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Acceptance of IoT by Students in Universities of Sindh, Pakistan: A Proposed Framework

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Abstract: The Internet of Things (IoT) encompasses a convergence of physical and virtual technologies, connecting devices through networks to enhance the overall quality of life. These technologies offer diverse interactions, featuring unique user interfaces and functionalities. Beyond its technological prowess, IoT presents contemporary methodologies and tools, catering to both modern and traditional learning approaches. While IoT components have received considerable attention, there exists a notable gap in exploring factors influencing students' receptiveness to these services. This research centers on the Unified Theory of Acceptance and Use of Technology (UTAUT 2), a widely acknowledged framework for assessing user willingness to adopt new technologies. The primary objective of our pilot study is to establish a conceptual framework based on UTAUT 2 and assess its reliability and validity. This framework sets the stage for future investigations into IoT acceptance among higher education students in Pakistan. To achieve this, an online pilot research questionnaire was distributed via Google Forms to students across various institutions, including the University of Karachi, University of Sindh Jamshoro, University of Sufism and Modern Sciences Bhitshah, Government College University Hyderabad, and SALU Khairpur. Fifty participants completed the questionnaire, and the ensuing data attests to the questionnaire's high reliability (ranging from .795 to .961), affirming its suitability for broader surveys.

Keywords: Internet of Things (IoT); Higher Education Institutions; UTAUT2, Smart Learning, Smart University, Technology Acceptance**.**

1. Introduction

The convergence of technological advancements has led to the integration of sensors into various gadgets and objects, enabling their connection to the internet. This phenomenon has bestowed the start of the IoT, where ordinary objects are interconnected through sensor-equipped smart devices, forming a network[1]. Kevin Ashton initially used the phrase "Internet of Things" in 1999 to describe a system where ubiquitous gadgets create links between the real world and the Internet[2] [3][4][5].

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The advent of IoT has introduced a significant transformation in the field of education, reshaping the way students engage with physical equipment, sensors, and controls via internet connectivity. Recent initiatives in IoT education have identified four key areas where IoT is utilized, namely access protection, healthcare monitoring, enhancement of teaching and learning experiences, and real-time environment tracking [6][7][8]. This development signifies the potential of IoT to revolutionize educational practices and improve various aspects of the learning environment.

Smart education, encompassing innovation, knowledge, and learning, holds significance within the context of smart cities, where education is a key focus area[9]. In Sindh, Pakistan, the concept of IoT in universities has emerged from the Smart Campus framework. This concept involves integrating IoT into Higher Education Institutions (HEIs) by leveraging existing infrastructure to support academic activities. While Pakistan has already embraced information and communication technology (ICT) in universities[10], including computer laboratories, internet connectivity, multimedia classrooms, and digital library access, the adoption of IoT, as a more recent and intelligent-based system for remote learning, is yet to be implemented in Pakistani universities. In contrast, the industrialized world has already embraced IoT and is reaping its manifold benefits[11]. Recognizing the value of IoT in education, Pakistan is keen to explore its potential applications, challenges, and benefits. Thus, the objective of this research is to examine and investigate the feasible applications, difficulties, and advantages linked with the integration of IoT in the realm of teaching and learning.

2. Problem Statement

The integration of IoT technology can enhance services by allowing users to connect physical devices to the internet, enabling computation and communication capabilities. In the context of education, effective communication between students and relevant individuals at the right time and location is crucial[12], [13]. Consequently, educational institutions have started reevaluating their teaching and learning approaches, transitioning from a traditional model of knowledge transmission in classrooms to a collaborative and technologically driven model[14]. However, from the specific perspective of HEIs in Pakistan, there is a pressing need to investigate and understand the reasons behind the scarcity of IoT implementation[15], [16]. Extensive experimental research is necessary to assess the acceptance and feasibility of IoT in universities, including identifying factors that contribute to success and challenges that hinder optimal IoT performance. Additionally, considering students' pivotal role in the educational system, this study aims to evaluate their acceptance and effective utilization of IoT[17], [18][19][20].

3. Research Aim

The primary objective of our study is to construct a viable model for gauging the acceptance of Internet of Things (IoT) in universities situated in Sindh, Pakistan. Specifically, we aim to investigate how this model can influence students' acceptance of IoT applications in their learning experiences. Our pilot study is designed to refine the research instrument, setting the stage for a comprehensive survey that assesses the degree of student acceptance towards adopting IoT services for educational purposes.

This initiative aligns with the 2025 vision for smart universities in Pakistan, emphasizing the integration of IoT technologies into the educational landscape. The pilot study not only serves as a crucial step in purifying our research instrument but also establishes the reliability and validity of our methodology. Our results, meeting predefined threshold values, affirm the readiness of the instrument for a full-scale survey within the context of Sindh, Pakistan. This larger-scale investigation aims to delve deeper into understanding the levels of acceptance of IoT among students, contributing valuable insights to the broader educational landscape. In terms of significance, our research strives to enhance the quality of the education system in developing countries. By effectively incorporating

IoT technologies in higher education institutions, we aspire to bring about positive transformations. This academic endeavor aligns with the broader vision of smart universities in Pakistan and underscores the potential of IoT in shaping a more advanced and efficient educational environment.

4. Comparison between UTAUT and other Theories

The selection of UTAUT 2 over other acceptance models is grounded in its unique advantages, making it particularly well-suited for the context of higher education in Pakistan, as compared to alternative models. Firstly, in comparison to the Technology Acceptance Model (TAM) and the Theory of Reasoned Action (TRA), UTAUT 2 integrates additional factors such as social influence and facilitating conditions. This extension allows for a more comprehensive understanding of the complexities involved in technology acceptance, which is crucial in the dynamic and socially influenced environment of higher education.

Moreover, the Combined TAM and TPB, while encompassing the strengths of both models, may result in redundancy. UTAUT 2, on the other hand, streamlines these elements while introducing performance expectancy and effort expectancy, providing a more concise yet inclusive framework [21]. The Motivational Model (MM) and the Motivational Post-Adoption Model (MPAM) primarily focus on post-adoption behavior. In contrast, UTAUT 2 not only considers the adoption phase but also delves into the influential factors that precede acceptance, making it more relevant for our investigation into the initial stages of IoT acceptance at universities. Considering the Media Richness Theory (MRT) and the Social Cognitive Theory (SCT), while valuable in their own right, they may lack the breadth of application demonstrated by UTAUT 2. UTAUT 2 adaptability to diverse cultural contexts, evident in its successful application in various international studies, aligns well with the multicultural higher education landscape in Pakistan.

In summary, UTAUT 2 stands out for its comprehensive nature, incorporating a wide range of determinants relevant to technology acceptance in higher education. Its adaptability to cultural nuances and ability to capture both pre-adoption and post-adoption factors make it the most suitable choice for our research on IoT acceptance at universities in Sindh, Pakistan[22].

5. Proposed Research Model

In order to propose and analyze the acceptability of technology, researchers have developed a number of theories and models throughout the years. The Theory of Reasoned Action, the Theory of Planned Behaviour, the Diffusion of Innovation Theory, the Technology Acceptance Model, and the Unified Theory of Use and Technology Acceptance are all prominent theories and models in this area [9]. These well-established models are used as benchmarks against which new technologies may be evaluated. This study, which is based on a literature review and many other studies, applies these preexisting ideas to the context of university students in Pakistan.

A framework has been devised that incorporates fundamental constructs from the UTAUT 2 theory along with additional external constructs. This study relies on the UTAUT 2 theory since it is the most recent and all-encompassing model of its kind, and hence the most appropriate starting point for our investigation. The UTAUT 2 theory outperforms previous models in terms of accuracy by integrating constructs and moderating variables; it may predict as much as 70% of the variation in intention[22]. The proposed model in this research comprises six core constructs from the UTAUT 2 theory, including Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, and Price Value. Additionally, three external constructs are included: IoT Skills, Personal Innovativeness, and Trust.

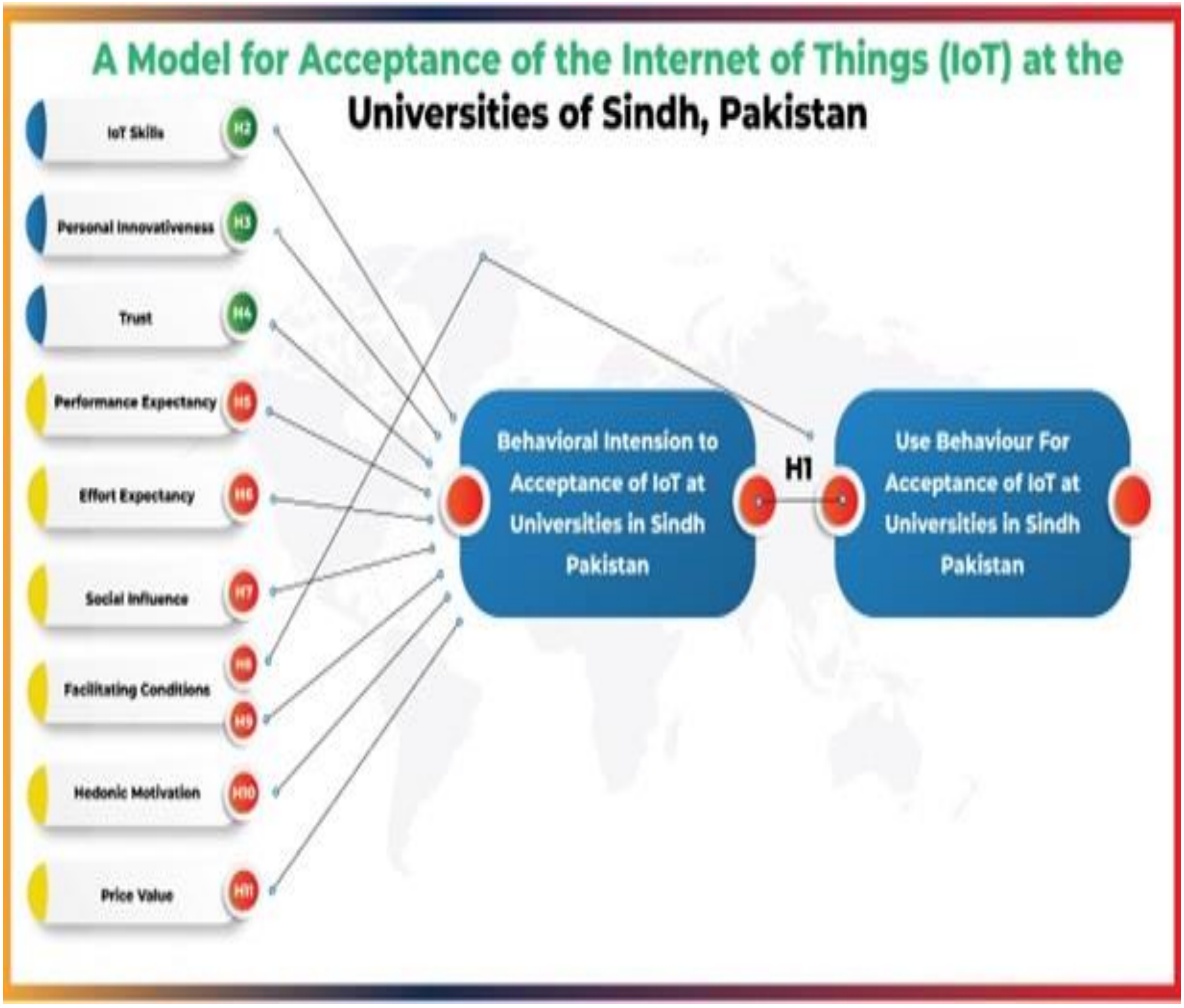

Fig: 1 - A Model for Acceptance of the IoT at the University of Sindh Pakistan

The proposed constructs in this study are categorized into two distinct groups of variables: Dependent Variables and Independent Variables. Dependent Variables refer to the outcomes or factors that are being observed, measured, or predicted in the research. These variables are expected to be influenced by the Independent Variables. whereas Independent Variables are the factors or conditions that researchers manipulate or control to examine their impact on the Dependent Variables. The Independent Variables are considered to have a potential influence on the outcomes or behaviours under investigation.

5.1 Dependent Variable

The proposed framework in this study incorporates two dependent variables, namely Behavioral Intention and Use Behavior, as given in Figure 1. These variables are utilized to assess the acceptance of the technology being studied by computing the intention of the academicians and their actual behavior or outcomes through the measurement of their use behavior. Both variables are interconnected, with Intention serving as an immediate precursor to use behavior. The inclusion of both dependent variables in the proposed framework allows for the simultaneous measurement of individuals' intentions and actual use. This study offers the advantage of capturing and evaluating both an individual's intention and their real-world utilization of the technology. The definitions for both dependent variables are provided below.

5.1.1 Use Behaviour

According to Viswanath[23], "use behavior" refers to the actual behavior exhibited by a user while utilizing technology and can be quantified by measuring the user's frequency of technology usage[24][25].

5.1.2 Behavioural Intention

Behavioral Intention (BI), a psychological construct, encapsulates an individual's cognitive inclination and motivational drive to engage in a specific behavior within a particular context[5]. Its significance within the realm of the IoT lies in its portrayal of an individual's subjective willingness and preparedness to accept and utilize IoT applications and services. It is worth noting that BI serves as a reliable indicator of an individual's willingness to accept and embrace IoT, thereby exerting a substantial influence on decisions regarding technology acceptance [25][26]. Recognizing the pivotal role of BI in shaping the acceptance of technology, the present study develops research hypotheses that serve as empirical propositions. These hypotheses are meticulously designed to be systematically examined and tested, with the ultimate goal of enhancing our comprehension of the features that induce BI in the context of IoT acceptance.

H1. The use behavior for IoT acceptance among students will be significantly positively influenced by BI.

5.2 Independent Variable

These variables are crucial factors that exert an impact on or have an impact on outcomes. Within the scope of this research, eight constructs have been identified as independent variables. Each of these constructs acts a distinct part in shaping the outcomes under investigation.

5.2.1 IoT Skills

IoT skills encompass the proficiencies required to effectively engage with smart devices, commonly referred to as "things," and the data collected by these devices[27]. These skills involve the ability to configure device settings, analyze and interpret gathered data, collaborate with others by sharing data, and create meaningful and logical visualizations of the data. By possessing IoT skills, individuals can optimize their utilization of smart devices, harnessing their full potential to enhance various aspects of their lives and work[28][27].

H2. The IoT possessed by students is expected to have a positive impact on their BI to accept IoT for learning purposes.

5.2.2 Personal Innovativeness

Personal Innovativeness (PI) is a psychological construct widely studied in the field of Information Systems research[29]. It assesses an individual's inherent tendency and inclination to adopt and embrace novel and innovative technologies. PI reflects an individual's receptiveness to change, their eagerness to explore and experiment with new technological solutions, and their willingness to engage in innovative practices. It encompasses traits such as curiosity, adaptability, and a propensity to take risks when it comes to adopting new technologies [30][31][32].

H3.PI is expected to exert a positive impact on the BI of students towards accepting the use of IoT for learning purposes.

5.2.3 Trust

Trust is a very important variable because establishing an effective and trustworthy privacy and security mechanism is vital for the successful implementation of IoT [33][34]. This is particularly significant from the perspective of universities, where the safety and privacy of the IoT ecosystem are vulnerable. Trust assumes even greater importance due to several reasons. Firstly, in Pakistan HEIs, IoT technologies are fairly new, making trust a critical factor in their acceptance. Secondly, the security and privacy concerns associated with the IoT ecosystem pose specific challenges in the higher education environment. Hence, understanding and fostering trust is essential to ensure the successful acceptance and integration of IoT in in Pakistani HEIs[35][36][37]. Based on these observations, the subsequent hypothesis is expected:

H4. The establishment of the trust is likely to positively influence the BI of students towards accepting IoT for learning purposes.

5.2.4 Performance Expectancy

Performance Expectancy (PE) is the degree to which a person believes that accepting IoT technology in their life would increase their professional performance[30][33][38]. The value of IoT is perceived differently by different people based on how they intend to use it. People see IoT as redundant or potentially harmful if they don't see any benefit from the actual hardware environment. As a result, the acceptance and adoption of IoT in Pakistan's HEIs are significantly influenced by the perceived value and user expectations of IoT capabilities. Based on these observations, the subsequent hypothesis is expected:

H5. The degree of PE is expected to have a positive impact on the BI of students to accept IoT for learning purposes.

5.2.5 Effort Expectancy

Effort Expectancy (EE), also referred to as ease of use, measures the ease with which a system can be utilized[30][33][38]. One of the primary goals of IoT is to offer convenience by simplifying remote surveillance, learning, and control of IoT devices, which subsequently reduces the need for physical travel and exertion of effort. Most IoT devices feature interactive interfaces, responsive, and user-friendly [23]. Consequently, the presence of an effortless and intuitive user experience in IoT devices becomes a critical factor influencing the acceptance and adoption of IoT, particularly when compared to non-IoT alternatives. Therefore, when considering the acceptance of IoT, the ease-of-use provided by IoT devices becomes a significant consideration in users' decision-making process. Based on these observations, the given hypothesis is expected:

H6. The level of EE is expected to exert a positive influence on the BI of students towards accepting the use of IoT for learning purposes.

5.2.6 Social Influence

Social Influence (SI) refers to the level to which users remark on the significance of influential individuals endorsing the use of an Information System. In the context of IoT technologies, their impact extends beyond individual users to students within educational institutions[30][33][38]. Consequently, it is anticipated that potential users of IoT will be aware of the prevailing views and opinions about IoT. Social influence plays a significant role in shaping users' perceptions and attitudes towards adopting and utilizing IoT. The endorsement and support from influential individuals can contribute to the acceptance and adoption of IoT technologies, not only among individual users but also within the educational setting. It highlights the importance of considering the social dynamics and influential factors that influence the decision-making process related to the adoption and integration of IoT technologies in educational institutions. Based on these observations, the given hypothesis is expected:

H7. The presence of SI is likely to positively impact the BI of students towards accepting IoT for learning purposes.

5.2.7 Facilitating Conditions

Facilitating Conditions (FC) pertain to the resources available that can support and enhance the utilization and adoption of IoT in the consumer context[30][33][38]. In general, users who have greater access to facilitating conditions are more inclined to utilize specific technologies. The availability of adequate resources, infrastructure, and supportive conditions can significantly influence users' willingness and readiness to embrace IoT technology. These facilitating conditions can range from technological infrastructure, such as reliable internet connectivity and compatible devices, to organizational support and training opportunities. Based on these observations, the following hypotheses are proposed:
H8. The presence of FC is expected to exert a positive influence on the BI of students towards accepting the use of IoT for learning purposes.
H9. FC is expected to have a positive impact on the use behavior of students who accept IoT for learning purposes.

5.2.8 Hedonic Motivation

Hedonic Motivation (HM) refers to the satisfaction and pleasure that users experience through the utilization of a specific technology[30][33][38]. HM is associated with the positive emotional impact and the influence it has on the adoption of the Internet of Things (IoT) [28]. The hedonic aspects of using IoT, such as the enjoyment, entertainment, and gratification derived from its functionalities, contribute to its perceived value and appeal. Understanding the role of hedonic motivation can provide valuable insights into enhancing the acceptance and utilization of IoT in the higher education context. Based on these observations, the following hypothesis is proposed:
H10. The presence of HM is expected to positively influence the BI of students towards adopting IoT technology for learning purposes.

5.2.9 Price Value

Price Value (PV) is the cognitive evaluation of consumers, weighing the perceived benefits of an Information System (IS) against its monetary cost[30][33][38]. PV significantly influences users' behavioral intentions, with higher PV indicating a stronger inclination towards a specific IS. It holds a central position in the UTAUT2 framework, impacting the acceptance and usage of IT by consumers. Studies have identified PV as a key determinant of behavioral intentions. In the context of IoT acceptance, PV is particularly influential, as users compare IoT technologies with non-IoT alternatives. The assessment of value in relation to costs greatly influences users' decisions to accept and adopt IoT. Recognizing PV's significance provides valuable insights into users' perceptions and decision-making processes regarding IoT acceptance and usage. Based on these observations, the following hypothesis is proposed:
H11. The affordability of PV is expected to positively impact the BI of students towards accepting IoT for learning purposes.

6. Research Methodology

This research employs quantitative methodology through the utilization of a survey method[39]. The survey instrument designed for this study consists of three distinct sections, namely demographic information, a general assessment of the Internet of Things (IoT) in universities, and variables measuring human behavior. To ensure the effectiveness and reliability of the survey instrument, a pilot study was conducted at this stage of the research. The purpose of the pilot study was to test and refine the survey instrument before its full implementation. Detailed information regarding the pilot study is presented below.

7. Questionnaire

A questionnaire is a pre-set list of inquiries that are designed to elicit responses from the participants, as explained by Sekaran[40]. In this study, the focus is on collecting quantitative data through the use of questionnaires. The questionnaires have administered both in person and electronically through the sharing of a Google Form. Based on a review of the relevant literature, it has been determined that the nominal and ordinal scales are suitable for this research topic. The nominal scale will be used for questions related to the participant's personal information, such as demographics. Meanwhile, the ordinal scale will be utilized for questions concerning the respondents' attitudes and perceptions regarding IoT acceptance and uses. A seven-point Likert scale, first published by Rensis Likert in 1932, will be used in this study[41]. This scale was chosen since it has already been used in relevant studies and is consistent with getting information from respondents using the survey approach[42].

The formulation of questions in our research instrument aligns meticulously with the constructs outlined in the UTAUT 2 model, ensuring both reliability and validity. Additionally, we introduced three independent constructs, subjecting the entire instrument to a rigorous content validity process before initiating the pilot study.

For each UTAUT 2 construct, corresponding questions were carefully crafted to encapsulate the essence of the theoretical framework. The wording and structure of these questions were designed to mirror the nuanced factors inherent in each construct, drawing on established literature and validated scales whenever applicable. To bolster the reliability and validity of our instrument, we undertook a thorough content validity assessment. Six expert panels from the relevant field were engaged to critically evaluate the clarity, relevance, and representativeness of each item in the questionnaire[43]. The content validity index (CVI) for each item met or exceeded the established threshold, affirming the instrument's content validity[44]. This process not only ensures that our questions effectively tap into the intended constructs but also establishes the credibility and appropriateness of the entire instrument[45], [46].

8. Pilot Study

A pilot study is similar to a feasibility study as it is used to assess the reliability and validity of the survey instrument. It involves administering the survey instrument to a small sample from the targeted population [47]. The findings and feedback from the pilot study are then used to refine the instrument before conducting the final survey. Pilot studies are crucial as they help to identify and remove weaknesses in the instrument, thereby increasing the likelihood of success in the main study[48]. Thabane [49]also emphasize the importance of conducting pilot studies as they serve as essential prerequisites before the final study.

The sample size plays a crucial role in determining the number of participants that will be selected for the study. Proper sample size is essential for achieving a high level of accuracy in the study results [50]. If the sample size is too low, it can result in poor study results, while a larger sample size can require more effort and resources[51][52][53][54]. Therefore, it is important to strike a balance between sample size and accuracy to obtain reliable results without incurring excessive costs or resource utilization. Typically, the recommended sample size for a pilot study ranges from 10 to 30 individuals from the relevant population, as suggested by Luck[55] [56][57]. For this pilot research, a sample of 50 students from the universities in the sample was used.

Table 1-Pilot Analysis Test

Requisite study	**Objective**	**Investigative method and their Cut-off value**	**Tool**
Data Coding	Create clear and descriptive labels for each variable in a dataset that correlates to each of the possible replies, Pallent, 2007	Variable coding	SPSS
Reliability	To confirm that measurements are error-free and so produce consistent findings	$\alpha > 0.6$ [58]	
		Item-to-total correlation >0.3[59]	
Factor analysis (EFA)	Ensure that the scale established for the current investigation is validated by data	KMO >0.6[60]	
		Bartlett's test of sphericity < 0.05[61]	
		Communality >0.5 Hair et al., 2006	

9. Analysis & Results

9.1 Demographic Details Results

Based on the collected data, it was found that 20 respondents (40.0%) were pursuing an undergraduate degree program, 16 (32.0%) were enrolled in a Master/M Phil. degree program, and 14 (28.0%) were pursuing a PhD degree program.

Table 2-Demographic Details

Variable	Category	Frequency	percentage
Gender	Male	39	78
	Female	11	22
Age	Under 20 years	1	2
	21-to-30	32	64
	31-to-40	13	26
	41-to-50	4	8
	>60	0	0
Qualification	UDP	20	40
	MDP	16	32
	PhDDP	14	28
Faculty	Arts	5	10
	Education	5	10
	Com & BAdm.	8	16
	Technology	19	38
	Natural Science	6	12
	Social Science	6	12
	Others	1	2
University	KU	4	8
	UoS	35	70
	SALU	4	8
	USMS	6	12
	GCU	1	2

9.2 Reliability of the Instrument

Cronbach's alpha, which assesses the internal consistency of the scale by assessing how well the questions are connected to each other and measuring the same idea, was used to evaluate the reliability of the survey questionnaire. This allowed for the assessment of the reliability of the questionnaire. According to Sekaran and Bougie, an alpha value that is larger than 0.7 is regarded to be acceptable, while values that are greater than 0.8 are considered to be good, and values that are greater than 0.9 are considered to be excellent. On the other hand, readings in the range of 0.6 are deemed to be inadequate. Therefore, a score that is closer to one suggests a higher degree of dependability. The findings of the pilot research include values that fall within the acceptable to excellent range, with a range of 0.795 to 0.961 for each variable.

Table 3-Reliability Test Results

Construct	**Item**	**Mean**	**Std. Deviation**	**Corrected Item Total Correlation >0.3**	**α if the Item Deleted (Current α= .960; Excellent)**
IOTS	IOTS1	4.8400	1.75383	.846	.954
	IOTS2	4.9000	1.83225	.869	.953
	IOTS3	4.9400	1.97339	.848	.954
	IOTS4	4.8400	1.82231	.809	.956
	IOTS5	4.9800	2.00499	.872	.953
	IOTS6	5.2000	1.79569	.892	.952
	IOTS7	4.9000	1.96136	.789	.958
	IOTS8	4.8800	1.79159	.849	.954
PI	PI1	4.7000	1.85439	.742	.603
	PI2	4.1600	1.68256	.441	.905
	PI3	4.7600	1.86875	.762	.578
T	T1	4.4800	1.99223	.843	.954
	T2	4.7600	1.89047	.889	.948
	T3	5.0400	1.84014	.864	.951
	T4	4.9600	1.85120	.911	.946
	T5	4.6400	1.69946	.828	.955
	T6	4.3800	1.88322	.882	.949
PE	PE1	5.2200	1.91972	.892	.940
	PE2	5.2200	1.88755	.914	.933
	PE3	5.2200	1.96178	.860	.950
	PE4	5.2800	1.78474	.895	.940
EE	EE1	5.2800	1.72662	.829	.918
	EE2	5.0600	1.81164	.831	.916
	EE3	5.1800	2.03731	.875	.903
	EE4	5.2400	1.93317	.843	.912

SI	SI1	5.0800	1.84988	.851	.867
	SI2	4.8600	1.69043	.860	.863
	SI3	4.9400	1.87801	.795	.914
FC	FC1	4.5000	1.89790	.743	.779
	FC2	4.9600	1.57739	.825	.755
	FC3	4.8600	1.85175	.760	.771
	FC4	5.0000	1.84842	.455	.901
HM	HM1	4.9600	2.01990	.819	.940
	HM2	4.9800	2.03530	.939	.901
	HM3	5.2400	1.83570	.901	.915
	HM4	5.3200	1.92131	.804	.944
PV	PV1	3.8200	1.75767	.583	.828
	PV2	4.2600	1.80487	.751	.658
	PV3	4.0800	1.83881	.674	.740
BI	BI1	5.0800	1.98813	.928	.933
	BI2	5.0600	1.96303	.957	.913
	BI3	5.0400	2.04001	.866	.980
UB	UB1	4.9000	2.09226	.872	.906
	UB2	4.8800	2.06664	.872	.905
	UB3	5.2400	1.87964	.868	.911

Therefore, it is essential to note that a score closer to one indicates a higher degree of dependability in the context of Cronbach's Alpha. In the pilot research, despite some values falling below the threshold, the overall range for each variable remains within the acceptable to excellent range, specifically ranging from 0.795 to 0.961. Given the limited sample size of fifty participants in this pilot study, these values, albeit below the threshold, are not dismissed outright. This cautious approach is justified by the recognition that in larger-scale studies, the reliability scores may exhibit improvement. It is noteworthy that the results, even with certain values below the threshold, still meet acceptable standards when employing Cronbach's Alpha if Item Deleted analysis. This underscores the need for prudence in the interpretation of reliability scores in the pilot phase, acknowledging the potential for refinement and strengthening in subsequent full-scale studies.

9.3 Factor analysis (EFA) of Constructs

It is vital to test the dependability of the instrument using Cronbach's in order to ensure the reliability of the measurements and remove any errors that may occur during the process of purification. In addition, an exploratory factor analysis, also known as an EFA, was conducted to verify that the results are consistent with the scale that was chosen for this particular research. As a consequence of the EFA, it was discovered that the Kaiser-Mayer-Olkin (KMO) statistic, which evaluates sampling adequacy, was more than the suggested minimum value of 0.60 for the majority of the constructs[62]. This was the case even though the minimum value was set at 0.60. In addition, the statistical significance of Bartlett's test of sphericity for all constructs suggested that the correlation among the measuring items was more than 0.3, which demonstrated that EFA was an appropriate method for analysis since it showed that EFA was a good approach.

Table 4- EFA Results

Construct	**No. of Items**	**KMO >0.6**	**Bartlett's Test Sphericity < 0.05**
IOTS	8	.883	0.000
PI	3	.608	0.000
T	6	.904	0.000
PE	4	.860	0.000
EE	4	.781	0.000
SI	3	.749	0.000
FC	4	.793	0.000
HM	4	.781	0.000
PV	3	.675	0.000
BI	3	.715	0.000
UB	3	.771	0.000

9.4 **Communalities**

To identify the common variance among a set of variables, communalities were used. In the EFA model, the communalities between the measured items varied from .604 for FC4 item to .921 for BI2 items[63].

Table 5- Communalities Test Results

Communalities								
	Initial	**Extraction**		**Initial**	**Extraction**		**Initial**	**Extraction**
IOTS1		.819	PE1		.874	HM2		.912
IOTS2		.844	PE2		.808	HM3		.819
IOTS3		.905	PE3		.779	HM4		.811
IOTS4		.826	PE4		.813	PV1		.681
IOTS5		.789	EE1		.782	PV2		.821
IOTS6		.821	EE2		.802	PV3	1.000	.747
IOTS7		.659	EE3		.835	BI1		.941
IOTS8		.796	EE4		.879	BI2		.921
PI1	1.000	.767	SI1	1.000	.877	BI3		.816
PI2		.757	SI2		.805	UB1		.834
PI3		.685	SI3		.774	UB2		.835
T1		.793	FC1		.676	UB3		.879
T2		.866	FC2		.848			
T3		.837	FC3		.749			
T4		.891	FC4		.604			
T5		.855	HM1		.841			
T6		.845	PE1		.874			

10. Discussion

Sekaran[40] emphasizes the importance of conducting a pilot study before the main data collection phase in the questionnaire survey design. The main aim of this step is to validate the instrument and ensure that the survey questionnaire is free from errors and ambiguities. The pilot study serves to identify any potential issues that may cause confusion or misinterpretations among participants and to detect and correct any errors or ambiguities present in the survey questionnaire. During the pilot study, a total of 60 questionnaires were distributed to students from the four targeted universities. Despite several follow-ups, only 50 completed questionnaires were returned, resulting in a response rate of 83%. The pilot survey lasted for eight weeks, and basic statistical analysis was conducted using SPSS 22. The findings of the pilot research for the second part of the questionnaire, which pertains to assessing IoT in universities, found that accessible resources are scarce (46.0%), with smartphones being the only resource available to 98.0% of respondents. Even though the majority of respondents are mediocre users, they utilize IoT for all of their learning tasks, including teaching and research. In addition, 56.0% of respondents said they needed training to improve their IoT abilities. Following the completion of all of the measures performed in the pilot research to assess instrument reliability, the overall reliability findings were positive. This implies that the research framework and its instrument are appropriate for large-scale research.

11. Conclusion

In order to construct a conceptual framework for Internet of Things (IoT) acceptance among students at Sindh institutions in Pakistan, this research analyzed and studied the elements determining students' preparedness to embrace IoT. This research investigates the ways in which students see and comprehend the Internet of Things, as well as the ways in which they may be more aware of the acceptability of IoT. When seen from this angle, the suggested framework functions for the students as both a motivator and a compass. Within the context of this framework, these statements take into consideration all of the potential factors that may have an effect on the learning aptitude and attitude of students. This investigation will, in general, help to improve educational systems in developing nations and will make a contribution to the area of information systems, particularly for the benefit of students in Pakistan. The current phase of our research is centered on the pilot study, where our primary focus is on validating the research instrument. While the paper acknowledges the broader challenges associated with IoT implementation in Pakistani universities, a dedicated section for an in-depth discussion on these challenges is planned for the subsequent full-scale survey, which constitutes the next phase of our study.

The rationale behind deferring the comprehensive discussion on challenges is to ensure that our exploration is grounded in empirical data specific to the context of Sindh, Pakistan. By addressing challenges based on real-time data obtained from the full-scale survey, we aim to provide a more accurate and context-specific understanding of the obstacles faced in IoT implementation in Pakistani universities. This strategic approach aligns with best research practices, ensuring that our analysis and recommendations are informed by the actual experiences and perceptions of stakeholders. It emphasizes a thorough examination of challenges within the local context, enhancing the practical relevance and impact of our study. In essence, the forthcoming full-scale survey represents the avenue through which we plan to delve deeper into the challenges associated with IoT implementation in Pakistani universities, allowing us to provide more nuanced insights and targeted solutions based on empirical evidence.

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