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Design Exploration for Medication Adherence of Elderly: *A Conceptual Twist Using Affordances*

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Abstract
Aging population is increasing particularly in developing countries. This increase causes higher rates of medicine consumption for chronic illnesses among the elderly. Poor medication adherence in the case of poly-pharmacy patients is a frequently reported pervasive healthcare problem. This paper elaborates on the design of a product service system that has been developed as the graduation project of the third author for improving adherence to medicine among the elderly and focuses on the exploration and conceptualization phases of the design process. Based on the theory of affordances, the study not only reveals the importance of numerous iterations during the conceptualization phases, but also the specific nature of designing health-related products for older adults. It is exemplary in terms of questioning the initially developed concept by means of using affordances and it shows how affordances may be used in redesigning a totally new concept.
Keywords: Design Studio, Theory of Affordances, Design for Elderly, Medication Adherence

INTRODUCTION

According to United Nations data as of 2017, 13% of world population is over 60 years old and it is estimated that this ratio will increase to 20% by 2050. Almost all areas of life are being affected by the ageing of the population (United Nations, 2010). The possibility of having several and/or long-term health complications and disability rates from illnesses increase with old age. The increase in the number of chronic diseases requires health management systems working from home. (Fisk et al., 2009). As a result, innovative health management interventions are required and understanding the everyday life of people at home and the potential tension between everyday life and medical ideals is crucial (Kanstrup, 2014).

Medication adherence is defined by the World Health Organization (2003) as "the degree to which the person's behaviour corresponds with the agreed recommendations from a health care provider." It is important for a successful treatment of the disease. Despite the importance of adherence, medication non-adherence is a serious problem, with the

World Health Organization noting that the average non-adherence rate is 50% among those with chronic illnesses such as diabetes, hypertension, asthma etc. (Chisholm-Burns and Spivey, 2012; WHO, 2003).

Consequences of non-adherence include worsening condition and quality of life, increased comorbid diseases, increased health care costs, and death (Costa et al., 2015; Chisholm and Spivey, 2012). Non-adherence to medical plans is a public health problem at every level of the population, especially in older adults (Costa et al, 2015). In his study, Gruman (2013) found that elderly patients with chronic diseases cost healthcare systems the most.

Among the elderly, those suffering from at least one chronic disease make 81.7 % of the population whereas 35% of the population has at least two chronic illnesses in Turkey (Ünsal et al., 2011). When the amount of medication consumption is analysed, 93,1% of the elderly use at least one type of medication regularly; 28.7% of the elderly population uses more than 5 different types of medication on a daily basis (Bozkurt Bulakçı, 2014).

This study elaborates on unintentional medication non-adherence of the elderly patients suffering from chronic diseases. These elderly patients either skip doses or take them at incorrect times and/or quantities. Furthermore, when visiting the clinician, it is difficult for them to summarize the rate of adherence they have accomplished. In order to overcome these problems that the elderly patients face, a product service system concept called Med (Med PSS) has been developed as the graduation project (4th year undergraduate level) of the third author studying at the Industrial Design Department of a university. Although the project started with the design of a multi-compartment dosing device initially, the concept has been redesigned carrying out several iterations. The aim of this paper to show how the exploration and conceptualization phases were achieved taking into consideration the theory of affordances.

Older adults and medication adherence

While older adults' abilities change over time, their health status could change from vigorous (mobile, independent, no significant health problems), to fragile (inconsistent health status, chronic illnesses) and fragile to dependent (severe illnesses and mostly treated in hospitals/clinics) (Le Deist and Latouille, 2016). To delay this change, health systems require regular checking, follow-up and intervention (Öney Doğanyiğit, 2018).

Most older adults are poly-pharmacy patients. Establishing an acceptable rate of medication adherence is particularly challenging in the case of poly-pharmacy patients because of the complexity of the treatment (Amassari et al, 2002). It is reported that in Turkey, 82% of patients forget to take their medication on time (Güneş, 2014). The rate of adherence -that is usually described as the percentage of the prescribed dose of medication actually taken by the patient over a specified period- is important because patients benefit from medication only if they follow prescribed treatment regimens closely (Osterberg and Blaschke, 2005). Existing literature suggests that adherence rates are lower among patients with chronic disease compared to patients with acute conditions (Jackevicius et al., 2002; Haynes, et al. 2002; Lehane and McCarthy, 2007). Since elderly patients suffer from chronic disease more, determining the rate of adherence is crucial for them. However elderly people have additional disadvantages in determining and reporting the rate of adherence due to physical and cognitive insufficiency. Besides, one of the difficulties of managing poor adherence is the lack of accurate and affordable measures (Haynes et al., 2002). However, if the rate of adherence is not reported correctly by the patient, the clinician has difficulty in adjusting the correct doses of medication during the treatment.

Vries et al. (2014), classify medication non-adherence as intentional and un-intentional, where the former is a conscious decision of not taking the medication and the latter refers to a passive behaviour that is more related to demographics. On the other hand,

Jimmy and Jose (2011) reported three types of adherence: First one is primary nonadherence; where providers write prescription, but the medication is never initiated by the patient. Second one is non-persistence adherence where patients decide to stop taking medication after starting it. And the last one is non-conforming adherence; where medication is not taken as prescribed and this behaviour can range from skipping doses to taking doses at incorrect times or at incorrect doses, to even taking more than prescribed.

Several tools and approaches that are available for improving medication adherence include medication packaging (e.g., calendar packs), digital health platforms (e.g., smart phone applications that use barcodes) and multi compartment dosing devices (MCDD). All of these are reported to have a positive impact on increasing the rate of adherence (Jabari, 2018). The prices of existing products range between 25-200 USD on the market. The economy segment of the market comprises of plastic boxes on one hand, whereas the premium segment offers storage units with electronically operated reminders. Wearable technology devices are also available in the market, however most of them are too complicated for the elderly to operate; besides they are beyond the reach of the elderly particularly in terms of price. Thus, the dominant design turns out to be the weekly dosing device with its 28 fixed size compartments.

Older adults are varied with miscellaneous needs and requirements (Plaza et al., 2011; Fisk et al., 2009). They accept technology once it meets their necessities and expectations (Venkatesh et al., 2003; Conci at al., 2009). Thus, when designing products for them, one needs not only rich research data but also powerful tools and theories to guide them throughout this process.

Using the theory of affordances as a design tool

Designing usable products requires an understanding of how older adults build relationships with products and how these relationships can be controlled by designers. Theory of affordances could be a useful instrument for understanding the relationships between product functions and user tasks (Galvao and Sato, 2005).

Gibson (1979) stated that the affordance of something does not change according to the need of the observer. Values and meanings are regularly assumed to be subjective and mental, but affordances of the environment are objective, real and physical (Gibson, 1979). An affordance is a fact of the environment and a fact of behaviour, both physical and psychical (Gibson, 1979). Maier and Fadel (2009) argued that the concept of affordance is more fundamental than other concepts, such as function. Scholars have so far agreed on the broader possibilities of use for the theory of the affordances and it has been expanded (Baerentsen and Trettvik, 2002; Pols, 2012). Norman (2002) stated that affordances suggest the range of possibilities and designers need to consider the thoughtful use of affordances. The theory of affordance affects how designers think that action possibilities are perceived by users in their effort to choose the 'proper' functionality for their products (Smets and Overbeeke, 1994). Thus, affordances can be a powerful tool for a designer when designing health related products for older adults.

The field of health care is commonly not well known and filled with unfamiliar terms and phrases by a typical user (Fisk et al., 2009). They emphasized that the result of making usage error in a health-related product might mean long-term illness, an extra visit to the hospital, or worse. Consequently, the user of a healthcare product who has recently been diagnosed with an illness, for example, may be in a more stressful and sensitive situation, than other users (Fisk et al., 2009). As health is a serious area for most of the users, developing a conceptual understanding of the subject focused on affordances for older adults is needed in order to develop successful pervasive healthcare design interventions.

METHODOLOGY

Design Studio courses, including the graduation projects, should be intertwined with the current problems of daily life and could be used as the platform for responding to the challenges of users. Consequently, "Design for good health and well-being" was given as the main topic for the graduation project (4th year under-graduate level) at the Industrial Design Department of a university in 2018-2019 Spring Semester.

United Nations states one of the 17 goals set for 2030 as "Good Health and Well-being (United Nations, 2017). Supporting a good and healthy life for all age groups is one of the most important components for welfare societies. In spite of major steps to improve people's health and well-being in recent years, disparities in access to health care continue. More than six million children still die each year before their fifth birthday and only half of all women in developing regions have access to the health care they need. However, living a healthy and good life is a human right and therefore the aim of the graduation project was to look for solutions to provide a new chance to ensure that not only the richest but also all segments of the society have access to the highest standards of health.

The Graduation Project was supervised by the Graduation Jury during the Spring semester, with three mid-jury and one final-jury sessions, audits and general criticisms. Graduation Jury expert team comprised of two experienced designers, four design academics three of which were also industrial designers and one engineer. All students had an advisor who worked closely with them. First author of this study was the coordinator of the graduation jury, while second author was one of the design academics in the jury.

Third author of this paper provided a counter brief reporting that she would like to work on medication adherence and second author was her advisor. This paper focuses on her project and the exploration phases of it.

Phase 1: Exploration for a multi-compartment dosing device

For her graduation project, third author suggested to work on a multi-compartment dosing device (MCDD) with the aim to improve features related to ergonomics since elderly patients had experienced difficulties in opening the dosing device compartments, which were also reported to be too small to contain all prescribed medication (Hall et al., 2016). On the other hand, Lecouturier et al. (2011) confirmed that if the compartments of the MCDDs were larger, it would make the device too big and bulky in terms of portability.

Starting with collecting secondary data and market analysis, third author's exploration phase proceeded with an online survey. Due to low computer literacy among the elderly, relatives and caregivers of the elderly were surveyed with the purpose to identify cases that were going to be analysed in detail throughout the design process. The questionnaire used in the survey is provided in the Appendix I. A total of 12 respondents completed the questionnaire who also provided detailed answers to open-end questions on medication adherence attitudes and the tools used to improve adherence.

During the next step of the exploratory phase, these 12 participants were contacted for interviews and detailed observation and 6 of them participated. The design student who also assumed the role of the researcher made face-to-face interviews with these 6 patients and their caregivers at their homes. The main objective of the interviews was to determine what types of medication these people used, the dosing regimen, which devices (if any) they used to improve medication adherence, how they used these devices and whether they were satisfied with them.

Results of Phase 1
One of the results revealed during Phase 1 was that the medication forms used for chronic diseases by these people were numerous, ranging from pills to injection vials. Having various types of medication forms was a design problem area identified concerning the existing multi-compartment dosing devices.

The results of the online survey revealed four key problems concerning the existing products: Firstly, one by one cutting and placing all the medication necessary to fill the standard 28 compartment weekly dosing device was stated as difficult and time consuming for the patients/caregivers (difficulty to refill). Secondly, the multi compartment dosing device was reported as too big to be carried as a daily routine (portability/size). Thirdly, all of the six users mentioned the hygienic concerns of placing the pills to the device without packaging. And finally, the compartment size was reported as being not large enough to store all the medication (suitability for all forms of medication).

These problems were elaborated during the interviews and other problem areas were also explored. One user mentioned the inconvenience of carrying the plastic box which made noise as the pills collided with each other. Although it was easier to achieve taking the pill out of the packaging instead of cutting the packaging, they also had concerns on the potential physical damages and interaction between pills during the carrying process. Both the caregivers and the patients mentioned that they sometimes forgot to take the medication on time and therefore the doses were skipped. They also had difficulty in remembering how many doses they skipped during their routine visits to the clinician.

Galvao and Sato (2005) proposes "the Functional Affordance Level" which defines advanced relationships that convey the utility element or sense of usefulness throughout the product lifecycle. Affordances at this level are described as "-abilities" and provide designers with generic requirements to which a final concept must correspond. By being inspired from Galvao and Sato's functional affordance level (2005) and based on the findings of literature review, online survey and interviews accomplished throughout Phase 1, a checklist of functional affordances that the final product needs to have was developed and used throughout the design study:

1. To afford reminding to take prescribed medication at correct dose, correct time and correct context (on full stomach vs. on an empty stomach): Remind-ability
2. To afford carrying (in terms of size and noise): Port-ability
3. To afford containing all different forms of medication: Contain-ability
4. To afford replenishment: Replenish-ability
5. To afford opening and closing easily by an older adult: Open-ability
6. To afford carrying medicine hygienically: Hygenic-ability
7. To afford carrying medicine without damage: Undamaged carry-ability
8. To be affordable for older adults: Afford-ability
9. To be able to report the medicine adherence rate accurately: Accurate report-ability

Phase 2: First and Second Conceptualizations-A Smart Multi-Compartment Dosing Device
First Conceptualization
Taking into account the affordances in the checklist, third author developed the first smart multi-compartment dosing device concept. The device would remind the user about the correct dose, correct time and correct context and comprised of compartments unique for each medication. The opening of the lid would be automatically activated by servomotors. Thus, problems concerning opening would be resolved.

However, issues concerning replenishment would be even more complicated. Another problem concerning the smart MCDD was that even though the proposed concept was more compact than the existing MCDDs, it was impossible for the user to carry it all the

time, therefore its reminder function was at risk while the user was on the go. The first concept is shown on Figure 1.

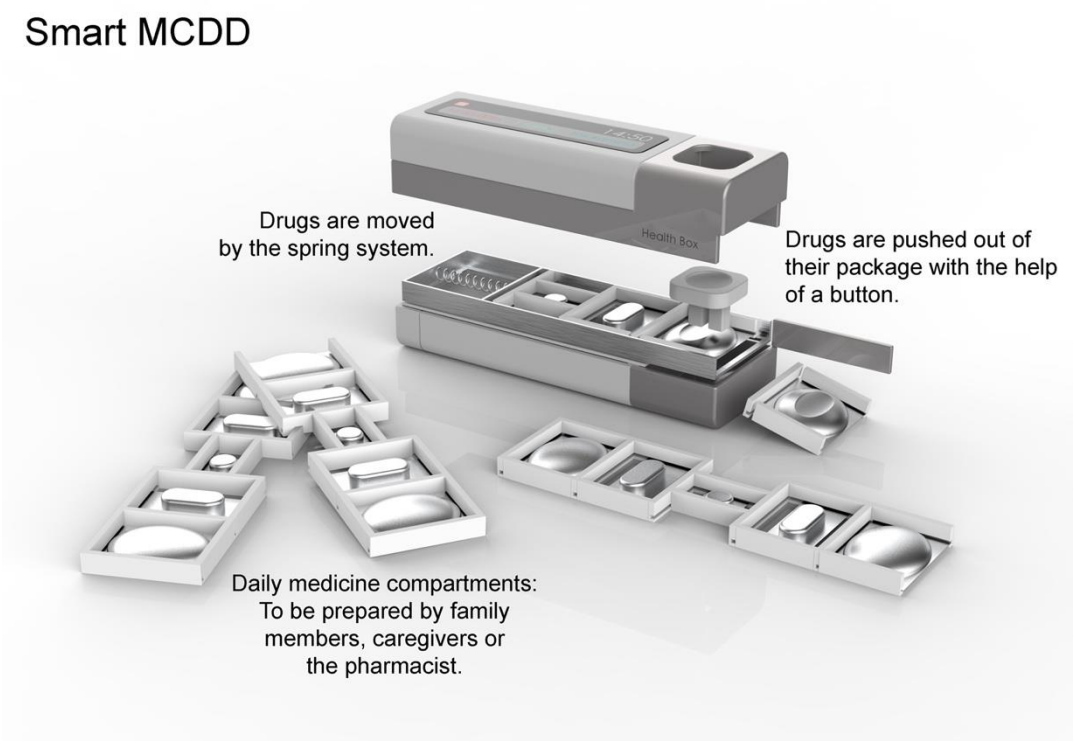

Figure 1. First Conceptualization: Smart MCDD

The first concept was evaluated by the advisor of the student and it was decided to combine the smart MCDD with a more portable wearable technology device that would communicate with it. Adding a wearable device to the concept would increase the likelihood of taking the medicine on time in cases the user was away from the smart MCDD.

Additional explorations and the second conceptualization:
In order to determine what accessories, the elderly carried on them, additional observations were made in public spaces and among the elderly acquaintances. The elderly people were asked as to which accessories they carried with them all the time. During the observations and conversations in the neighbourhood, it was noticed that contrary to younger people, the elderly people did not carry their cellular phones with them all the time, although they owned one. Females usually carried jewellery and small bags, whereas males had wallets and key holders. This fact was inspirational in designing a new concept i.e., the smart watch for MCDD that could also be used as a key holder or a pendant. As a result, second conceptualization was a smart MCDD with a smart watch (Figure 2).

Figure 2. Second Conceptualization: Smart MCDD + Smart watch

Results of Phase 2
Results of Phase 2 were evaluated by all six experts during a mid-jury session. The MCDD was more compact in terms of portability compared to the existing MCDDs. Also, the compartments were more flexible compared to the existing MCDDs, however different medications such as injection vials could not be stored due to the size of the compartment.

By checking the items on the affordances list at Phase 1, the second conceptualization was assessed. Items # 1, # 2, # 5, # 6, # 7 on the affordances list were fulfilled; however, items # 3, # 4, were left intact. Due to complicated electronic requirements item #8 was at question, but #9 was fulfilled. The expert team was particularly concerned about the expensive mechanisms that would have to be embedded to the dosing device for dispensing.

Phase 3: Exploration for a Smart Multi-Compartment Dosing Device
At the end of Phase 2, affordability turned out to be a major issue since most of the elderly are pensioners and the average salary of a pensioner is around 300 USD in Turkey. The target was set as 20 USD per device.

Opening of the compartments was a major problem observed during the research and also reported in existing literature (Hall et al., 2016). Since the electro-mechanic components of the dosing device were increasing the cost, student worked on mechanical solutions. The findings from existing literature indicate that the shape of packaging affects older peoples' ability to physically open packaging (Chavalkul et al, 2011; Berns, 1981). In order to examine which form is easy for older adults to open, third author organized an experiment with 20 older adults. In searching of the most ergonomic form, the student asked them to open a box with a round cross section: six of older adults could not complete the task. Afterwards the same users were asked to open a box with a square cross section: This time two of the elderly could not complete the task (Figure 3). Thus, third author decided to proceed with a prism form for the shell of the MCDD.

Figure 3. Users experiencing different forms: Opening of the lid of a cylinder versus a prism.

These findings were in line with a previous study aiming to examine the impact of shape, diameter and height of lid on wrist torque opening strength (Crawford, Wanibe, Nayak, 2002). Wrist torque strength a group of younger and older adults were measured, and it was found that participants could exert greater force with square test pieces compared to circular test pieces of the same diameter.

Phase 4: Third Conceptualization - A Smart MCDD + Wearable Alarm

In addition to reducing the cost of the smart MCDD, at Phase 4, the designer also studied how the cost of the smart watch could be reduced. For this purpose, she designed a wearable alarm with a light and a buzzer whose only function would be to remind the user to take the medication.

Taking the pills out of the box was a problem reported during the online survey and the interviews, therefore she also designed mechanical tools that would facilitate the process. Figure 4 demonstrates the components of the third conceptualization which are a smart MCDD and a wearable alarm.

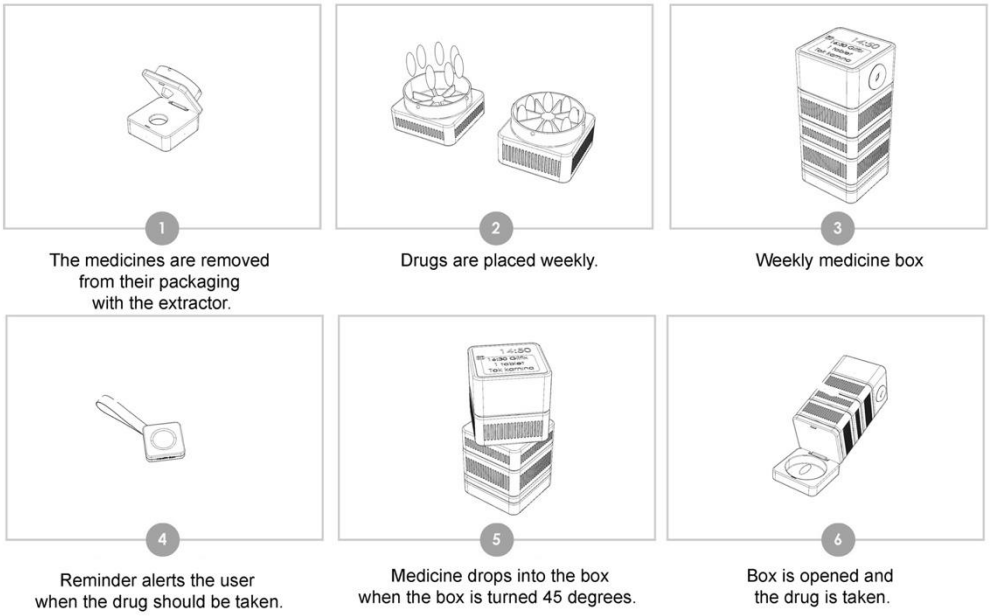

Figure 4. Third Conceptualization: Smart MCDD + Wearable Alarm

The third concept was evaluated by the graduation jury experts. Affordability was improved to some extent however there was not much improvement in terms of affordance list items # 3, # 4, # 6 and # 7. Reporting accurately was still intact. Besides item # 1 was worse compared to the second conceptualization because the reminding function was limited with time, dosing and context functions were omitted on the box due to cost constraints. Reporting function was completely omitted.

Phase 5: Final Exploration

The time for the final jury was close so third author decided to carry out more observations among the elderly within her reach. Those next-door cases certainly caused bias as the sample was from the same neighbourhood, similar education background and financial means; however, the advantages of being able to spend more time with them during her visits, the ease of photography and video shooting made the biased sample quite convenient for in depth research. She particularly focused on the medication storage and carrying habitudes of the users. She noticed that they kept the outer packaging for storage at home, but they were got rid of the outer packaging on the go and kept only the inner blister packaging. Figure 5 depicts the context in which medication is stored at home and on the go.

Figure 5. Medication storage habitudes: At home (on the left) and on the go (on the right)

Based on the assumption that influencing user behaviour is a challenging task third author focused on potential solutions that would foster current user behaviour in terms of storage. The users tended to keep the inner packaging of medication firstly, for hygiene concerns. Secondly, they kept it for maintaining the integrity of the medication. Lastly, particularly during transportation, they were concerned about noise not only because it disturbed them but also because they were concerned about their social relationships.
In her article Lilley (2009) summarizes the strategies for designing sustainable behaviour. Eco-feedback, behaviour steering, and persuasive technology are the paths that can be used in designing behavioural change. Eco-feedback enables the user to have higher power in decision-making, whereas persuasive technology transfers most of the power in decision making toward the product. Behaviour steering on the other hand is a method that makes a balance in empowerment by means of encouraging users to behave in ways prescribed by the designer through the embedded affordances and constraints (Lilley, 2009).

Many of the existing multi compartment dosing devices (MCDDs) are forcing the user to take the medication out of its packaging; they are not suitable for all forms of medication, they are not convenient in terms of portability due to noise and hygiene concerns; they do not act as a reminder to take correct dose at correct dose, correct time and in correct context; besides they are not capable of reporting the medication adherence rate to the health professionals such as doctors. On the other hand, smart dosing devices act as a reminder. However, they are not wearable, and they are too expensive thus they are beyond many pensioners' financial means.

Table 1 Functional affordances versus existing products and proposed concepts

Functional Affordances	MCDD	Smart MCDD	Concept #1	Concept #2	Concept #3	RESULTING PRODUCT CONCEPT
(1) Remind-ability		@home	@home			
Time	-	+	+	+	+	+
Dose	-	+	+	+	-	+
Context	-	+	+	+	-	+
(2) Port-ability						
Size	-	-	+	+	+	+
Noise	-	-	+	+	-	+
(3) Contain-ability (all forms of medication)	-	-	-	-	-	+
(4) Replenish-ability	-	-	-	-	-	+
(5) Open-ability	-	-	+	+	+	+
(6) Hygenic-ability	-	-	+	+	-	+
(7) Undamaged carry-ability	-	-	+	+	-	+
(8) Affordability	+	-	-	-	+	+
(9) Accurate report-ability	-	+	+	+	-	+

RESULTING PRODUCT CONCEPT: MED PRODUCT SERVICE SYSTEM

Third author finally developed the concept of a product service system comprising of three items: a cellular phone application (Med App), a reminder (Med Pendant) and a storage case (Med Case). Instead of complicated screens, smart watches or smart multi-compartment dosing devices with fixed compartment space, the whole system is designed to work based on colour coding. Each medication is assigned a different colour code by the smart phone application Med App by means of reading the barcodes from the outer box. This task is carried out only once, either by the pharmacist or the caregiver. This colour code will be used by Med Pendant to remind the patient the correct time to take the medication. The Med Pendant will also display the amount of medication to be taken and whether the medication should be taken on full or empty stomach. The accessories provided in the Med Case would label each medication in its inner packaging using the same colour code. Thus, hygiene and noise concerns, preparation difficulty would be eliminated. The three push buttons on the pendant are yes/no/snooze. By pressing one of the three buttons the user gives input whether the medication is taken on

time, or not. This feedback is accumulated and provides input for the accurate reporting. Figure 6 shows the resulting product concept which is named as Med Product Service System.

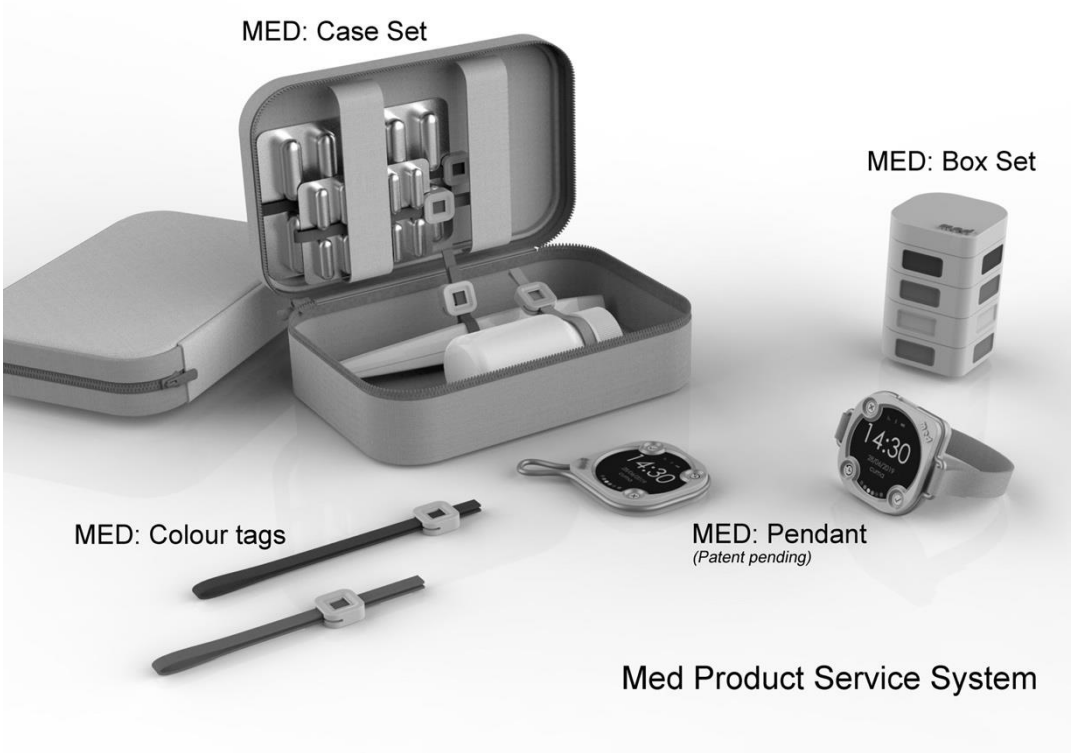

Figure 6. Resulting Product Concept: Med Product Service System (Med App+ Med Pendant + Med Case)

During the interviews one respondent had commented as:

> "I buy the medication through the national healthcare system. Every six months, I have to get an approval of the prescriptions by the commission. Although I keep the copies of the approval reports, sometimes I forget the expiry date, but since I know the pharmacist, she gives me a few pills before I get the next approved report. However, I should not be concerned with such things. The system should remind us a few days before the expiry date."

Thus, the resulting product concept was enhanced to integrate the data of the national care system so that all stakeholders in the national healthcare system - the hospital, clinician, the pharmacy and the patient/caregiver- could have access to the application. Therefore, costs related to non-adherence would be decreased and a smoother service would be provided to the patient. Karaca Şalgamcıoğlu (2019) stated that in Turkey there is a gap between real-life health services and mobile health applications. By integrating the data of the national care system, the resulting concept could close this gap.

Elderly users see mobile phones as a more accessible technology than personal computers (Plaza et al., 2011). A growing portion of older adults own mobile phones today. By using the Med App, third author involved a ready-to-use technology that older adults already have in their lives to the proposed design.

Norman (2002) identified human beings as analogue presences who are surrounded by the digital world. They care about meanings, not the signals. However, in the digital world, precision is the most important thing (Norman, 2002). By using colour coding, the resulting product concept helps the user to escape from the digital world.

Testing the resulting product concept
The resulting product concept was tested with seven potential users who were older adults aged 65 and older. The participants of this final exploration were close relatives of one of the authors which made getting comprehensive insights easier.

In order to get their insights, an image showing the rendering of Med Product Service System (PSS) was shown (same as Figure 6) to the participants, and the following question was asked: "What would you use this product for?" Six seven of the respondents related the resulting concept to medication.

Norman stated that when a product has sufficient affordances, it can be interacted correctly and intuitively to perform appropriate uses. The ideal affordance is one in which "the user knows what to do just by looking" (Norman, 2002). Some of the participants used the word "watch" to describe the shown image. By using two everyday products (a watch and a key chain) as a part of the product service system, the resulting concept lets the user "know what to do just by looking" with Med Pendant.

The following words were also used once by the participants to describe the shown image of the resulting product: smart watch, blood sugar measurement, blood pressure measurement, perfume, injection, comb, brush, first aid, reminder, colour coding. It was clear that the PSS mostly reminds the participants words related to health. Unfortunately, the fact that most respondents did not mention colour coding, hints that there is need to improve the form of the concept so that it is more self-explicative.

CONCLUSION
Smart products make use of information and communication technology (ICT) to collect, process and produce information, while e-services are web portals, apps and means alike, which facilitate the communication between service providers and consumers. A smart product-service system (Smart PSSs) integrates smart products and e-services into a single solution (Valencia et al, 2015).

This study explains the design of a smart product service system for improving adherence to medicine among the older adults and it focuses on the exploration and conceptualization phases of the design process of a product service system including a MCDD, a wearable technology device and an App for smart phones. The research started with the development of smart product and later on evolved to the development of a smart PSS. For this purpose, various qualitative research techniques including observation and interview has been carried out on different exploration phases using an affordances-based approach. As to the knowledge of the authors this is the first study that uses an affordance-based approach in designing to improve medication adherence of the elderly.

Studies emphasize that older adults do not represent a homogenous group. There are variances in rates of changes in their abilities, patterns of changes, life experiences, compensatory strategies, motivation, attitudes, and more (Fisk, Rogers, Charness, Czaja, Sharit, 2009). However, designers who can understand the general patterns will develop product systems that are more usable and preferable by older adults, and probably by other age groups as well. Taking the theory of affordances into account when designing the products may help to understand the general patterns.

The description of affordances model classifies affordances into four categories: opportunity for manipulation; opportunity for effect, opportunity for use and opportunity for activity (Pols, 2012). The fourth concept creates the opportunity for manipulation by means of enabling the user to press the alarm, opportunity for effect is achieved by taking the medication on time, opportunity for use is fulfilled by means of wearing the alarm all the time, and opportunity for activity is accomplished when the Med PSS is integrated within the national healthcare system.

DISCUSSION

This paper elaborated on the question how to do research through design in the studio to improve a pervasive healthcare problem -medication adherence of the elderly- by means of using affordances theory. The affordances were multiple in number, some of them contradicting with each other thus the student had to focus on each affordance one by one. This required developing consecutive concepts and iterations.

The case study showed us that determining the affordances in advance is important in achieving an efficient conceptualization process in design. The design project was completed in four months and four consecutive concept proposals have been developed smoothly thanks to abiding by the theory of affordances. The fourth concept being superior compared to the first three in fulfilling the affordances determined, the case study also showed us the importance of numerous iterations in achieving the goals.

Due to various constraints, existing design graduation studio practices may tend to stick with the same concept once the concept is developed and selected. This study is exemplary in terms of questioning the initially developed concept by means of using affordances and it shows how affordances may be used in redesigning a totally new concept by an undergraduate student.

Since health is a life-threatening domain for human beings, their perceptions and abilities for health-related products are unique. Thus, designing health-related products for older adults demands its own interpretation of well-known design theories and methods.

Limitations and Future Implications

In this research through design, the goals were the affordances determined in Phase I. These affordances were determined by means of a literature review, a market review and interviews with 6 chronic patients and their caregivers. All of the 6 chronic patients were in vigorous health conditions. On the other hand, in addition to health conditions, existing literature emphasizes the importance of differences between the elderly with respect to cognitive ability, social relationships, attitude to life and satisfaction in senior technology acceptance (Chen and Chan, 2014). Integrating all of these factors during interviewee selection remains as a future implication.

Since this was an undergraduate graduation project, time and budget were limited. Therefore, a working model of the concepts was not developed and tested. Instead, 2D models, and 3D printer outputs were used during the exploration phases. This was a major limitation of the study. As Pols (2012) states, in practice users rarely encounter completely unknown artefacts without any sign and symbols but if they do the only affordances of those artefacts, they will be able to perceive will be manipulation opportunities. In order to give a manipulation opportunity to the potential users, repeating the study with 3D working models would enable the users to perceive the product better and comment on it more profoundly thus more realistic feedback could be obtained.

The colour coding that was used in the resulting concept is not suitable for blind/visually impaired users. Additional design work is required in order for the product to be suitable for all.

Finally, existing research identifies camouflage as an important factor in the design of products, services and systems related to chronic illnesses (Kanstrup, 2014). Therefore ‘need for camouflage’ could be added to the list of affordances in future investigations.

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APPENDIX I
Online survey questions:

- Do you have anyone over sixty years of age of whom you take care? What is your degree of relationship?
- How old is he/she?
- Male/female?
- Education?
- Does he/she live alone? If not, with whom?
- Can he/she cook on her own?
- Can he/she eat on her own?
- Can she use the phone? Can she answer the coming call?
- What forms of medication does he/she use?
- Can he/she use the medication on her own?
- Can he/she buy the medication on her own? Does he/she use any medication that has not been prescribed by the doctor?
- Is there any medication that is prescribed by the doctor, but he/she does not use?
- Why does he/she prefer not to use the prescribed medication?
- If there is a problem concerning the mediation what does he/she do?
- Does he/she know why he/she takes the medicine?
- Does he/she know when he/she has to take the medicine?
- Does he/she know how he/she has to take the medicine?
- Where does he/she keep the medication?
- Does he/she ever forget to take the medication? If yes, what is the frequency?
- Is there a method he/she uses in order not to forget to take the medication?
- Does he/she use a pill box/case? If yes, what kind of a pill box/case is it?
- Is he/she satisfied with the pill box/case? If not, what do you think the main reason is?
- Does he/she ever lose the pill box?
- Is there a precaution he/she takes in order not to lose it?