Study on Usefulness of Smartphone Applications for the People with Parkinson's

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Abstract. The population of developed countries is becoming older and likely more chances of elderly people to face problems due to Parkinson. Mobile applications play a vital role in the lives of people having Parkinson. They use mobile applications for communication, social media network, surfing websites, medication, online shopping, and for many other purposes. However, the developers normally consider the youngster while designing the mobile Apps, consequently, the people with Parkinson (PwP) face numerous usability related issues while interacting with applications. This study elaborates the detailed limitations of PwP regarding the use of mobile applications and also determined the impact of related factors such as ease of use, information quality, and aesthetic quality on the usefulness of mobile applications. The objective is to purpose a theoretical model or framework for the usefulness of mobile applications in case of PwP. An empirical study is conducted on 25 PwP to test this model. A Structure equation modeling with other reliability tests are applied to verify and validate the proposed model. The results illustrate that ease of use and information quality strongly influence the usefulness whereas, aesthetic quality has a weak but indirect effect on usefulness. This study will provide the guidelines to the developers of the mobile application to understand the limitations of PwP and also to improve the usefulness of mobile applications by employing the appropriate design features.

Keywords: Usefulness · User experience · Structure equation modelling · Ease of Use · Information Quality · Aesthetic Quality · Parkinson Disease · People with Parkinson

1 Introduction

Traditionally the "elderly" word considered for those people who have aged more the 65 years. The rate of growth in this segment of the population is growing rapidly especially in developed countries like in the US and European countries due to birth control and other related factors. According to data by National Center for Health Statistics (NCHS), between 1987 and 2030 the total US population is projected to increase by 26% but older is expected to increase by 100 percent that is estimated around 67 million [1]. It is likely more chances of elder people to affect with Parkinson

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Disease (PD), Study estimates that the number of an individual over the age of 50 affected with PD was between 4.1 and 4.6 million and projected this figure will double in 2030 to between 8.7 and 9.3 million [2]. Parkinson's is a non-reversible chronological disorder, that affects the nervous system, slowness of movement, poor balance, gait freezing, impairment related to cognition and other age-related limitations [3]. These symptoms are likely to reduce the autonomy and mobility of an Individual that may force to change lifestyle [4]. Symptoms of PD also affect the interaction of smartphones [5].

According to [6], most of the elderly people in developed countries use the internet as a regular part of their lives. Most of them use smartphones with touch screen enabled to use the internet. In a study by [7], argue that 69% of elderly people have their own mobile phones. In the elegant literature, various researches emphasized on the development of smartphone application for the People with Parkinson (PwP) e.g. [8, 9]. However, limited research presented related to interface design or user experience (UX) factors that affect the PwP. The mobile application plays a vital role in the improvements in the lives of PwP. They use mobile application for exercising, medicine recommender systems, watching movies, social media usage and other purposes. Due to the lack of guidance or limited literature on PD patient's mobile/smartphone usage, the usefulness of mobile applications is still considered an important problem for PwP. In a recent survey, titled "Parkinson's IT challenges" on the usage of computers by PwP [10]. The statistics show that 80% of users with PD reported severe or highly severe difficulties by using computers. A similar study conducted on the usefulness of computer peripherals for PwP reported core limitations of PD regarding computer usage and suggested a projector based technology for PwP to use computers easily [11].

The aim of this study is to examine what are the core factors may affect the use of a smartphone by PD patients. Furthermore, also to determine the impact of some UX attributes i.e. ease of use (EOU), information quality (IQ), and aesthetic quality (AEQ) on the overall usefulness (UF) of mobile applications in the context of PwP. An empirical study is performed on 25 PwP to test this model. Structure Equation Modeling (SEM) with some other reliability tests are applied to verify and validate the model. The overall results show that EOU and IQ have a direct and high impact on the UF while AEQ indirectly influences the UF. The current study will provide the guidelines to designers and developer to adopt appropriate design strategy to design mobile or smartphone applications for PwP.

This study is organized as follows: Sect. 2 provides a detailed literature review on Parkinson's disease, its symptoms, interaction with smartphones/touchscreens and related factors employed in the current study. Section 3 purposes the research model and hypotheses; Sect. 4 describes the research method; and Sect. 5 provides the results of empirical tests and discussions. Section 6 presents conclusions, limitations and Future work.

2 Literature Review

2.1 Parkinson's Disease

The first step in this research is to understand the basic characteristics of PD and the basic symptoms of PD. This will minimize our effort to make the interaction of smartphone-related to people with Parkinson [12]. This portion of the research reviews PD symptoms from medical literature, some publications from patient associations and other health-related websites. Some areas are covered like motor and non-motor symptoms of PD. The On/Off phenomenon is also a specific characteristic of PD. These symptoms are discussed below.

Motor Symptoms

Some common types of symptoms of Parkinson's are bradykinesia, rigidity, rest tremor and gait impairment [13]. There is another issue which is that every patient of Parkinson's experiences different symptom. According to an estimate, around 70% of Parkinson patients are affected with Tremor [14], and around 47%, must affect with gait impairment [15]. Movement of hands and body in PD patients is very much affected due to Bradykinesia. Main issues involve the slowness of amplitude and speed while performing simultaneous and sequential tasks [16]. Changes in voice, facial expressions and handwriting are also documented [13]. These things directly affect mobile phone use by the patients of Parkinson's.

Rest tremor is basically an involuntary movement that occurs when usually muscles are relaxed and are supported by some kind of surface [17]. Sometimes this tremor is looking quite normal but sometimes it became vigorous. They may shake the whole body of a patient with hands. So, in this state, mobile phone usage is a very difficult task.

Rigidity is another type of motor symptom that increases the resistance to passive movement of a limb [15]. Rigidity has direct effects on fine motor tasks such as getting up from the chair, turning around and sometimes even on facial expressions [18]. It also makes general movement difficult and is also responsible for pain [15].

Gait impairment and Postural instability are also very common in Parkinson's patients, It usually occurs during the advance phase of diseases [15]. As disease more increases the gait became more unstable and slower [13]. And ultimately it also effects on smartphone usage.

Non-motor Symptoms

Non-motor symptoms tend to be under-recognized because complaints are very rare by the patients during medical appointments [19]. These symptoms may include sexual dysfunction, cognitive or sensory abnormalities and neurobehavioral disorders [19]. Sensory symptoms like akathisia, genital pain, oral pain, olfactory etc. are much common in patients with Parkinson's but these are not recognized or considered as Parkinsonian's symptoms [20].

Cognitive disorders are also very common in PD. Neuropsychological investigations have shown impairments in early stage/part of disease [21], which are usually shortfall of behavioral regulation in planning, regulation in sorting and low use of

memory stores [22]. Cognition has a direct and indirect relationship with the usage of the smartphone can be easily found in HCI literature [23].

2.2 Parkinson's Patient Interaction with the Smartphone

The researchers found in their study that PD directly affect the usage of input devices while using computers [24]. As mentioned in the previous studies related to the usage of the smartphone in PD patients and limitations. Recent research is also conducted on 39 people with Parkinson. The authors provide detailed guidelines related to interface design [25]. Similarly [12] also conducted interviews with the patients of Parkinson's, Neurologists and Physiotherapists because they have directly or indirectly related to PD patients. The major goals of these interviews were to understand how the major and minor symptoms of that disease related to daily activity like smartphone usage. The interview was focusing on the four main areas that are

- How PD changes and affects the lives of patients with Parkinson?
- How cognitive skills and motor affect Parkinson's disease?
- How a mobile phone is used by the people of Parkinson's? and
- What are the basic symptoms that directly affect the usage of the smartphone?

The detailed questions were asked in the interview and lasted between 30 min to an hour and were recorded using a recording device. The audio-recorded were then analyzed by grounded theory [26]. The analysis was also supported by [12], using qualitative data. Similar attributes were also observed in a medical study but the results analyze from this study are quite different from the available literature. The results of the interview mainly divided into three categories i.e. motor characteristics, cognitive characteristics, and general characteristics. These characteristics have direct effects on smartphone usage. The details of these characteristics are given below. These characteristics must be under-considered while designing an application for people with Parkinson's.

Bradykinesia, Rigidity, Dyskinesia's, visual disabilities are some common motor problems found in patients with Parkinson's disease. These disabilities make the movement very slow and difficult. Some different uncontrolled movements also occur that directly related to the use of a smartphone. Parkinson's does not directly link up with visual disabilities but incoordination and weakness in muscles caused blurred and double vision, discrimination in color and contrast also occurs which also affects the use of mobile phone [12]. There are some other issues that are faced by Parkinson's patients related to the use of smartphones like short-term memory loss, slowness of thoughts, depression, and dementia.

2.3 Parkinson Disease and Touch Screen

Parkinson's is a disease which is found mostly in elderly people. PD is based on a disorder that affects the human being's nervous system. According to the study an estimated two million people are affected with PD only in Europe [27]. PD symptoms vary from patient to patient and the conditions of disease are also different from the initial level to high severity levels. The conditions of Parkinson's patients are often

characterized by the symptom of motors, which includes slowness of movement or tremor [14]. Sometimes it is also due to Non-motor Problem [13]. These symptoms reduce the mobility of the patient and thus change its lifestyle [18].

In a study [5], the authors argue that motor symptom affects the interaction of the patient with a smartphone. The authors also determined how PWP performs some gestures with touch screen and also purposes some set of guidelines for the designing of applications for PwP. Summary of previous studies regarding interaction with small screen devices by PwP is discussed below.

Some studies are available regarding the development of an application that is especially for the people that are affected by Parkinson's disease, such as [8]. Some research/studies are also available regarding the use of the stylus in the application of PWP. These studies are not so much mature nor provide guideline related to the interface of the application and their usability [12]. Neither these studies evaluated the systematical interaction of PWP with applications. The findings from these studies are mostly based on the researchers self-assumptions. [5] and documented only to the interaction of PWP with a smartphone. Tremors, as well as fine motor skills, are also the major cause that affects the interaction of PWP with a smartphone. Similarly, in another study, the researchers observed an estimated 15% error rate while selecting a target on touch screen [28] and review became broaden from smartphone to some other touch screen interfaces. In the study [29], the researchers also designed a platform that was tablet interface, and this was specially designed for PD patients, also underline the importance of large screen or targets that overcame potential issues in fine motor skills or issues in visions. This contributes a lot to this field and research of this dimension but the study of [29] is not complete to design an interface of smartphones for PD patients.

2.4 Existing Interface Design Guidelines for Parkinson's Patients

It is the reality that Parkinson's disease is very complex and demonstrates different symptoms in the patients, that's why we cannot generalized its pattern, neither the guidelines can be applied to all type of patients having this disease. However, few usability related heuristics are suggested by [12] based on interviews from the Parkinson's patients. The authors argue that it is very complex to apply these guidelines on all type of patients that's why the developers must need more dynamic and proactive in this regard. The guidelines are as follows i.e. targets using tap must of 14 mm or more in both of sides, always prefer multi-tap over the drag, always use high colored contrast elements, always must avoid time controlled information, consider the design guidelines presented by other authors for elderly people [30–33] and present clear information if needed.

By considering these limitations of PD, the usefulness of mobile is still a problem. How we design a mobile phone useable for the PWP and what are the basic parameters that affect the usefulness? There are different factors that may influence the UF but in the current study, the authors attempt to determine the impact of IQ, EOU, and AEQ on UF.

2.5 Usefulness

According to [34], UF is the degree or comfort-ability of a user while performing certain activities. It also refers to "persons believe that using a system would enhance his or her performance" [35]. A recent study conducted on the usefulness of computers peripherals for PD people [11]. In this study, the researcher conducted a usability test using a standard peripheral on the people with Parkinson (PwP). They studied the individuals' limitations while using these peripherals and claimed that how projector-based technology may improve computer interaction without risking strain injuries. As the literature on Parkinson disease, clearly shows the limitations regarding mobile usage. Most of the studies were conducted using the technology acceptance model (TAM) in different contexts and observed UF is the core variable in TAM [36]. In another study, the researchers adopted the TAM to determine the mobile usage acceptance and they observed UF as a key determinant of acceptance [37]. In the current study, we consider UF as a key attribute in the PD usage context. In several studies [34, 38–54], TAM was adopted to measure the UF or related factors. The common variables used in the above studies such as EOU, IQ, and AEQ were assessed previously through questionnaire strategy [35, 55–58].

2.6 Information Quality

Information Quality is the term used frequently in various domains of human-computer-interaction and information visualization, several researchers defined IQ from a different perspective. In the current research, the authors adopted the IQ in terms of information arrangement and design to develop the interfaces of the mobile application. According to [59], the IQ is the quality of important contents of the website, it is also considered as the suitability of the information i.e. format, accuracy, and relevancy. There are some other information related aspects discussed in the prior studies such as information must be accurate, believable, timely presentable, the level of details included in information and the presentation of information in an appropriate format. Martin [60] in his studies categories the IQ into the following factors that are consistency, accessibility, conciseness, clarity, accuracy, traceability, interactivity, speed, and comprehensiveness. We can also consider these factors while designing the interfaces for a smartphone because better IQ leads us to better usability [61]. The smartphone has small size screen as compared to desktop computers and has the equal or large amount of information to be presented to users due to this developers and designers of the smartphone have to pay much attention to IQ. It is also very complex to manage all aspects of IQ on a small screen of smartphones. It was observed in the previous studies that the better the IQ the better the user satisfaction [62]. According to [63], IQ influence the user, information system (IS), service quality, and system quality. In another study [64], the researchers proposed that there are 14 major directions or dimensions of IQ i.e. accuracy, accessibility, completeness, believability, appropriate amount, consistency, complexity, understandability, timeliness, security, reputation, relevance, objectivity and ease of operation. Accessibility is usually known as the ease and ability of information that is to be accessed on and displayed by the user on a specific type of media like a smartphone or screen of a laptop or personal computers.

Accuracy is defined as the amount of data that is accurate enough or contains enough or accurate information for the user. Appropriate amount term is defined as the appropriate amount of data or information displayed at a certain time on screen. Believability is the ability and credibility of the information that can be trusted by the user. Complexity involves the structure of information i.e. the information displayed on the screen is far enough to present to the user. Thus, it has been proved that less the complexity in information higher the quality of information. Ease of operation is known as the ability of the user to process information like to find the required content from complete displaying information. Objectivity belongs to the relevancy of information i.e. the information displaying on screen is only relevant content that user wanted to show on the screen. Security of information belongs to the unauthorized or fake use of information for example information on the other website you are using in your information or any other person will not use your information. Timeliness is the regular update of information like a regular update in the information of date or some other contents related to the information you want to present. Understandability is the way to understand information by the user can easily understand the required information. A similar study conducted by [65], to check the effect of information quantity and user thoughts on the satisfaction level. In the study [66], the researcher combines the product quality with IQ and observed that we can achieve more usefulness through this, they conducted this experiment on 3 different firms and achieve positive results. [67] Used 8 items of IQ to evaluate the usefulness of an MIS system. The study related to mobile word of mouth [68] researchers proved that there is a significant impact of IQ on the usefulness of information. Another study on the impact of Information System Quality on the intention to use IPTV [69], and observed that IQ has a positive effect on usefulness. There are several other studies also showing the positive impact of IQ on EOU and UF [38–49, 69, 70].

2.7 Ease of Use

Ease of Use is the most common adopted term in HCI related studies. Like IQ, EOU also discussed in different perceptivities but in the current study, we employed this in terms of cognitive complexity to assess the mobile applications for Parkinson Disease patients. According to [34], EOU is basically the degree of simplicity associated with the user while using mobile interface or technology. If you are deeply involved with the software or certain type of application then it definitely affects the EOU [71]. EOU is the degree the person believe or think to use the system without effort [35]. Computer anxiety is known as the fear to face the computer and it is mostly found in elderly people related studies [72]. Computer anxiety is another important factor that directly influences the EOU of computer or smartphone usage [73]. In another study [50], it was observed that EOU has a significant positive impact on UF in the context of internet usage. The authors argue that if the internet is easy to use the more favorable chances of a person to use the internet more. A study conducted by [51], argue that EOU influences the UF for older people. Another model proposed by [74], adopted the EOU, system quality, IQ to observe the comparative effect on user satisfaction. Similarly, various other researchers [34, 50–53] also observed the positive impact of EOU on UF in the related contexts.

2.8 Aesthetic Quality

The aesthetic word simply associated with the beauty, attractiveness, or the appreciation of beauty. According to [75], the aesthetics used to design the engaging environment by incorporating the colors, visual elements, sounds, and multimedia artifacts to increase the level of individuals level of involvement. According to [76], aesthetic is known as heuristics for attractiveness. It mainly focuses on the use of color, typography, designs, flash, and animations. Sometimes, we employed it to improve the legibility via size of text displayed on mobile screens, layout, expressions, style, and pattern. It is mainly used to improve the website and mobile usability. Guidelines form researchers and scientists are available for making better AEQ. It also supports the contents understandability and increases functionality. The aesthetic effect also related to age, gender and shows strong implication from the cultural perspective. Different age group peoples prefer different colors scheme and both male or female have also different opinion on the usage of aesthetics aspects. Aesthetic involves the target audience for better results. A study conducted related to the aesthetic design by [77], suggest that aesthetic design is an important aspect while assessing usability. Different studies observed the relationship between the usability and AEQ of an interface and also between AEQ and satisfaction [76]. Several researchers also observed the impact of AEQ on EOU and UF [49, 54, 78–80] that's why we include this in our study to check the impact in our scenario.

3 Conceptual Model and Hypothesis Development

Figure 1 illustrates the hypothetical/conceptual research model proposed in our study. It is actually a modified model derived from previous studies. It asserts that the UF of mobile applications is determined by IQ, EOU, and AEQ. Further, EOU used as a mediator between the relationship of IQ and UF and also between AEQ and UF.

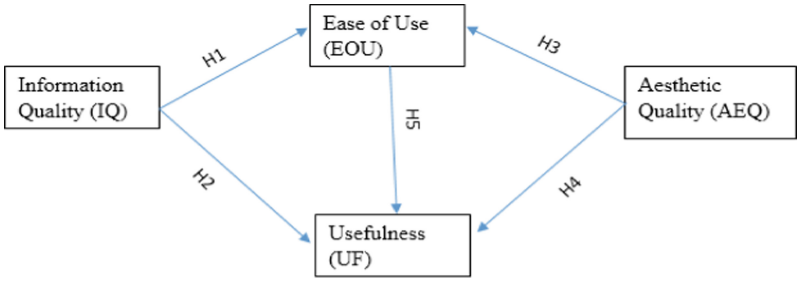

Fig. 1. Purposed hypothetic research model for usefulness

Definition of constructs, the network of relationship illustrated in the above model and the rationale for the proposed links are explained in the literature review section.

According to [59], IQ is the quality of informational contents of a website, it is also considered in term of the suitability of the information such as format, accuracy, and

relevancy. various studies in different contexts observed the positive impact of IQ on EOU and UF [43–48, 69]. Accordingly, we hypothesize:

Hypothesis 1: IQ positively influences the EOU.
Hypothesis 2: IQ positively influences the UF.

According to [76], Aesthetics is known as heuristics for attractiveness. It mainly focuses on colors, typography, designs, flash, and animations. Previous studies discussed the relationship between AEQ and EOU and also between AEQ and UF [49, 54, 78–80]. Accordingly, we hypothesize:

Hypothesis 3: AEQ positively influences the EOU.
Hypothesis 4: AEQ positively influences the UF.

According to [34], EOU is the degree of simplicity associated with the user while using mobile interface or technology. Based on the prior studies, the researchers believe that EOU significantly influences the UF of the smartphone. The relationship between EOU and UF was also observed in prior studies [34, 50–53]. Accordingly, we hypothesize:

Hypothesis 5: EOU positively influences the UF.

4 Methodology

4.1 Participants/Sample

The questionnaire was filled by 25 Patients of Parkinson's. In order to increase better or concise results, the researchers used an enormous method [81] to help the patients in the understanding of the context of questions that were asked in the questionnaire. All employed patients were above the age of 65 therefore, written as elderly patients in the most part of the paper. Out of 25 respondents, 18 (72%) were male and 7 (28%) were female. Moreover, 56% of the respondents had 1–3 years of experience in using the smartphones and the remaining 24% of respondents had more than 3 years of experience. (The purpose of the usage of smartphone/mobile applications is discussed in the section of results i.e. Table 5). 29% of respondents had up to primary level education, 12% up to middle and 59% had a higher level of education respectively.

4.2 Measurement Development

The questionnaire was developed from the elegant literature and the list of items are presented in Appendix A. In recent years similar studies were conducted and published in which various researchers used these similar items [56]. Hence most of the items were derived from the existing literature and modified slightly to suit the context of mobile applications. Furthermore, the think-aloud technique [82] is also used on 5–10 patients regarding the use of the mobile application to correct or modify items of various constructs.

Apart from the demographic factors, additional question explained in result section See Table 5. Each item/question employed in this study were measured using a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). Before conducting the main survey, we performed a pilot and pre-test to validate the instrument. Pre-test involved 10 respondents (PwP) that had higher education and wide experience of smartphones and mobile applications. The respondents were asked to comment on employed items that corresponded to the constructs, including scale wording, length, and format of the questionnaire. Furthermore, the instrument was also discussed with more than 7 Neurologists from different hospitals in Pakistan to verify the exact requirements regarding the usefulness of mobile applications in Parkinson' Patients.

5 Results

5.1 Descriptive Statistics

Table 1 describes the means and standard deviations (SD) of different constructs. It is found that the average mean of respondents in case of EOU is 4.2 explaining the fact that out of total respondents' majority of the individuals have provided their outcomes in a range of agree and strongly agree. The response against IQ proxies is slightly less with 2.7 that means it is in between disagree and neutral. Respondents do not agree with the presentation of IQ in applications. The AEQ mean value is 3.3 explaining the fact that users quite agree with the proxies of AEQ.

Table 1. Descriptive statistics (Means and SD)

Constructs	Mean	SD
Ease of Use (EOU)	4.2	0.6
Aesthetic Quality (AEQ)	3.3	0.8
Information Quality (IQ)	2.7	0.9

5.2 Analytical Strategy for Assessing the Model

The purposed research model has tested through the structural equation modeling (SEM) technique. SEM is a second-generation most popular and powerful multivariate technique. It is mostly used to analyze casual models that involve two or more components of a causal model. The structure model is also used to investigate the direction and strength of relationship among the theoretical constructs. It specifies how the latent variable will be measured through observed variables. In recent years this technique is mostly used by HCI (mobile application) researchers [83–87]. In this study, the AMOS an additional SPSS module was used in order to access the structure model and measurement [88].

5.3 Measurement Model

The results of the Measurement Model test are written in Table 2. The values/data show that the reliability of different items is ranging from 0.62 to 0.89 that exceeds the acceptable value which is 0.5. Composite Reliability is computed to access the internal consistency of the measurement model. According to the benchmark presented by [89], composite reliability must be above 0.6. In our model, the value of the composite reliability of all the constructs is greater than 0.6. The [90], recommended that the value of average variance extracted (AVE) must exceed the threshold of 0.5 since in our case the values of all the constructs are greater than the threshold limits. Due to this, we have confidence regarding the reliability of our all constructs.

Table 2. Reliability

Construct	Item	Item reliability	Composite reliability	Average variance extracted
Ease of Use	EOU1	0.651	0.68	0.66
	EOU2	0.743		
	EOU3	0.682		
	EOU4	0.676		
	EOU5	0.753		
	EOU6	0.669		
	EOU7	0.605		
Aesthetic Quality	AEQ1	0.649	0.69	0.67
	AEQ2	0.671		
	AEQ3	0.764		
Information Quality	IQ1	0.897	0.75	0.69
	IQ2	0.654		
	IQ3	0.623		
	IQ4	0.738		
	IQ5	0.867		

Different fitness measures were applied to the data and model, the result is presented in Tables 3 and 4. All the measures of fitness are acceptable. Measures taken in this work consequently showing that the model is a good fit to the data.

Table 3. Extended reliability

Construct	Cronbach's alpha coefficients	Full collinearity VIFs
Ease of Use	0.72	1.184
Aesthetic Quality	0.62	1.052
Information Quality	0.82	1.886
Recommended criteria by authors	[91]	[92]

Table 4. Fitness indicators for the measurement

	X2/df	GFI	AGFI	CFI	NFI	NNFI
Results	2.12	0.96	0.92	0.98	0.96	0.98
Recommended criteria	<3.0	>0.9	>0.8	>0.9	0.9	0.9
Suggested by authors	[93]	[94]	[94]	[95]	[91]	[91]

5.4 Structure Model

Structure Equation Model (SEM) is also used to test the hypothetical relationship between constructs. Figure 2 is showing the complete details of the relationship among employed constructs and their effect on each other and overall on UF. The results show the positive influence of IQ on EOU ($\beta = 0.25$, $p = 0.01$), supporting H1. The results also support H3, $\beta = 0.26$, $p < 0.01$). The effect of IQ on UF is significant with (0.61, $P < 0.01$) and supporting the H2. Contrary to expectations, the effect of AEQ on UF is not much significant with $\beta = 0.04$, however, it has an indirect effect on UF due to its significant impact on EOU. Lastly, the results also support the H5 with $\beta = 0.33$, $P < 0.01$.

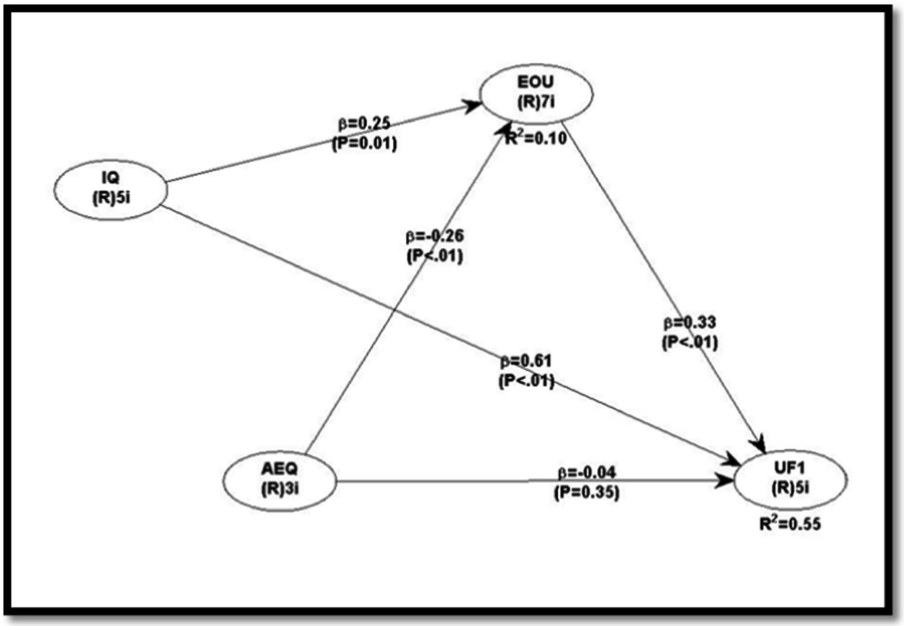

Fig. 2. Results of structural modeling analysis

5.5 Purpose and Problems of Mobile Applications for Parkinson's Patients

To gain further insights into information about the usefulness of mobile applications in case of Parkinson's Patients, the two questions (close-ended) were also added to obtain the following information:

Table 5. Purpose of using mobile applications by Parkinson's patients

Items	Number of respondents	Percent
Communication	25	82
Kill time	25	77
Watching movies and songs	25	25
Playing games	25	62
Other use	25	25

Purpose: To find out the purpose of using mobile applications by Parkinson's Patients, Users were asked why they use mobile applications.

6 Conclusion, Future Work and Limitation of Study

The results show that EOU significantly influences the UF, similarly, the positive relationship is also observed between IQ and EOU and also between IQ and UF. On the other side, AEQ observed as a strong determinant of EOU but indirectly influence the UF. The finding indicates that both IQ and EOU are important aspects to determine usefulness. Thus, both aspects are important while designing the interface of the mobile application for PwP. In our case participants are less satisfied with the employed constructs related to AEQ that why the AEQ has a weak impact on UF. Overall the findings from the current study may contribute to the future development of mobile apps for PwP. The proposed model also provides a conceptual depiction of key factors that heighten the PwP involvement in the design of mobile Apps. In the future, the researcher may extend the proposed model by incorporating the other aspects to provide the additional design related guidelines for PwP. The current study also suffers several limitations; this study involves a few numbers of participants due to the non-availability of PD patients in local hospitals. This is because people do not consider it as a disease or disorder except an aging factor. Second, the Parkinson's disease, includes 4–5 stages from less severe to high severity, in the current we employed all type of people and did not categorize participants that is why may have different results (Table 6).

Table 6. Appendix A: list of items by construct

Construct	Items
Ease of Use	I often get confused when I use the Cell/Mobile phone [35]
	Existing applications are easy to use [96]
	Using the existing Mobile Application, I became more productive [35]
	Whenever I make a mistake using application, I am unable to recover easily and quickly [96]
	I can use the existing mobile applications with confidence [96]
	The existing applications make me frustrated [35, 96]
	It is very complicated to operate the existing systems [96]
Aesthetic Quality	Icon and colors used by applications are very good and appealing [97]
	Reading character on the screen is very hard to read in existing applications [98]
	Shortcuts/Gestures are clearly identified and can be used [99, 100]
Information Quality	All menu and functionality are clearly visible and readable in current applications [66]
	Messages displaying on the screen are clearly visible and understandable [66]
	The organization of information on the application screens is clear [101]
	The information provided for the existing applications are easy to understand [101]
	Organization of information is very confusing [66, 101]

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