and the plants which are irrigated by them.

It aims to change the current practices and behaviours around medication usage and disposal to reduce medication waste. It opts for transformations toward a more sustainable society both in economic and environmental aspects by showing the alternative reuse opportunities of leftover medications.

Next to legislation reasons, since it is a joint responsibility to reduce waste and create more sustainable futures, realising this impactful project in Turkey would only be possible with further cooperation and developments with the Ministry of Health, the Ministry of Environment, Urbanisation and Climate Change and the Ministry of Agriculture and Forestry. Furthermore, along with these, collaborations with different industries where the leftover medications might be valued may lead to future improvements and developments in the U-Med concept.
I would like to express my gratitude to many for this thesis’ development and process. Firstly, I would like to thank Jens Pedersen for his valuable supervision and coaching throughout this entire process. Without his support, this thesis would not be the same. I would like to continue paying my deepest regard to all the health specialists I have contacted in this journey, especially the ones in the health centre in Sarıyer, Istanbul for their indispensable input, insights, knowledge, efforts and support. This thesis would not have been where it is now without them. Then I would like to continue to thank the pharmacists around this health centre who have shared their knowledge and insights as well. I would also like to express my thanks to Dr Armağan Eren, the health director in Sarıyer municipality and Thanasis Vratimos, the co-founder and business developer of GIVMED in Greece for sharing their experiences and invaluable insights toward medicine sharing. Thanks to Max Angenius and Sarah Skavron for giving their precious feedback on my first drafts. I would like to share my appreciation for all who have participated in my user interviews, questionnaires, workshops and testing sessions for their time, contribution and insights. Last but not least, I would like to share my special thanks to my parents, my uncle and my aunt for their support and motivation.

REFERENCES


Cambridge Dictionary. (2022, May 11). trust definition: 1. to believe that someone is good and honest and will not harm you, or that something is safe and... Learn more. Cambridge English Dictionary. Retrieved May 14, 2022, from https://dictionary.cambridge.org/dictionary/english/trust

Intelligent Systems, and The 13th International Symposium on Advanced Intelligence Systems. [https://doi.org/10.1109/scis-isis.2012.6505415](https://doi.org/10.1109/scis-isis.2012.6505415)


FINBIN CitySolar - Smart waste management. (2020, September 21). [Video]. YouTube. [https://www.youtube.com/watch?v=4TEpDvlVf0s&ab_channel=Finbin](https://www.youtube.com/watch?v=4TEpDvlVf0s&ab_channel=Finbin)


Myers, M. D. (2013). *Qualitative Research in Business and Management* (Second ed.). SAGE Publications Ltd.


Rana, M. E., Shanmugam, K., & Yi, K. Q. (2022, March). IoT Based Reverse Vending Machine to Identify Aluminium Material and Allocate Point Reward. 2022 *International Conference on Decision Aid Sciences and Applications (DASA)*. https://doi.org/10.1109/dasa54658.2022.9765296


APPENDIX 1

Interview Notes | Thanasis Vratimos, GIVMED

08 April 2022
The main motivation of the individual users of the platform is finding a quick way to dispose of their medications rather than altruism.

Their main stakeholders are social pharmacies, other NGOs, pharmaceutical companies which donate medication, public organizations and political legislation.

The most critical aspect for this system to work efficiently is the institutions called Social Pharmacy being present in Greece, currently in 2022 located around 120 different spots, where medications and pharmaceutical products are provided free of charge to the people who are in need and have limited access to the health system such as unemployed, elderly people, homeless people and migrants.

Their part as a platform ends when the medications reach donation points which are generally Social Pharmacies.

Even though Social Pharmacy’s foundation in Greece was supported by the Government of Greece back in days, right now they are facing some legislation problems with the government. One of the reasons these problems have been occurring is the concern of the profit from the medication.

While organising campaigns are considered costly, some campaigns around raising awareness towards donating medicine, MEDforU and MEDforALL apps were organised by the organisation yet the public awareness towards medication waste, donation and platforms are not at the desired stages.

They accept all kinds of medicine which are unexpired except the open creams, drops, syrups, inhalers and medicines that need to be stored in the fridge.

Even though they do not accept expired medications, they receive many. In these cases, they send these medications to pharmacies to be destroyed.

They have been operating for around 7 years now and no side effects have been reported.

They are interested in developing educational materials such as apps and games for children around the medication field. Another aspect they hope to collaborate on is the advocacy for the social pharmacies.

APPENDIX 2

Activity Report of Ücretsiz İlaç Desteği (Free Medication Support) Project
According to the activity report, between 2009 and 2017, they could reach 11960 patients and donated 27897 packages of medication which would make 2.3 packages per patient overall (appendix 2)

In these pharmacies, they were giving the unused medications from, for instance, deceased people and people who had changed doses to people in need with drug prescriptions.
Additionally, items like prostheses, orthosis, oxygen tubes and baby food were also attained for these people.

The documentation of the medication’s in and out was carried out by only 2 staff on an Excel sheet.

The main target group of this project was the citizens who are not able to pay their premiums due to financial reasons and therefore cannot be able to obtain their medications from pharmacies because of the Turkish legislation even though they are insured.

APPENDIX 4

The Questionnaire, Medication Usage Behaviour | Main findings and notes

14 April 2022

The questionnaire was conducted among 88 Turkish citizens to understand their medication usage behaviours till disposal and decision-making process when it comes to donating, sharing or obtaining unused and unexpired medications. The main subjects which had been aimed to gain insights with this questionnaire were as follows:

- The current habits around the disposal of expired and unexpired medications
- The main motivations to share medication with someone and to accept medication from someone
- The current habits around sharing and accepting medications
- General opinions and beliefs around donating and sharing medications
- COVID-19’s impact on purchasing medication

The main findings of the questionnaire were as follows:

- The majority of the respondents, 71.6%, stated that they throw their expired medications away in the bins. Around 16% of them declared that they give it to their pharmacists. The ones who additionally stated that they would dispose of the expired medications as medical waste were the ones who are health specialists.
- Although many health specialists dispose of their expired medications as medical wastes, a considerable amount of them still use regular bins.
- Awareness of mixing medications with unwanted materials (cat litter etc.) before disposing of have not been observed.
- 42.5% of the respondents wonder how to properly dispose of unused and unexpired medications.
- The majority of the respondents which is around 70% would use unused and donated medications if they have a chronic disease.
- Around 60% of the respondents who would not prefer using unused and donated medications would prefer taking the donated unused medications from their doctors if they have to instead of their pharmacists or acquaintances.
- Although 75% of the respondents stated that they have shared medication before with someone else, around 39% of the respondents expressed that they have borrowed medication from someone else before.
- The first three motivations observed for sharing medications with someone else are having similar symptoms with that person, the respondent’s own knowledge about the medication and the familiarity with the other person respectively.
The first three motivations observed for borrowing medications from someone else are having similar symptoms with that person, the familiarity with the other person and the respondent’s own knowledge about the medication respectively.

Around 9% of the respondents stated that they have purchased medications which they have not finished during COVID-19. Additionally, while some stated that they purchased antiviral medications in case they will not be able to find them, some say they obtained many vitamins for the same reason.

While the majority stated positive comments towards the idea of sharing or donating their unused and unexpired medications to a safe place (a place that takes care of the medications and donates them to people in need), some still showed concerns about misuse and storage history of medications. Trust towards the system seemed the most crucial concern according to the open-ended answers.

APPENDIX 5

Interview Notes | Patients in the health centre in Sariyer

18 - 22 April 2022

topics discussed during the interviews were as follows:

- Medication storage behaviours
- Medication sharing and borrowing habits
- Medication usage and disposal behaviours

The main insights gathered from the interviews are as follows:

- The majority of the participants were there to collect medicines for their family members along with themselves. Some even brought the previously prescribed medications' packages to reference.
- The majority store their medications in a drawer in their kitchen. Some mentioned putting syrups and unused ones in their fridge. One mentioned having some medications next to her bedside drawer.
- Different methods for avoiding forgetting to take their medications were stated. Some ask their family members to remind them to take, one creates physical notes and attaches them to several places for both his and his wife’s medications, and one mentioned creating alarms on her mobile device.
- Some mentioned borrowing medications from their doctors when either they forget their medications in their hometown or somewhere else, lose them or cannot obtain the medications from the pharmacies for economic or prescription protocol (some medications can only be prescribed after a certain amount of time) reasons.
- One was extremely against borrowing medications from people who are not health specialists and shared one of her experiences: Once her neighbours suggested giving the same medication (with the same dose) to the interviewee’s husband, she did not want her husband to take that medication, she insisted to suggest their doctor. Another interviewee stated that she has asthma and borrows and shares asthma medications in emergencies.
- The awareness towards disposal of medication is poor. The majority throw the medications into the regular bins. Some mentioned giving them back to pharmacies or their doctors if they have not used them. One interviewee stated that she never
thought of throwing the medications away and said that she keeps all of the medications in a drawer.

- The majority mentioned feeling content while sharing their unused medications for the sake of altruism and showed willingness and support to participate in this project if it were to be realised.

APPENDIX 6

Interview Notes | Health specialists in the health centre in Saryaer

14 - 22 April 2022

The objectives of these interviews were as follows:

- Gaining insights into important aspects of medicine usage and sharing
- Discovering patients’ behaviours around medicine usage from usage to disposal from an expert perspective
- Gaining insights into their own practices when it comes to using unused medications either expired or not
- Exploring the feasibility of a platform/system where citizens can donate their unused medication to be used by someone else again
- Exploring the incentives of the stakeholders around the platform/system of this project from their perspective

The main insights gathered from these expert interviews are as follows:

- Storage history of the medication is critical and important to be reused. Some patients who are uneducated can store even their own medications in the wrong way such as storing insulin medications in their freezer while they should have stored them in the fridge.
- To avoid medication waste, the doses and packages of the drugs along with the distribution system have to be redesigned. One doctor stated, that they had been giving the exact amount of medications to patients by cutting the blisters during his obligatory military service where he worked as a doctor.
- Medication or medical waste disposal awareness and knowledge of patients is insufficient but still exists. Some of their neighbours give their used and unused medications to them to dispose of or reuse at their health centre. Some think that medications are destroyed in hospitals. Some people give their metal insulin needles (not shots) to be recycled in these health centres. Even though they do not have enough medical waste bins in these centres to collect medical waste from patients, health specialists try to do their best to collect and help patients. The need of having larger spaces for medical waste and awareness of the topic is undeniable.
- Sharing items around the health centre is an applied practice. Since it is a health centre and welcomes people in need, they collect from their acquaintances or other patients baby food, cloth and other items to donate to people in need. They are working on creating newborn baby boxes with diapers, lotions, creams, cloths etc. too. There are also donation boxes for clothes located by the centre as well.
- Sharing unused medication is an applied practice even though it is not supported openly by the authorities. Sample medications from companies, vitamin Ds and some other drugs are given to patients for several reasons such as reducing the rate of child-mother death and advertisement. Also, some doctors stated they used to send medications to war zones where they even sent the expired ones. Once they receive
unused medications from a patient or someone else, the first thing they do is to sanitize them with sprays.

- There are alternative ways of using unused or expired medications for different cases. Some health specialists mentioned they have been using kidney medications for flowers and birth control pills for their hair. Some pharmacists mentioned a WhatsApp group chat of doctors, pharmacists, veterinarians and pharmaceutical representatives where they collect expired medications and items (eye drops, cleaning solutions, baby food, antibiotics) and use them in animal shelters under a veterinarian’s supervision. They give unexpired and suitable ones to the ones in need under doctors’ supervision. Medications are controlled by doctors and pharmacists in this group and pharmaceutical representatives are responsible for the delivery.

- The platform/system of this project needs to be trusted.

- It is critical to find the people in need to share the donated medications for this platform/system to work. Neighbourhood representatives can be consulted to find people in need.

- For this platform/system, family doctors can have an indispensable role in knowing the patients and their history, monitoring them and accepting their unused medications which are not being used by them.

APPENDIX 7

Selected questions from UseToUse Design Toolkit and adapted versions

The adapted questions are as follows:

- How can you build trust between everyone involved in the medication sharing?
- How can you make medication sharing and disposal accessible to people?
- How can you activate people to circulate their unused, unexpired or expired medications so others can use them?
- How can you facilitate the cleaning of the packages?

APPENDIX 8

Brainstorming Sessions Notes | Health specialists in the health centre in Sarıyer

The main aspects of the platform/system according to the brainstorming sessions are as follows:
KULTUR OCH SAMHÄLLE

- The platform/system of this project needs to be supported by the ministry of health.
- The platform/system of this project needs to be synced with pharmacists' systems for avoiding multiple purchases.
- The collection of normal medicines (the ones which are not cold chain) can be done in large hospitals, health centres and places like supermarkets where abuse and intrusion can be prevented.
- The collection of normal medicines can be done with reverse vending machines in mentioned places above where sanitization can be undertaken.
- The collection of cold-chain medicines is critical and difficult. They can be collected by collection teams after citizens create requests.
- Circulation of these medications should be quick. For instance, the cloth donation boxes are opened in 2-3 months but these vending machines should be checked in shorter periods.
- Collection points can be found through an app which can be downloaded by citizens.
- Collection requests for cold-chain medicines can be facilitated through the app.
- Donations can only be accepted by citizens with IDs. This would also help the system to assess whether the medications are safe since the medications are assigned to individuals and can be tracked.
- The control of the medications can be done by a group of allocated pharmacists in the neighbourhoods. When in need of further examinations, sending the medications to their production sites can be considered.
- Incentives of the stakeholders:
  - To motivate doctors to prescribe donated medications, defining positive performance for the ones who prescribe those drugs can be considered. Additionally, a certain amount of money for each prescribed donated medicine can be allocated to the health centre to be used for the needs of this health centre such as utility bills.
  - To motivate citizens to donate their unused and unexpired medications, points or a certain amount of money can be defined to their ID for each medication they donate which eventually can enable them to get ahead in the health system in terms of setting appointments and having discounts in pharmacies etc. These points are assigned after the donated medications pass the controls done by the pharmacists.
  - For pharmacists, controlling these medications will be another branch of work.
- To minimise the possible side effects and build trust in the system and these donated medications, patients need to be monitored after taking unused donated medications.

APPENDIX 9

Prototype and screens of U-Med mobile application and U-Med RVM

The prototype:
The U-Med Mobile Application’s Screens:

U-Med (Unused-Med) is a non-profit platform supported by the Turkish Health Ministry where Turkish citizens can give their unused medications which are either expired, unexpired, open or unopened. After the examinations, we help the people in need to access the safe medications. For the other medications, we either send them to dispose of, to be used in animal shelters or in other industries.
What and how can you donate?
You can donate your unexpired and unopened normal medications at drop-off points or self-serve machines. Our team comes to your place to collect your self-serve medications at your convenience.

- Normal
  The ones don’t require special storage
- Cool-chain
  The ones require to be stored in fridge etc.

Learn more about the medications

What and how can you dispose of?
You can dispose of your expired or opened medications at drop-off points to be destroyed or reused in other facilities such as irrigation and animal shelters.

Why?
- Your donation can help people in need to access medications.
- You will be environmentally friendly with your disposals.
- You can earn points with each donation and disposal you make, and can have special services in the health system.

What are the points?
- You can earn points with every donation of your unexpired self-serve medications and disposal of your expired or opened ones.
- Points are assigned after the examinations by the safety officer or the pharmacist, after you have your medications to donation spots.

Points earned
The points that already assigned you. If your donation of unexpired drugs pass the examinations or if you dispose of opened medications you can earn points.

Potential points
The points that may be assigned to you after examinations.

What can you do with the points?
- You can get discounts in the pharmacies.
- You can have special services in health centers such as having the priority or extra treatments.
The U-Med RVM's Screens:
Welcome,
To start your donation or disposal of your medications, please identify yourself by either scanning your ID or log in with e-Devlet.

What and how can I donate or dispose of?

Why?
While being environmentally friendly, you can also earn points that you can use in the health system for every donation or disposal you make.

Log In with e-Devlet

- ID Number
  Enter your ID number

- e-Devlet Password
  Enter your e-Devlet Password

Log in with e-Devlet

OR

Scan your ID
Hi Ecenur,

To start donation or disposal of your medications, leave them one by one to the tunnel.

Keep putting your medications to the tunnel! Once you are done, check your medications on the right side panel and continue!

### Meds in the tunnel

<table>
<thead>
<tr>
<th>Name: Medication name</th>
<th>Expiry date: 21.03.2025</th>
<th>Status: Opened Package / Disposal</th>
<th>Points earned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>1x</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name: Medication name</th>
<th>Expiry date: 21.03.2020</th>
<th>Status: Expired / Disposal</th>
<th>Points earned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>1x</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name: Medication name</th>
<th>Expiry date: 21.03.2025</th>
<th>Status: Under examination</th>
<th>Potential point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>5x</strong></td>
</tr>
</tbody>
</table>

Do you need help?

Finish
Thank you!
Thank you for your social and environmentally friendly action! You will potentially earn up to 7X points with today’s donation and disposal after examinations.

Your donated and disposed leftover medications will be reused in health care system and other industries. You can follow the process either in D-spot app or your e-Nabiz.

You have successfully logged out and can leave now the donation point.

Donate again ➔

APPENDIX 10
Final diagrams of normal and cold-chain medications
The final diagram of normal medications

The final diagram of cold-chain medications

APPENDIX 11

Diagrams of normal and cold-chain medications in Turkish
KULLANILMAMİŞ NORMAL İLAÇLAR

1. Kullanılmamış ilaçlar, kullanılmamış ilaçlar veya ilaçların depolama durumundaki ilaçlar.
2. ilaçların depolama durumundaki ilaçlar.
3. ilaçların depolama durumundaki ilaçlar.
4. ilaçların depolama durumundaki ilaçlar.

KULLANILMAMİŞ SOĞUK ZİNCİR İLAÇLAR

1. Kullanılmamış ilaçlar, kullanılmamış ilaçlar veya ilaçların depolama durumundaki ilaçlar.
2. ilaçların depolama durumundaki ilaçlar.
3. ilaçların depolama durumundaki ilaçlar.
4. ilaçların depolama durumundaki ilaçlar.

*Kullanılmamış normal ilaçlar: Şuruplar, tabletler, ığneler, ampuller...
*Soğuk zincir ilaçlar: İnsülin ilaçları, enteraller vb.
APPENDIX 12

Questionerie results (left to right)

APPENDIX 13

Project plan with overseen design activities
<table>
<thead>
<tr>
<th><strong>KULTUR OCH SAMHÄLLE</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Week 1: Cultural Discovery</strong></th>
<th><strong>Week 2: Cultural Discovery</strong></th>
<th><strong>Week 3: Cultures and political ideas</strong></th>
<th><strong>Week 4: Case study and historical context</strong></th>
<th><strong>Week 5: Literature and research methods</strong></th>
<th><strong>Week 6: Group project and final presentation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project plans</td>
<td>Project plans</td>
<td>Project plans</td>
<td>Project plans</td>
<td>Project plans</td>
<td>Project plans</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>