Wardat and Akour
Smart Learning Environments (2024) 11:35
https://doi.org/10.1186/s40561-024-00323-8

Smart Learning Environments

RESEARCH Open Access

Adoption of smart watches as wearable technology in TESOL education among university students

Saja Wardat[1*] and Mohammed Akour[2]

*Correspondence:
saja.wardat@bau.edu.jo

[1] Department of English Language and Literature, Irbid University College, Al-Balqa Applied University, Irbid 1293, Jordan
[2] College of Computer and Information Sciences, Prince Sultan University, Riyadh, Saudi Arabia

Abstract

This research explores the key motivating factors that influence student engagement with wearable technology (WT) in teaching English to speakers of other languages (TESOL) education. The study employs a novel, integrated framework that merges elements from the established technology acceptance model (TAM), Flow Theory, and additional factors pivotal to WT's efficacy, namely content richness and personal innovativeness. TAM and Flow Theory are utilized to identify the variables that drive WT adoption. Data for the research was gathered through an online survey comprising 23 questions, distributed among students in the KSA, with a total of 468 participants. Analysis of the data was conducted using Smart PLS Software to evaluate the research model, constructs, and hypotheses. The findings reveal varying contributions of the model's main constructs to WT acceptance. Specifically, content richness and innovativeness significantly enhance the perceived usefulness of WT. Additionally, perceived ease of use is a strong predictor of perceived usefulness and behavioral intention. The results underscore a growing demand for WT in TESOL Education, highlighting its role in streamlining information exchange among students. The study underscores the significance of certain external factors in technology acceptance, offering a fresh perspective by incorporating a framework that links TAM's perceived usefulness and ease of use with user satisfaction, content richness, and innovativeness. Moreover, the inclusion of Flow Theory adds a unique dimension by assessing engagement and control over WT. The research contributes to understanding the underlying motivations for employing WT in TESOL Education, primarily aimed at enhancing the effectiveness of both instructors and students. A limitation of this study is its focused application of TAM and Flow Theory within a specific educational context, which may not fully capture the complex societal, psychological, and gender-specific factors influencing WT adoption across diverse settings.

Keywords: Engagement, Innovativeness, Motivation, TESOL education, Wearable technology

Introduction

The Internet of Things (IoT) has been a transformative force in the technological landscape, leading to the widespread adoption of interconnected devices that offer information accessibility anywhere and anytime (Sharma et al., 2019). Among these innovations,

Wearable Technology (WT), such as smartwatches and other devices, has emerged as a significant component of IoT. The ubiquity of WT has facilitated instant access to an array of data, ranging from healthcare information to physical activity tracking (Niknejad et al., 2020). The market for such devices, especially smartwatches, has seen a substantial surge, with sales figures escalating steadily over time (Lyons, 2015).

The allure of smartwatches and similar wearable devices lies in their multifaceted features that cater to modern-day needs. These devices have evolved beyond their initial timekeeping functions to become holistic lifestyle companions. Key functionalities that have spurred their adoption include seamless integration with smartphones, enabling users to access a wide range of phone features on their wrists. Users receive timely notifications, manage their schedules, and monitor their health metrics, all through their wearable devices. Moreover, the aesthetic aspect, such as customizable watch faces, adds to the personalization and attractiveness of these technologies. Smartwatches have proven to do different educational tasks including scheduling and time management, facilitating quick access to educational resources, enabling real-time communication and collaboration, providing instant notifications for updates and reminders, tracking and analyzing learning progress, and supporting immersive and interactive learning experiences through apps and multimedia content.

In this thought-provoking illustration (Fig. 1), we observe a dynamic and technologically enriched educational setting where university students are deeply immersed in a TESOL lesson, facilitated by an array of WT. The image captures students equipped with

Fig. 1 Students in a tech-enhanced TESOL class (generated (*Openart AI*, 2024))

advanced gadgets such as smart glasses, smartwatches, and VR headsets, each device seemingly tailored to augment their language learning experience. Notably, the classroom atmosphere is depicted as modern and interactive, with digital screens displaying a variety of language learning applications and engaging activities. This visual narrative eloquently articulates the potential of WT to revolutionize language education, offering a glimpse into a future where learning is not only interactive and personalized but also seamlessly integrated into the fabric of student life. The incorporation of these innovative tools in TESOL education signifies a transformative step towards a more immersive and tech-driven approach to language learning, reflecting a broader trend in educational paradigms that prioritize digital fluency and interactive learning experiences.

The drive to innovate and introduce education-specific functionalities has spurred researchers to delve deeper into this domain. The primary contributions of this research are multifaceted and significant. Firstly, it explores both the direct and indirect precursors to the adoption of WT, employing a comprehensive and novel research framework. This framework not only enhances our comprehension of the factors influencing WT adoption but also integrates the technology acceptance model (TAM) (Davis, 1989), the diffusion of innovation (DOI) theory (Rogers, 1995), and flow theory (Csikszentmihalyi, 1988), ensuring the robustness and predictive power of the findings.

Secondly, the core focus of this study is on assessing the effectiveness of WT integration in the educational sector, an area that holds immense potential for both educators and students, particularly in the context of TESOL Education. The adoption of WT extends beyond individual preferences, influencing the communal use and facilitating the exchange of information within specific social networks of teachers and learners. This aspect underscores the collective dynamics of technology adoption and the dissemination of attitudes and practices within educational communities.

Thirdly, this research distinguishes itself by incorporating specific external variables pertinent to WT's relevance in education, moving beyond the conventional emphasis on availability and mobility seen in prior studies (Jeong et al., 2017; Kim & Shin, 2015b). It introduces novel dimensions such as innovation, content richness, and the degree of satisfaction as central external factors of WT. This approach not only sets this study apart from previous research but also addresses a significant gap in the literature by providing a holistic and integrated model to understand WT acceptance in an educational setting. To our knowledge, this constitutes a pioneering effort to quantify WT acceptance in education, marking a notable advancement in the field.

Literature review

The exploration of WT adoption has garnered considerable attention from researchers globally, with particular focus in countries like UAE, Oman, KSA, China, France, Thailand, and Taiwan where surveys have become a prevalent method for data collection among participants. Notably, the divergence in these studies often stems from the selection of external factors considered. For instance, research conducted by Hsu et al. (2022) in Taiwan emphasizes self-efficacy and behavioral intention as key factors, contrasting with the work of Alfaisal et al. (2022) in UAE, which delves into the novelty and social influence of Google Glass.

In Kim and Shin (2015a) have identified affective quality, relative advantage, mobility, availability, and subcultural appeal as pivotal factors driving WT adoption. Moreover, (Woodside & Reinbold, 2018) explored the determinants influencing the utilization of WT by devising an explanatory framework. They not only pinpointed the key factors driving WT usage but also formulated a set of guidelines and optimal practices for integrating WT effectively within educational settings. Echoing this perspective, (Adapa et al., 2018) investigates both the inhibiting and contributing factors that shape attitudes towards the use of WT. This study aims to understand the complex dynamics that influence how individuals perceive and engage with WT, by examining the elements that both encourage and discourage its adoption.

Recent trends indicate a growing impact of smartwatches on user behavior across different regions in Africa. An international study by Uzir et al. (2023) concentrated on exploring the intentions to use and purchase, as well as satisfaction levels and the likelihood of spreading positive word-of-mouth recommendations among Ghanaian participants. Table 1 summarizes a few studies on Wearable Technology Adoption/Acceptance in Education.

Research outlined in Yanamandra (2024) expands the examination of wearable devices, delving into their general understanding as well as their specific utility within the educational sector. It accentuates the devices' applications, advantages, motivational elements, and obstacles to user adoption. The goal is to craft an integrated framework that facilitates the effective application of these devices in educational settings, aiming for positive outcomes. Through a systematic review of the literature, the study constructs a comprehensive framework that positions WT as a pivotal tool in the educational domain, offering insights into its potential to enhance learning experiences and operational efficiencies.

From the synthesized data, it's evident that the majority of research on WT adoption consistently utilizes questionnaires as the primary instrument, with the TAM frequently forming a foundational part of the investigative framework (Choe & Noh, 2018; Hong et al., 2017; Kim, 2016). This trend underscores TAM's robustness in assessing

Table 1 Studies on wearable technology adoption/acceptance in education

Author(s)	Technology	Country	Model	Method	Samples
Al-Maroof et al. (2020)	Google glass	UAE, Oman, and KSA	TAM	Questionnaire	University students (*n* = *968*)
Dutot et al. (2019)	Smartwatch	China, France, and Thailand	TAM	Online-Survey	University students (*n* = *446*)
Hidayanto and Samik-Ibrahim (2021)	Smartwatch	Indonesians	UTAUT, TAM & TPB	Online-Survey	University students (*n* = *215*)
Kao et al. (2019)	Fitness trackers	Taiwan	TAM	Questionnaire	University students (*n* = *226*)
Alfaisal et al. (2022)	Google glass	UAE	TAM	Questionnaire	University students (*n* = *528*)
El-Masri et al. (2023)	Smartwatch	Qatar	Task-Technology-Identity-Fit	Questionnaire	University students (*n* = *248*)
Hsu et al. (2022)	Wearable virtual reality language-learning platform	Taiwan	TAM	Questionnaire	University students (*n* = *131*)

technology adoption behaviors. However, a notable deviation is observed in the research conducted by Kranthi & Ahmed (2018), which integrates the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) as a comprehensive extension to the traditional model. In these studies, TAM influences WT adoption through two primary pathways. The first pathway centers on the perceived usefulness of the technology, a variable that can be significantly swayed by a range of extended factors. The second pathway focuses on the perceived ease of use, a critical determinant often linked with attributes like fashion and innovativeness. These external factors are instrumental in shaping the adoption landscape of smartwatches, as they directly impact user attitudes and acceptance levels.

This research addresses a significant gap in understanding the factors that drive student engagement with WT in TESOL Education, providing a comprehensive analysis of its acceptance and effectiveness. While existing studies have acknowledged the potential of WT in enhancing educational experiences, this study introduces a novel, integrative approach by combining the established TAM and Flow Theory with crucial variables like content richness and personal innovativeness. These elements are rarely examined collectively, thus offering a unique contribution to the field. The research's use of a robust methodological framework, involving an extensive survey and advanced analytical tools like Smart PLS Software, allows for a nuanced understanding of how various constructs influence the adoption of WT. The findings not only highlight the distinct roles of content richness and innovativeness in enriching the user's perceived usefulness of WT but also reaffirm the central tenets of TAM in the context of WT. Moreover, by integrating Flow Theory, the study sheds light on the psychological aspects of technology usage, emphasizing the importance of user engagement and control. This comprehensive approach marks a significant advancement in the research on WT in education, providing valuable insights for educators, policymakers, and technologists aiming to foster a more engaging and effective learning environment.

Development of the adopted model and hypotheses

Content richness

Content richness encompasses three pivotal dimensions that characterize the quality of learning resources: relevance, timeliness, and adequacy (Jung et al., 2009). Among these, 'sufficiency' pertains to the diversity and volume of information made accessible to users. Conversely, 'timeliness' or 'currentness' measures the degree to which provided information is updated and current, a crucial aspect considering that outdated information often lacks utility (De Wulf et al., 2006; Doll & Torkzadeh, 1988). The notion that time-sensitive information fetched from technology is critical forms the backbone of this dimension (Eiriksdottir & Catrambone, 2011). 'Relevance' delves into the alignment between the type of information procured and the specific needs of the users (Cooper et al., 2019). Research, including studies by Lee (2006), has explored the intricate relationship between content richness and perceived usefulness, underlining that technology is deemed high in quality or content when it proves genuinely beneficial to users. This observation lays the groundwork for the following hypothesis:

H1 Content richness has a positive effect on the perceived usefulness of WT.

Personal innovativeness

Personal innovativeness is intimately linked to an individual's eagerness to embrace new technologies as they emerge and become accessible (Rogers Everett, 1995). This trait is often closely tied to one's confidence in and perceptions of technology. Individuals with heightened personal innovativeness tend to exhibit a stronger belief in their technological competencies. Likewise, a more pronounced perception of technology's potential often correlates with increased personal innovativeness (Lewis et al., 2003).

This premise posits that personal innovativeness influences decision-making regarding technology adoption. It represents a crucial factor in an individual's repertoire, significantly impacting their acceptance and utilization of new technologies. The impact of personal innovativeness is generally seen as positive, actively fostering the acceptance or adoption of technology among users. This concept aligns with the TAM, where ease of use and perceived usefulness are believed to positively influence personal innovativeness (Bailey et al., 2022; Bhatti, 2007; Cheng & Huang, 2013; Serenko, 2008). Accordingly, the following hypotheses are proposed:

H2 Innovativeness has a positive effect on the perceived usefulness of WT.

H3 Innovativeness has a positive effect on the perceived ease of use of WT.

Users' satisfaction

Satisfaction typically signifies a psychological condition where an individual's emotional responses are intertwined with their anticipations based on prior experiences. It's intimately associated with the overall positive or negative impressions that technology imparts upon initial usage. In other words, when technology is perceived as beneficial, user-friendly, and fulfills specific needs, it triggers both intrinsic and extrinsic motivational factors (Akour & Alenezi, 2022). This activation enhances users' self-efficacy and personal innovativeness, thereby shaping their expectations. Satisfaction is realized when these anticipations are met or surpassed (Bhatt et al., 2020; Venkatesh et al., 2000).

Furthermore, user satisfaction is a pivotal component in the adoption of products or services. The degree of user satisfaction is directly proportional to their continuous engagement with the technology (Alenezi et al., 2023). Extensive research has highlighted the strong correlation between the ongoing intention to use technology and user satisfaction, pinpointing it as a key determinant in the sustained utilization of technological solutions (Ambalov, 2018; Nascimento et al., 2018). Based on these insights, the subsequent hypotheses are formulated:

H4 Users' satisfaction has a positive effect on the adoption of WT.

TAM model

The TAM has been extensively leveraged in prior research to forecast the adoption, acceptance, and intent to utilize technology across diverse domains (S. A. S. Salloum &

Shaalan, 2018a, 2018b). Specifically, this study hones in on two key constructs of TAM that are posited to have a direct impact on the adoption of WT. The first of these constructs is 'perceived usefulness,' which essentially reflects users' beliefs regarding the extent to which the technology can enhance their performance or add value (Akour et al., 2021). The second construct pertains to 'perceived ease of use,' representing the degree to which users anticipate the technology to be effort-free and straightforward to engage with (Davis, 1989). In line with these considerations, the following hypotheses are articulated:

H5 Perceived usefulness positively affects the adoption of WT.

H6 Perceived ease of use positively affects the adoption of WT.

Flow theory

Flow, in its essence, is characterized by a profound sense of control, deep engagement, and enjoyment. When users perceive technology as thoroughly enjoyable, their readiness to consistently engage with it increases. This engagement activates users' cognitive, emotional, and behavioral faculties, giving rise to positive sensations that contribute to the flow experience associated with technology usage (Csikszentmihalyi, 1988; Fredrickson et al., 2003). As users enter this state of flow, time seems to elapse swiftly, and intrinsic motivation intensifies, fostering what is known as a consistent flow. This continuous flow is defined as a sustained interaction marked by feelings of pleasure, immersion, and engagement (Hoffman & Novak, 1996, 2009).

In recent times, the concept of flow experience has been incorporated into the adoption models of various IT systems, including e-learning platforms, the Internet, and entertainment technologies. It's perceived as a complete immersion, where self-awareness fades in the face of technology interaction (Ang et al., 2007). Given its significant influence on user engagement and satisfaction, flow theory is increasingly recognized as a predictive element in technology adoption. Consequently, the following hypothesis is postulated:

H7 Flow experience has a positive effect on the adoption of WT.

Figure 2 illustrates a visual representation of the comprehensive model adopted for our study, detailing the interrelationships among the various constructs central to understanding the adoption of Wearable Technology in education. It systematically presents the hypotheses developed, delineating how elements such as Content Richness, Innovativeness, User Satisfaction, Perceived Usefulness, Perceived Ease of Use, and Flow Experience contribute to and influence each other within the framework. This diagram serves as a foundational guide, illustrating the theoretical pathways and expected interactions that lead to the adoption of wearable technology, thereby offering a clear and structured overview of the research hypotheses in the context of the broader study.

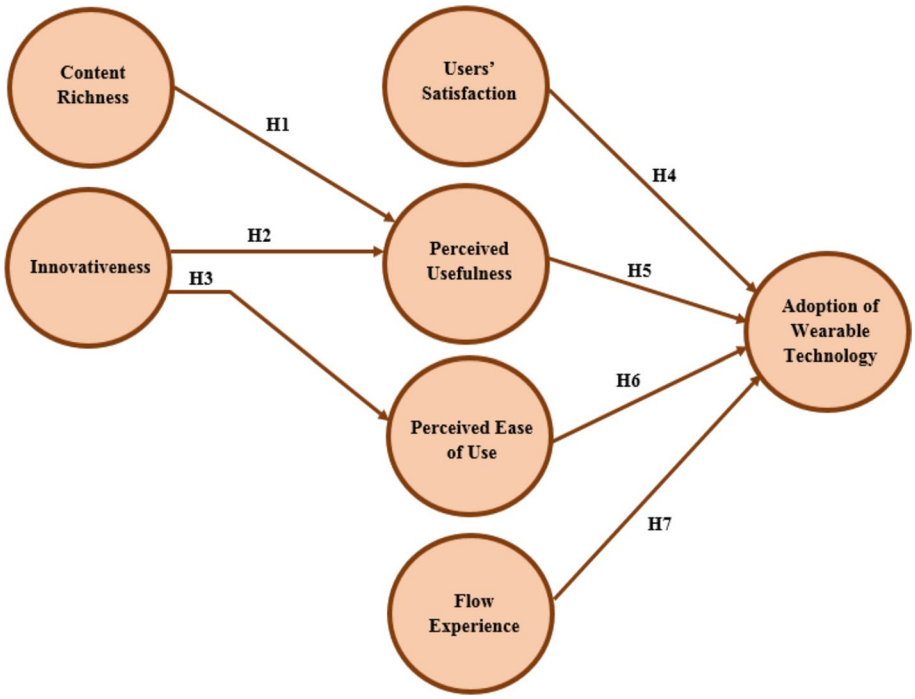

Fig. 2 Research model

Research methodology

In this analytical study, which adopted a descriptive cross-sectional framework, a deductive approach was employed. The primary means of gathering data was a self-administered online questionnaire, targeting academic entities within the Saudi Arabia (KSA). The research was conducted across five universities, spanning from September 30, 2023, to December 30, 2023, utilizing emails and social media channels, including WhatsApp, for communication and data collection. In the realm of empirical research focusing on educational service management, a multitude of scholars have recognized the significance of selecting the target population as the central unit for analysis in the present investigation (Terziovski, 2006). Reference (Sit et al., 2009) highlighted that these individuals possess a comprehensive understanding of various operational strategies in the domain of educational management, as well as insights into the level of service quality and client satisfaction their institutions offer. This study opted for a non-probability sampling method, specifically convenience sampling, due to several compelling reasons. Primarily, the stringent regulations prevailing in KSA's academic institutions regarding the confidentiality and safeguarding of faculty information influenced this decision. Furthermore, the accessibility policies concerning sampling, stipulated by the participating universities, also played a crucial role in the adoption of this method. Additionally, it's worth noting that (Easterby-Smith et al., 2012) has underscored the efficiency of convenience sampling in terms of both time and budget, and its effectiveness in reaching a substantial sample size. In our study, understanding the participants' prior interactions with wearable technology (WT) was paramount. Our preliminary survey revealed that a significant majority, approximately 82%, reported having previous experience with WT. This experience spanned across general daily usage and was particularly notable in

specialized applications within the field of Teaching English to Speakers of Other Languages (TESOL).

Data collection

In this investigation, a total of 500 questionnaires were disseminated randomly, out of which 32 were discarded due to incomplete responses. The remaining 468 questionnaires, representing a 93.6 percent response rate, were deemed valid and were subsequently subjected to analysis. This sample size of 468 not only exceeds the threshold recommended in Krejcie and Morgan (1970), which suggests a sample size of 306 for a population of 1500, but also significantly surpasses the minimum requirement, thereby enabling the use of Structural Equation Modeling (SEM), as per the guidelines mentioned in Chuan and Penyelidikan (2006). This substantial sample size lends robustness to the study, allowing for a thorough verification of the hypotheses. It is important to note that while these hypotheses are anchored in established theories, they are uniquely tailored to align with the specific context of smartwatch adoption. The SEM technique is utilized to meticulously assess the measurement model, before proceeding to the scrutiny of the final path model. This step-by-step approach ensures a comprehensive evaluation of the theoretical constructs and their interrelations within the framework of smartwatch adoption.

Students' personal information/demographic data

Figure 3 presents a detailed breakdown of the personal and demographic characteristics of the study's participants. The gender distribution of the respondents was fairly balanced, with females constituting 58% and males making up 42%. Age-wise, the respondents were almost evenly split, with 49% falling in the 18 to 29 years bracket, while the remaining 51% were aged above 29 years. A significant portion of the participants came from an educated background, predominantly holding university degrees.

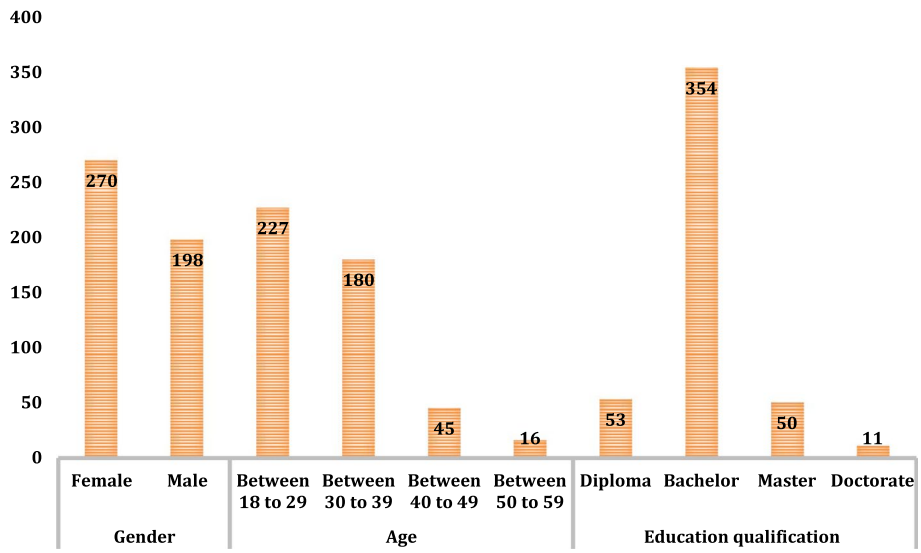

Fig. 3 Demographic data of the respondents ($n = 468$)

Specifically, the educational attainment of the respondents was distributed as follows: 11% held a diploma, a substantial 76% had obtained a bachelor's degree, 11% reported having a master's degree, and a smaller fraction, 2%, possessed doctoral degrees. The selection of participants was guided by a purposive sampling strategy, as outlined in (S. A. S. A. Salloum & Shaalan, 2018a, 2018b), chosen particularly because the respondents were willing to engage voluntarily in the study. This approach enabled the inclusion of a diverse group of individuals, representing a range of ages, sectors, and varying levels of experience. IBM SPSS Statistics version 23 was the tool of choice for analyzing the demographic data.

Study instrument

In this study, a meticulously crafted survey instrument was incorporated to validate the proposed hypotheses. The survey comprised 23 carefully curated items, each designed to measure one of the seven constructs identified within the questionnaire framework. In an effort to enhance the relevance and accuracy of the research, the questions were not directly adopted from prior studies. Instead, they underwent a thorough review and revision process to ensure they are well-suited to the current research context. This deliberate refinement of questions aimed to bolster the precision and applicability of the survey instrument, thereby strengthening the validity of the research findings. The origins and theoretical underpinnings of the constructs employed in the questionnaire are detailed in Table 2, providing transparency and allowing for a clearer understanding of the conceptual foundation of the survey items.

Findings and discussion

Data analysis

In this study, the data analysis was conducted using the partial least squares-structural equation modeling (PLS-SEM) through the SmartPLS V.3.2.7 software (Ringle et al., 2015). The analytical approach adopted was a dual-layered assessment framework, comprising both the measurement model and the structural model (Hair Jr et al., 2017, 2017b). Several compelling reasons justified the selection of PLS-SEM for this research. Firstly, PLS-SEM is widely recognized as a preferable choice for studies aimed at consolidating existing theoretical frameworks (Urbach & Ahlemann, 2010). Secondly, it is particularly adept at handling exploratory research involving complex models, offering enhanced analytical capabilities (Hair et al., 2017a, 2017b). Thirdly, PLS-SEM distinguishes itself by evaluating the model in its entirety rather than in fragmented parts, ensuring a holistic analysis (Goodhue et al., 2012). Lastly, the use of PLS-SEM is known to produce more accurate outcomes due to its capacity to perform simultaneous analyses of both the measurement and structural models (Barclay et al., 1995).

Convergent validity

Convergent validity refers to the degree to which two measures of constructs that theoretically should be related, are in fact related (Campbell & Fiske, 1959; J. F. Hair et al., 2006). According to Hair Jr et al. (2017, 2017b), the evaluation of the measurement model involved examining construct reliability (incorporating both Cronbach's alpha and composite reliability) and validity (comprising convergent and discriminant

Table 2 Constructs and their sources

Constructs	Items	Instrument	Sources
Adoption of WT	AWT1	It is advisable to employ WT among students engaged in TESOL Education	Davis (1989), Rai and Selnes (2019)
	AWT2	Integrating WT in TESOL with students contributes positively to my professional development	
Users' satisfaction	URS1	Overall, my interaction with WT as a TESOL student has been fulfilling	Oliver (1981)
	URS2	Overall, my engagement with WT in TESOL Education seems capable of meeting all my requirements	
	URS3	Overall, my experience with WT has been gratifying	
Flow experience	FEP1	I am fully immersed each time I utilize WT	Bilgihan et al. (2014), Csikszentmihalyi (1988)
	FEP2	My attention is solely dedicated to WT during its usage	
Perceived ease of use	PEU1	I believe that WT is user-friendly for both instructors and students	Huang et al. (2012), Larsen et al. (2009)
	PEU2	I perceive WT as a viable substitute for other technologies due to its ease of use	
	PEU3	I consider WT to be straightforward and undemanding in terms of mental effort	
Perceived usefulness	PUS1	I believe that WT contributes to enhancing my technical skills	Huang et al. (2012), Larsen et al. (2009)
	PUS2	I feel that WT fosters my inclination towards acquiring new knowledge consistently	
	PUS3	I view WT as a valuable resource for educational content in TESOL education for both instructors and students	
Content richness	CNR1	WT delivers the comprehensive content that meets my requirements	De Wulf et al. (2006)
	CNR2	WT contains highly beneficial information pertinent to my needs	
	CNR3	WT furnishes ample educational content specifically in the field of TESOL	
	CNR4	WT consistently provides me with the information I seek, to my satisfaction	
	CNR5	WT is capable of supplying the specific information I require	
	CNR6	WT maintains a current and relevant educational repository for my TESOL-related needs	
Innovativeness	INV1	I am always prepared to adopt new technology as it emerges	Yi et al. (2006)
	INV2	Among my peers, I am typically the earliest adopter of new technology	
	INV3	Generally, I approach the adoption of new technology with openness and minimal hesitation	

validity). In the realm of construct reliability assessment, Table 3 reveals that Cronbach's alpha values range from 0.738 to 0.844, comfortably exceeding the recommended benchmark of 0.7 (Nunnally & Bernstein, 1994). Furthermore, the table illustrates that composite reliability (CR) values span from 0.812 to 0.915, surpassing the generally accepted

Table 3 Convergent validity

Constructs	Items	Factor loading	Cronbach's Alpha	CR	AVE
AWT	AWT1	0.895	0.738	0.812	0.684
	AWT2	0.803			
URS	URS1	0.814	0.844	0.878	0.562
	URS2	0.812			
	URS3	0.847			
FEP	FEP1	0.840	0.807	0.915	0.837
	FEP2	0.924			
PEU	PEU1	0.905	0.831	0.898	0.747
	PEU2	0.899			
	PEU3	0.852			
PUS	PUS1	0.813	0.761	0.829	0.622
	PUS2	0.818			
	PUS3	0.799			
CNR	CNR1	0.906	0.836	0.901	0.753
	CNR2	0.830			
	CNR3	0.877			
	CNR4	0.900			
	CNR5	0.840			
	CNR6	0.910			
INV	INV1	0.893	0.794	0.906	0.683
	INV2	0.895			
	INV3	0.907			

* Values meet acceptable standards (Factor loading, Cronbach's Alpha, composite reliability $\geq$ 0.70, and AVE > 0.5)

minimum of 0.7 (Kline, 2015). These figures affirm the reliability of the constructs, indicating their robustness and error-free nature.

To ascertain convergent validity, it is imperative to evaluate factor loadings and the average variance extracted (AVE) (Hair Jr et al., 2017, 2017b). Table 3 presents factor loadings that notably exceed the conventional threshold of 0.7. Additionally, the table outlines AVE values ranging between 0.562 and 0.837, surpassing the standard minimum value of 0.5. These results collectively confirm that convergent validity has been adequately achieved for each construct under consideration.

Discriminant validity

Discriminant validity assesses the extent to which concepts or measurements that are supposed to be unrelated are actually distinct (Campbell & Fiske, 1959; J. F. Hair et al., 2006). The assessment of discriminant validity in this study necessitated consideration of the Fornell-Larker criterion and the Heterotrait-Monotrait ratio (HTMT), as outlined in (J. Hair et al., 2017a, 2017b). Table 4 demonstrates that the square root of each Average Variance Extracted (AVE) value significantly exceeds the respective correlation values with other constructs, thereby satisfying the Fornell-Larker criterion (Fornell & Larcker, 1981).

Moreover, as depicted in Table 5, the HTMT ratios for all constructs are consistently below the threshold of 0.85 (Dijkstra & Henseler, 2015), firmly establishing the validity

Table 4 Fornell-Larcker scale

	AWT	URS	FEP	PEU	PUS	CNR	INV
AWT	**0.827**						
URS	0.439	**0.750**					
FEP	0.532	0.491	**0.915**				
PEU	0.235	0.168	0.476	**0.864**			
PUS	0.138	0.563	0.160	0.065	**0.811**		
CNR	0.547	0.493	0.653	0.516	0.233	**0.868**	
INV	0.605	0.674	0.569	0.236	0.443	0.535	**0.817**

The bold values demonstrate the discriminant validity of the constructs in the model

Table 5 HTMT

	AWT	URS	FEP	PEU	PUS	CNR	INV
AWT							
URS	0.630						
FEP	0.803	0.571					
PEU	0.348	0.185	0.580				
PUS	0.193	0.697	0.161	0.120			
CNR	0.813	0.553	0.792	0.616	0.239		
INV	0.797	0.786	0.562	0.250	0.695	0.534	

of the HTMT criterion. This conclusively affirms discriminant validity, ensuring that the constructs are sufficiently distinct from one another.

The verification of both Fornell-Larker criterion and HTMT ratio, coupled with the earlier assessment of construct reliability and convergent validity, underscores the absence of errors in the reliability and validity measures within the measurement model. This comprehensive validation paves the way for the subsequent utilization of the gathered data in the evaluation of the structural model, marking a significant milestone in the analytical process of the study.

Hypothesis testing with PLS-SEM

Following the thorough assessment of the measurement model, the focus shifts to the structural model, involving an intricate evaluation of the coefficient of determination (R^2) and path coefficients, with the latter being derived from an extensive bootstrapping process involving 5000 re-samples. Table 7 meticulously presents the path coefficients, t-values, and p-values corresponding to each hypothesis within the path analysis. The interpretation of the data reveals unanimous support from researchers for every hypothesis, with empirical data affirming hypotheses H1 through H7.

The scrutiny of the structural model primarily hinges on the coefficient of determination (R^2 value), a pivotal metric that encapsulates the squared correlation between the actual and predicted values of a given endogenous construct (Hair Jr et al., 2016). This coefficient is integral to gauging the model's predictive accuracy, quantifying the combined effect of exogenous latent variables on an endogenous latent variable (Senapathi & Srinivasan, 2014). As a measure of variance, the R^2 value provides insight into the degree of explained variability in the endogenous constructs. An R^2 value

Table 6 R^2 values of the dependent latent variables

Constructs	R^2	Results
AWT	0.505	Moderate
PEU	0.664	Moderate
PUS	0.543	Moderate

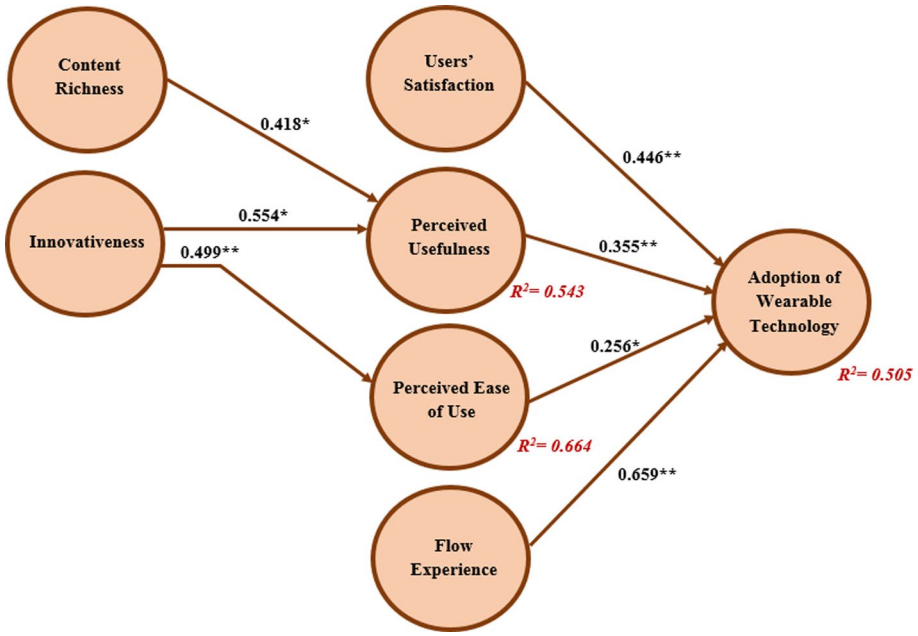

Fig. 4 Model path coefficient

exceeding 0.67 is deemed high, signifying robust predictive capability, while values ranging between 0.33 and 0.67 indicate moderate predictive power. Conversely, values between 0.19 and 0.33 are considered weak, and any value below 0.19 is deemed inadmissible (Chin, 1998). As delineated in Table 6 and depicted in Fig. 4, the model demonstrated moderate predictive prowess, accounting for approximately 50.5%, 54.3%, and 66.4% of the variance in the adoption of WT, perceived usefulness, and perceived ease of use, respectively.

The analysis of the structural model reveals insightful connections and effects among the constructs. The relationship between content richness (CNR) and perceived usefulness (PUS) is substantial, as evidenced by a path coefficient (β) of 0.418 and a significance level (P) below 0.05, thereby affirming Hypothesis H1. Similarly, Innovativeness (INV) exerts a strong influence on perceived usefulness (PUS), with a path coefficient (β) of 0.554 and a significance level (P) below 0.05, validating Hypothesis H2. The link between Innovativeness (INV) and perceived ease of use (PEU) is also statistically significant, marked by a path coefficient (β) of 0.499 and a significance level (P) below 0.001, thus supporting Hypothesis H3.

Furthermore, the study highlights notable effects of Users' satisfaction (URS), perceived usefulness (PUS), perceived ease of use (PEU), and flow experience (FEP) on

the adoption of AWT. Specifically, the path coefficients (β) are 0.446, 0.355, 0.256, and 0.659 respectively, with corresponding significance levels (P) below 0.05, 0.01, 0.05, and 0.001. These results collectively indicate strong support for the underlying hypotheses concerning these relationships. A comprehensive summary of the findings from the hypotheses testing is systematically presented in Table 7, providing a clear and structured overview of the research outcomes.

Discussion and conclusion

This study rigorously assesses the adoption efficacy of WT in the realm of TESOL Education, employing a comprehensive model that synergizes the principles of the TAM with specific external factors. These external factors encompass personal innovativeness and content richness, alongside flow theory and user satisfaction metrics. The research underscores the pivotal role of content richness in promoting smartwatch adoption, highlighting its capacity to significantly enhance perceived usefulness and, consequently, adoption rates. This is particularly evident when content aligns with the essential attributes of timeliness, relevance, and sufficiency.

Moreover, the study delineates the significant influence of content richness on perceived usefulness, resonating with previous research that underscores the correlation between high-quality content and the ease and utility of technology use (Rhein, 2021). The research positions content richness as a critical external factor, echoing the findings of acceptance studies (Hong et al., 2017; Wang et al., 2021) and reinforcing the nexus between well-curated content and user engagement.

Personal innovativeness emerges as a crucial determinant in the study, closely linked to individual characteristics. Individuals with a heightened sense of personal innovativeness exhibit a greater propensity to embrace technology, a trend that is notably pronounced in terms of perceived ease of use and, to a lesser extent, perceived usefulness. This finding aligns with prior research asserting the decisive impact of personal innovativeness on technology adoption (Jimenez et al., 2021), suggesting a symbiotic relationship between personal traits and the inclination towards innovative platforms.

Interestingly, the study reveals a tangible connection between personal innovativeness and user enjoyment, positing that heightened enjoyment correlates with increased personal innovativeness (Saprikis et al., 2021). This relationship underscores the role of user experience in fostering an environment conducive to technology adoption.

Table 7 Hypotheses-testing

H	Relationship	Path	*t*-value	*p*-value	Decision
H1	CNR—> PUS	0.418	6.451	0.019	Supported*
H2	INV—> PUS	0.554	3.450	0.048	Supported*
H3	INV—> PEU	0.499	17.174	0.000	Supported**
H4	URS—> AWT	0.446	9.080	0.000	Supported**
H5	PUS—> AWT	0.355	7.189	0.003	Supported**
H6	PEU—> AWT	0.256	3.107	0.017	Supported*
H7	FEP—> AWT	0.659	10.074	0.000	Supported**

* Significant at $p^{**} <= 0.01$, $p^{*} < 0.05$)

From the perspective of TAM, the study affirms the direct and substantial influence of perceived ease of use and perceived usefulness on WT adoption. The research supports the notion that technologies characterized by ease and utility are more likely to be embraced across various domains, including educational and non-educational settings (Ozkan-Yildirim & Pancar, 2021). This trend is particularly pronounced in the educational sector, where both instructors and students demonstrate a predilection for technologies that are user-friendly and beneficial (Tung et al., 2008; Zaman et al., 2021).

Flow theory emerges as a significant external factor in this study, with the results indicating a substantial impact on technology adoption. The degree of user engagement, as dictated by flow theory, can markedly influence adoption rates, with the study suggesting that WT notably enhances user engagement, thereby fostering a positive adoption climate. This finding is supported by previous research, which contends that a rich flow experience can significantly steer user behavioral intentions (Ma et al., 2021; Wang et al., 2021).

Finally, the study delves into the realm of user satisfaction, revealing its dependence on factors such as ease of use and perceived usefulness. Users who perceive WT as effortless and advantageous are likely to exhibit higher levels of satisfaction, a sentiment that subsequently influences their adoption behavior. These insights corroborate the assertions of other scholars (Al-Maroof R.S., 2021; Najjar et al., 2021), who posit that significant perceived value and ease of use contribute to enhanced user satisfaction and, by extension, a more favorable disposition towards technology adoption.

Practical implication in the TESOL education

This research makes a substantial contribution to the field of WT development, particularly in its application within educational settings. The findings of this study underline the necessity for WT investments to meticulously cater to the specific needs of users and meet the broader demands of the educational ecosystem. It is imperative for developers to have a deep understanding of how future WT innovations can be tailored to meet the unique requirements of educators, thereby encouraging their willingness to integrate such technologies into their teaching methodologies. WT developers must be attuned to the critical timing and functionality of specific features. The ability of WT to perform certain tasks, particularly providing accurate information promptly, can significantly influence user reliance and adoption rates. Both instructors and students are more likely to embrace WT when its features are continually refined and aligned with their evolving needs. The alignment of WT functions with the demands of the educational sector is pivotal. WT managers must be adept at identifying and understanding individual user needs, enabling them to fine-tune WT features for optimal integration. When the functionalities of WT resonate with the specific requirements of users, it ensures a harmonious alignment, fostering long-term engagement and satisfaction. This alignment not only enhances the immediate utility of WT but also supports its sustained use, contributing to the overarching objectives of educational enhancement and technological advancement.

Managerial implication in the TESOL education

The adoption of WT in the TESOL education among university students presents a myriad of managerial implications that necessitate thoughtful consideration and strategic planning. This technological integration transforms the educational landscape by fostering an immersive and interactive learning environment, thereby enhancing student engagement and facilitating personalized learning experiences. However, managers and academic leaders must address the associated challenges, including ensuring equitable access to these technologies, safeguarding student data privacy, and providing adequate training for educators to effectively incorporate these tools into their curriculum. Moreover, the adoption of WT necessitates a review and potential revision of institutional policies and teaching methodologies to harness the full potential of these innovative tools while maintaining academic integrity and quality of education. Consequently, the managerial approach to integrating WT in TESOL education should be holistic, focusing not only on the technological aspects but also on the pedagogical, ethical, and logistical factors to fully capitalize on the benefits and navigate the complexities of this digital transformation.

Limitations of the study

In this study, a series of notable constraints were identified, which merit consideration for future research enhancements. The investigation was confined to just five universities within the KSA, presenting a significant limitation due to the narrow scope, potentially affecting the comprehensive understanding of WT adoption. The inclusion of a more extensive and diverse array of universities across the KSA would have broadened the study's applicability and enriched the insights into the factors influencing WT adoption. The participant count in this research was limited to 468 individuals, highlighting another constraint regarding the study's representativeness and depth. The data collection was executed through a survey questionnaire, as highlighted by (S. A. S. A. Salloum et al., 2019), which suggests the necessity for refined research instruments and methodologies. Expanding the research to incorporate more educational institutions from the wider Arab region, including countries such as UAE, Jordan, Kuwait, and Bahrain etc. could provide a more holistic view and generate results with greater validity and acceptance. Further engagement from a larger student cohort is advocated for future studies to ensure a more robust data set. Employing qualitative methods such as interviews and focus group discussions, especially in specific Arab academic institutions engaged in the research, would offer deeper insights and facilitate a more nuanced understanding of WT integration. The research's focus on frontline healthcare workers potentially limits its generalizability; the exclusion of other academic and non-academic stakeholders was a pragmatic decision but narrows the study's applicability. Constraints related to time and budget led to the sampling being restricted to the governmental sector, thereby capturing a limited service culture perspective. This sector-specific approach also poses challenges to the generalization of findings across different service industries. Given the reliance on a survey questionnaire as the primary data collection tool, future research could benefit significantly from a mixed-methods approach. Incorporating data triangulation techniques, such as observations and in-depth interviews with educational

personnel, would provide a comprehensive perspective on the deployment and implications of WT in various settings, enriching the understanding of this emerging technology's potential and limitations.

Future work

The present study meticulously examines select external variables, aiming to illuminate the factors that bolster the prominence and acceptance of WT. However, the dynamic and evolving nature of WT necessitates continuous reassessment of these variables to align with the technology's evolving features and applications. While this research primarily navigates the interplay of the TAM and Flow Theory, there's ample scope for future investigations to explore alternative theoretical frameworks. Such frameworks could offer more nuanced insights, especially in addressing specific societal and psychological dimensions of technology adoption. Additionally, while the focus of this study is entrenched in the educational realm, specifically within TESOL Education, there's a rich tapestry of opportunities for subsequent research to branch out. Future studies might consider a broader spectrum of settings, encompassing various academic disciplines as well as professional and casual environments. This expansion would not only enrich our understanding of WT's versatility but also its applicability across diverse contexts. Moreover, this study does not delve into the intricacies of gender differences in the adoption and utilization of WT, a dimension that holds significant potential for insightful discoveries. Subsequent research could therefore benefit from a more detailed exploration into how gender influences the perception, acceptance, and use of WT. By shedding light on these gender-specific nuances, future studies can contribute to a more comprehensive and inclusive understanding of WT adoption dynamics.

Acknowledgements
The authors would like to acknowledge the support of Prince Sultan University for paying the Article Processing Charges (APC) of this publication.

Authors' contributions
Conceptualization, MA and SW; investigation, MA and SW; writing—original draft preparation, MA and SW; writing—review and editing, SW; project administration, MA. All authors have read and agreed to the published version of the manuscript.

Data availability
Meta data are available from the corresponding author on reasonable request.

Declarations

Conflict of interest
Conflict of interest not applicable.

Received: 1 May 2024 Accepted: 17 July 2024
Published online: 02 August 2024

References

Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences, 12*(11), 784.

Akour, M., Alenezi, M., Sghaier, H. A., & Shboul, Y. A. (2021). The COVID-19 pandemic: When e-learning becomes mandatory not complementary. *International Journal of Technology Enhanced Learning, 13*(4), 429–439.

Adapa, A., Nah, F.F.-H., Hall, R. H., Siau, K., & Smith, S. N. (2018). Factors influencing the adoption of smart wearable devices. *International Journal of Human-Computer Interaction, 34*(5), 399–409.

Alenezi, M., Wardat, S., & Akour, M. (2023). The need of integrating digital education in higher education: Challenges and opportunities. *Sustainability, 15*(6), 4782.

Al-Maroof, R. S. R. S., Alfaisal, A. M. A. M., & Salloum, S. A. S. A. (2020). Google glass adoption in the educational environment: A case study in the Gulf area. *Education and Information Technologies*. https://doi.org/10.1007/s10639-020-10367-1

Al-Maroof R.S., Salloum, S. A. (2021). An integrated model of continuous intention to use of google classroom. *In:* Al-Emran M., Shaalan K., & Hassanien A. (Eds) *Recent advances in intelligent systems and smart applications. Studies in systems, decision and control* (Vol 295). Cham: Springer.

Alfaisal, R., Alhumaid, K., Alnazzawi, N., Abou Samra, R., Salloum, S., Shaalan, K., & Monem, A. A. (2022). Predicting the intention to use google glass in the educational projects: A hybrid SEM-ML approach. *Academy of Strategic Management Journal, 21*(6), 1–13.

Ambalov, I. A. (2018). A meta-analysis of IT continuance: An evaluation of the expectation-confirmation model. *Telematics and Informatics, 35*(6), 1561–1571.

Ang, C. S., Zaphiris, P., & Mahmood, S. (2007). A model of cognitive loads in massively multiplayer online role playing games. *Interacting with Computers, 19*(2), 167–179.

Bailey, D. R., Almusharraf, N., & Almusharraf, A. (2022). Video conferencing in the e-learning context: Explaining learning outcome with the technology acceptance model. *Education and Information Technologies, 27*(6), 7679–7698.

Barclay, D., Higgins, C., & Thompson, R. (1995). *The partial least squares (pls) approach to casual modeling: Personal computer adoption ans use as an illustration*.

Bhatt, V., Chakraborty, S., & Chakravorty, T. (2020). Impact of information sharing on adoption and user satisfaction among the wearable device users. *International Journal of Control and Automation, 13*(4), 277–289.

Bhatti, T. (2007). Exploring factors infuencing the adoption of mobile commerce. *Journal of Internet Banking and Commerce, 12*, 1–13.

Bilgihan, A., Okumus, F., Nusair, K., & Bujisic, M. (2014). Online experiences: Flow theory, measuring online customer experience in e-commerce and managerial implications for the lodging industry. *Information Technology & Tourism, 14*(1), 49–71.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56*(2), 81.

Cheng, Y.-H., & Huang, T.-Y. (2013). High speed rail passengers' mobile ticketing adoption. *Transportation Research Part C: Emerging Technologies, 30*, 143–160.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research, 295*(2), 295–336.

Choe, M.-J., & Noh, G.-Y. (2018). Combined model of technology acceptance and innovation diffusion theory for adoption of smartwatch. *International Journal of Contents, 14*(3).

Chuan, C. L., & Penyelidikan, J. (2006). Sample size estimation using Krejcie and Morgan and Cohen statistical power analysis: A comparison. *Jurnal Penyelidikan IPBL, 7*, 78–86.

Cooper, G., Park, H., Nasr, Z., Thong, L. P., & Johnson, R. (2019). Using virtual reality in the classroom: Preservice teachers' perceptions of its use as a teaching and learning tool. *Educational Media International, 56*(1), 1–13. https://doi.org/10.1080/09523987.2019.1583461

Csikszentmihalyi, M. (1988). *The flow experience and its significance for human psychology.*

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

De Wulf, K., Schillewaert, N., Muylle, S., & Rangarajan, D. (2006). The role of pleasure in web site success. *Information & Management, 43*(4), 434–446.

Dijkstra, T. K., & Henseler, J. (2015). Consistent partial least squares path modeling. *MIS Quarterly, 39*(2), 297–316.

Doll, W. J., & Torkzadeh, G. (1988). The measurement of end-user computing satisfaction. *MIS Quarterly*, 259–274.

Dutot, V., Bhatiasevi, V., & Bellallahom, N. (2019). Applying the technology acceptance model in a three-countries study of smartwatch adoption. *The Journal of High Technology Management Research*.

Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2012). *Management research*. Sage.

Eiriksdottir, E., & Catrambone, R. (2011). Procedural instructions, principles, and examples: How to structure instructions for procedural tasks to enhance performance, learning, and transfer. *Human Factors, 53*(6), 749–770.

El-Masri, M., Al-Yafi, K., & Kamal, M. M. (2023). A task-technology-identity fit model of smartwatch utilisation and user satisfaction: A hybrid SEM-neural network approach. *Information Systems Frontiers, 25*(2), 835–852.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.2307/3151312

Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Larkin, G. R. (2003). What good are positive emotions in crisis? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology, 84*(2), 365.

Goodhue, D. L., Lewis, W., & Thompson, R. (2012). Does PLS have adavantages for small sample size or non-normal data? *MIS Quaterly*.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. (2006). *Multivariate data analysis*. Uppersaddle River, NJ: Pearson Prentice Hall.

Hair, J., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017a). An updated and expanded assessment of PLS-SEM in information systems research. *Industrial Management & Data Systems, 117*(3), 442–458. https://doi.org/10.1108/IMDS-04-2016-0130

Hair Jr, J. F., Hult, G. T. . T. M., Ringle, C. C. ., Sarstedt, M., Hair, J., Hult, G. T. M., Ringle, C., Sarstedt, M., Hair, J. F. F., Hult, G. T. M., … Sarstedt, M., Hair Jr, J. F., Hult, G. T. . T. M., Ringle, C. C. ., Sarstedt, M., Hair, J. F. F., Hult, G. T. . T. M., Ringle, C. C. ., Sarstedt, M., Hair Jr, J. F., Hult, G. T. . T. M., Ringle, C. C. ., Sarstedt, M., Hair, J. F. F., Hult, G. T. . T. M., … Sarstedt, M. (2016). A primer on partial least squares structural equation modeling (PLS-SEM). In *Sage Publications.* (2nd ed.). Sage Publications.

Hair Jr, J. F., Sarstedt, M., Ringle, C. M., & Gudergan, S. P. (2017). *Advanced issues in partial least squares structural equation modeling*. Sage Publications.

Hidayanto, A. N., & Samik-Ibrahim, R. M. (2021). Analysis of factors affecting adoption intention on smartwatch adoption in human and technology factor perspective. In *2021 IEEE 7th international conference on computing, engineering and design (ICCED)*, 1–6.
Hoffman, D. L., & Novak, T. P. (1996). Marketing in hypermedia computer-mediated environments: Conceptual foundations. *Journal of Marketing, 60*(3), 50–68.
Hoffman, D. L., & Novak, T. P. (2009). Flow online: Lessons learned and future prospects. *Journal of Interactive Marketing, 23*(1), 23–34.
Hong, J.-C., Lin, P.-H., & Hsieh, P.-C. (2017). The effect of consumer innovativeness on perceived value and continuance intention to use smartwatch. *Computers in Human Behavior, 67*, 264–272.
Hsu, C.-C., Chen, Y.-L., Lin, C.-Y., & Lien, W. (2022). Cognitive development, self-efficacy, and wearable technology use in a virtual reality language learning environment: A structural equation modeling analysis. *Current Psychology*, 1–15.
Huang, Y.-M., Huang, Y.-M., Huang, S.-H., & Lin, Y.-T. (2012). A ubiquitous English vocabulary learning system: Evidence of active/passive attitudes vs. usefulness/ease-of-use. *Computers & Education, 58*(1), 273–282.
Jeong, S. C., Kim, S.-H., Park, J. Y., & Choi, B. (2017). Domain-specific innovativeness and new product adoption: A case of wearable devices. *Telematics and Informatics, 34*(5), 399–412.
Jimenez, I. A. C., García, L. C. C., Violante, M. G., Marcolin, F., Vezzetti, E., Castiblanco Jimenez, I. A., Cepeda García, L. C., Violante, M. G., Marcolin, F., & Vezzetti, E. (2021). Commonly used external TAM variables in e-learning, agriculture and virtual reality applications. *Future Internet, 13*(1), 7.
Jung, Y., Perez-Mira, B., & Wiley-Patton, S. (2009). Consumer adoption of mobile TV: Examining psychological flow and media content. *Computers in Human Behavior, 25*(1), 123–129.
Kao, Y.-S., Nawata, K., & Huang, C.-Y. (2019). An exploration and confirmation of the factors influencing adoption of IoT-based wearable fitness trackers. *International Journal of Environmental Research and Public Health, 16*(18), 3227.
Kim, K. J. (2016). Round or square? How screen shape affects utilitarian and hedonic motivations for smartwatch adoption. *Cyberpsychology, Behavior, and Social Networking, 19*(12), 733–739.
Kim, K. J., & Shin, D.-H. (2015a). An acceptance model for smart watches: Implications for the adoption of future wearable technology. *Internet Research*.
Kim, K. J., & Shin, D.-H. (2015b). An acceptance model for smart watches. *Internet Research*.
Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications.
Kranthi, A. K., & Ahmed, K. A. A. (2018). Determinants of smartwatch adoption among IT professionals-an extended UTAUT2 model for smartwatch enterprise. *International Journal of Enterprise Network Management, 9*(3–4), 294–316.
Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610.
Larsen, T. J., Sørebø, A. M., & Sørebø, Ø. (2009). The role of task-technology fit as users' motivation to continue information system use. *Computers in Human Behavior, 25*(3), 778–784.
Lee, Y.-C. (2006). An empirical investigation into factors influencing the adoption of an e-learning system. *Online Information Review, 30*(5), 517–541.
Lewis, W., Agarwal, R., & Sambamurthy, V. (2003). Sources of influence on beliefs about information technology use: An empirical study of knowledge workers. *MIS Quarterly*, 657–678.
Lyons, K. (2015). What can a dumb watch teach a smartwatch? Informing the design of smartwatches. In *Proceedings of the 2015 ACM international symposium on wearable computers*, 3–10.
Ma, Y., Cao, Y., Li, L., Zhang, J., & Clement, A. P. (2021). Following the flow: Exploring the impact of mobile technology environment on user's virtual experience and behavioral response. *Journal of Theoretical and Applied Electronic Commerce Research, 16*(2), 170–187.
Najjar, M. S., Dahabiyeh, L., & Algharabat, R. S. (2021). Users' affect and satisfaction in a privacy calculus context. *Online Information Review*.
Nascimento, B., Oliveira, T., & Tam, C. (2018). Wearable technology: What explains continuance intention in smartwatches? *Journal of Retailing and Consumer Services, 43*, 157–169.
Niknejad, N., Ismail, W. B., Mardani, A., Liao, H., & Ghani, I. (2020). A comprehensive overview of smart wearables: The state of the art literature, recent advances, and future challenges. *Engineering Applications of Artificial Intelligence, 90*, 103529.
Nunnally, J. C., & Bernstein, I. H. (1994). Psychometric theory. *In McGraw-Hill, New York*. https://doi.org/10.1037/018882
Oliver, R. L. (1981). Measurement and evaluation of satisfaction processes in retail settings. *Journal of Retailing*.
Openart AI. (2024). https://openart.ai/home
Ozkan-Yildirim, S., & Pancar, T. (2021). Smart Wearable technology for health tracking: What are the factors that affect their use? In *IoT in healthcare and ambient assisted living* (pp. 165–199). Springer.
Rai, R. S., & Selnes, F. (2019). Conceptualizing task-technology fit and the effect on adoption–A case study of a digital textbook service. *Information & Management, 56*(8), 103161.
Rhein, F. E. (2021). B2B Innovation adoption and diffusion. In *The dynamics of green innovation in B2B industries* (pp. 35–56). Springer.
Ringle, C. M., Wende, S., & Becker, J.-M. (2015). *SmartPLS 3. Bönningstedt: SmartPLS*.
Rogers, E. (1995). *Diffusion of Innovations (Fourth* (Paperback). New York: The Free Press Simon & Schuster Inc.
Rogers Everett, M. (1995). Diffusion of innovations, vol. 12. *New York*.
Salloum, S. A. S. A., Alhamad, Q. M., & A., Al-Emran, M., Abdel Monem, A., Shaalan, K., Alhamad, A. Q. M., Al-Emran, M., Monem, A. A., & Shaalan, K. (2019). Exploring students' acceptance of E-learning through the development of a comprehensive technology acceptance model. *IEEE Access, 7*, 128445–128462. https://doi.org/10.1109/ACCESS.2019.2939467
Salloum, S. A. S. A., & Shaalan, K. (2018a). Adoption of E-book for university students. *International Conference on Advanced Intelligent Systems and Informatics, 845*, 481–494. https://doi.org/10.1007/978-3-319-99010-1_44
Salloum, S. A. S., & Shaalan, K. (2018). *Investigating students' acceptance of E-learning system in Higher Educational Environments in the UAE: Applying the extended technology acceptance model (TAM)*. The British University in Dubai.

Saprikis, V., Avlogiaris, G., & Katarachia, A. (2021). Determinants of the intention to adopt mobile augmented reality apps in shopping malls among university students. *Journal of Theoretical and Applied Electronic Commerce Research, 16*(3), 491–512.

Senapathi, M., & Srinivasan, A. (2014). An empirical investigation of the factors affecting agile usage. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering*, 10.

Serenko, A. (2008). A model of user adoption of interface agents for email notification. *Interacting with Computers, 20*(4–5), 461–472.

Sharma, N., Shamkuwar, M., & Singh, I. (2019). The history, present and future with IoT. In *Internet of things and big data analytics for smart generation* (pp. 27–51). https://doi.org/10.1007/978-3-030-04203-5_3

Sit, W., Ooi, K., Lin, B., & Chong, A. Y. (2009). TQM and customer satisfaction in Malaysia's service sector. *Industrial Management & Data Systems*.

Terziovski, M. (2006). Quality management practices and their relationship with customer satisfaction and productivity improvement. *Management Research News*.

Tung, F.-C., Chang, S.-C., & Chou, C.-M. (2008). An extension of trust and TAM model with IDT in the adoption of the electronic logistics information system in HIS in the medical industry. *International Journal of Medical Informatics, 77*(5), 324–335.

Urbach, N., & Ahlemann, F. (2010). Structural equation modeling in information systems research using partial least squares. *Journal of Information Technology Theory and Application, 11*(2), 5–40. https://doi.org/10.1037/0021-9010.90.4.710

Uzir, M. U. H., Bukari, Z., Al Halbusi, H., Lim, R., Wahab, S. N., Rasul, T., Thurasamy, R., Jerin, I., Chowdhury, M. R. K., & Tarofder, A. K. (2023). Applied artificial intelligence: Acceptance-intention-purchase and satisfaction on smartwatch usage in a Ghanaian context. *Heliyon, 9*(8).

Venkatesh, V., Davis, F. D., Hossain, M. A., Dwivedi, Y. K., Piercy, N. C., Hu, P. J., Chau, P. Y. K., Sheng, O. R. L., & Tam, K. Y. (2000). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *Management Science, 46*(2), 319–340.

Wang, Y.-T., Lin, K.-Y., & Huang, T. (2021). An analysis of learners' intentions toward virtual reality online learning systems: a case study in Taiwan. In *Proceedings of the 54th Hawaii international conference on system sciences*, 1519.

Woodside, J. M., & Reinbold, R. (2018). Wearable technology in education. *Journal of Innovative Education Strategies, 6*(1&2), 39.

Yanamandra, R. (2024). Developing an integrated framework of application of wearable devices in education. *International Journal of Business Excellence, 32*(1), 85–104.

Yi, M. Y., Fiedler, K. D., & Park, J. S. (2006). Understanding the role of individual innovativeness in the acceptance of IT-based innovations: Comparative analyses of models and measures. *Decision Sciences, 37*(3), 393–426.

Zaman, N., Goldberg, D. M., Kelly, S., Russell, R. S., & Drye, S. L. (2021). The Relationship between Nurses' training and perceptions of electronic documentation systems. *Nursing Reports, 11*(1), 12–27.

Publisher's Note