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Investigating acceptance of telemedicine services through an extended technology acceptance model (TAM)

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ABSTRACT

Background: Developing countries around the globe are striving continuously to provide free access to health care services. Telemedicine services represent a significantly increasing form of an adequate health care delivery mechanism in developing countries.
Research objective: This research study was aimed at investigating the factors influencing the acceptance of telemedicine services among the rural population of Pakistan. Technology Acceptance Model (TAM) was used as a theoretical framework for this research, with the inclusion of several other antecedents.
Research method: A face-to-face survey method was used to collect research data from 275 participants. The data were analyzed using Partial Least Squares (PLS) method.
Results: The findings suggest that usage intention of telemedicine services is a function of perceived ease of use, technological anxiety, social influence, perceived ease of usefulness, trust, facilitating conditions, perceived risk, and resistance to technology.
Conclusions: This research study confirms the applicability of TAM with the inclusion of additional variables to model the adoption of telemedicine services in developing countries. The study offers valuable information for policymakers and health service providers for understanding the facilitators and inhibitors influencing the large scale implementation of telemedicine services. The research findings regarding factors including perceived risk, trust, facilitating conditions and resistance to change can aid in the design and adequate provision of telemedicine services in developing countries.

1. Introduction

Recent evidence suggests that over the past few years, information and communication technologies (ICT) have brought tremendous changes to the traditional environment of healthcare services [1,2]. Research studies have shown that telemedicine is gradually becoming the most prominent service of ICT with remarkable effects on the traditional mechanism of health care services [3]. Around the globe, telemedicine services are enhancing the efficacy of physicians, reducing medical costs and improving the access to health care services [4,5]. Telemedicine services allow health-care professionals to monitor, diagnose and offer medical treatment at great distances using telecommunication technologies. Research studies have also advocated telemedicine services as a promising solution to improve several chronic medical conditions including hypertension, obesity, diabetes, depression, and cancer [6,7].

Pakistan ranks as the sixth most populated country in the world. Healthcare system in rural areas of developing countries including Pakistan is generally marred by the lack of access to even basic primary health services [8]. Approximately 64% of its population is located in rural areas and only 30% of its rural population has access to basic health facilities. Despite some notable improvement in certain health indicators over the last decades, rural health care system of Pakistan continues to be dominated by a high escalation in population growth, maternal mortality rates and increasing burden of chronic diseases. According to the health statistics of 2017, the infant mortality rate in rural areas of Pakistan was 61.27 per thousand births and maternal mortality was 261 per ten thousand births [9,10]. Akin to the settings of other developing countries, ease of access to health care facilities is also poorly disseminated in rural areas of Pakistan. The financially deprived,

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resource-constrained rural population is often unable to access timely efficient medical information [10]. People living in rural areas have to spend a huge amount of money on traveling and bear considerably large expenditures for various medical treatments [9].

Nonetheless, the recent remarkable growth in modern information and communication technology (ICT) and potential of telemedicine services has paved new ways for reaching out to the rural population of Pakistan for improving its access to health care services. Telemedicine services represent a promising future for addressing the critical lack of access to manage several health-related issues, especially in rural areas of Pakistan [11]. Current medical evidence also advocates for telemedicine as a powerful tool to improve the accessibility of existing health-care facilities particularly for people living in rural areas [12,13].

Despite its acknowledged benefits, telemedicine will be a useful health service only when people will begin to utilize it. Therefore, the general attitude of end-users towards acceptance of telemedicine services will play a significant role. To foster the adoption of telemedicine services among people, it is initially very important to analyze the factors influencing their perception. The aim of this study is, therefore, to develop a research model using the Technology Acceptance Model (TAM) as the main theoretical framework. The research model is focused on investigating the key facilitators and inhibitors of telemedicine services in the perspective of a developing country by using a face-to-face questionnaire-based survey. Based on the research findings and data analysis using Partial least squares (PLS), the empirical validation of proposed research model is carried out.

The remainder of the paper is structured as follows. Section 2 describes the research background for determination of factors influencing usage intention of respondents towards telemedicine services. Section 3 highlights the hypotheses development and section 4 represents the research methodology. Results obtained from data analysis are presented in section 5. Section 6 highlights discussions in light of data analysis. Conclusions and recommendation drawn from the research findings are presented in section 7. Limitations of the current research study are presented in section 8.

2. Research background

In Pakistan, telemedicine services were first introduced in 1998 by Elixir Technologies in collaboration with Holy Family Hospital Rawalpindi [14]. Afterward, a telemedicine project in Sakurdu was launched with the collaboration of Stanford University and Physician Association of North in 2006 [15]. Another project called “Pakistan Telemedicine” was launched by the collaborative efforts of the United States and Pakistan in 2007. This project was aimed at providing better health care facilities at Holy Family Hospital Rawalpindi and also at Spoke hospital in Attock. The project offered medical consultation in a variety of domains including cardiology, radiology, surgery and infectious diseases [14]. Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) also launched a satellite-based telemedicine project. The project was aimed at connecting the remotely located hospital at Shikarpur with Jinnah Medical Centre in Karachi via Paksat-1 satellite for the provision of medical consultations [16]. Another successful venture of telemedicine was the startup known as “Telesehat’’ started by a telephone company “Comcept”. The founders of this project collaborated with doctors across Pakistan to design and develop various software systems and interfaces for medical products. Some other notable initiatives of telemedicine were “Jaroka’’ and “Sehat-first”. More than 2000 patients were treated with the help of these initiatives [16].

Despite the implementation of above-mentioned projects, acknowledgment of potential benefits of telemedicine services and the agreed consensus on its reliability and accuracy, telemedicine services have yet to become a fundamental part of rural health care system of Pakistan. Research studies identify this low adoption of telemedicine technology among developing countries as a common pattern [17]. The utilization of eHealth applications including telemedicine and Electronic Medical Records remain uniformly insignificant in rural hospital settings and clinical practices [12]. Although various research studies suggest positive outcomes for the adoption of telemedicine services yet the willingness of patients/users of rural areas to adopt telemedicine and their respective satisfaction with these services demands further research [18,19]. In spite of the rising interest in health informatics studies [18], limited information is available regarding the patient’s willingness to adopt and utilize telemedicine services in the perspective of developing countries [17]. Patients represent the principal users of telemedicine services and their willingness to adopt telemedicine services has a remarkable impact on its successful implementation. Research studies have shown that there exists a distinct paucity of literature describing how telemedicine services can be utilized in the rural environment of Pakistan to medically equip an economically marginalized population [20]. Patients’ resistance is a very common phenomenon whenever changes are introduced into traditional systems of medical care [21].

Rural Pakistani patients may exhibit reluctance to utilize telemedicine services. Although telemedicine systems offer to open up new avenues for accessing medical services, it will not be easy to radically transform the current landscape of rural health care if people are not willing to utilize these services [20,21]. Therefore, a prior understanding of factors influencing the acceptance of telemedicine services among rural population is necessary. The wide-scale implementation of telemedicine services in rural areas requires an overwhelming acceptance and active participation from local communities. The benefits of telemedicine can be manifested only if patients are ready to use it proactively. Therefore the investigation of attitude and acceptance of patients towards telemedicine services become integral for its effective utilization [22,23]. Furthermore, various studies have already established the importance of understanding the resistance of users and how they can be successfully managed [24]. However, the theoretical explanation of rural users’ resistance towards telemedicine is in dire need of further exploration. The limitation of empirical evidence, suggests the need to develop a generalized model for analyzing the acceptance and resistance of users towards telemedicine services in the ongoing stream of research. The following research query is undertaken by this study:

What are the major drivers and barriers influencing the intention of patients to use telemedicine services in a developing country like Pakistan?

The prime objective of this research is, therefore, to focus on investigating the factors influencing patients’ willingness to accept telemedicine services. To analyze the key factors influencing the adoption of telemedicine, a theoretical model (Telemedicine service acceptance model) based on the extension of TAM (Technology Acceptance Model) has been proposed which contains few variables from the original TAM. The outcomes of this study are expected to benefit government, policymakers and healthcare providers for successful development of telemedicine services.

2.1. Technology acceptance model (TAM)

The choice of an individual to voluntarily accept new technology is known as technology acceptance. For successful implementation and utilization of technology, users’ willingness is a crucial factor [25]. During the last few decades, researchers have developed several models to understand the attributes of technology acceptance among users. These models have been verified multiple times to determine their effectiveness for many information technology-based applications [26]. However, the technology acceptance model TAM by Davis so far represents the most established and substantial foundation of technology acceptance [26]. TAM, which originated from the fields of sociology and psychology, is the most frequently used model in various research studies. The major goal of TAM is to forecast the adoption of new technology among users and to highlight the design problems of the information system before its usage becomes prevalent among people [27]. TAM consists of two main constructs: perceived ease of usefulness

and perceived ease of use which are used in numerous technological contexts [27–29].

Nonetheless, several research studies have expressed concerns regarding the usage of TAM with its original constructs to explain users' intention towards health information technologies. For a specific user context such as the adoption of telemedicine services, the usage intention of respondents cannot be sufficiently explained with few variables only. The specific utilization of telemedicine services among people is dependent on multiple social and behavioral factors which are not present in the TAM model. Research studies have highlighted that the intertwined effect of various social factors such as social influence and facilitating conditions can significantly alter the user behavior towards acceptance of new technology. Telemedicine services represent an improved alternative for health care services in developing countries; hence it is pertinent to focus on inclusion of additional social variables (with their underlying effect as inhibitor/facilitator) in TAM model and how these variables can influence the perception of users? Therefore, this research study has included variables such as social influence, facilitating conditions, trust, privacy, perceived risk, technological anxiety and resistance towards technology to gain a better insight into user's perception.

3. Research model and hypotheses development

3.1. Technology acceptance and resistance

Despite the acknowledged potential of information technology (IT) in health care systems for improving the quality of medical care and safety of patients, the majority of IT-based health systems encounter resistance from users or fail altogether. Users have a general tendency to exhibit resistance whenever any new innovative technology is implemented based on their pre-conceived evaluation of change. Resistance can significantly alter the decision of a user to adopt or discard a new technology, hence, the failure and problems of many IT-based health systems can be tracked to user's resistance because of the inclusion of hard influence tactics [30]. In many health informatics based ventures, resistance is mostly overlooked because of its probable effects on the sustainability of the system. Also, the primary purpose of designing a new system is to enable the user and not to minimize the consideration of resistance from the perspective of the user. Hence, the probable effects of resistance are often overlooked in IT-based health care system. According to early research studies on organizational resistance, some researchers deem it as a change which is the direct product of unfreezing the equilibrium of the established dynamics of the system before the change can impart any significant contribution [31].

In the context of information and communication technologies, resistance is generally defined as the social inertia towards a change which is possibly brought by the new technology [32]. Resistance can't be termed equivalent of non-usage of the system because non-usage may imply that users are still evaluating the new system or they simply exhibit a lack of awareness about the existing system, whereas, resistance implies the complete rejection of technology by the users. Hence, resistance can't be merely called a lack of change rather it is a comprehensive opposition towards a change, a cognitive force which arises when status quo is endangered due to any form of change [33]. Therefore, it becomes necessary to examine the effects of resistance within a technology acceptance model to understand how resistance can become a barrier in the adoption of telemedicine services [34,35].

3.1.1. Trust (T)

Over time, various studies have supported the inclusion of factors such as risk and trust in theoretical models of TAM for explaining the acceptance and integration of IT-based medical care technologies [36,37]. Trust has been widely regarded as an important determinant in the assessment for the acceptance of new eHealth services [38]. This also holds for telemedicine services where trust is considered as an equally important factor of patients' acceptance [39–41]. Due to its central role in facilitating various social interactions among members of society, trust becomes an integral condition for maintaining successful interpersonal relations [42]. In the context of online medical services, trust has been defined in many ways; various authors consider it to be one dimensional while others perceive it as two dimensional. Whereas in the context of research investigating the acceptance of telemedicine services, the importance of trust is further enhanced for engaging in activities such as medical prescription or purchasing medicine [43]. Within the context of this research, we perceive trust as faith in the adoption of a new technology that end-users/patients place in it with regards to the services this technology can provide. Based on that, for the current study, it is recommended that the perception of users regarding placing their trust in the technological infrastructure and procedural guarantees should also enhance their intention to use telemedicine.

3.1.2. Perceived usefulness and perceived ease of use (PU and PEOU)

Based on the review of empirical results of TAM in the context of health care research, we decided to operationalize the most common constructs of TAM in health-related studies.

Hence, perceived usefulness, perceived ease of use, facilitating conditions and usage intention are selected for this research study. In the initial research of TAM, perceived usefulness and perceived ease of use are the most common and significant determinants of technology acceptance [44–48]. Perceived usefulness is generally defined as the extent to which a person believes that using a system will help in enhancing his/her performance. In the context of this study, PU had to be redefined because the usefulness of a system for patients has somewhat altered meaning from previously included definitions of PU. Patients feel that adopting to telemedicine services will be useful only if it will lead to faster delivery of health care services with the low-cost of medical inspection, improved documentation and reduced service time of health care [49]. PEOU is defined as the degree as to which a person believes that using technology will bear minimum effort on his/her expense [24,50]. Based on that, we expect that patients will prefer to accept and use telemedicine services only when they feel that using these services will lead to better results.

3.1.3. Social influence (SI)

Social influence is the degree or the extent to which a person believes that others, especially, his/her acquaintances and friends believe that he/she should use a new system [29]. Studies have confirmed that social influence has a noteworthy effect on the intention of users to accept a new technology [51,52]. Moreover, in developing countries, people often live in joint family systems and are dependent on each other in multiple social and economic contexts. The usage of telemedicine services in such an environment will not only be visible to their family-members/neighbors/acquaintances but the opinion of these people can also encourage the end-users to utilize telemedicine services. Hence it is very important to examine the effect of this construct upon acceptance of telemedicine services. In the context of this research, we define social influence to be the attribute which encourages or prevents people to use telemedicine.

3.1.4. Facilitating conditions (FC)

Another direct determinant of behavioral intention to accept technology is facilitating conditions. This determinant is not included in the original TAM [27]. Facilitating conditions is defined as the existence of adequate organizational and technical infrastructure for a user's support to adopt a new technology [53]. Facilitating conditions combine three basic constructs: perceived behavioral control, facilitating conditions, and compatibility [54,55]. The successful usage of telemedicine services is significantly dependent upon the presence of adequate technological infrastructure. Moreover, the usage of telemedicine services also requires a continuous connection between health care professionals,

service providers, and end-users, located in distant areas.

The capability of a medical health professional to monitor and offer medical feedback using adequate health care infrastructure is a prerequisite for fostering the adoption of telemedicine services among people. Hence, this research study extends the original TAM by the inclusion of facilitating conditions as a facilitator for the adoption of telemedicine services. Literature has also widely acknowledged the significant effect of facilitating conditions on usage intention [56,57].

3.1.5. Technological anxiety (TA)

In this study, we have expanded the basic TAM model with some additional variables including technological anxiety, resistance to change and privacy concerns. With the advancement in science and technology, it becomes critical to explore and understand the willingness of users to adopt new technologies [58]. Technological anxiety can be described as the fear or apprehension that people experience when they begin to consider using or start using a computer-based technology they have not used before [59].

Technological anxiety is a negative emotional response and a negative relationship exists between using a new system and TA. Similarly, in the context of telemedicine, people might feel anxious to utilize these services. Hence, it is important to investigate the effect this factor can impart on usage intention.

3.1.6. Resistance to use (RC)

Studies have also verified that resistance towards technology decreases the intention of users to utilize a new technology [60]. The inclusion or introduction of a new technological system usually endangers the established working setting of the users. In extreme conditions where users are compelled to utilize telemedicine services in absence of any alternative to accomplish the health-related task or they may start using the system voluntarily, however, they will stop using it after some time. Contributing to the resistance of users towards telemedicine, another factor could be the prior experience of a user with a system. If the prior usage of the system has left the user uncomfortable or it has failed to provide the necessary information, users will not tend to use it again [61,62].

3.1.7. Perceived risk (PR)

The importance of risk as a key predictor of human behavior can't be denied. Perceived risk is defined as the perception of a person if he/she decides to undertake an action or activity [63]. The effects of risk and uncertainty can't be mitigated in the domain of health and information communication technologies, Nevertheless, the sources of variation of risk and uncertainties concerning usage of IT vary significantly among patients and doctors [64,65]. Previous studies have identified various aspects of the risk, dividing into six types: performance, financial, social, psychological, safety, social, and opportunity/time [66]. In the context of uncertainty and task-related problems with online services, research has indicated further seven facets of risk which include: time, performance, financial, social, physiological, privacy, and overall risk. Building on that, in this research study we define perceived risk for patients in terms of psychological, financial and performance risk. Performance risk: the probabilistic perception of a telemedicine system harming the patients because of the unavailability of adequate information. Psychological risk: the perceived threat based on the perception that the use of telemedicine services won't yield any mental satisfaction, resulting in psychological discomfort. Financial risk may be defined as the inability to incur the cost associated with the usage of telemedicine services in time. For general consumers where individual decisions are integral to utilize or purchase telemedicine services, it becomes important for them to consider the financial and time-loss aspects of risk as well. Hence, for this study, the perceived risk becomes a critical variable for assessment of patients' acceptance. It is identified in the literature that perceived risk contributes to the expectations of destructive consequences, thus, imparting a negative effect on usage intention [35,67,68].

3.1.8. Privacy (P)

Generally, privacy can be described as the state to be left alone [69]. Privacy can be categorized into four major types. However, in the context of health care information systems privacy stands out. Reviewing the definition of information privacy, it can be interpreted as the lack of control a person experiences about his/her personal information once they have adapted themselves to a new system. Privacy can be perceived as the sense of establishing a user's faith into a system such that he/she will feel secure enough to share personal health information. The importance of privacy, when it comes to exchanging medical information within the health care system, can't be denied. Previous studies have acknowledged the importance of privacy as an important determinant for technology acceptance. If a user believes his/her information is not being kept safe in an online health care program, it will reduce the adoption of new technological initiatives [70,71]. Similarly, in the context of health care studies, privacy concerns are shown to reduce the usage intention for the adoption of electronic health records and various web-based health care interventions [72,73]. Hence, users with high privacy concerns regarding the exchange of information within a telemedicine system might become reluctant to adopt it.

The technological (acceptance of telemedicine) and geographical context (Pakistan) of this research study points towards an early stage of implementation. Hence, we propose that usage intention of patients towards telemedicine services is primarily comprised of five prime enablers which are: perceived ease of use, perceived ease of usefulness, social influence, trust and facilitating conditions. The inhibitors of usage intention in the current study include technological anxiety, perceived risk, resistance to use, and privacy.

Based on the above discussion, the following hypotheses are proposed in Table 1 as listed below.

4. Research methodology

The research aim of this study is to analyze and explore the factors, shaping and influencing patients' attitude towards telemedicine. Fig. 1 represents the research model of this study where "Intention to use Telemedicine" is considered as a dependent variable. The targeted population for this research was patients in hospitals and ambulatory care. It should be noted as there would be larger variations among this group; hence, it can't be considered homogenous. Also, possible support of IT in the treatment of one patient significantly differs from the rest. To ensure the validity of all measures, the individual constructs of determinants were adopted from previous studies, the details of which are provided in Appendix A.

Table 1
List of Proposed hypotheses for research constructs.

Factors	Abbreviation	Hypothesis
Trust	(T)	**H1**: Trust positively influences the intention to use telemedicine services.
Perceived usefulness	(PU)	**H2**: Perceived usefulness positively influence the intention to use telemedicine services.
Perceived ease of use	(PEOU)	**H3**: Perceived ease of use positively influences the intention to use telemedicine services.
Social Influence	(SI)	**H4:** Social influence positively influences the intention to use telemedicine services.
Facilitating Conditions	(FC)	**H5:** Facilitating conditions positively influences the intention to use telemedicine services.
Technological Anxiety	(TA)	**H6:** Technological anxiety negatively influences the intention to use telemedicine services.
Resistance to Use	(RC)	**H7:** User's resistance negatively influences the intention to use telemedicine services.
Perceived Risk	(PR)	**H8**: Perceived risk negatively influences the intention to use telemedicine services.
Privacy	(P)	**H9**: Privacy negatively influences the intention to use telemedicine services.

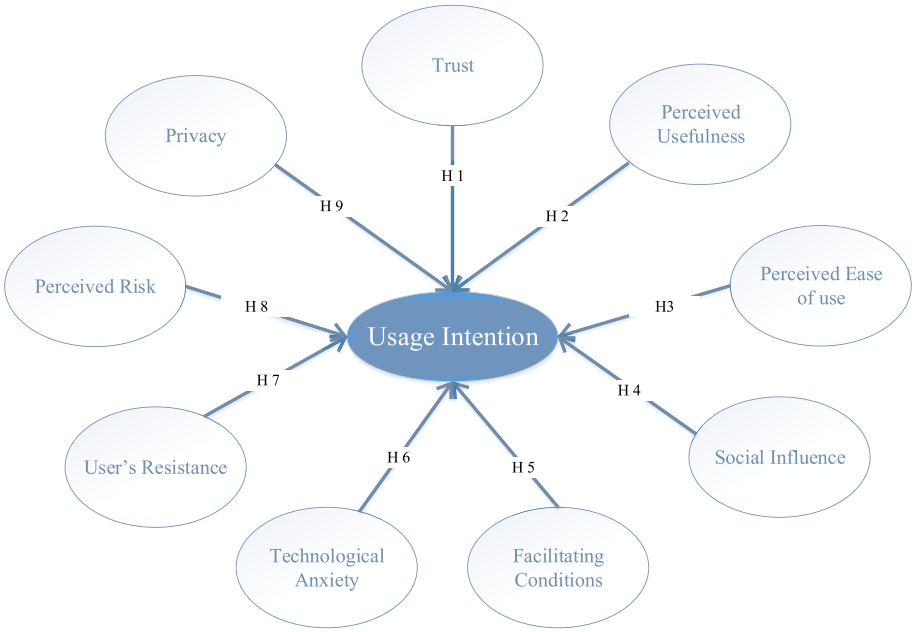

Fig. 1. Research model.

4.1. Research instrument and data collection

This research study was officially and ethically approved by the Board of Post Graduate studies at the University of Engineering and Technology Taxila, Pakistan. Initial questionnaire for this study was developed in English and was later translated into a local language (Urdu) by a linguistic expert at University of Engineering and Technology Taxila who was already well familiar with telemedicine. It was ensured that both questionnaires reflected the same meaning in terms of perception.

The questionnaire consisted of two sections: part A comprised the basic demographic characteristics of the participants, including information regarding gender, age, qualification, access to internet, income, and the number of visits to the doctor. Part B contained questions for various factors presented in the research model (Fig. 1). Likert scale of point-5 was used that oscillated between strongly disagree (1) to strongly agree (5). To validate the effectiveness of the questionnaire, a pilot study was conducted at the University of Engineering and Technology, Taxila, for which 15 professors and 10 postgraduate students were recruited. The participants were chosen because of their technical competencies and thorough understanding of Telemedicine. Questionnaires collected from the pilot study assisted in improving its effectiveness with some specific adjustments in terms of its context.

The target study population primarily consisted of patients who visited "Christian Hospital" and "District Head Quarter Hospital", Taxila. The recruitment of participants from these hospitals had several reasons: firstly, these hospitals have access to network coverage, providing the patients with access to tele-consultation, and secondly, these hospitals are visited not only by the locals of Taxila city but also people residing in rural areas. The research project began in November 2018 and was completed in December 2018 in terms of data collection. All the participants were informed regarding the purpose of this research study and consent of every participant was ensured by asking them to sign a consent form.

4.2. Data analysis

The data collected from respondents were analyzed using Partial Least Squares (PLS), a statistical technique embodied in structural equation modeling (SEM) [74]. PLS was employed to empirically test the proposed model and to validate the hypothesized relationship of determinants. PLS is being commonly used in multiple fields including accounting, marketing, sociology, business, and health care informatics. PLS model primarily consists of structural and measurement models. Analysis of the structural model is carried out using measures of internal reliability and validity. Once the structural model is analyzed, the PLS algorithm then utilizes t-testing and path values for hypothesis verification. Based on the proposed research model, this study has also utilized the PLS model for analyzing the factors influencing usage intention of users towards telemedicine services.

5. Results

Out of 275 distributed questionnaires, 226 were selected for data analysis and the rest were discarded as they were incomplete.

Table 2 summarizes the demographic characteristics of participants. As shown in Table 2, 64.6% of the total participants were males. The age of respondents varied in the range of 20 years–50 years; maximum frequency of respondents was observed in the age group of 20–30 years. The academic qualification of participants was observed mainly for the bachelor's category (58.4%). 60.2% of participants belonged to the rural environment and 39.8% belonged to the urban environment. Participant's monthly income was observed mostly in the income range of 10–20 thousand. 59.3% of the participants visited hospitals once every 6 months. Moreover, 51.3% of the participants reported they had access to internet services.

For statistical analysis, data follows normality characteristics. The value of skewness for all the variables lie in the range of $+1$ to -1 exhibiting that distribution of data was normal. Moreover, the results for kurtosis of all the determinants lie in the range of -2.58 to $+2.58$ indicating that distribution of data was normal.

Once normality of the data was confirmed, the next step was to determine the internal reliability, convergent validity and discriminant validity of the model. To measure the internal reliability of the data, Cronbach alpha was evaluated against the standard threshold of 0.7, the criterion for acceptable internal consistency of data [75,76].

Convergent validity was calculated using Average Variance Extracted (AVE), Composite Reliability (CR), and item loadings, such that minimum 0.50 of AVE exists for construct validity. As clearly depicted by Table 3, the calculated values of Cronbach alpha ranged from 0.73 to

Table 2
Demographic analysis.

Variable	Frequency	Percent (%)
Gender		
Male	146	64.6
Female	80	35.4
Age		
Less than 20 years	2	0.9
Between 20 and 30 years	146	64.6
Between 30 and 40 years	62	27.4
Between 40 and 50 years	10	4.4
50 years or above	6	2.7
Qualification		
Matriculation	18	8
Bachelors	132	58.4
Masters	68	30.1
Doctorate	8	3.5
Living Environment		
Urban	90	39.8
Rural	136	60.2
Monthly Income		
Between 10 and 20 thousand	136	60.17
Between 20 and 30 thousand	62	27.43
Between 30 and 40 thousand	28	12.38
Health Incentives		
Yes	104	46
No	122	54
Do you have any access to Internet facilities?		
Yes	110	48.7
No	116	51.3
No of Visits		
Once every 6 months	134	59.3
Once every 3 months	36	15.9
Once a month	10	4.4
Which chronic disease do you suffer from?		
Cardiac	65	28.76
Hypertension	71	31.41
Diabetes	90	39.82

0.878, composite reliability varied in the range of 0.815–0.942. As the calculated indices were all above the recommended threshold [77], strong internal reliability of data was supported. The individual item loadings of constructs oscillated between 0.818 and 0.973, whereas, the values for AVE ranged from 0.638 to 0.803, exceeding the recommended level, hence, the required criterion for convergent validity is also fulfilled.

Table 3
Measurement model.

Constructs	Items	Loadings	AVE[a]	CR[b]	Cronbach's alpha
T	T1	0.892	0.803	0.891	0.755
	T2	0.901			
PU	PU1	0.834	0.663	0.854	0.745
	PU2	0.882			
	PU3	0.818			
PEOU	PEOU1	0.872	0.709	0.879	0.715
	PEOU2	0.899			
	PEOU3	0.848			
SI	SI1	0.941	0.891	0.942	0.878
	SI2	0.947			
FC	FC1	0.815	0.638	0.840	0.715
	FC2	0.835			
	FC3	0.842			
TA	TA1	0.936	0.844	0.815	0.817
	TA2	0.901			
RC	RC1	0.88	0.779	0.876	0.716
	RC2	0.877			
PR	PR1	0.827	0.780	0.876	0.732
	PR2	0.936			
P	P1	0.747	0.752	0.856	0.728
	P2	0.973			
UI	UI1	0.833	0.697	0.873	0.782
	UI2	0.856			
	UI3	0.815			

[a] AVE = Average variance extracted.
[b] CR= Composite Reliability.

To measure the discriminant validity of data, cross-loading matrix along with the square root of AVE was determined. It is to be noted that for discriminant validity, the square root of AVE of a determinant must surpass the correlation it exhibits with other constructs [53]. Also, the entries present in corresponding columns and rows of correlation matrix must be less than the diagonal element [53]. Results presented in Table 4 confirm the discriminant validity of this data.

Table 5 represents a summary of the structural model, developed to determine the relationship between various factors in the model. The theoretical model was tested by using a standardized path coefficient and t-statistics with the help of the bootstrapping method. It can be seen from the table below that positive influence of perceived usefulness, perceived ease of use, social influence, facilitating conditions and trust is supported by hypothesis testing.

It can also be seen that negative influence of technological anxiety, perceived risk and resistance to technology is also validated by hypothesis testing. However, the proposed negative effect of privacy was rejected by hypothesis testing.

6. Discussions

This research study developed a theoretical model based on TAM to determine the usage intention for telemedicine among rural patients. From Fig. 2 drawn below, it can also be seen that overall 62.45% of the variance in usage intention towards telemedicine services is explained by this research model. The research aim of this study was to determine the drivers and barriers influencing usage intention of telemedicine services among people. Based on the research findings, it can be seen that constructs including perceived usefulness, social influence, trust, perceived ease of use and facilitating conditions represent the drivers influencing usage intention of telemedicine services. Research findings also indicate that technological anxiety, resistance towards technology, and perceived risk act as the significant barriers influencing the usage intention of telemedicine services.

It can be seen that perceived usefulness ($t = 4.428$, $\beta = 0.313$), and perceived ease of use ($\beta = 0.148$, $t = 2.207$) are important drivers for acceptance of telemedicine services in the context of a developing country. This result is in line with previous research studies [3,6,78]. Therefore, these factors are significant in the health care context of Pakistan as has been found elsewhere. The more people view telemedicine as an easy to use technology, the more they will be motivated to utilize these services. Consequently, telemedicine services must be designed according to patients' acceptance level of technology. In this way, people will not have to spend a tremendous amount of time and effort to utilize these services. Therefore, telemedicine service providers must focus on the clinical needs and rural health care environment of end-users for its effective utilization.

Social influence ($t = 2.629$, $\beta = 0.161$) was also found out to be an influential determinant of usage intention, which is consistent with the findings of previous studies [5,79]. Patients and medical professionals living in joint family settings are likely to form dependent evaluations of the telemedicine system. People will be more likely to utilize telemedicine services if their family members and acquaintances view these services as effective for improving health care conditions. For this purpose, prominent community members, health workers and, local religious figures must be engaged in research discourse regarding telemedicine services which can lead to more positive results. Moreover, the service providers of telemedicine should focus on the provision of various incentives among rural communities which will encourage them to promote this technology as well.

The research results for trust ($t = 2.401$, $\beta = 0.145$) indicate its significance for large scale implementation of telemedicine services and confirm the findings of previous studies [80,81]. Trust signifies the faith users place in telemedicine services for acquiring better health services

Table 4
Correlation analysis.

Constructs	T	PU	PEOU	SI	FC	TA	RC	PR	P	UI
T	1									
PU	0.454	1								
PEOU	0.567	0.650	1							
S1	0.542	0.556	0.611	1						
FC	0.511	0.544	0.579	0.687	1					
TA	0.256	0.356	0.455	0.627	0.410	1				
RC	0.249	0.464	0.405	0.599	0.394	0.378	1			
PR	0.443	0.454	0.507	0.634	0.396	0.384	0.393	1		
P	0.029	0.042	0.029	0.150	0.157	0.108	0.488	0.081	1	
UI	0.559	0.674	0.509	0.524	0.687	0.627	0.599	0.634	0.150	1

Table 5
Analysis of the model.

Hypothesis	Path Coefficients	T-values	Conclusion
H1: Trust positively influences the intention to use telemedicine services.	0.145	2.401 > 1.96	Supported
H2: Perceived usefulness positively influence the intention to use telemedicine services.	0.313	4.428 > 1.96	Supported
H3: Perceived ease of use positively influences the intention to use telemedicine services.	0.148	2.207 > 1.96	Supported
H4: Social influence positively influences the intention to use telemedicine services.	0.161	2.629 > 1.96	Supported
H5: Facilitating conditions positively influence the intention to use telemedicine services.	0.126	2.190 > 1.96	Supported
H6: Technological anxiety negatively influences the intention to use telemedicine services.	- 0.242	5.053 > 1.96	Supported
H7: User's resistance negatively influences the intention to use telemedicine services.	- 0.158	3.091 > 1.96	Supported
H8: Perceived risk negatively influences the intention to use telemedicine services.	- 0.160	2.996 > 1.96	Supported
H9: Privacy negatively influences the intention to use telemedicine services.	0.035	1.281 < 1.96	Not Supported

Significant at p-value ($p < 0.05$); Arrows exhibit the direct relationship between the independent and dependent variable.

in the future. If people living in rural areas start believing that telemedicine services are effectively reliable, then they will have fewer doubts about using these services. Therefore, service providers of telemedicine services should work on establishing trust among users. This can be accomplished if users are provided with multiple service offers and ubiquitous access.

Based on the results of hypotheses testing, it can be seen that facilitating conditions ($\beta = 0.126$, $t = 2.190$) are highlighted as significant drivers for acceptance of telemedicine services. These research findings are in line with the findings of previous studies [82–84]. People living in rural areas fully comprehend the importance of adequate technical infrastructure and its subsequent impact upon usage intention. Therefore, the government of Pakistan actively needs to collaborate with stakeholders to launch health care incentives and interventions for telemedicine services. For instance, the government of Pakistan can collaborate with telecommunication companies to provide easy access to internet facilities to residents of rural areas. It can also launch initiatives by engaging primary health care providers, doctors, and physicians in the research stream of telemedicine services. Tele-care units should be established in remote areas of Pakistan and must be given complete financial support so that monetary concerns do not discourage people. Such initiatives can lead to the design and development of programs where affordability of end-users is carefully gauged. Eventually, a cost-effective recovery mechanism will encourage both physicians and patients to adopt telemedicine services.

According to findings of this study, it was identified that resistance to technology ($\beta = -0.158$, $t = 3.091$), and technological anxiety ($\beta = -0.242$, $t = 5.053$), had a significantly negative relationship with the usage intention. It is because that in a developing country like Pakistan where people don't have frequent access to doctors, most of the people prefer a face-to-face meeting with doctors instead of relying on remote modes of communication and diagnosis. Although, it can be seen from the demographic characteristics that nearly 48% of the total respondents had access to the internet. However, the idea of using the internet or mobile services for health care procedures is still relevantly new for them to adopt. Therefore, awareness campaigns and programs need to be designed in rural areas for public awareness as it will help to reduce the resistance towards the acceptance of telemedicine services.

Perceived risk ($\beta = -0.160$, $t = 2.996$) is also seen as a major barrier for acceptance of telemedicine services, confirming its effect on usage intention in the context of health care studies [78,85]. Due to meager health resources, people of a developing country like Pakistan associate a perceived sense of risk with the adoption of new technology. Not to forget the digital barrier and limited technical competencies further increase the resistance to adopt Telemedicine. On the other hand, according to findings of this study, facilitating people with adequate infrastructure will aid them in adapting telemedicine, which is the need of the hour and consistent with the previous studies of TAM.

It is also important to note that another prime factor for enhancing the awareness regarding telemedicine services among the public is the formulation of viable policies and regulations, the responsibility of which solely lies on the government. Unfortunately, Pakistan lacks any formal policy regarding implementation of telemedicine, encouraging and guiding service providers, health care professionals, and users to utilize these services. Hence, the government should place a strong emphasize on devising policies and mechanisms to effectively communicate the clinical utility of telemedicine among service providers and users.

7. Conclusions and recommendations

Telemedicine in Pakistan has a great potential to serve the country's declining health care system. Telemedicine services can serve as an integral building block of the existing traditional health set up in Pakistan. The research study developed a theoretical model based on TAM to investigate factors influencing the acceptance of telemedicine service. This research study explored the drivers and barriers influencing the willingness of patients to utilize telemedicine services. The research findings highlight that perceived usefulness, perceived ease of use, social influence, facilitating conditions, and trust are main drivers influencing the acceptance of telemedicine services. However, technological anxiety, resistance to technology and perceived risk can inhibit the acceptance of telemedicine services. Privacy was found to be an insignificant determinant of usage intention and there was no significant correlation

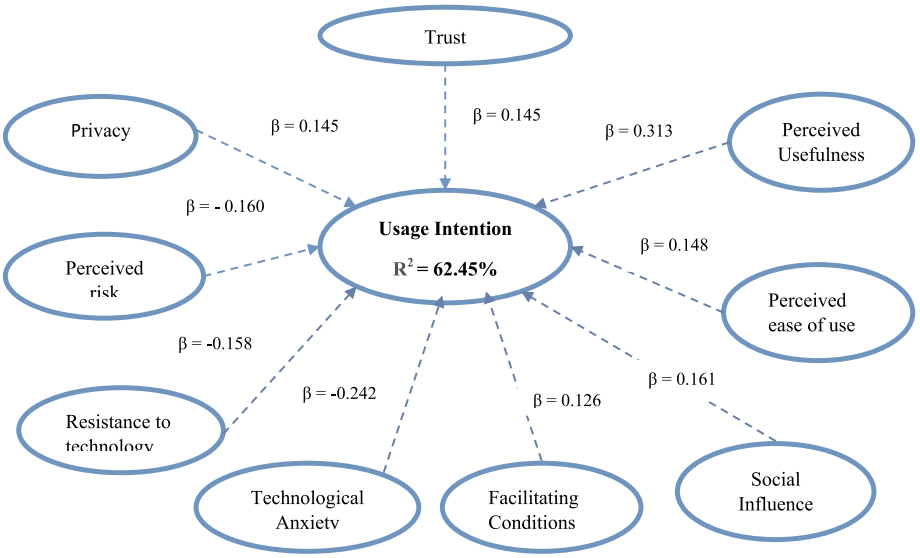

Fig. 2. Research model.

between privacy and intention to utilize telemedicine services.

Regardless of the substantial influence of facilitating conditions and social influence on the acceptance of telemedicine services, it can be seen that people of Pakistan are not provided with adequate opportunities to utilize telemedicine services. It was identified that trust is an essential determinant for acceptance of telemedicine services. Thus a higher level of trust in telemedicine systems can significantly enhance the usage intention of patients.

It is also suggested that new education-support programs and development initiatives should be introduced to encourage people for the acceptance of telemedicine services. However, the focus of these support programs shouldn't be restricted to develop evidence-based telemedicine interventions and the formulation of recommendations and guidelines. Instead, the focus should also be on increasing the awareness and acceptance of telemedicine services not only among the users but among all the stakeholders of the health care system as well.

The findings of this study contribute to the existing body of knowledge regarding the design and development of telemedicine services. The research findings also highlight how this entire process can be made more effective for the adoption of telemedicine services among the people of developing countries. This research represents the first empirical study identifying barriers and drivers of telemedicine services from patients' perspective in Pakistan based on the extension of TAM with additional constructs. Based on the identified factors including facilitating conditions, social influence, technological anxiety and, perceived risk; telemedicine service providers, planners, and policy-makers can design better strategies for the successful implementation and adoption of these services in a developing country. Because of the empirical approach of this study, the research findings can be easily applied to the health care settings of other developing countries for the uptake of telemedicine services.

8. Limitations

The end-participants of this study were mainly patients, despite the involvement of multiple other entities in the health care system. Firstly, the research study population primarily consisted of a mixed sample (rural and urban). Hence it is recommended for future studies to explore the acceptance of telemedicine services using the research sample which is more representative of the survey population. Further studies are essentially required to explore the other substantial antecedents in the health care system for the acceptance of telemedicine services among people nationwide including psychological parameters such as price value, hedonic motivation, self-efficacy and, habit. Additional constructs such as personal motivation, innovativeness and, cultural constructs should also be examined to unveil more reliable findings of the proposed model for the adoption of telemedicine services in a developing country.

Appendix A

Constructs	Definitions	References
Perceived Usefulness (PU)	PU1: Using Telemedicine would improve the quality of my health care. PU2: Using telemedicine would improve my access to healthcare services. PU3: Using Telemedicine would be useful in my daily routine.	[29,86,87]
Perceived ease of use (PEOU)	PEOU1: I would find learning to use telemedicine would not be very difficult for me. PEOU2: I would find it easy for myself to interact with doctors using telemedicine. PEOU3: Interacting with telemedicine systems would be clear and understandable for me.	[88,89]
Resistance to use (RC)	RC1: I wouldn't want the telemedicine to alter my traditional way of using health care services. RC2: I wouldn't want the telemedicine to interfere or change the way I interact with doctors. RC3: I don't want telemedicine services to change the way I deal with my health problems and choices.	[35]
Trust (T)	T1: Telemedicine services would be trustworthy for improving my health care routine T2: Telemedicine systems will require me to be cautious with this technology. T3: I feel satisfied and confident that I will be able to rely on the benefits of telemedicine	[90]
Technology Anxiety (TA)	TA1: Using telemedicine would make me feel nervous. TA2: Using telemedicine would make me confused and uncomfortable	[91,92]

(*continued on next page*)

(*continued*)

Constructs	Definitions	References
Facilitating conditions (FC)	FC1: I would be able to have all the necessary resources for using the telemedicine services FC2: I would acquire sufficient knowledge for using telemedicine service FC3: Telemedicine will suite well with my health care routine	[93,94]
Social Influence (SI)	SI1: People around me who mean to me a lot would prefer if I would use telemedicine services SI2: People who significantly influence my behavior would prefer if I use telemedicine services.	[53,95]
Perceived Risk (PR)	PR1: Learning how to use telemedicine services and adapting it would be a loss of my time. PR2: Using telemedicine systems would be a loss of money and resources. PR3: Using telemedicine wouldn't be compatible with my moral values and image	[90,96]
Usage Intention (UI)	Assuming that I was given the chance to access telemedicine, I intend to use telemedicine services. Whenever I would need remote medical care from professionals, I would gladly use telemedicine services. I intend on informing my relatives and friends about telemedicine	[91]

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.techsoc.2019.101212.

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