Investigating the Acceptance of the Internet of Things based on the Grounded Theory Approach for Taking Care of Patients at Home (A Case Study of War Veterans)

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Abstract
Background: The Internet of Things (IoT) for patient care at home, which means that instead of going to the hospital and spending a lot of time and money, patients' clinical data can be viewed remotely and the data can be processed and then sent to the doctor.
Objectives: The use of any new technology by the society faces challenges. For this particular reason, before the introduction of any technology, the effective factors in its use must be investigated. In this research, the acceptance rate of the IoT for patient care at home is investigated.
Methods: This research was conducted using the grounded theory method with a case study of veterans who need home care. In order to collect information, 15 veterans and their nurses were interviewed in the statistical community of Zahedan.
Results: The findings of the present research revealed that the impact of IOT on the improvement of health services can be understood, and positive advertising about the performance of the IoT has a significant effect on its use and confidence. However, due to the unknown nature of the IoT and the security issue of users' information, there are doubts about its use.
Conclusion: In order to increase the use of IoT in order to take care of patients at home, the influencing factors of the IoT should be taken into account in order to create trust in IoT.
Keywords: Internet of Things, Veterans of Imposed War, Health, Grounded Theory

1. Background

The physical condition and health of the people of a community have a direct impact on the development of that community. Investigating the health and treatment system of any community leads to the health of the community and as a result, leads to economic and political stability.[1] Today, the Internet plays a vital role in providing health services such as education, disease management, support, initial decisions of medical treatment, and doctor-patient communication, and the increasing importance of electronic health services in expanding public health, saving time and costs, and improving prevention processes.[2] Remote health control systems of people such as using the Internet of Things to control the patient's vital signs, patient care without the presence of the patient in the treatment centers, intelligent monitoring and regulation of the environmental conditions of patient care, remote visitation of patients in Special conditions, monitoring the physical activities of elderly people with special diseases and conditions, and setting up internet and online medical consultations can help to increase the health of the society.[3] The increasing patient

population, especially those who need care, puts additional pressure on healthcare systems worldwide in terms of operational costs and resources. To minimize this pressure and provide efficient healthcare services, the use of the IoT and wearable technologies can be promising.[4] The IoT was introduced by Kevin Stein in 1999 in such a way that everything, even inanimate objects, functions digitally and is programmed and managed by computers.[5] In the medical health care system, any object that can measure and collect data about people's physical condition, such as smart bands, digital drugs, implantable surgical devices or other portable devices that can collect health data and connect to the Internet for measurement is called the IoT. According to surveys, the most common use of the IoT is in the field of health and medicin.[6] The functioning of the IoT is that based on the use of the equipment and the purpose of using the IoT, different sensors are used, so that the sensors perform the required measurements, and then the measured information is sent to a server through the network. The information sent is processed and, in

this way, we reach the desired information.[7] The IoT technology is used in various applications including healthcare, industries, educational institutions, power plants, and homes to connect machines and home appliances and control them remotely over the Internet. The IoT uses wireless sensors, radio frequency identifiers, Internet modules, and Bluetooth.[8] It actually defines a network of virtual reality objects, software, and other technologies to connect and exchange data with other devices and applications on the Internet. The word "object" may refer to a connected medical device, a biochip, a solar panel, or any sensory object capable of collecting and transmitting data over a network. The use of IoT technology is widespread, because it can be used in almost any technology to measure the environmental conditions or to measure a specific feature or function and eventually use these measurements and conditions to improve functions and decisions.[9]

The IoT in medical care is a communication network between the patient and the treatment staff that can use the doctor's equipment such as sensors to provide information about blood pressure, the amount of oxygen in the blood, the number of breaths per minute, body temperature, blood sugar level, electrocardiography of the heart, etc. to receive the help of the treatment staff in emergency cases as soon as possible and also to benefit from remote and home medical care by increasing the interaction between the patient and the treatment staff.[10] Other applications include the use of IoT technology in hospital beds, equipped with smart beds, as well as the use of IoT in medicine, reducing waiting time in emergency rooms, faster access to required medical information, tracking patients with Alzheimer's or dementia, tracking drugs etc.[11,12]

Health care professionals can basically only measure the patient's vital parameters when dealing with emergencies such as accidents, heart attacks, etc. to save patients' lives. However, for some treatment decisions, doctors need to wait for more details for a complete diagnosis which causes us to lose time for test results, and as a result, sometimes the lives of patients are put at risk by delays in carrying out treatment processes and procedures. Accordingly, the IoT will be useful for doctors and patients to be equipped and thus increase the scope and chances of recovery.[13]

Patient care has changed due to the changes in the structure of diseases and the increase in the age of the population and the costs of treatment as well as the risks of attending medical centers. Therefore, to care for patients at home, it is necessary to examine the needs and limitations of the patient and family for a targeted approach to achieve the highest level of physical, mental, and functional health of the patient.[14] Technologies equipped with the IoT made remote monitoring possible in the health sector, made it possible to keep patients safe and healthy, and empowered doctors to provide specific treatments that require real-time information. It also increased patient participation and satisfaction with doctors' availability. In addition, the possibility of remote monitoring of people's health helps to reduce the time of hospitalization. The IoT also significantly affects cost reduction and improvement of therapeutic effects in health care.[15] In addition, when patients are more comfortable using IoT devices, they are more likely to be satisfied and recover faster. The IoT is needed to monitor patients more closely and provide better health care. Furthermore, medical staff, patients, and doctors are safer from infectious diseases due to remote patient monitoring by IoT. The IoT system can be actively monitored and controlled and the health care department can be informed about immediate changes in the health parameters of each patient.[16] Big data and cloud storage have made great progress in the healthcare system. Speed and reliability are key features of cloud computing. The IoT is used for smart connected devices and goods, whose applications include clinical diagnosis with extensive record keeping. The use of IoT in healthcare will drive innovation, save time and money, increase accuracy, and expand services. Healthcare stakeholders have recently shifted their focus from creating automated scientific methods and digitizing medical records to big data analytics. Cloud-based data can help healthcare organizations deliver better care to providers. For accurate diagnosis of healthcare devices, they collect medical photos and then analyze this information in the cloud and provide accurate statistics for health management.[17]

2. Objectives

Due to the increasing age of veterans, it has become difficult to diagnose the disease in those who are involved in multiple diseases, treatment resources are limited, and also veterans who do not have access to medical centers, for example, who live in villages or remote areas, have limitations for treatment.[18] The obstacles which veterans face to use the treatment system include mobility restrictions, transportation problems, etc. Therefore, due to the stress caused by the harsh physical conditions and the stress endured during the war, the veterans are exposed to mental illnesses. This is why remote medical care plays an important role in the military field for war veterans.[19] Facilitating access to treatment through the IoT brings peace of mind to patients by identifying the disease, assisting in treatment and carrying out rehabilitation activities of injured soldiers during the war by doctors.[20] Considering that the necessity of remote care of veterans has been realized in studies, this task has not been fulfilled yet. The purpose of this study was to investigate the conditions of acceptance and use of IoT for taking care of patients at home.

3. Methods

3.1. Grounded Theory

Structured qualitative theory creates an interactive relationship between the researcher and the participants. In qualitative methods, the theory that is presented is based on the analysis of the questions raised, which is one of these methods, the analysis and examination of theories. The grounded theory method is a qualitative method which collects data through oral questionnaires. The data is classified step by step and forms a more general category until the final stage presents the theory.[21,22]

In this article, the acceptance of the IoT in the care of patients at home has been investigated using the grounded theory method, and because it is not possible to survey the entire population, first a statistical population was selected and the research was conducted based on that sample. Finally, the result were generalized to the whole society. It is worth mentioning that the tested sample from the statistical population must have at least one common trait that by measuring the variables of that population, generalizing its behavior to the entire population will be possible.[23]

3.2. Statistical Society

The common trait in the statistical population of this research is the veterans of the imposed war in Zahedan City. For this purpose, 15 of them were randomly selected.[24] It is believed that when the answers to the questions do not add new points to the study and no new findings are obtained, the number of interviewees is considered sufficient.[25] The reliability of the research in the grounded theory method is measured in such a way that if the interview is repeated, it will have the same result as the previous interview in order to measure reliability, with a time interval of a few days after the first interview. In other words, we select a sample of people who were interviewed for the first time and repeat the same interview for the second time and compare the results of the two interviews. If they have the same results, the conducted interview has a sufficient reliability.[26]

In the ground theory method, the answer to all the questions is verbal. The completion of this questionnaire is conducted in the form of an interview, and people must express their full opinion on each question. Then in the first stage, the concepts are taken from the answer. People's responses are collected and then coded in such a way that each response is studied and the meaning taken from it is summarized in one phrase, and then the codes are categorized based on the similarity of the meaning of each response. These categories have also been investigated and categorized in its more general sense so that a theory can be expressed for a problem.[27] In this research, the coding method (open, central, selective) was used to categorize the answers.

3.3. Data Collection

In this research, information was collected through interviews with 15 people. The results of the last three interviews were almost the same. In addition, the number of samples was sufficient. In the second stage, after 5 days, from two One of the interviewed people was asked to be interviewed again to check the reliability of the questionnaire. During investigations, the answers were consistent and the reliability of the questionnaire was confirmed.

First, it was explained to the veterans and their nurses, who were in the sample, how the use of IoT was for those who need care at home so that they could have an idea of it while getting to know the IoT and ask questions. Then they were asked the questions of this interview which were based on their perception of the IoT and its impact on their lives, and finally the topic was discussed whether they were willing to use the IoT for care? Were their veterans at home or not? And what will be their concerns for using it? Since the focus of the test has been imposed on war veterans, the statistical population was only men, and even male nurses have been helped in completing the questionnaire, as it can be seen below.

In Table 1, the information related to the frequency of education of the interviewees is mentioned. In the random samples of the statistical population, the highest frequency is related to the diploma degree. In Table 2, the information related to the age of the interviewees is mentioned, that people between 50-60 years old have the highest number. The history of needing to care for patients at home or the history of the duration of patient care has been mentioned in Table 3, (how long has the veteran been in need of care, or how many years has the patient (veteran) been doing this work at home?). The patient's nurse at home is a family member or a person who has the job of nursing patients at home and most people over 20 years of age have dealt with this issue (Table 1).

The highest frequency of educational qualifications is related to diploma, bachelor's degree, higher than bachelor's degree, and the least number of them are illiterate (Table 2).

The most age of the interviewees is between 50-60 years, then 40-50 years, then the age group over 60 years, and finally people with the age of 30-40 years (Table 3).

Table 1. Information Related to the Education of Interviewees

Education	Number	Frequency
Illiterate	1	6.7%
Diploma	7	46.7%
Bachelor's degree	5	33.3%
Above bachelor's degree	2	13.3%

Table 2. Information about the Age of Interviewee

Age	Number	Frequency
30-40	1	6.7%
40-50	3	20%
50-60	8	53.3%
Above 60 years	3	20%

Table 3. Information related to Patient Care History or the Need for Home Care

History of home care	Number	Frequency
Less than 10 years	2	13.3%
10-20 years	6	40%
More than 20 years	7	46.7%

Most of the interviewees have dealt with the issue of caring for veterans at home for more than 20 years.

In the grounded theory method, based on the interview conducted between the researcher and the interviewee, information has been extracted in several stages, in such a way that first the answers are summarized and its concepts are extracted, then it is collected in the next stage. Grouped concepts and answers that have similar meanings are placed in a category so that we can finally get concise and comprehensive information about the subject in question.

In this research, after interviewing the people present in the sample and expressing the opinion of the people

about the impact of using the IoT and their concerns regarding its performance on patient care at home, a preliminary classification was made such as saving money, saving time, easy to use, etc. Then their answers were coded and categorized (Table 4). In addition, the coding was based on the sentences answered by the interviewees.

For example, in response to the question of whether you use the Internet, an interviewee answered yes if the costs are not high and buying it will reduce my treatment costs.

From the above answer, firstly, the concept of understanding the usefulness of the IoT- reducing costs - is taken. In the next step, we divide the information into two categories of perceived usefulness and cost reduction.

Table 4. Classification of Interviewees' Answers

Basic concepts	Answer sentences
Be useful	It can be useful for me
Information accuracy-reliability	If I know that the output information is reliable, I use it
Cost	The cost is important to me
reduction in costs	I would use it if it decreases my needing of medical centers
Reducing stress	I think using it will reduce my worries
Reliability-security-information	This device should assure me that my personal information will not be disclosed and that my identity
Protection	information will not be misused
Being unknown	am very concerned about the performance of this device
Performance accuracy	In my opinion, the accuracy of this device is not as accurate as a human
Lack of need	Care as before is useful and sufficient, I don't feel the need to use the device
Speed up treatment	If it can affect the speed of treatment in emergency situations, I will use it
Reliability	If someone else uses it and is satisfied, I will also use it
No restrictions on the use	If the use of its equipment does not create any restrictions for me, I will use it
Control the treatment process	I think using it gives me more control over my care
Saving time	It saves my time to go to medical centers
Ease of learning	If it is not difficult for me to learn how to use it, I will use it
Trust in stakeholders	It should be ensured that the treatment staff do not misuse the information for their benefit

Table 5. Final Classification of Interviewers' Answers

Main category	Grouping	Topics
Acceptance of the Internet of Things in the care of patients, especially war veterans imposed at home	Ease of use	Easy to learn Easy operation No restrictions
	User security	Non-disclosure of personal information The impossibility of identity abuse The impossibility of therapeutic abuse Ensuring correct performance High performance accuracy
	Service development	Personal control over the treatment Process Its effective efficiency
	Advertising	Can be used in emergencies Advertisements of medical centers Observing the effect on the treatment process
	Usefulness	Reduce anxiety Increase accuracy Reduce cost wastage Reduce time wastage Increase the confidence factor Topics Easy to learn Easy operation

In the next step, based on the similarity of the answers and the perceived meanings, we put them in more general categories, for example, in this research, the categories included: easy learning, easy operation, and no restrictions were grouped into a general category called ease of use. Accordingly, it can be concluded that patients will benefit from the IoT at home if the manufacturers of it implement the following concepts such as ease of use, and respect for user security in their equipment so that users can take care of patients in need at home (Table 5).

4. Results

After examining the results obtained from the classification of answers, a theoretical model for the acceptance of the IoT in-home care was made, which is has been presented in Figure 1.

In this theoretical model, the diagram taken from the responses is categorized and it has been revealed that these items are effective in the acceptance of IoT technology for the care of veterans at home. If these points are followed, the IoT can also be used for the care of veterans.
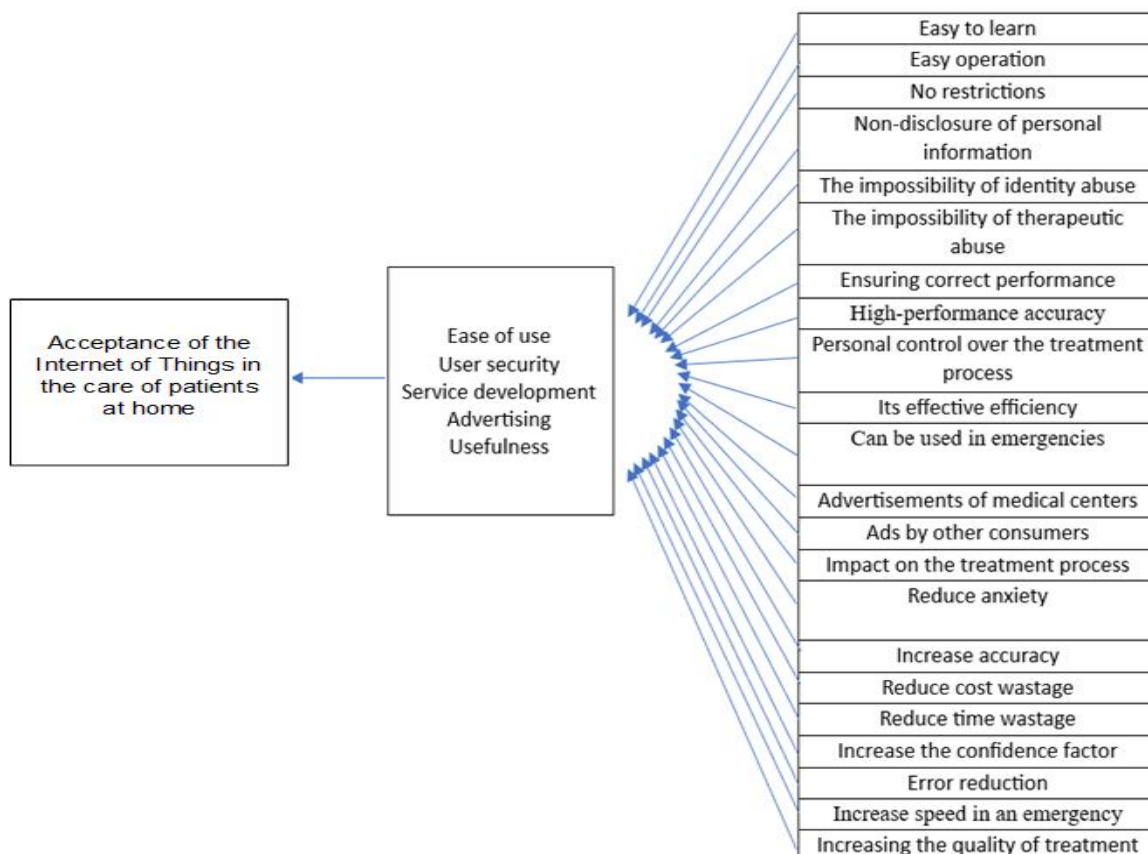

Figure 1. Theoretical model of the Acceptance of the Internet of Things in the care of patients at home

5. Discussion

After the imposed war until now, the veterans are trying to live their normal lives, but considering the problems created after the war along with physical and mental injuries such as brain trauma and post-traumatic stress disorder, their problems are considered significant. On the other hand, medical expenses are high, and due to the lack of access to medical staff at all times and places and the lack of health and medical services in all villages and remote areas, it is a big challenge to pay full attention to each veteran. In addition, since war veterans are covered by military hospitals, they must use IoT. Health care systems based on the IoT play a significant role in the development of medical information systems. The development of health care systems based on the IoT should increase patient safety, quality of life, and increase

the tracking and monitoring of the activities of health care workers. This system allows doctors (treatment workers) to measure the vital parameters of patients in order to take preventive measures and warns of changes in the situation.[28]

The field of health care in the care of patients at home is one of the sensitive and important areas that should be developed and strengthened by intelligent systems that have optimal efficiency to provide medical interventions at the required time. In addition, it should be simple, with low energy consumption and the feedback must be on time.[30]

In previous studies, the effect of remote care at home was investigated. One of these researchers used the follow-up care model to improve the sleep quality of veterans who suffered from stress disorder, which as a

result, improved their sleep quality. Therefore, this method was considered effective.[31] The use of IoT is considered as a way to deal with difficult disease conditions with high care needs. All these new facilities offer different opportunities to improve the lives of affected people and their families, friends and care takers.

However, there are challenges such as protecting the interests of the affected people, information security, and information reliability. In addition, the use of increasingly sophisticated technological tools requires medical staff to be able to transfer them to patients.[32] The level of acceptance of technology by the society is an important and debatable. Various research have been conducted in this field and their results have shown that in the acceptance of technology, issues such as perceived usefulness and the risk of losing privacy in using a new product depend on individuals' decision. If a person does not understand the usefulness of the product or feels that this product has not respected his privacy, it will affect his decision to use the device.[33]

In the investigated research, the biggest challenge in the use of IoT devices was security protecting the privacy of sensitive data.[34] In the conducted research, the conditions for accepting the IoT were investigated in order to help those who need care at home. It can be concluded that in case of ease of use, ensuring the user's security in terms of identity information and possible abuses, the development of services related to obtaining applications from the IoT that have an impact on the health of a person, effective advertising regarding the functioning of the IoT and the understanding of the usefulness of the functioning of the IoT, it may become applicable and accepted. One of the important points in this research is the cost of providing the IoT. It is believed that if it is less than the cumulative costs of continuous and direct visits to treatment centers in the short term, it will not affect the decision to use it. However, in using the IoT, the cost of its preparation, the reliability of the information, the ability to use it in all situations and places, as well as the safety of its use are among the concerns raised by people. In previous research such as the research of Yuan and Che, it was also concluded that the factor of ensuring the security of users' information is one of the important points for users and it is one of the main concerns of people in using the IoT.[35] Also, in the present study, one of the influential factors in the adoption of the IoT is the issue of ensuring the security of users. Just as it was stated from the results of this research that the ease of use of the device and the assurance of its performance have an effect on its acceptance rate, Raj et al. also stated that one of the important and influential factors in the use of the IoT in caring for patients at home, is to ensure its performance.[36] According to Philip et al., similar to other research and also the observations made in this research, it was stated

that increasing the reliability and performance of the device, the affordable cost of the device, and improving the security and privacy of the device have an effect on its acceptance.[37]

6. Conclusion

To conclude, as military hospitals are more in contact with veterans, the results of the present research can help them to increase the health level of veterans who need to be taken care of at home. Taking care of veterans at home requires all-around attention by using the IoT. It is possible to increase attention to the changes in the health factors of veterans, and to accept the IoT to take care of veterans at home by introducing it to their families. To accept the IoT, he acted to increase the health of veterans and reduce care costs. Furthermore, increasing the security of IoT information can increase the acceptance of its use by veterans.

Research Highlights

What Is Already Known?
- Providing user security in terms of identity information and possible abuses.
- Developing services related to receiving applications from the IoT that affect a person's health.
- Effective advertising about the functioning of the Internet of Things and the understanding of the usefulness of the functioning of the IoT.
- The IoT can be used to care for patients at home.

What Does This Study Add?
In this study it has been investigated how patients in need of home care, especially war veterans, tend to use the IoT. Also, we have revealed the factors motivating and preventing the use of IoT.

Author Contributions
MR: concept and design of the study and critical revision.
SJ: collection data and manuscript drafting.

Conflict of Interest Disclosures
All authors declared that they have no conflict of interest.

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