# User Goals Extraction for a mhealth-based Medication Management System for Individuals with Visual Impairment

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## Abstract

**Background:** Prevalence of visual impairment is increasing all around the world and this impairment makes the medication management process more complicated. According to literature, Technology, particularly mobile technology has a significant impact on both medication adherence and improving quality of life for people with visual impairment. Due to aforementioned facts, the researchers decided to identify the user's goals for a mHealth-based medication management system for visually impaired individuals to help the developers to design and develop a medication management system for visually impaired individuals considering to improve their medication adherence and also preserve their independence.

**Methods:** A goal directed approach, introduced by Cooper, has been used in order to extract the goals of visually impaired users who would employ a medication management system. One the most important concepts of this method are designing personas. The needed data for designing personas were extracted from two literature reviews and interviews with 14 visually impaired individuals and three experts of this area. Therefore the personas' different goals were defined.

**Results:** As the results of this study, three personas were designed according to the extracted data and three categories of user goals including experience goals, end goals and life goals were determined for this system.

**Conclusion:** This study could help the researchers and developers to design and develop an appropriate digital product for people with visual impairment, in order to increase their medication adherence. In addition, the findings of this study could help the policy makers of different areas to increase the quality of life for the people with visual impairment by eliminating the barriers of independent and effective medication adherence.nt..

## Keywords

Visual impairment; Medication management; Mobile health; mHealth; Independent living

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## 1 Introduction

Vision disorder means visual impairments limiting one or more of the basic functions of the eye [1]. According to WHO statistics, there are around 285 million visually impaired people worldwide which about 86 percent of them have low-vision and nearly 14 percent are blind [2]. The prevalence of visual impairment is increasing [3] and near ninety percent of the visually impaired individuals belongs to low and middle income countries which 82% of them are older than fifty [4]. About 58% of visually impaired are above sixty and this impairment increases by aging [5]. On the other hand aging is an important problem all around the world [6] and all countries will front this problem eventually [7]. Therefore, visual impairment is an indisputable problem all around the world. On the other hand, visual impairment defines the level of participation in daily activities [8] that regard to WHO (2001) is an essential aspect of human development [9] and according to researches there are different challenges to participation for young persons with visual impairment [10]. Moving from handicapped to participation, according to

International Classification of Functioning, Disability and Health (ICF), has become a topic in research [11]. One of the daily living activities is medication management [12]. Totally, healthcare services are less available for people with visual impairment [13]. One of the challenges which they experience is the difficulties which the face through their medication intake or their probable responsibility for their children medication intake [14] because medication management is a complicated process including multiple activities [15] and visual impairment makes this, more complicated [16, 17]. There are many challenges in medication management among visually impaired individuals and strategies that are employed cannot overcome all these challenges [14]. Designing the protocols, guidelines and policies of medication management, decrease the medication errors [18] that is a major problem in all care settings [19] and effect on ten percent of people around the world [20]. There are many researches that indicate the role of technology in medication management [21] and the documentations indicate the significant impact of information technology. Specifically, mHealth technology has a considerable potential in this area [22]. Conversely, even though the ability of technology for preventing visual impairment is limited, there are possibilities which support people with this disability to manage their life [23]. The progress of information technology, particularly mobile technology has caused better quality of life for people with disabilities like visual impairment [24] and researches on them show that the mobile technology is a potential solution for the problems which is caused by multipharmacy among them [25]. Therefore according to prevalence of visual impairment and the relationship between visual impairment and aging, also the increasing use of medication and multipharmacy at older ages [26] in addition to significant increment of medication errors in this ages [27], developing a mHealth-based technology for medication management can be a significant step for visually impaired individuals to manage their medications themselves and live more independently.

The most important phase in system development is the design phase which is one of the main phases of the Software Development Life Cycle [28]. Interaction and goal directed design are the design approaches which help the designers achieve the better solutions [29]. Cooper who explained the essentials of interaction design tool in his book (About Face: The Essentials of Interaction Design.), believes that a digital product developer should design personas in order to extract the user goals and the data that is necessary to design successful persona can be extracted from user interviews, information about users supplied by stakeholders and subject experts and the literature reviews and previous studies [30]. Therefore, the researchers performed this study using concepts of interaction design, in order to extract the needs of visually impaired community in an effective medication management process. The results of current research could help developers to design and develop a mHealth-based assistive technology to improve the medication adherence among people with visual impairment as a step for independent living.

## 2 Related Works

In order to extract the users' goals, there are researches which have been performed for finding the problems which visually impaired people individuals face during the medication management process. Weeraratne et al. have accomplished a research among 63 students in Sri Lanka using interviewer-guided questionnaires to extract the insights of participants about medications and medications errors which occur in medication management process. The researchers have suggested Braille and audio platform for visually impaired individuals. Also, they have mentioned that policymakers in developing countries should become aware about challenges experienced by people with this impairment [14]. In another study, Martin et al. performed similar survey among elderlies with low vision. The researcher's aim was to determine the needed information and also problems in over-the-counter (OTC) medications. As a result, the researchers have indicated that if the future technologies consider the information accessibility as an important feature, they would help in medication management [31]. Zhi-Han and colleagues have used an interviewer-guided questionnaire to extract the problems which are encountered by visually impaired people while they take their medications. In this study the authors asked questions about the tasks in six steps of medication management comprising self-administration, access to information sources, maintain current medication list, storage of medicine, disposal of medicine, and medication reviewed by health-care team. 100 participants had to determine the rate of difficulty experienced by them in every task ranged from 1 to 5 [32]. Another research has been done by Neubeck et al. in order to develop and evaluate an eHealth tool for people with or at high risk of cardiovascular disease. This tool contains a medication management system. In the first phase of this study, the researchers have summarized the similar apps and also have attained the end-users' insights using personas [33]. It is clear that challenges may vary from one country to another. Moreover, mHealth has been a solution in many field of health, therefore, the authors of current study decided to extract the user-goals of visually impaired individuals for using a medication management systems using personas and literature reviews.

## 3 Methods

### 3.1 Literature Review and Previous Studies

The preliminary phase of the research was two descriptive studies. In the first study, four electronic databases (PubMed, Embase, Web of Science and ScienceDirect) were searched by different combination of keywords about mobile health and medication management in January 2017 without time limitation. Then the features and employed technologies in these medication management systems were extracted. The next literature research was conducted to identify the

experiences of people with visual impairment which was pointed out in other studies. This section of study was done by searching the mentioned databases. The search strategy of this study contained two groups of keywords in concepts of visual impairment and medication management. Again after omitting the irrelevant, duplicate and unavailable papers, the key points were extracted as the data which can define the personas goals. The procedures of the review studies are presented in Figures 1 and 2.

## 3.2 Experts and User Interviews

The second phase was subject experts and user interviews. In the first step, the experts' interview was done by one of the researchers. The experts include three managers of three institution of visually impaired individuals in Tehran and two visually impaired psychologists. This interview was an open interview about their experience in medication management among visually impaired people and their opinions about employing mobile technology for solving problems faced by visually impaired people. In the next step, the user interview was performed by a valid interviewer guided questionnaire. This questionnaire was designed according to the results of literature review phase. After that it was validated by a medical informatics specialist, an educational psychologist who had experiences with visually impaired individuals and a clinical psychology PhD candidate with visual impairment. At the last step of questionnaire development, it was piloted by three participants and inappropriateness and ambiguity of the questions were identified and corrected or removed according to specialists' opinions. Then the inclusion and exclusion criteria were defined and the study was performed in the institutions which State Welfare Organization of Tehran had introduced. The questionnaires were completed by interviewer and the results entered to SPSS and analysis was done.

***Designing the personas***

At the end of current study the outcomes were concluded in order to design the personas to help the developers in designing these kinds of products.

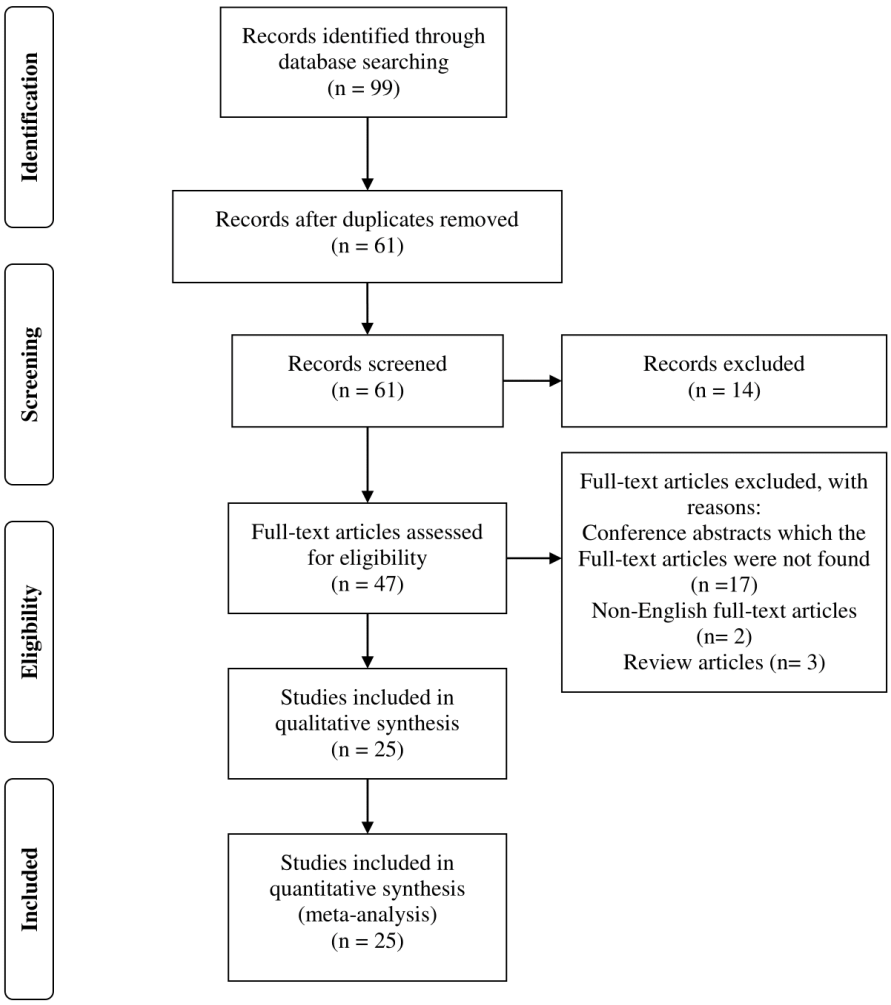


Figure 1: PRISMA flow diagram for first review process.

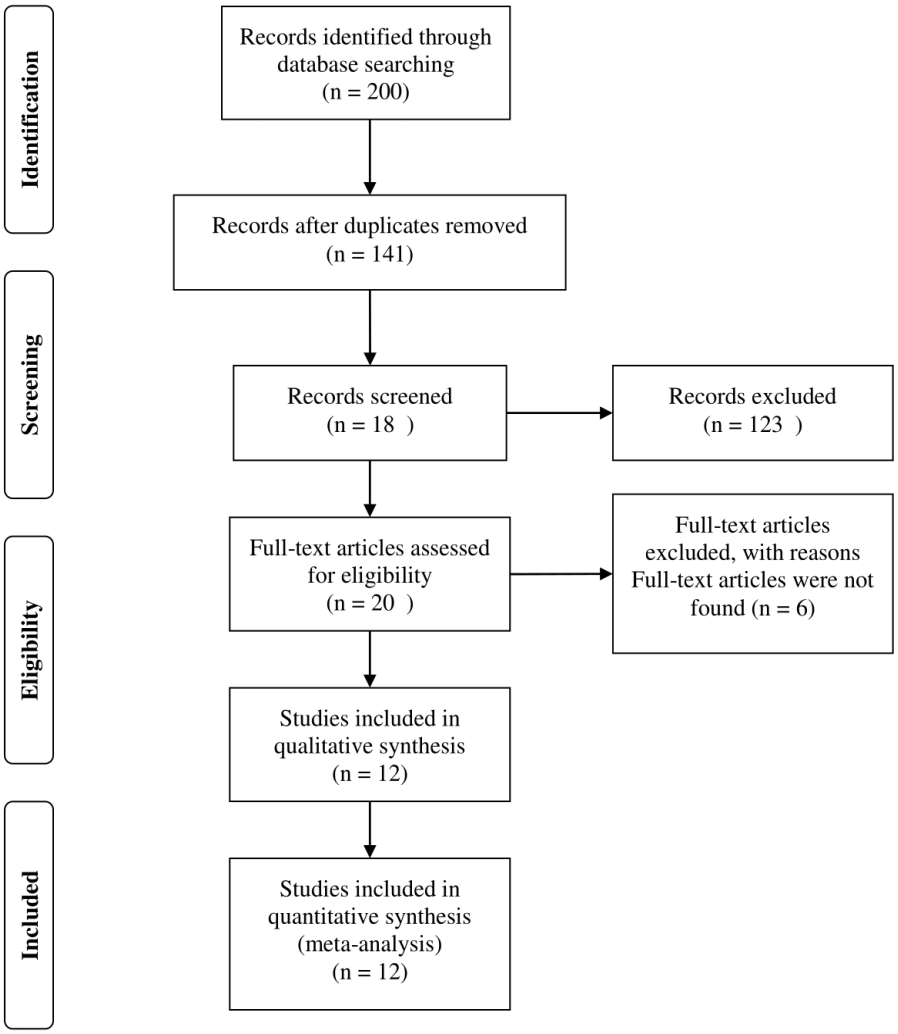


Figure 2: PRISMA flow diagram for the second review process.

# 4 Results

## 4.1 Medication Management Systems' Requirements

After screening the abstracts and publications information, duplicate, conference abstracts, non-English publications and review papers were eliminated. Then the studies that had not presented a new medication management system or were irrelevant were omitted and one unavailable full text paper was excluded. Therefore the first descriptive study performed on fifteen papers and the requirements of these kinds of systems extracted. The system's requirements can be divided into functional and user requirements as the classification that mentioned by Ferreira and colleagues [34]. The review process of included papers accomplished according to this approach. As the result of this section of the study, thirteen main functional requirements were excerpted and the user requirements classified in six groups and general recommendations which developers should consider in development process.

Containing the medication list with instruction, frequency and dose [33, 35, 36, 37, 38 39], medication information like adverse effects [33, 36, 37, 38, 40], medication regimen [36, 37, 38, 41], medication alert and reminder [34, 36, 38, 39, 42, 43, 44, 45, 46], prescription refill [36, 40], medication identification [40, 42, 47], medication recommendations [45], informing the medication non-adherence to the third party [36, 37], location of pharmacies [34], actions when medication errors occur [34], medication intake reports [34, 35, 43], reporting the adverse effects that experienced [34] and medication tracking [35, 37, 38, 39, 42, 44, 46], are the functional requirements of the medication management systems which mentioned in the papers of this descriptive study.

As mentioned above, the user requirements were classified in six groups, including creating user account [33], consistency with target group [34, 42], increasing the possibility of system usage [33, 36, 38, 44, 48], receiving

feedback in order to quality improvement [33], representation of system effectiveness scales [33, 38, 43] and user friendliness [33, 34, 37]. In addition to these main groups the validity [34, 38], reliability [34] and portability [42] of the system are the general recommendations that help the developers to design a system. Challenges experienced by individuals with visual impairment in medication intake.

In the second descriptive study, 200 papers were found and after applying the inclusion and exclusion criteria in which indicated in the method section, twelve papers included in this study. The evidences in these researches show that the challenges experienced by visually impaired people can be categorize in nine types. Unavailability of information sources [32], difficulty in reading the information of medication labels [23, 25, 32, 49, 50, 51, 52, 53], inappropriateness of medical equipment and technologies for this group [25, 53], occurrence of medical errors [25, 32], difficulties in identification of different medications [25, 32, 49, 52], difficulties in opening the containers, bringing the medications out and medication intake [23, 25, 32, 52, 53, 54, 55], loss of privacy and independence [25, 56] and problems in remembering the medication schedule [25, 32] are the types of challenges which have been experienced by people with visual impairment.

According to the present literature which has been found in current study, there are some solutions for these challenges. The reviewers in this section of the study screened the papers and extracted the solutions of each type of challenges. Some of The extracted information can be employed by a visually impaired person to overcome the barriers and the other solutions are the methods that should be considered by the pharmaceutical industry policy makers. The main types of challenges and the related solutions are shown in Table 1.

## 4.2 Interviews

After performing the descriptive studies, the expert interview was done. Five experts were included in this section and they indicated their points of view about medication management among visually impaired people. All of them were agreed that this is one of the health challenges among them and has caused dependency in this group. One of the managers of introduced institutions mentioned that low level technologies like medication boxes that are specified for people with visual impairment can improve the situation of this community. One of them explained about a case who was a member of institution that was pregnant and had to use lots of medication in her pregnancy. He described that her husband had to sort the medications by the time in a specific medication box, so that she could use these medications and when he had forgot to do this, she could not use the medications. Another manager presented a device called "intelligent pen" that was invented by that institution. This device was capable of reading and writing the label tags. The visually impaired individuals can record their voice by this device and write a tag and paste it on the object that they want to identify later. The disadvantage of this device was its price that caused the low rate of consumption while employing the smartphone as a part of this system could decrease the cost of this system development. The experts were agreed that mobile health is a potential solution to improve medication adherence among this community.

After expert interview, the questionnaire was designed to be completed by interviewers in the interviews with visually impaired individuals. This questionnaire had eight parts including demographic information (Table 2), information about medications (Table 3), history of experiencing problems in the correct way that are prescribed (Table 4), being assisted in the medication management process (Figure 3), challenges experienced by them in medication management (Table 5), information about the way that the medications kept (Table 6), employing the assistive tools, strategies and technologies (Tables 7 and 8) and essential functional requirements (Table 9). The extracted functional requirements from the previous step of the study, were included in the essential functional requirements section of the questionnaire but the location of pharmacies, because of the barriers to implementation of that like Persian language processing was omitted and the informing the medication non-adherence to the third party requirement was changed to the informing the medication non-adherence to his/her trusted person because of the existing conditions. Furthermore the medication regimen and the medication list with instruction, frequency and dose were merged as medication list and regimen.

As mentioned before the designed questionnaire was used to perform the questionnaire based interview. The visual impairment, chronically use of at least one medication and satisfaction of the participants for their participation in this survey, were the inclusion criteria and the exclusion criteria included retardation and speech disorders. Finally, 40 participants who were the members of centres which introduced by State Welfare Organization of Tehran were investigated whether they meet the inclusion and exclusion criteria or not. Fourteen participants included in this survey.

The results of this fourteen questionnaire indicated that the medication management is a complicated process for most of them, because their responses to the questions indicate that, although almost all of them, pay attention to the importance of locating the medications in an appropriate place, have experienced difficulties in medication management process and the various challenges are experienced by them which most of them are related to reading the labels of medications. In addition, demographic information showed that most of them live with their family and are assisted by one of the family members in this process which can be evidence about their dependency in this daily living activity. Another point extracted from the questionnaire was the fact that visually impaired individuals are not educated to use strategies, assistive tools and technologies in this process and it can be a threat to

Table 1: Challenges experienced by individuals with visual impairment and suggested solutions.

| Type of challenges | Solutions |
|---|---|
| Unavailability of information sources | Using audio and braille format for information [32]<br>Screen readers [32]<br>Asking the pharmacist or specialist physician [25] |
| Difficulty in reading the information of medication labels | Using audio and braille format [25, 32]<br>Recording the information and instructions by the physicians[49]<br>Using mobile phones as an appropriate platform for access to these information[23]<br>Using the labels with larger fonts[49, 53]<br>Using the colors, pictograms and holograms that make the information reading easier for people with low vision[53] |
| Inappropriateness of medical equipment and technologies for this groups | Developing the medical devices which have audio outcomes[25] |
| Occurrence of medical errors | Checking the medications after getting the medications from pharmacy by another person and keeping a list of medications in order to be reviewed by the friends or family members[32]<br>Returning the extra medications to pharmacies[32] |
| Difficulties in identification of different medications | Employment of tangible markers as an identifier[55] (rubber band, raised dots, Adhesive tape, stickers and stapler)[32]<br>Locating the medications in an appropriate place to save the medications, in order to decrease the risk of confusion[32]<br>Identification of medications by considering the differences between shape and texture of medication containers[49]<br>Utilization of mobile applications like Colorsay[25] |
| Difficulties in opening the containers and bringing the medications out and medication intake | Employing the strategies for taking the liquid medications for example using one hand to keep the bottle and the thumb of another hand to control the pouring of liquid[25] |
| Loss of privacy and independence | Utilization of medication management technologies[25] |
| Problems in remembering the medication schedule and the time of prescription refill | Considering the medication intake in daily plan[25]<br>Sorting the medications by the time that should be administered[25]<br>Setting the mobile phone's clock or alarm clocks a reminder[25]<br>Checking the number of pills in the medication containers to find out when the time of prescription refill is approaching[25] |

Table 2: Demographic information of participants.

| Demographic Information | | Frequency | Percentage |
|---|---|---|---|
| Sex | Male | 7 | 50 |
| | Female | 7 | 50 |
| | Total | 14 | 100 |
| Age | 20-30 | 1 | 7.1 |
| | 30-40 | 4 | 28.6 |
| | 40-50 | 6 | 42.9 |
| | 50-60 | 1 | 7.1 |
| | >60 | 2 | 14.3 |
| | Total | 14 | 100 |
| Education | Primary school | 2 | 14.3 |
| | High school | 0 | 0 |
| | Diploma | 3 | 21.4 |
| | Associate's degree | 3 | 21.4 |
| | Bachelor | 5 | 35.7 |
| | Master | 1 | 7.1 |
| | PhD | 0 | 0 |
| | Total | 14 | 100 |
| Severity of visual impairment | low | 2 | 14.3 |
| | Moderate | 3 | 21.4 |
| | Severe | 9 | 64.3 |
| | Total | 14 | 100 |

| Demographic Information | | Frequency | Percentage |
|---|---|---|---|
| Onset of Visual impairment | Birth | 8 | 57.1 |
| | Childhood | 2 | 14.3 |
| | Adolescent | 0 | 0 |
| | Early adulthood | 4 | 28.6 |
| | Middle age | 0 | 0 |
| | Old age | 0 | 0 |
| | Total | 14 | 100 |
| Life arrangement | On your own | 2 | 14.3 |
| | Living with family | 12 | 75.8 |
| | Hospice | 0 | 0 |
| | Total | 14 | 100 |
| Other impairments | No | 12 | 75.8 |
| | Smelling problems | 1 | 7.1 |
| | Hear loss | 1 | 7.1 |
| | total | 14 | 100 |
| Knowledge of Braille | No | 4 | 28.6 |
| | A little | 3 | 21.4 |
| | Dominant | 7 | 50 |
| | Total | 14 | 100 |

Table 3: Information about medications.

| Criteria | Number of medications | Duration of treatment (Months) |
|---|---|---|
| Mean | 3.43 | 125.79 |
| Median | 2.00 | 54 |
| Standard deviation | 2.74 | 123.056 |
| Domain | 7.00 | 357 |
| Min | 1.00 | 3 |
| Max | 8.00 | 360 |

Table 4: History of experiencing problems in the correct way that are prescribed.

| | Occurrence | Frequency | Percentage |
|---|---|---|---|
| Forgetting the medications | Never | 4 | 28.6 |
| | Less than once a month | 7 | 50 |
| | Once a week | 0 | 0 |
| | Twice a week | 2 | 14.3 |
| | More than twice a week | 1 | 7.1 |
| | Total | 14 | 100 |
| Medication errors | Never | 9 | 64.3 |
| | Less than once a month | 5 | 35.7 |
| | Once a week | 0 | 0 |
| | Twice a week | 0 | 0 |
| | More than twice a week | 0 | 0 |
| | Total | 14 | 100 |

independent living. Nevertheless, most of them believed that smartphones have a potential to assist visually impaired people in medication management and a significant rate of them had smartphone or tablet. The results of the medication information section in questionnaire show that most of the participants of this study had the knowledge about their medications' names and the instructions that they had to follow but they did not have extra information about expiration date of them. Moreover, a few numbers of them were aware about the side effects of their medications. It would be possible that there is a relationship between their information about the names and the right way of medication administration, and the level of their education. The high level of education among the participants in this study, as the demographic information of the questionnaire may be related to the fact that the educated visually impaired individuals are more willing to increase their level of skills which becomes true in these institutions. Therefore the awareness of medication information is a need for any person with visual impairment but the level of needed information is different among them. At the last section of this interview the essentiality of the extracted requirements were asked from the participants. They indicated that 1) medication list and regimen 2) medication information like adverse effects, 3) medication alert and reminder, 4) actions when medication errors occur, 5) medication identification, 6) medication recommendations, 7) reporting the adverse effects that experienced and 8) medication tracking, are essential and one of them expressed the point that informing medication non-adherence to another person, could be a danger to their privacy. Therefore after analysis of the participants' responses to the questionnaire, the necessity of a mHealth-based medication management system for the people with visual impairment was proved and the functional requirements of this system were determined.

## 4.3 Introducing Personas

The software design consists of designing the stakeholders' requirements, business requirements and technical considerations.

Table 5: Challenges experienced by visually impaired individuals in medication management.

| Difficulties in medication management | | Frequency | Percentage | Mean |
|---|---|---|---|---|
| Reading the medication labels | Not at all | 1 | 7.1 | |
| | Not really | 0 | 0 | |
| | Neutral | 2 | 14.3 | 4 |
| | Somewhat | 1 | 7.1 | |
| | Very much | 10 | 71.4 | |
| Opening blister containers | Not at all | 12 | 85.7 | |
| | Not really | 2 | 14.3 | |
| | Neutral | 0 | 0 | 1 |
| | Somewhat | 0 | 0 | |
| | Very much | 0 | 0 | |
| Opening the bottles of the medications | Not at all | 8 | 57.1 | |
| | Not really | 0 | 0 | |
| | Neutral | 3 | 21.4 | 2 |
| | Somewhat | 2 | 14.3 | |
| | Very much | 1 | 7.1 | |
| Identification of containers | Not at all | 8 | 57.1 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 2 | 14.3 | 2 |
| | Somewhat | 3 | 21.4 | |
| | Very much | 0 | 0 | |
| Identification of capsules and pills | Not at all | 4 | 28.6 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 0 | 0 | 3 |
| | Somewhat | 4 | 28.6 | |
| | Very much | 5 | 35.7 | |
| Using drops | Not at all | 5 | 35.7 | |
| | Not really | 2 | 14.3 | |
| | Neutral | 1 | 7.1 | 3 |
| | Somewhat | 3 | 21.4 | |
| | Very much | 3 | 21.4 | |
| Using pomades | Not at all | 9 | 64.3 | |
| | Not really | 2 | 14.3 | |
| | Neutral | 1 | 7.1 | 2 |
| | Somewhat | 2 | 14.3 | |
| | Very much | 0 | 0 | |
| Using powder medications | Not at all | 9 | 64.3 | |
| | Not really | 3 | 21.4 | |
| | Neutral | 0 | 0 | 2 |
| | Somewhat | 0 | 0 | |
| | Very much | 2 | 14.3 | |
| Using liquid medications | Not at all | 5 | 35.7 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 4 | 28.6 | 3 |
| | Somewhat | 2 | 14.3 | |
| | Very much | 2 | 14.3 | |
| Remembering the medication doses | Not at all | 8 | 57.1 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 2 | 14.3 | 2 |
| | Somewhat | 1 | 7.1 | |
| | Very much | 2 | 14.3 | |

After literature reviews and interviews which were performed, The personas are the fictional user which their characteristics the needed data for designing the personas were provided. and conditions are extracted from mentioned gathered data. The

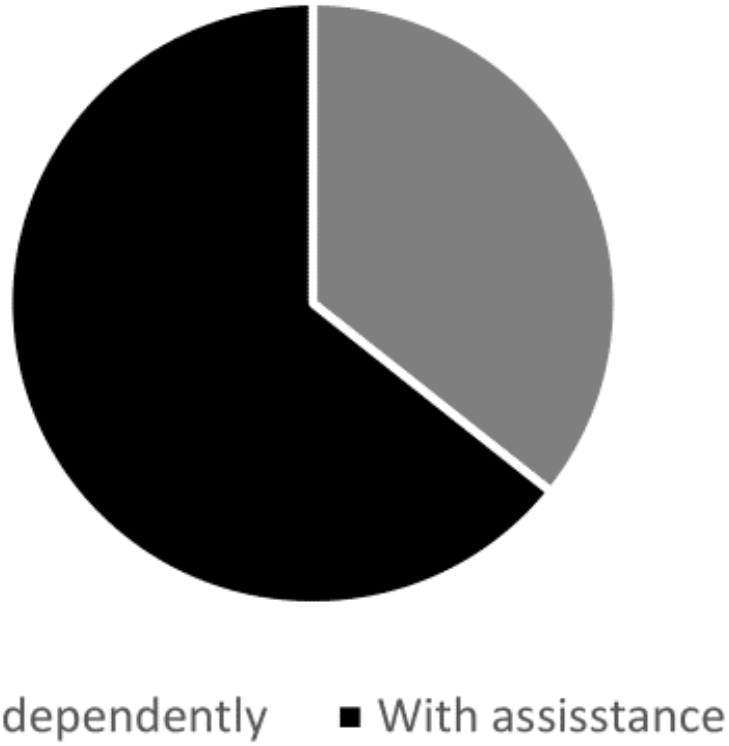


Figure 3: Medication management among participants.

Table 6: Information about the way that the medications kept.

| Location of medications | Responses | | Percentage of participants with this feature |
|---|---|---|---|
| | Frequency of using these locations | Percentage | |
| Refrigerator | 7 | 33.3 | 50 |
| Cabinet | 2 | 9.5 | 14.3 |
| In medication basket in kitchen | 4 | 19 | 28.6 |
| Pocket | 1 | 4.8 | 7.1 |
| Drawer | 6 | 28.6 | 21.4 |
| Bag | 1 | 4.8 | 7.1 |
| Total | 21 | 100 | 150 |

Table 7: Information about employing the assistive tools and strategies.

| Assistive tools and Strategies | Responses | | Percentage of participants used these |
|---|---|---|---|
| | Frequency of using tools and strategies | Percentage | |
| Large letter | 4 | 21.1 | 33.3 |
| Glasses | 6 | 31.6 | 50 |
| Magnifier | 3 | 15.8 | 25 |
| Braille | 6 | 31.6 | 50 |
| Total | 19 | 100 | 158.3 |

Table 8: Information about employing the assistive technologies.

| | Technologies and the priority of them | Frequency | Percentage |
|---|---|---|---|
| **Smartphone** | Not exist | 4 | 28.6 |
| | 1st | 6 | 42.9 |
| | 2nd | 3 | 21.4 |
| | 3rd | 1 | 7.1 |
| | 4th | 0 | 0 |
| | 5th | 0 | 0 |
| **Computer** | Not exist | 5 | 35.7 |
| | 1st | 0 | 0 |
| | 2nd | 4 | 28.6 |
| | 3rd | 5 | 35.7 |
| | 4th | 0 | 0 |
| | 5th | 0 | 0 |
| **Cellular phone** | Not exist | 3 | 21.4 |
| | 1st | 7 | 50 |
| | 2nd | 3 | 21.4 |
| | 3rd | 0 | 0 |
| | 4th | 1 | 7.1 |
| | 5th | 0 | 0 |
| **Tablets** | Not exist | 9 | 64.3 |
| | 1st | 1 | 7.1 |
| | 2nd | 3 | 21.4 |
| | 3rd | 1 | 7.1 |
| | 4th | 0 | 0 |
| | 5th | 0 | 0 |

Table 9: Essentiality of the requirements.

| Requirements and the level of essentiality | | Frequency | Percentage | Mean |
|---|---|---|---|---|
| Medication alert and reminder | Not at all | 0 | 0 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 2 | 14.3 | 4 |
| | Somewhat | 5 | 35.7 | |
| | Very much | 6 | 42.9 | |
| Medication list and regimen | Not at all | 1 | 7.1 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 5 | 35.7 | 4 |
| | Somewhat | 2 | 14.3 | |
| | Very much | 5 | 35.7 | |
| Medication tracking | Not at all | 1 | 7.1 | |
| | Not really | 2 | 14.3 | |
| | Neutral | 2 | 14.3 | 4 |
| | Somewhat | 5 | 35.7 | |
| | Very much | 4 | 28.6 | |
| Medication identification | Not at all | 0 | 0 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 1 | 7.1 | 4 |
| | Somewhat | 5 | 35.7 | |
| | Very much | 7 | 50 | |
| Informing the medication non-adherence to another person | Not at all | 3 | 21.4 | |
| | Not really | 3 | 21.4 | |
| | Neutral | 4 | 28.6 | 3 |
| | Somewhat | 2 | 14.3 | |
| | Very much | 2 | 14.3 | |
| Medication information like adverse effects | Not at all | 0 | 0 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 3 | 21.4 | 4 |
| | Somewhat | 2 | 14.3 | |
| | Very much | 8 | 57.1 | |
| Actions when medication errors occur | Not at all | 1 | 7.1 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 3 | 21.4 | 4 |
| | Somewhat | 4 | 28.6 | |
| | Very much | 5 | 35.7 | |
| Reporting the adverse effects that experienced | Not at all | 3 | 21.4 | |
| | Not really | 2 | 14.3 | |
| | Neutral | 3 | 21.4 | 3 |
| | Somewhat | 4 | 28. 6 | |
| | Very much | 2 | 14.3 | |
| Medication refill | Not at all | 2 | 14.3 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 6 | 42.9 | 3 |
| | Somewhat | 4 | 28.6 | |
| | Very much | 1 | 7.1 | |
| Getting reports about the adverse effects that experienced by user | Not at all | 1 | 7.1 | |
| | Not really | 2 | 14.3 | |
| | Neutral | 3 | 21.4 | 4 |
| | Somewhat | 4 | 28.6 | |
| | Very much | 4 | 28.6 | |
| Medication recommendations | Not at all | 1 | 7.1 | |
| | Not really | 1 | 7.1 | |
| | Neutral | 2 | 14.3 | 4 |
| | Somewhat | 7 | 50 | |
| | Very much | 3 | 21.4 | |

personas' characteristics are not the average of the gathered data because being representative for target group is very important for personas. Three personas where designed with their personal information.

## 5. Discussion

This paper described a study which used a goal-directed approach to extract the requirements of a medication management system for individuals with visual impairment. At the end of current study the outcomes were concluded to design the personas in order to extract the goals of the system and help the developers in designing these kinds of products. Moreover, in addition to system requirements, this study presented some solutions which extracted from literature and should be considered by policy makers to make the medication management process easier for individuals with visually impaired.

### 5.1 Goals

According to the Cooper's interaction design [30], the personas' goals are in three categories named experience goals, end goals and life goals. The experience goals of this study will be achieved by considering the user requirements which was mentioned in the previous section as a group for requirements introduced by Ferreira et al. Because the experience goals are the experiences that the user wants to encounter and user requirements are the features that should be consider in order to meet the preferences of the users. The end goals of this system are the functional requirements that were obtained. They are the goals that are the users' motivations to use the system. For example, a visually impaired person uses a medication management system to identify his/her medications. Therefore the capability of medication identification is an end goal for the current system. The other category of personas' goals is life goals that all the end goals are intended to reach these goals.

In addition to personas' goals there are other goals which designers should consider in the design process. Business goals, customer goals and technical goals are such goals. The business goals are the requirements which organizations and businesses define for their products, services and systems and are accordant to their strategies. Customer goals are specified according to the customer's consideration about the user's safety and happiness. Customers could be parents, family members or friends of users. Moreover most of the software based products are developed compatible to the programmer's technical goals. Considering the impact of these goals on the developing process, they have a high priority. For example the capability of execution on different browsers is a technical goal [30].

Analysis of the collected data from literature reviews and interviews determined the user experience goals and end goals. The experience goals of these systems are considering the ease of use, user friendliness and consistency with target group in development process and consistency with target group because when a system contains these requirements, the visually impaired user experiences the sense of ability to use digital products. Moreover, representation of system effectiveness scales, which can show the rate of medication adherence to the user and caregivers, is an experience goal of users. Furthermore, each system should satisfy the user end goals as mentioned above. According to extracted functional requirements a medication management system for visually impaired users should contain medication list with instruction, frequency and dose, medication regimen, medication information like adverse effects and should have reminders for medication intake prescription refill program, medication identification, medication recommendations and immediate actions when medication errors occur. Furthermore, the system should be capable of reporting the history of medication intake, getting reports about the adverse effects that experienced by user and tracking the medication intake. In addition to functional requirements, every function of the system which would be capable to eliminate or decrease the experienced challenges by visually impaired individuals could be considered as end goals. Therefore, according to the extracted challenges, access creation to the information sources, using OCR (Optimized Character Recognition) to read the labels and brochures, invention of containers specific to limitations of visually impaired patients and decreasing the role of others in medication management process in order to keep their privacy as much as possible, could be another end goals for the medication management systems which are specific to visually impaired users. Finally, the independent living and medication adherence are the users' life goals for this system.

The next group of goals are business goals. The business goals of the a medication management system for users with visual impairment, depend on the organization that intends to develop the system but according to type of these systems which are included in assisted technology, the State Welfare Organization of Tehran could be one of the possible stakeholders in development of these systems. Therefore the business goals are associated with this organization's strategies. In this study the users are considered as customers, therefore the customers' goals are included in user goals. Moreover, the technical goals that should be considered by developers include receiving feedback from users (for quality improvement), providing the user accounts for users and developing a responsive system on different smartphones.

### 5.2 Implications for Policy Makers

The findings of this study illustrate that there are possible solutions for challenges which people with visual impairment experience in medication management process. One of the most important solutions is funding on assistive technologies, especially mobile health technology, in order to develop appropriate products for patient with visual impairment to

manage their medications and evaluate the products through clinical trials. The accomplishment of other actions which need to be considered by policy makers, are classified in two categories according to related policy makers. The first actions are related to pharmaceutical industry. The literature and interviews indicated that one of the important challenges for patient with visually impairment is reading the medication information on the labels. Therefore producing the medication information with different format like audio and braille could be a significant solution. Moreover, creating the containers which does not need collaboration between hand and vision is necessary for these patients. The second policies that should be made and executed for this problem are about education. The educational actions should be done for both groups of caregivers and people with visual impairment. According to the results of interviews that have been performed in this study, participants were not educated for medication management and have not learned the effective strategies in this area. Therefore, educational programs in schools can play an important role for medication management of this community. In addition, the caregivers like pharmacists and physicians should be made familiar to their barriers, in order to help them in this process.

## 6 Conclusions

This research which contains literature reviews and interviews, has determined the requirements of a mHealth-based medication management system, using the concepts of a goal directed approach. This study helps the researchers to design an appropriate digital product for this community in order to increase their medication adherence while keeping their independence at the same time. Moreover, the findings of this study could help the policy makers of different areas. The most important policies should be made in pharmaceutical industry and education. In pharmaceutical industry, the policies are needed to be considered by domain experts to produce products which could be used by visually impaired patients easier. On the other hand the educational programs should be held for caregivers and visually impaired people in order to increase their quality of life by increasing their participation in one of the important daily activities. In future works, considering the users' goals extracted in this paper, design and development of a mHealth-based medication management system for people with visual impairment will be performed. Furthermore, future studies should be designed in order to evaluate the effectiveness of this system in medication adherence rate among visually impaired individuals.

## 7 Competing Interests

The authors have declared that no competing interests exist.

## 8 Authors' Contributions

K. Farhadyar and R. Safdari have contributed substantially to the conception and design; K. Farhadyar has acquired the data and performed the statistical analysis in SPSS; K. Farhadyar, R. Safdari and A. Beh-Pajooh have contributed in analysis and interpretation of data; K. Farhadyar has drafted the article; K. Farhadyar, R. Safdari and A. Beh-Pajooh revised the article critically for important intellectual content; all authors have given approval of the final version to be published.

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