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Investigating The Content Validity of An Iot-Acceptance Survey Instrument in Higher Education: A Study in The Context of Sindh, Pakistan

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Abstract

In the realm of educational research, this study embarks on a pivotal exploration into the acceptance of the Internet of Things (IoT) by students in their learning environment. Recognizing the indispensable role of content validity in ensuring the robustness of measurement tools, particularly in the context of questionnaire development, this research meticulously employed a systematic approach guided by evidence and best practices. Drawing inspiration from the Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2) model, our aim was to bridge a critical gap in the existing body of knowledge. IoT, a cornerstone in Higher Education Institutes (HEIs), prompted the development of a sophisticated educational acceptance instrument. However, prior to embarking on the pilot study phase, our focus turned to the intricate process of content validation. Six esteemed experts were judiciously selected to form our expert panel, each bringing a wealth of experience and knowledge to the evaluation. Employing the Expert Panel Rating Chart (EPRC), their invaluable insights were systematically incorporated, utilizing both item-level Content Validity Index (I-CVI) and scale-level CVI (S-CVI). The outcomes not only met but exceeded the established thresholds of acceptability, affirming the content validity of our instrument. The significance of this meticulous content validation process cannot be overstated. It serves as the bedrock upon which the reliability and validity of our educational acceptance instrument rest. As latent variables and study items underwent meticulous scrutiny and refinement, the resultant instrument emerged as a beacon of precision, ready to navigate the uncharted waters of assessing students' acceptance levels of IoT in their academic journey. In essence, this research underscores the paramount importance of content validity in the development of assessment tools, offering a methodologically robust approach anchored in evidence and best practices. The validated UTAUT2-based acceptance instrument now stands poised to contribute significantly to future studies, unraveling the intricate dynamics of IoT acceptance and its applications in the realm of university education.

Keywords Internet of Things, , Content Validity Ratio CVR, Content Validity Index (CVI), Smart

INTRODUCTION

The internet has become an indispensable facet of our daily existence, continuously evolving and gaining prominence due to its pivotal role in facilitating cutting-edge

technologies(Mircea et al., 2021). Originating as the internet of computers, it initially served as a global network connecting computing devices and enabling services like the Worldwide (Wang, 2010). Over time, this paradigm has metamorphosed into the internet of people, with a growing number of individuals actively contributing to and accessing information, thereby giving rise to the social web(Fernández-Batanero et al., 2023).
In the backdrop of swift technological progress, the internet's scope has burgeoned. Affordable broadband internet access has proliferated, and various technology firms are diligently working towards extending high-speed internet coverage to every corner of the globe. Concurrently, our devices are being endowed with sophisticated sensors that empower them to connect to the internet, enabling functionalities such as sensing, computation, and action. Additionally, commonplace objects are now embedded with tags, detectable by these smart devices. This amalgamation of elements heralds the era of the IoT, connecting everyday objects through a network facilitated by sensors on smart devices(Gopalakrishnan, 2009). In 1999, Kevin Ashton introduced the term "Internet of Things" (IoT) for the first time. Ashton conceptualized the "Internet of Things" as a paradigm where pervasive devices establish a seamless connection between the tangible world and the Internet(Madakam et al., 2015) (Abdel-Basset et al., 2019).

The term "Internet of Things" (IoT) encompasses a diverse array of interconnected objects that communicate through the Internet, transcending temporal and spatial boundaries for seamless information exchange and service delivery(Mohamed & Lamia, 2018). Positioned at the forefront of contemporary internet services, the IoT represents a transformative era, fostering global connectivity among physical components(Hong-tan et al., 2021). At its core, IoT facilitates communication between objects, offering heightened control and enhanced operational efficiency. Its pervasive influence extends across varied domains, leaving a profound impact on agriculture, healthcare, transportation, urban landscapes, and corporate environments(Al-Emran et al., 2020),(Zhu et al., 2020).

The digital transformation brought about by the IoT in the realm of university education has profoundly reshaped learning environments. This innovation enables students to engage with tangible equipment, sensors, and controls via the internet, presenting a paradigm shift in educational institutions. The application of IoT in education is delineated across four key domains, as delineated in recent initiatives: energy conservation and real-time environmental monitoring, healthcare surveillance, institutes access security, and the augmentation of teaching and learning experiences(Wang, 2022),(Mylonas et al., 2019). Smart cities leverage technology to enhance the overall well-being of their residents. Within the realm of smart cities, a particular focus is directed toward education, and the term "smart education" is employed to describe the educational initiatives within these urban environments. Therefore, it is acknowledged that the attainment of "smartness" by cities is intricately tied to innovation, education, knowledge, and continuous learning, as underscored by(Molnar, 2021). The integration of the IoT into universities in Sindh, Pakistan, stems from the concept of HEC Islamabad Smart Campuses. This involves harmonizing the existing infrastructure with IoT technologies within Higher Education Institutions to enhance academic processes. Pakistan has notably embraced Information and Communication

Technology (ICT) in its universities, evident in various projects such as well-equipped computer laboratories, internet access, multimedia classrooms, and digital library facilities. Despite the decade-long utilization of remote learning methods like m-learning, p-learning, and e-learning, the latest approach incorporating intelligent-based systems, known as IoT, has yet to be fully implemented in Pakistani universities. In contrast, the industrialized world has already adopted and is reaping substantial benefits from IoT integration. Pakistan, recognizing the significant potential of IoT in education, acknowledges its value. Consequently, this research seeks to explore the potential applications, challenges, and advantages of implementing IoT in the educational landscape.

When crafting a new scale, researchers adhere to meticulous scale development protocols designed to extract comprehensive insights into the scale's reliability and validity. Emphasis is placed on obtaining substantial information regarding the content validity of the measure, a critical factor for drawing inferences about the scale's excellence. The assessment of criterion-related and construct validity holds particular significance for a newly devised survey instrument. In the context of content validity, it is defined as ensuring that the instrument possesses a suitable array of items aligning with the construct it seeks to measure(Jamali et al., 2023). This definition highlights the significance of aligning the content of the instrument with the meant construct, thereby reinforcing the instrument's efficacy and relevance.

In addition, scholarly discourse aligns with the perspective that content validity is inherently grounded in judgment, unfolding in two distinct yet interconnected phases. Initially, the a priori stage demands meticulous efforts from the scale developer, involving strategic conceptualization and area analysis before the actual crafting of individual items commences. The ensuing a posteriori stage pivots towards evaluating the pertinence of the scale's fundamental content, with a focus on expert assessments. This essay primarily directs its attention to the nuanced intricacies of this latter phase. Over the past two decades, a proliferation of robust assessment scales has emerged, dedicated to prognosticating the acceptability of users towards the IoT. Despite the multitude of methods available for appraising technological acceptance, a significant number languish in underutilization, and their correlation with real-world system usage remains elusive. This essay seeks to illuminate the second phase of the content validity assessment process, delving into the innovative methods deployed to forecast user acceptability of IoT. It grapples with the existing gaps and underexplored avenues within the current academic discourse, humanizing the exploration of these critical dimensions.

In a groundbreaking leap in 1989, Davis ushered in a new era by conceptualizing and validating pioneering scales for two critical variables: PU and PEOU. These variables, identified as key contributing factor of user endorsement, became pivotal in shaping the landscape of user acceptance. Davis meticulously outlined the intricacies involved in crafting scale items, subjecting them to rigorous pretesting for content validity, and subsequently validating their reliability and construct validity(Davis, Bagozzi, 1989). The transformative potential of digital technology hinges on the profound engagement of end users; without this engagement, the promise of fundamental performance improvement remains elusive. Unveiling the nuances of why students embrace or resist computers assumes paramount significance, offering invaluable insights for refining user acceptability, predictive modeling, and comprehensive understanding. Davis posits that predicting students' intentions and their inclination to adopt novel technologies can be decoded by scrutinizing their actions, subjective norms, perceived utility, and associated variables. This perspective not only sheds light on the intricate dynamics of technology adoption but also underscores the profoundly human dimensions influencing the acceptance of technology within the academic realm.

In the realm of literature, the validation process is often portrayed as a series of meticulously designed procedures aimed at assessing the accuracy of a measurement tool employed to capture the nuances of the ideas under scrutiny. An effective measuring instrument, crucial for instrument development, should possess the ability to precisely and systematically gauge the content it aims to measure. The validation process in research holds paramount importance, serving as the litmus test for whether an instrument can effectively fulfill the objectives of the study. This validation journey is marked by a focused and specific drive toward a particular cluster of respondents. The landscape of validities encompasses four essential types: content, construct, face, and criterion-related validity. Emphasizing its pivotal role as a prerequisite for other validities, content validity took precedence during the instrument construction phase. The refinement of the instrument was guided by insights from an expert panel, coupled with meticulous attention to the representation and clarity of related items in the specific domain.

Within the context of this study, we adopted the most widely recognized methods for evaluating content validity—utilizing both the CVI and CVR methods. These approaches provided a robust framework for scrutinizing the instrument's effectiveness in capturing the essence of the subject matter. In this way the validation process serves as the backbone of credible research, ensuring the precision and relevance of the measurement tool. Through a strategic focus on content validity and the meticulous application of recognized evaluation methods, this study aimed not only to construct an instrument aligned with the objectives but also to elevate the standards of validity within the research domain.

SCOPE OF THE STUDY

This study endeavors to assess and justify a survey instrument tailored to evaluate the content validity concerning the Acceptance of the Internet of Things (IoT) in the academic settings of the Universities of Sindh. The evaluation process is conducted through the robust methods of CVR and CVI, aiming to ensure the precision and relevance of the instrument in capturing the intricacies of IoT acceptance within the unique educational landscape of Sindh.

CONTEXT OF THE STUDY

In August 2023, the Pakistan Bureau of Statistics (PBS) shared exciting news about the country's first-ever digital census. This milestone revealed that Pakistan's population is a significant 241.49 million, showing a growth rate of 2.55% (Statistics, 2023). According to the United Nations' World Population by Country 2023 (Live), Pakistan is now the fifth most populous country globally, the fourth in Asia, and the second in South Asia. Additionally, Pakistan proudly holds the title of being the second-largest Muslim country(Nation, 2023). This insightful data, gathered through the careful digital census, highlights Pakistan's demographic importance on both a regional and global scale. The accuracy of this information, made possible by modern technology, represents a crucial step forward in how we conduct censuses. This not only gives us a clearer understanding of our population but also provides a solid foundation for making well-informed policies and planning for our society's future. Pakistan is intricately divided into four provinces: Sindh, Punjab, Balochistan, and Khyber Pakhtunkhwa, each contributing distinctive hues to the rich cultural canvas of the nation.

Additionally, the administrative regions of Azad Kashmir and Gilgit-Baltistan add unique dimensions with their individual features and characteristics(Pakistan, 2023). Significantly, Sindh commands attention as the second-largest province, harboring an approximate populace of 55.69 million(Statistics, 2023). This demographic panorama and regional heterogeneity illuminate the opulent tapestry of the nation, intertwining a plethora of cultural, historical, and geographical elements in a harmonious symphony. The educational landscape at the tertiary level within the nation underwent a noteworthy metamorphosis following the implementation of the 18th constitutional amendments, orchestrated by the national assembly or Parliament (List, 2010). This transformative shift vested provinces with the authority to establish dedicated higher education commissions, charged with the comprehensive oversight of matters pertaining to universities. Particularly noteworthy is the ascendancy of the Sindh Higher Education Commission (SHEC) as a linchpin, assuming pivotal responsibilities in the allocation of funds and vigilant monitoring of educational institutions within the province.

However, it is imperative to underscore that certain pivotal domain, such as the accreditation of degree programs, continue to fall under the purview of the Higher Education Commission (HEC) situated in Islamabad (18th Act 2010)(List, 2010). This central regulatory entity remains instrumental in financial allocation and surveillance of institutions until the provincial HEC attains full operational capability. Acknowledging the authoritative role of universities within provincial governance, this research endeavors to delve into the acceptance and utilization of IoT in universities within the province of Sindh, Pakistan. Sindh boasts 27 public institutions, duly chartered by the provincial government, predominantly comprising universities. These educational entities are strategically positioned across the province, facilitating admissions from all districts, adhering meticulously to both quota and general merit criteria. The present research endeavors to unravel the intricate dynamics surrounding the adoption of the IoT within Sindh's distinctive higher education landscape. Through a nuanced exploration, this study aims to illuminate the profound implications and potential contributions of IoT in reshaping the educational milieu of the region(SHEC, 2023).

The following are the important points for selecting Pakistan for this research.

- The Internet of Things (IoT) is poised to exert a profound influence on the economy, ushering in a digital transformation for numerous enterprises and fostering innovative business models. This transition holds the promise of enhancing operational efficiency while bolstering engagement with both employees and customers. However, the journey toward realizing these benefits is multifaceted, and in certain instances, it may involve challenging adjustments. A significant impediment to widespread IoT adoption lies in the fact that many enterprises grapple with the intricacies of incorporating this technology into their frameworks. Even for those with IoT plans, there looms uncertainty regarding who will spearhead these initiatives. This apparent void presents a distinctive opportunity for Chief Information Officers (CIOs) and IT leaders to step into leadership roles and guide organizations through the uncharted terrain of IoT implementation (Hung & President, 2017).

- The Government of Pakistan, in collaboration with the Higher Education Commission (HEC), has launched the Vision 2025 Smart Universities program, marking a significant stride towards integrating Smart University concepts nationwide. A key aspect of this initiative is the commendable effort to identify and nurture talent by distributing laptops to deserving students. This substantial allocation of half a million laptops underscores the dedication to empowering students across Pakistan (Taylor, 2017).
- In pursuit of the broader goal to transform universities into Smart Education hubs, the Higher Education Commission has strategically implemented comprehensive measures. A pivotal move involves the initiation of Smart Campuses, characterized by the extensive provision of PERN Wi-Fi connectivity and the distribution of Smart Bags. This forward-thinking initiative sets the stage for the logical progression into Smart Classrooms, a transformative step that promises to redefine the educational landscape in every institution is described in Figure 1.(HEC, 2017)

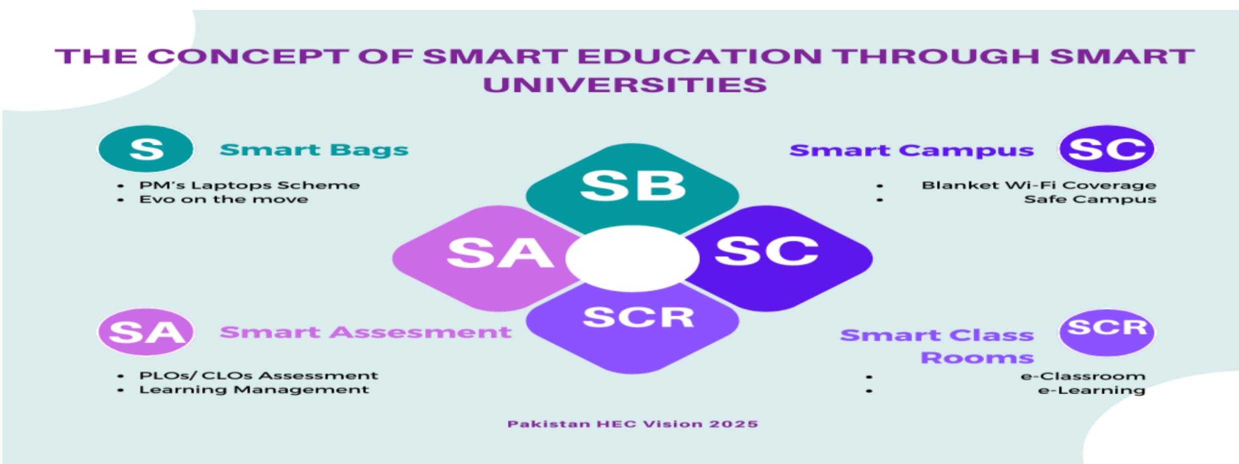

Figure 1.
Pakistan Vision 2025

- The cultural milieu in Pakistan stands distinct from that of more developed nations where the roots of technology acceptance theories originated. This distinctiveness prompts the necessity for a dedicated examination within the contextual framework of Pakistan. An exploration into the unique cultural dynamics of the country becomes imperative to comprehend and tailor technology acceptance theories appropriately. This nuanced investigation seeks to unveil the intricacies of technology adoption within the specific socio-cultural fabric of Pakistan, contributing to a more comprehensive understanding of technology acceptance in diverse global contexts.

Considering the outlined information this research endeavors to comprehensively evaluate the extent of IoT acceptance within universities across the province of Sindh. It specifically focuses on identifying the key factors influencing students' acceptance and utilization of IoT technologies. By undertaking this study, we seek to unravel the intricacies of the prevalent IoT ecosystem in the academic sphere, shedding light on its overall acceptance, potential challenges, and the key determinants influencing students' engagement with this transformative technology.

METHODOLOGY

Ensuring our survey tools are clear and effective is crucial, as highlighted by Sekaran and Bougie (2013). The pretesting phase is a vital step to make sure respondents grasp the survey and identify any issues with wording or measurement. When researchers create new scales, they follow strict protocols to understand the scale's reliability and validity thoroughly. Assessing the content validity of a measure is crucial, focusing on the criterion-related and construct validity of a new survey. Content validity, meaning having the right set of items for the topic being measured, involves two stages. Initially, the scale designer endeavors to augment content validity through meticulous pre-item formulation planning. The second stage evaluates the relevance of the scale's basic content through expert evaluation. Davis's scales in 1989, specifically for perceived Usefulness (PU) and perceived ease of use (PEOU), are primary factors in user approval. Predicting students' intentions and their openness to accept new technologies involves looking at their actions, subjective norms, perceived utility, and associated variables, as explained by Davis. In the research validity process, crucial for checking the accuracy of a measurement tool, four types are considered: content, construct, face, and criterion-related validity. Content validity, given top consideration during instrument construction, is critical for achieving study objectives. Expert panels contribute valuable suggestions to enhance the survey, addressing concerns about representation and clarity. In this study, we employed widely accepted methods like the Expert Panel Rating Chart (EPRC), CVI, and CVR to assess the content validity of the survey instrument.

These careful steps in developing and validating the survey contribute to the overall reliability and strength of the research, ensuring that the survey accurately captures the ideas being assessed. To enhance the quality of survey-based research, researchers take a meticulous approach to identify and rectify any biases or issues within questionnaires before distributing them to respondents. Throughout various stages of this study, experts and specialists actively engaged in conducting a pre-test during the data collection phase. The assessment of the instrument's weaknesses was done using the CVI, a critical metric for ensuring the validity of the questionnaire. The pivotal role of experts in this context cannot be overstated, as their contributions encompassed clarifying, adding, completing, and modifying essential elements. For this study, the content validity of the questionnaire underwent a rigorous evaluation by a panel of experts, each possessing a doctoral degree and extensive experience in fields such as computer science, information systems, information technology, organizational behavior, or technology management, coupled with a deep understanding of technology adoption. Specialists played a crucial role in defining, elaborating on, incorporating, augmenting, and modifying the necessary elements, ensuring a comprehensive and nuanced evaluation. The content validation process included a thorough examination of the 11 domains and 53 items. The assessment was conducted by a panel of nine experts and professionals, with representatives from both Malaysia and Pakistan, ensuring a diverse perspective. The evaluation criteria were clear, and the items were systematically listed. To measure the relevance of each item, experts were requested to provide ratings, contributing to a comprehensive understanding of the content's validity. This robust and inclusive approach to content validation underscores the commitment to methodological rigor and the credibility of the research findings.

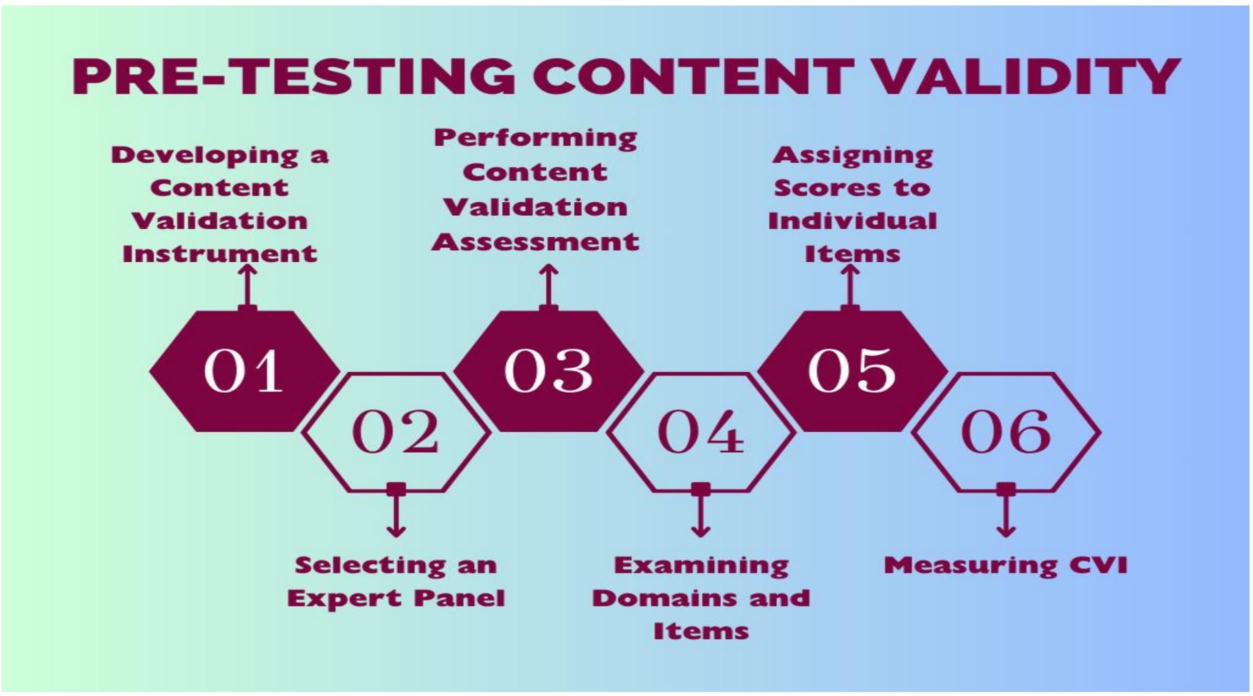

Figure 2.
Methodology for Content Validity

Step 1: Developing a content validation Instrument

In the beginning stages of content validation, a crucial task unfolds—carefully crafting the content validation form. This step is pivotal, setting the foundation for our esteemed panel of experts, ensuring they embark on their assessment with clear expectations and a deep comprehension of their assigned task. Picture this initial phase through the lens of Figure 3, a practical illustration showcasing sample instructions and a rating scale thoughtfully designed to guide our experts in their evaluation. The tailored rating scale, fine-tuned for gauging relevance, becomes the tool of choice for scoring individual items, as vividly portrayed in Figure 4. Elevating the scoring process further, we advocate for providing our experts with concise definitions of each domain. This thoughtful addition aims to empower our experts, fostering a more accurate and cohesive evaluation of the content at hand.

QUESTIONNAIRE

CONTENT VALIDITY FORM

Dear Expert,

As a Ph.D. scholar, I'm delving into a research project titled 'A Model for Acceptance of the Internet of Things (IoT) at the Universities of Sindh, Pakistan.' The survey I've crafted involves 12 key domains and comprises 51 items or statements directly related to my research focus. I am reaching out to you for your expert opinion on the relevance and clarity of each item within the specified domains. Your insights, measured through the provided rating scales, are crucial for ensuring the validity of the content. I greatly value your expertise and appreciate your assistance in contributing to the success of this study.

Degree of agreement:

1: The item doesn't really fit the research.

2: The item is somewhat related to the research.

3: The item fits quite well with the research.

4: The item is a perfect fit for the research.

Thanks for your contribution.

Anees Muhammad Jamali
Ph.D. Scholar (Computer Science)
Institute of Mathematics & Computer Science (IMCS)
University of Sindh Jamshoro.
Email: anees.cie@gmail.com

CONSENT:

By selecting the Agree option below, I agree to participate in this study. I also affirm that I am at least 18 years of age.

☐ Agree ☐ Disagree

1

Figure 3.
CV Form

Human attitude measurement variables:

You must choose your degree of agreement with the statements connected to each variable. A 4-point ordinal scale is used to measure it for this purpose. Please rate your level of agreement/disagreement with the following statements on a scale of 1 to 4.

You need to encircle the number like 1 2 3 ④.

1. PERFORMANCE EXPECTANCY					
	STATEMENT	**Degree of Agreement**			
1	I find IoT Devices useful in my daily life.	1	2	3	4
2	Using IoT Devices increases my chances of achieving things that are important to me.	1	2	3	4
3	Using IoT Devices helps me accomplish things more quickly.	1	2	3	4
4	Using IoT Devices increases my productivity.	1	2	3	4
2. EFFORT EXPECTANCY					
	STATEMENT	**Degree of Agreement**			
5	Learning how to use IoT Devices is easy for me.	1	2	3	4
6	My interaction with IoT Devices is clear and understandable.	1	2	3	4

Figure 4.
CV Form Scale

Step 2: Selecting an Expert Panel

When selecting individuals to assess and provide insights on an assessment tool, such as a questionnaire, the choice is typically guided by their expertise in the subject matter. Table 1 provides a clear overview of the recommended number of experts and its impact on defining the acceptable threshold score for CVI. It is generally acknowledged that, for content validation, a minimum of two experts is acceptable, with many recommendations suggesting a minimum of six. Considering these guidelines and drawing from the author's experience, the optimal number of experts for content validation should range between six and ten. In our research, we engaged six experts to ensure a comprehensive and well-informed evaluation.

Table 1.
Experts and their acceptable Threshold value

Expert Panel Size	Satisfactory CVI Threshold	Literature Trace
Experts=2	CVI ≥ 0.80	(Davis, 1992)
3≤ Experts ≤ 5	CVI=01.00	(Lynn M. R., 1986)
Experts≥6	CVI ≥ 0.78	(Denise F. Polit, Cheryl Tatano Beck, Owen, 2007)
6≤ Experts ≤ 8	CVI ≥ 0.83	(Denise F. Polit, Cheryl Tatano Beck, Owen, 2007)
Experts≥9	CVI ≥ 0.78	(Lynn M. R., 1986)

Step 3: performing content validation assessment

Content validation can be approached through two methods: the in-person method, involving a convened expert panel meeting where the researcher guides the validation process from Step 4 to Step 5, and the remote method, where experts receive an online validation form accompanied by clear instructions (depicted in Figure 2) to navigate through Steps 4 to 5. Critical considerations include cost, time, and response rate. Conducting face-to-face sessions may pose challenges in terms of cost and time due to the difficulty of gathering all foreign experts in one place. However, it ensures the highest response rate. On the contrary, the non-face-to-face method may face challenges in response rate and time, as there is a risk of delayed or no response from experts. Nevertheless, it offers significant cost savings. In the author's experience, the non-face-to-face approach proves efficient with a systematic follow-up plan to enhance response rate and time. Therefore, online settings are preferred for foreign experts, while a face-to-face approach is adopted for Pakistani experts, involving multiple visits to gather their valuable opinions.

Step 4: examining domains and items

Within the content validation form, as illustrated in Figure 4, the experts are presented with a comprehensive definition of the domain and its associated items. It is imperative for experts to conduct a thorough examination of both the domain and its items before assigning scores to individual items. Moreover, experts are actively encouraged to articulate their insights through either verbal or recorded statements, with the overarching goal of improving the relevance of items within the specified domain. Every comment contributed by the experts is meticulously considered in the iterative refinement process applied to both the domain and its constituent items.

Step 5: Assigning scores to individual items.

After thoroughly reviewing the domain and items, experts are kindly asked to independently assign a score to each item, utilizing the provided scale in Figures 3 and 4. Once they have comprehensively scored all items, experts are then requested to submit their responses to the researcher. This ensures a systematic and organized collection of expert evaluations for further analysis.

Step 6: Measuring CVI

Table 2.
Measuring CVI Formula

The CVI indices	Formula
I-CVI (item-level content validity index)	I-CVI = $\frac{\text{experts affirming the relevance of the item}}{\text{Total Experts}}$
S-CVI/Ave (scale-level CVI based on the average method)	S−CVI/Ave= $\frac{\Sigma(\text{I−CVI})}{\text{Total items}}$
S-CVI/UA (scale-level CVI based on the universal agreement method)	S-CVI/UA= $\frac{\Sigma(\text{UA})}{\text{Total items}}$

RESULTS AND DISCUSSION

An Analysis of CVI, the Scholars organized for six subject experts with substantial knowledge in their domain and having professional knowledge in the field to partake in this study. One of them selected Malaysia and other from Universities of Pakistan. All selected have more than 5 years of experience in research in core areas. The content-form distributed face to face and digitally.

Profile of Experts

Table 3.
List of Experts

Experts	Experience	Designation	Research Area	Affiliation
Exp 1	>22 years	Professor	Computer Science	University of Sindh
Exp 2	>15 years	Associate Professor	Computer Science / Information System	University of Sindh
Exp 3	>15 years	Associate Professor	Information System (IIUM Malaysia)	ILMA University
Exp 4	>15 years	Assistant Professor	Computer Science	USMS Bhitshah
Exp 5	> 6 years	Lecturer/PhD Scholar	Information Technology	UTAR Kampar Malaysia
Exp 6	> 6 years	Lecturer/PhD Scholar	Information Technology	University of Sindh

Table 4.
CVI Results

	Exp1	Exp2	Exp3	Exp4	Exp5	Exp6	Number of Expert Agreement	Item-CVI	CVR	UA
I find IoT Devices useful in my daily life.	A	A	A	D	A	A	5	0.83	0.83	0.00
Using IoT Devices increases my chances of achieving things that are important to me.	A	A	A	A	A	A	6	1.00	1.00	1.00
Using IoT Devices helps me accomplish things more quickly.	A	A	A	A	A	A	6	1.00	1.00	1.00
Using IoT Devices increases my productivity.	A	A	A	A	A	A	6	1.00	1.00	1.00
Learning how to use IoT Devices is easy for me.	A	A	A	A	A	A	6	1.00	1.00	1.00
My interaction with IoT Devices is clear and understandable.	A	A	A	A	A	A	6	1.00	1.00	1.00
I find IoT Devices easy to use.	A	D	A	A	A	A	5	0.83	0.83	0.00
It is easy for me to become skillful at using IoT Devices.	A	A	A	A	A	A	6	1.00	1.00	1.00

People who are important to me think that I should use IoT Devices.	D	A	A	A	A	A	5	0.83	0.83	0.00
People who influence my behavior think that I should use IoT Devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
People whose opinions that I value prefer that I use IoT Devices.	A	A	D	A	A	A	5	0.83	0.83	0.00
I have the resources necessary to use IoT Devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
I have the knowledge necessary to use IoT Devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
IoT Devices are compatible with other technologies I use.	A	A	A	A	A	A	6	1.00	1.00	1.00
I can get help from others when I have difficulties using IoT Devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
Using IoT Devices is fun.	A	A	A	A	A	A	6	1.00	1.00	1.00
Using IoT Devices is enjoyable.	D	A	A	A	A	A	5	0.83	0.83	0.00
Using IoT Devices is very entertaining.	A	A	A	A	A	A	6	1.00	1.00	1.00
I believe that using IoT Devices makes me feel more comfortable while learning.	A	A	D	A	A	A	5	0.83	0.83	0.00
IoT Devices are reasonably priced.	A	A	A	A	A	A	6	1.00	1.00	1.00
IoT Devices are a good value for the money.	A	A	A	A	A	A	6	1.00	1.00	1.00
At the current price, IoT Devices provide a good value.	A	A	D	A	A	A	5	0.83	0.83	0.00
To setup IoT devices for different users is easy for me.	A	A	A	A	A	A	6	1.00	1.00	1.00
To connect IoT devices to the network is easy for me.	A	A	A	A	A	A	6	1.00	1.00	1.00
I believe that the data collected from IoT devices is correct.	A	A	A	A	A	A	6	1.00	1.00	1.00
I can adjust the privacy settings of IoT devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
I know how to	A	D	A	A	A	A	5	0.83	0.83	0.00

achieve my learning goals with IoT devices.										
I can take action based on data from IoT devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
I can assess my progress with IoT devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
I know how to give different users access to my smart device.	D	D	D	A	A	A	3	0.50	0.50	0.00
I know how to display data from my smart device in an understandable way.	A	D	D	A	A	D	3	0.50	0.50	0.00
I know how to set up with whom I can share the collected data from a smart device	A	A	D	D	D	A	3	0.50	0.50	0.00
When I hear about new IoT Devices, I generally think about ways I could use and experiment.	A	A	A	A	A	A	6	1.00	1.00	1.00
Among my peers, I am usually the first to try out new IoT Devices.	A	A	A	A	A	A	6	1.00	1.00	1.00
I like to experiment with new assistive technology devices (IoT Devices)	A	A	D	A	A	A	5	0.83	0.83	0.00
IoT devices are trustworthy.	A	A	A	A	A	A	6	1.00	1.00	1.00
IoT device providers keep my best interests in mind.	A	A	A	A	A	A	6	1.00	1.00	1.00
IoT devices provide reliable information.	A	A	A	A	A	A	6	1.00	1.00	1.00
IoT device providers keep promises and commitments.	A	D	A	A	A	A	5	0.83	0.83	0.00
I feel assured that IoT device providers protect me from problems I may encounter.	A	A	A	A	A	A	6	1.00	1.00	1.00
IoT products and applications are trustworthy.	A	A	A	A	A	A	6	1.00	1.00	1.00
The use of IoT Devices has become a habit for me	A	A	A	A	D	D	4	0.67	0.67	0.00
I am addicted to using IoT Devices	A	D	A	D	A	A	4	0.67	0.67	0.00
I must use IoT Devices	A	D	D	A	A	A	4	0.67	0.67	0.00

Using IoT Devices has become natural to me.	A	D	A	D	D	A	3	0.50	0.50	0.00
I intend to continue using IoT devices in the future.	A	A	A	A	A	A	6	1.00	1.00	1.00
I will always try to use IoT devices in my daily life.	A	A	A	A	A	A	6	1.00	1.00	1.00
I plan to continue to use IoT devices frequently.	A	A	A	A	A	A	6	1.00	1.00	1.00
I use IoT devices for my academic work almost every day.	A	A	A	D	A	A	5	0.83	0.83	0.00
I spend at least about two to four hours a day using IoT devices for my academic work.	A	A	A	A	A	A	6	1.00	1.00	1.00
I always enjoy using IoT devices for my academic work.	A	A	D	A	A	A	5	0.83	0.83	0.00
						S-CVI/Ave				0.90
						S-CVI/UA				0.63
Proportion Relevant:	0.94	0.84	0.82	0.90	0.94	0.96	**Mean expert proportion**		0.90	

The composite content validity index (I-CVI) for each of the 12 domains consists of 51 items, ranging from 0.5 to 1. The scale-level content validity index/average (S-CVI/AVE) across all 12 domains is 0.90, indicating a high content validity for the items in the instrument development construct. The overall scale-level content validity index/universal agreement (S-CVI/UA) for the 51-item scale is 0.63, affirming the robust content validity of the items within the context of instrument development. Items with an item-level content validity index (I-CVI) below 0.78 are excluded, while those with an I-CVI between 0.80 and 1 are retained. Therefore, items with lower I-CVI values, reflecting disagreement among experts, have been omitted from the final research instrument. Specifically, the items "I know how to give different users access to my smart device," "I know how to display data from my smart device in an understandable way," and "I know how to set up with whom i can share the collected data from a smart device" from the IoT skills domain were excluded due to expert disagreements.

Similarly, items related to habits, such as "the use of IoT devices has become a habit for me," "I am addicted to using IoT devices," "I must use IoT devices," and "using IoT devices has become natural to me," from domain 10 (habit) have been excluded. This led to the removal of the habit domain from the research, as experts believe that the examination of habit factors is only relevant when IoT acceptance or availability at universities reaches a certain level, and students incorporate it into their daily routines. In summarizing the feedback from experts, it's clear that most items are deemed suitable, affirming the instrument's alignment with the study's context. Experts specifically focused on sentence structure and item repetition in their comments on the instrument. Importantly, no significant errors were noted, resulting in the final research instrument comprising 11 domains with a total of 44 items.

CONCLUSIONS

The primary objective of this study was to evaluate the content validity and appropriateness of an instrument designed to measure the acceptance of IoT in Sindh's universities. Following the validation process, only 7 items exhibited CVR values below the critical threshold. The results strongly support the instrument's suitability for assessing IoT acceptance in university settings within the Sindh region, highlighting its validity and functional appropriateness. Based on these initial findings, the researchers suggest that the instrument holds promise as a reliable tool for evaluating IoT acceptance in Sindh's universities. The use of the CVR method has empirically validated the instrument's accuracy through expert consensus. With this evidence, decisions about maintaining, improving, or refining instrument items can be confidently made after conducting CVR analysis. In summary, this study establishes that the constructed instrument for measuring IoT acceptance in Sindh's universities demonstrates high content validity and is well-suited for application in the field. However, it is crucial to note that the instrument is still in development and requires further examination, particularly through a pilot study, to assess its validity and reliability before integration into actual studies. Therefore, the logical next step in refining this instrument involves conducting a pilot test to scrutinize its reliability. It is recommended that all 11 domains and 44 items undergo refinement for a comprehensive pilot study, utilizing statistical analyses, including factor analysis, to delve deeper into item analysis.

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