

Article

The Role of Human–Computer Interaction in Shaping User Engagement with E-Commerce Applications

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Abstract

This research aimed to determine the influence of human–computer interaction usability on the behavioral intention and self-reported continued usage intentions of e-commerce applications. Moreover, it investigated the moderating role of trust in the relationship between behavioral intention and self-reported continued usage intentions of e-commerce applications. The data were gathered from 398 Bahraini individuals using a convenience sampling approach and analyzed using SmartPLS 4. The results highlighted that human–computer interaction usability sub-characteristics, including appropriateness, recognizability, user interface esthetics, learnability, and operability, are significantly associated with behavioral intention toward e-commerce applications within this sample. Furthermore, the results reported that trust strengthens the influence of behavioral intention on self-reported continued usage intentions toward e-commerce applications. The research provides context-specific exploratory insights from a segment of the Bahraini e-commerce sector. Due to the study's non-probabilistic convenience sampling design, the cross-sectional nature of the data, and a sample predominantly composed of young, male, English-proficient respondents, the findings should be interpreted as exploratory rather than representative of the entire Bahraini population. In addition, the research findings helped e-commerce application developers and marketing experts within e-commerce companies develop efficient, operable, attractive, and learnable applications.

Keywords: human-computer interaction; usability; learnability; e-commerce; self-reported continued usage intentions; user interface aesthetics



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1. Introduction

The current growth and development of e-commerce are closely tied to market demand and the ongoing evolution of the e-commerce sector. Initially, the scope of e-commerce was limited to email and a basic web interface. However, now it has expanded to social

commerce and diverse mobile-based applications, referred to as m-commerce [1]. Moreover, e-commerce company owners have invested heavily in designing reliable and user-friendly mobile applications [2] to meet the emerging needs of customers and provide them with updated services. The use of e-commerce mobile applications has accelerated the growth of the e-commerce sector. Furthermore, these applications have enabled customers to enjoy a more comfortable shopping experience than traditional websites. E-commerce is growing rapidly in the Middle East and in the North Africa (MENA) region, as it has facilitated customers' online shopping and payment through digital payment methods, such as digital wallets or apps. Furthermore, growth in business digitalization has prompted companies to ensure easy and secure online shopping experiences tailored to customers' needs [3]. Technological advancement has also digitalized consumer behavior in Bahrain; now, consumers prefer to shop online via e-commerce websites or applications [4]. Therefore, the government of Bahrain considers e-commerce an important economic driver. The growth of e-commerce in Bahrain has expanded locally, despite facing numerous challenges; therefore, to reach an international level, e-commerce companies must update and refine their strategies [5].

In Bahrain, the growth of the e-commerce sector accelerated during the COVID-19 pandemic [4,6,7], but this surge declined after the pandemic [8]. Moreover, the market penetration of e-commerce is lower in Bahrain compared to most countries in the MENA region, as Shannaq et al. [9] noted that fashion products and beverages primarily dominate Bahrain's e-commerce market. In Oman, people prefer to purchase food, fashion products, beverages, and various other items through e-commerce platforms. Furthermore, they highlighted that the projected annual growth rate by compound annual growth rate (CAGR) 2023–2028 of e-commerce in Oman, of 8.45%, is more than that of Bahrain, with 8.09%. Despite the country's growth in e-commerce [10], individuals exhibit low participation in or adoption of e-commerce applications, as they feel insecure while using these applications and consider them difficult to use. Therefore, to increase the number of users, e-commerce platforms should prioritize improving the customer experience [11] by enhancing human–computer interaction (HCI), as this can enhance or satisfy the user experience [12–14].

HCI is an area that mainly focuses on the design, layout, relevance, and use of computer technologies to facilitate human interaction with computers or technology [15]. Moreover, as compared to external factors such as pleasure and comfort, usability of HCI can better predict and enhance the user experience [16] because, due to technological advancements, the traditional interface designs lack the agility to adapt to real-time needs that can enhance the user experience, thus they are incapable of coping with the modern and dynamic needs of users. Therefore, in addition to addressing the challenges, HCI can develop functional and responsive interfaces for users [17]. Recent studies have further demonstrated that sophisticated interactive technologies, such as augmented reality, significantly shape consumer decision-making in digital retail environments by enhancing spatial presence, personalization, and mental imagery [18–21].

The owners of e-commerce platforms must design effective strategies that can overcome challenges, create new business opportunities [22], and increase the number of users by considering factors that enhance human–computer interaction. Moreover, to provide a convenient shopping experience and foster e-commerce growth, policymakers must formulate effective strategies in response to evolving consumer needs [23]. Furthermore, they must devise effective and sustainable market penetration strategies [9]. These strategies could be based on focusing on and enhancing the usability of HCI, as it not only provides ways to enhance the user experience [24] but also helps understand consumer behavior, particularly the factors that lead to consumer satisfaction [25]. The domain of HCI has consistently played a crucial role in shaping the consumer journey from pre-purchase to

post-purchase since the launch of the first e-commerce online store. However, technological advancements have now transformed the entire e-commerce world, from consumer experience to customer support [26]. Thus, policymakers, business owners, or entrepreneurs of e-commerce platforms must focus on the usage of HCI to enhance consumers' adoption of e-commerce applications.

Usability is a crucial determinant of any system intended for human use, as it reflects the system's success or failure [27], determines the users' acceptance of that system [28–30], and highlights the users' experience [16]. Therefore, this research aimed to determine how the usability of HCI is associated with behavioral intention toward e-commerce applications, which in turn shapes self-reported continued usage intentions. The usability was examined by adopting its sub-characteristics, including appropriateness, recognizability, user interface esthetics, learnability, and operability [31], which were computed by focusing on ISO 9241-210 [32] and ISO/IEC 25010:2011 [33] and explained as a strong predictor of user experience satisfaction.

E-commerce has transformed business patterns globally, but beyond changing global trade, it has created several challenges for customers/users in terms of data security and delivery [34]. Therefore, online shopping brands aiming to provide excellent service and enhance their user experience must ensure the security of their users' data [10]. Moreover, e-retailers in Bahrain must secure their e-commerce websites [35] or applications to establish trust among users, as the lack of security or trust features in e-commerce applications operating in the MENA region has led to a 40% decrease in cash-on-delivery transactions [3]. Furthermore, trust in the system is positively associated with the intention to use it [36]. It can strengthen the relationship between behavioral intention towards e-commerce applications and self-reported continued usage intentions. In addition, there is a dearth of research on e-shopping behavior in Bahrain [8]. This study aims to address this gap by applying and testing the ISO 9241-210 and ISO/IEC 25010:2011-based HCI-usability model within a sample of e-commerce users in Bahrain. Given the exploratory nature of this investigation and the sampling constraints, the findings offer preliminary insights into this under-researched context rather than definitive conclusions about the broader Bahraini population. While prior studies have established the importance of HCI for user experience, few have empirically examined its specific sub-characteristics (appropriateness, recognizability, user interface esthetics, learnability, operability) as direct antecedents of e-commerce adoption in the Gulf region. Furthermore, this research investigates the moderating role of trust within this specific model, offering a novel configuration to explain technology adoption beyond traditional frameworks like UTAUT or TAM.

2. Literature Review

Emerging technologies, particularly modern information systems, have changed our lifestyles and have become an essential part of our daily lives. However, the increasing trend of technological adoption has created challenges for HCI professionals and practitioners, demanding more devotion from them while designing the interface of any system. Moreover, children and older adults now use mobile platforms more frequently. Therefore, before designing mobile applications, developers should understand all of the factors of HCI usability [37]. A study by Pushpakumar et al. [38] highlighted that the technological shift has changed user-centered techniques in human–computer interaction, and now it is essential to understand the needs and wants of users before designing an interactive system that can enhance the user experience. The practical design of a computer system's interface can improve the user experience [39]. Many studies have focused on examining the effect of HCI usability on the user experience [16,40,41]. However, there is a dearth of literature on its influence on self-reported continued usage intentions, and Miraz et al. [42]

argued that while designing the interface, the designers must consider the abilities of users that originate from their self-reported continued usage intentions instead of relying merely on the feedback. Therefore, this research has developed the HCI usability model and aimed to determine its influence on the behavioral intention and self-reported continued usage intentions of e-commerce applications.

Despite the growing body of research on HCI and e-commerce, the literature remains fragmented along several dimensions. First, existing studies have predominantly focused on the relationship between HCI usability and user experience outcomes such as satisfaction and perceived ease of use [16,40,41], yet comparatively little attention has been paid to how specific HCI sub-characteristics translate into self-reported continued usage intentions, particularly in emerging e-commerce markets like the Gulf region. Second, where studies have examined e-commerce adoption, they have largely relied on traditional technology acceptance models (e.g., TAM, UTAUT) that emphasize utilitarian drivers while underplaying the nuanced role of interface design attributes such as esthetics, learnability, and operability. Third, a notable gap exists in the application of the ISO/IEC 25010 usability framework to e-commerce contexts, with most prior work focusing on general software quality rather than consumer-facing applications. This study addresses these gaps by applying a structured HCI-usability model to examine how its core sub-characteristics influence behavioral and self-reported continued usage intentions among e-commerce users in Bahrain.

The increasing complexity of software systems has made computer interfaces more difficult to design in a way that meets users' needs. However, this complexity is important to cater to the diverse needs of users based on the system interaction and includes making the system more interactive by including additional features that can save users' time, create ease for them [42], and enhance the use intention of other individuals. HCI has always played an important role in facilitating users, particularly shaping consumer behavior since the launch of the first online store. Now, the technological shift has revolutionized the e-commerce world [26] and directed HCI professionals and marketing practitioners to work together on enhancing the usability of HCI to enhance the users' intention to use the system.

This research adopted the HCI-usability model that includes appropriateness, recognizability, user interface esthetics, learnability, and operability. Appropriateness recognizability means the extent to which users can recognize whether the system is satisfying their needs [43], and in the context of this research, it is defined as the degree to which the users of e-commerce applications can recognize whether these applications are appropriate for their needs.

It is important to note that while the ISO/IEC 25010 standard delineates appropriateness and recognizability as separate sub-characteristics, they were operationalized as a single composite construct in this study. This decision was informed by prior empirical applications [31,43] that have treated them together due to their conceptual overlap in capturing the extent to which users can perceive whether a system meets their needs. Moreover, in the context of e-commerce applications, the two dimensions are empirically intertwined: a user's recognition that an application is suitable for their purpose inherently reflects both the system's appropriateness and its recognizability. While this approach prioritizes parsimony in the measurement model, it represents a limitation that should be addressed in future research seeking to examine the distinct effects of each sub-characteristic.

User interface esthetics shows the degree to which the interface of the system is pleasing and provides a satisfying interaction to users [44–46]. Similarly, this research has defined it as the degree to which the interface of e-commerce applications is pleasing and engaging to satisfy the users' needs. Learnability refers to the degree of ease of doing simple

tasks when the user encounters the design for the first time. Moreover, it enables users to easily understand the application, navigate the mechanism, and look for the specific information they want [47]. This research has conceptualized learnability as the degree to which users easily understand the e-commerce application and look for information about any product they are seeking. Operability refers to the degree to which the attribute of the system makes the system easy to operate [45]. Similarly, this research has conceptualized it as the degree to which attributes of an e-commerce application create ease for users to operate and control the application.

Beyond foundational usability characteristics, contemporary e-commerce platforms increasingly employ personalization strategies to enhance user engagement. These include adaptive user interfaces that dynamically adjust content, layout, or product recommendations based on individual user behavior, preferences, and contextual factors [42,48]. Personalization can manifest through different UI variants targeted at distinct user segments, for example, novice versus experienced shoppers, or users with varying device capabilities [49]. Such approaches not only improve learnability by reducing cognitive load but also enhance perceived relevance and satisfaction. However, the integration of personalization features within the ISO/IEC 25010 usability framework remains under-explored, particularly in terms of how personalized interfaces interact with core usability sub-characteristics like operability and user interface esthetics. This study does not directly examine personalization mechanisms, but its focus on foundational usability attributes provides a baseline for future investigations into how personalization moderates or amplifies these effects. The literature review on the HCI-usability model and its outcomes is given below.

2.1. Appropriateness, Recognizability, and Behavioral Intention

The rapid growth of the e-commerce industry demands a more advanced, adaptable and an appropriate system to enhance the users' experience, as suggested by Pu and Quan [50]. ISO/IEC 25010 highlights that the appropriateness and recognizability of the system show the adequacy of the system to satisfy the needs of users. Moreover, appropriateness recognizability is associated with the acceptability of the system [51,52]. Furthermore, the appropriateness recognizability of the system ensures its readability, completeness, coverage, and self-description; thus, it creates ease for users [53]. Bimantara and Rochimah [31] investigated the usability of online food applications and highlighted that applications must be more recognizable to satisfy the needs of users. While prior studies have established the importance of appropriateness and recognizability in software quality contexts, their specific role in shaping e-commerce behavioral intention, particularly in under-researched Gulf markets, remains underexamined. Therefore, the combined effect of appropriateness recognizability can also enhance behavioral intentions towards e-commerce applications. Thus, the following is hypothesized:

H1. *Appropriateness recognizability positively influences behavioral intention.*

2.2. User Interface Esthetics and Behavioral Intention

The interface of the system is important to enhance users' experience; thus, designers must design an efficient and esthetic interface [38]. Moreover, to develop an esthetically appealing and functional interface, they must consider the needs of all types of users, including individuals with color blindness and disabilities [53]. Pratama and Mutiara [43] highlighted that, besides learnability and operability, user interface esthetics are also an important factor that must be considered by developers while designing a system. Similarly, Bhandari et al. [54] demonstrated that the visual esthetics of applications ensures quality and enables individuals to download them. Furthermore, Bimantara and Rochimah [31]

argued that online food applications can improve their interface esthetics to enhance their usability and users' satisfaction [16]. The esthetic experience provided by applications not only satisfies the users but also is positively associated with their behavioral intentions [55,56]. Although esthetic design has been linked to user satisfaction and download intentions, its influence within a structured HCI-usability framework has rarely been tested in e-commerce contexts, representing a key gap addressed by this study. Therefore, the user interface esthetics of an e-commerce site can enhance behavioral intention. Thus, the following is hypothesized:

H2. *User interface esthetics positively influence behavioral intention.*

2.3. Learnability and Behavioral Intention

According to Bayomi et al. [53], who developed an evaluation metric to evaluate the usability of applications, developers must focus on ensuring learnability by providing complete user guidance and a self-explanatory interface. Particularly, e-commerce applications must incorporate information about their business, including the profile of the company, contact information, and aims and objectives, because such information makes the users more confident [57]. Moreover, the emerging trend of e-commerce and dynamic customer preferences demands an effective recommender system [48] that can provide users with specific information [47] and suggest products or services according to their interests. Thus, learnability is more critical than appropriate recognizability [43] and is associated with behavioral intention. Despite the acknowledged importance of learnability for user confidence and system adoption, empirical evidence linking learnability directly to behavioral intention in e-commerce applications remains limited, particularly in the Middle East region. Therefore, this research has proposed that learnability can enhance behavioral intention towards using e-commerce applications hypothesizes the following:

H3. *Learnability positively influences behavioral intention.*

2.4. Operability and Behavioral Intention

Operability and learnability of the system are important to determine its quality [43] and ability to satisfy the users' needs and enhance their behavioral intentions [58,59]. Similarly, Kivijärvi and Pärnänen [16] highlighted that operability is the most important factor among all the other usability sub-characteristics and that is positively associated with the users' satisfaction. Operability has been identified as a critical determinant of user satisfaction in software systems, yet its role as an antecedent of behavioral intention in e-commerce applications warrants further investigation, especially in emerging digital markets. Therefore, the operability of e-commerce applications can enhance the behavioral intention of individuals [60]. Thus, the following hypothesis is developed to determine the influence of operability on behavioral intention towards e-commerce applications:

H4. *Operability positively influences behavioral intention.*

2.5. Behavioral Intention, Trust, and Self-Reported Continued Usage Intentions

A study by Imtiaz [61] used the UTAUT model to predict the factors influencing mobile commerce and highlighted that behavioral intentions in m-commerce are associated with self-reported continued usage intentions. Similarly, Maulidina et al. [62] focused on Indonesian individuals and indicated that behavioral intention is associated with the self-reported continued usage intentions of e-commerce applications. Yassierli et. al. [63] gathered data from 230 customers and argued that self-reported continued usage intentions for m-commerce applications are associated with the behavioral intention. In addition,

Pramudito et al. [64] and Cao [65] argued that behavioral intention enables individuals to use e-commerce applications. Most of the studies focusing on behavioral intentions in e-commerce applications or m-commerce have focused on traditional models, such as UTAUT [64,66,67], UTAUT 2 [62,68,69], or TAM [70,71], but there is a dearth of research in the context of HCI usability. The ISO/IEC 25010 usability framework posits that system quality attributes directly influence user responses. However, the framework does not explicitly theorize the mechanism through which these usability characteristics translate into sustained engagement. This study proposes that behavioral intention serves as the mediating mechanism linking HCI usability to self-reported continued usage intentions. Specifically, when users perceive e-commerce applications as appropriate, esthetically pleasing, learnable, and operable, they form favorable behavioral intentions, which in turn manifest as intentions for continued use. Furthermore, trust is proposed as a moderator that strengthens the translation of behavioral intention into self-reported continued usage intentions, consistent with prior research showing that trust amplifies the commitment to continued system use [16]. Therefore, based on the discussion given above, the following hypotheses are developed:

H5. *Behavioral intention toward e-commerce applications positively influences self-reported continued usage intentions.*

H6. *Trust positively moderates the relationship between behavioral intention and self-reported continued usage intentions towards e-commerce applications.*

Based on the discussion above, the conceptual framework of this research was developed. Figure 1 shows that sub-characteristics of HCI usability (appropriateness, recognizability, user interface esthetics, learnability, and operability) generate the behavioral intention that is associated with self-reported continued usage intentions of e-commerce applications.

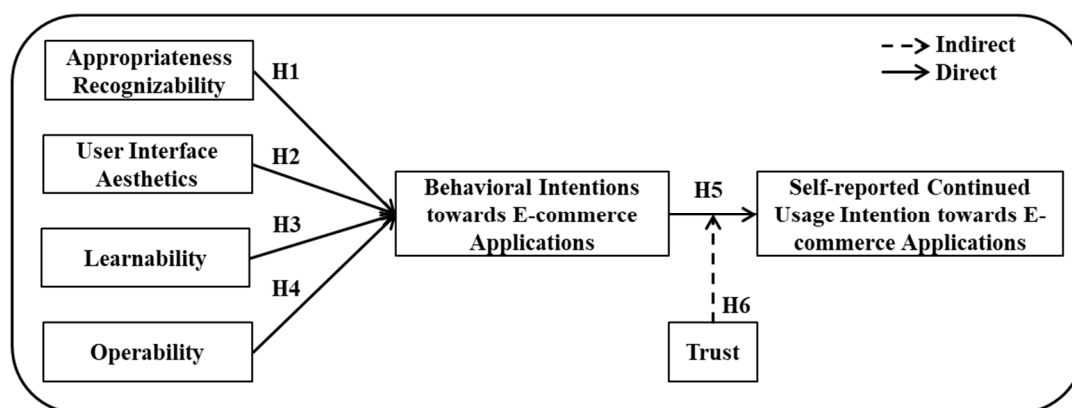


Figure 1. Research model. Source: Developed by the authors.

3. Methodology

Bahrain implemented an e-commerce law in 2006; however, due to technological advancements, these laws should be thoroughly reviewed again [5], and e-commerce owners should focus on enhancing the usability of their e-commerce applications. Prior studies on the adoption of e-commerce applications have focused on developed countries, but there is a paucity of research on e-shopping behavior in Bahrain [8]. Moreover, most studies relied on UTAUT or UTAUT 2 models to determine the acceptance of e-commerce [64,72,73] instead of focusing on improving HCI and identifying the factors that can improve the usability of e-commerce applications and enhance user adoption. Therefore, this research has

followed the ISO 9241-210 and ISO/IEC 25010:2011-based HCI-usability model developed by Realpe-Muñoz et al. [74] to reveal the factors influencing the behavioral intention of Bahraini individuals toward e-commerce applications and their self-reported continued usage intentions of e-commerce applications. It has investigated how HCI-usability factors, including appropriateness, recognizability, user interface esthetics, learnability, and operability, can influence the behavioral intentions of Bahraini individuals toward e-commerce applications, which in turn shape their self-reported continued usage intentions. Moreover, it aimed to determine the moderating role of trust in the relationship between the behavioral intentions of Bahraini individuals toward e-commerce applications and their self-reported continued usage intentions.

3.1. Measurement Items

The questionnaire comprised three sections. In Section 1, information was provided about the research and the respondents were assured that their participation would be voluntary; they could ask any questions or withdraw from the research at any time. Section 2 comprised three questions related to the demographic characteristics of the respondents. Section 3 was based on questions about all the variables, including HCI usability, behavioral intention, and self-reported continued usage intentions of e-commerce applications. The HCI usability was examined in terms of its four sub-characteristics. First, following prior applications of the ISO/IEC 25010 framework in HCI-usability research [31,43], appropriateness and recognizability were combined into a single composite construct and measured with five items. The second sub-characteristic of user interface esthetics was examined with four items. The third and fourth sub-characteristics, learnability and operability, were measured using three items each. The items of all the sub-characteristics were taken from Pärnänen [75].

Trust in the e-commerce application was measured using three items adopted from Palmatier et al. [76]. The behavioral intention towards e-commerce applications was measured using three items adopted from Venkatesh et al. [77]. Self-reported continued usage intentions toward e-commerce applications were measured using three items adapted from Venkatesh et al. [78] and Venkatesh et al. [77]. The items captured users' intentions to continue using, recommend to others, and increase future usage of e-commerce applications. As a self-reported measure, this construct reflects perceived intentions rather than objectively tracked usage behavior. Every item of the HCI usability, behavioral intention towards e-commerce applications, trust, and self-reported continued usage intentions of e-commerce applications was analyzed on the five-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). Moreover, despite the validation of all the items from prior studies, pre-testing was done before finalizing the questionnaire. The pre-testing was done in two steps. In the first step, feedback was gathered from academicians, and in the second stage, the opinions of e-commerce experts were sought regarding the items selected for the research. The academicians provided some basic suggestions related to the items, and based on their recommendations, the items were modified accordingly. Similarly, the suggestions of e-commerce experts/practitioners were also incorporated to finalize the questionnaire.

3.2. Sampling, Data Collection, and Analysis

The e-commerce sector is growing rapidly in the MENA region [3]; however, in Bahrain, the trend of e-commerce, particularly online shopping, declined after the COVID-19 pandemic [8]. Moreover, the growth of e-commerce in Bahrain is lower than in Oman due to the low participation of individuals [9]. Furthermore, individuals lack trust in using e-commerce applications, and many find it challenging to use them. Therefore, this research aimed to determine the factors leading to the use of e-commerce applications. The

survey/questionnaire method was employed to collect data from Bahraini individuals. The questionnaire was administered in English. While this may limit participation to English-proficient individuals, it was retained to preserve the semantic integrity of the validated scales. This potential sampling bias is acknowledged as a limitation of the study (see Section 7). A convenience sampling technique was employed to collect data from users of e-commerce applications in Bahrain. The resulting sample exhibited a demographic skew, with 78% male and 78% aged 25–35 years. The questionnaire was administered in English, which may have limited participation to English-proficient individuals. This method was chosen for feasibility and to gather initial exploratory insights from an accessible segment of the user base. Consequently, the findings reflect the perspectives of this specific demographic segment and are not intended to be statistically representative of the entire Bahraini population. Any inferences drawn from this sample should be interpreted with these sampling constraints in mind. The questionnaire was manually distributed to selected individuals in Manama, and a link to the online questionnaire was also shared in various social media groups. The entire data collection process took 12 days, from 2 May 2025 to 14 May 2025.

The population of Bahrain is approximately 1.6 million. While a sample size of 398 exceeds the minimum requirements for PLS-SEM analysis [79], the convenience sampling approach and demographic skew limit the generalizability of the findings. Therefore, the results should be viewed as exploratory and specific to the sampled demographic segment rather than representative of the broader population. To mitigate and assess the risk of Common Method Bias (CMB), both procedural and statistical remedies were employed. Procedurally, respondent anonymity was assured, and scale items were presented with clear instructions to reduce evaluation apprehension. Statistically, Harman's single-factor test indicated 34.011% variance for the first factor (<50% threshold). More robustly, the Full Collinearity VIFs for all constructs were examined and found to be below the conservative threshold of 3.3, suggesting CMB is not likely to bias the model estimates [80] significantly. The results of the demographic characteristics highlighted that most respondents are males, which is a proportion of 78%. The age of most respondents was between 25 and 35 years, i.e., 78% of respondents, indicating that in Bahrain, individuals in this age group frequently use e-commerce applications or are more inclined towards them. Moreover, the demographic information highlighted that most respondents hold a bachelor's degree.

3.3. Data Analysis

The research focused on e-commerce applications in Bahrain, and the data were gathered from Bahraini individuals who use these applications. SPSS 29.0 was used to determine the demographic characteristics and descriptive statistics of the data. Moreover, SmartPLS 4 was employed to investigate the hypothetical statements, as the PLS-SEM approach is efficient in handling non-normal data [81] and in analyzing complex models [79] or multiple relations simultaneously [82]. Furthermore, it provides an adequate and precise estimate of moderating relationships [83]. Therefore, this approach was preferred to determine the complex relationship between HCI usability, behavioral intention, trust, and self-reported continued usage intentions of e-commerce applications.

4. Results

SmartPLS4 analyzes the data in two stages, with the first being a measurement model stage and the second a structural model stage [84]. Therefore, in this research, the same pattern was adopted, and in the first stage of analysis the measurement model was estimated. It is considered an important stage because, in addition to defining the relationship between indicators and latent variables [85], it investigates the characteristics of each construct and

ensures reliability and validity [86]. The results of the measurement model indicated that the loadings for all factors of trust, behavioral intention, and self-reported continued usage intentions exceeded the minimum threshold value of 0.5 suggested by Hair et al. [87]. Moreover, the loadings of the factors of HCI usability exceed this threshold except for the three items of the user interface esthetics with UIA1: -0.420 , UIA2: -0.387 , UIA3: -0.436 , and the one item of operability with OPR3: 0.497 . Thus, these items were eliminated from further analysis.

The three items initially measuring user interface esthetics (UIA1–UIA3) exhibited negative loadings. These items were not reverse-coded; their negative loadings suggest potential issues with item interpretation, translation clarity, or cultural relevance of the esthetics construct within the Bahraini e-commerce context. After removing these problematic items, the remaining two items (UIA4 and UIA5) demonstrated strong factor loadings exceeding 0.80, and the construct's composite reliability (CR) and average variance extracted (AVE) exceeded the recommended thresholds. The theoretical stability of the two-item user interface esthetics construct was further supported by its high convergent validity and discriminant validity, as well as its significant and theoretically consistent relationship with behavioral intention ($\beta = 0.606$, $p < 0.001$), which aligns with prior HCI research [43,54].

The high negative loadings may indicate a potential issue with item wording, translation, or respondent interpretation of the “esthetics” construct within this specific cultural and application context. This measurement challenge is discussed as a limitation (Section 7). The AVE for the constructs of HCI usability, behavioral intention, trust, and self-reported continued usage intentions was above the minimum threshold of 0.5 as suggested by Darsono et al. [88] and Hair et al. [79]. The multicollinearity was determined by examining the variance inflation factor (VIF), and the findings highlighted that the VIF values for all items were less than 5, confirming the absence of multicollinearity [79].

Table 1 shows AVE, CR, and Cronbach's alpha of each construct, and presents the VIF values for each item of the constructs. The table highlights that the reliability of each construct is above the minimum threshold of 0.7; thus, the data is reliable. Moreover, it confirms the convergent validity as the AVE exceeds 0.5 and ranges between 0.611 and 0.861, and the values of CR were between 0.778 and 0.924. Notably, operability demonstrated a composite reliability of 0.924, confirming strong internal consistency for this construct. Furthermore, the estimation of the measurement model ensured discriminant validity by evaluating Fornell–Larcker's criterion and the Heterotrait–Monotrait ratio of correlations (HTMT).

Table 2 shows the result of discriminant validity. As shown in the table, the diagonal values (in bold) represent the square roots of the AVE for each construct, while the off-diagonal values represent the correlations between constructs. For discriminant validity to be established, the square root of AVE for each construct must exceed its correlations with all other constructs [79]. In Table 2, all diagonal values are greater than their corresponding off-diagonal correlations, confirming discriminant validity. The HTMT criterion was used to ensure the discriminant validity, and the results highlighted that the values for each construct were below 0.85, which is the maximum threshold suggested by Hair et al. [79]. Thus, both criteria ensured discriminant validity. Discriminant validity was further assessed using the HTMT ratio of correlations, with all values falling below the conservative threshold of 0.85 [89]. Convergent validity was confirmed as all AVE values exceeded 0.50. Specifically, the AVE values ranged from 0.611 to 0.861, indicating that each construct explains more than half of the variance in its respective indicators. Internal consistency was established through CR and Cronbach's alpha, both exceeding 0.70 for all constructs. These results collectively support the adequacy of the measurement model prior to structural model estimation. In the second stage of data analysis, the structural

model was evaluated by following the suggestion of Sarstedt et al. [81], who recommended using the bootstrapping technique with a minimum of 10,000 subsamples and reporting R^2 and t-values. Accordingly, bootstrapping was performed with 10,000 subsamples using the no-sign-changes option, and significance levels were assessed based on two-tailed tests at the 95% confidence interval. The explanatory power of the model was analyzed using R^2 , which measures the variance in each endogenous construct. The result demonstrated that the R^2 values for behavioral intention and self-reported continued usage intentions were 0.486 and 0.612, respectively, indicating moderate to substantial variance [90]. The confirmation of reliability, discriminant validity, convergent validity, variance, and predictive relevance led to the statistical analysis of hypothetical statements.

Table 1. Results of measurement model.

Constructs and Items		Loadings	CR	AVE
HCI Usability (Appropriateness Recognizability) (α : 0.792)				
AR1	The elements of the applications were self-explanatory.	0.799	0.822	0.611
AR2	I easily understood what the applications were meant for.	0.787		
AR3	The applications were intuitive.	0.728		
AR4	I could easily tell whether I could accomplish the given tasks through these applications.	0.811		
HCI Usability (User Interface Esthetics) (α : 0.839)				
UIA4	The applications are attractive/esthetic.	0.840	0.907	0.830
UIA5	The applications are fascinating.	0.977		
HCI Usability (Learnability) (α : 0.838)				
LL1	I found it easy to start using e-commerce applications.	0.893	0.840	0.755
LL2	It was easy to learn to use e-commerce applications.	0.864		
LL3	I was able to learn how to use all the functionalities in e-commerce applications needed to complete the required tasks.	0.850		
HCI Usability (Operability) (α : 0.827)				
OPR1	It was easy to do the tasks with the applications.	0.921	0.924	0.830
OPR2	I found it easy to control the applications while completing the tasks.	0.935		
Behavioral Intention Towards E-commerce Apps (α : 0.727)				
BI1	I intend to continue using e-commerce applications in the future.	0.754	0.778	0.642
BI2	I will always try to use e-commerce applications in my daily life.	0.767		
BI3	I plan to continue to use e-commerce applications frequently.	0.877		
Self-reported Continued Usage Intentions for E-commerce Apps (α : 0.887)				
SCUI1	I have or plan to use the e-commerce applications.	0.893	0.887	0.815
SCUI2	I would recommend that someone use e-commerce applications.	0.903		
SCUI3	I will be using e-commerce applications more frequently in the future.	0.912		
Trust (α : 0.809)				
TT1	E-commerce applications give me a feeling of trust.	0.853	0.864	0.713
TT2	I have trust in E-commerce applications.	0.823		
TT3	E-commerce applications are trustworthy.	0.857		

AR: Appropriateness recognizability, BI: Behavioral intention, LRN: Learnability, OPR: Operability, TT: Trust, SCUI: Self-reported continued usage intentions, UIA: User interface esthetics. Source: Table by authors.

Table 3 represents the structural model of this study, which encompasses five direct and one moderating relationship(s). The direct hypotheses were assessed with the direct path analysis. The direct paths are measured between appropriateness recognizability (AR), user interface esthetics (UIA), learnability (LRN), operability (OPR), and behavioral intention towards e-commerce applications. Moreover, $BI \rightarrow SCUI$, a direct hypothesis,

was examined using direct path analysis. The first four hypotheses were developed to investigate the relationship between HCI usability sub-characteristics and behavioral intention towards e-commerce applications.

Table 2. Discriminant validity.

Variable	AR	BI	LRN	OPR	TT	SCUI	UIA
AR	0.782						
BI	0.298	0.801					
LRN	0.126	0.447	0.869				
OPR	0.079	0.154	0.100	0.911			
TT	0.056	0.309	0.339	0.160	0.844		
SCUI	0.047	0.433	0.497	0.168	0.786	0.903	
UIA	0.079	0.788	0.525	0.101	0.229	0.506	0.911

AR: Appropriateness recognizability, Bold values: Square Root of AVE, BI: Behavioral intention, LRN: Learnability, OPR: Operability, TT: Trust, SCUI: Self-reported continued usage intentions, UIA: User interface aesthetics. Source: Table by authors.

Table 3. Hypotheses testing.

Hypothesis	Relationship	Std. Beta	Std. Dev.	t-Value	p-Value	LL	UL	f2
H1	AR → BI	0.185	0.040	4.683	$p < 0.001$	0.115	0.245	0.066
H2	UIA → BI	0.606	0.034	17.813	$p < 0.001$	0.550	0.661	0.575
H3	LRN → BI	0.088	0.044	1.987	0.023	0.013	0.158	0.012
H4	OPR → BI	0.127	0.047	2.729	0.003	0.003	0.183	0.031
H5	BI → SCUI	0.268	0.028	9.695	$p < 0.001$	0.222	0.313	0.176
H6	TT*BI → SCUI	0.159	0.038	4.222	$p < 0.001$	0.097	0.221	0.056

AR: Appropriateness recognizability, BI: Behavioral intention, LRN: Learnability, OPR: Operability, TT: Trust, SCUI: Self-reported continued usage intentions, UIA: User interface esthetics. Source: Table by authors.

H1 aimed to determine the relationship between appropriateness, recognizability, and behavioral intention towards e-commerce applications. The results reported that behavioral intention towards e-commerce applications is significantly associated with appropriateness recognizability of the e-commerce application ($\beta = 0.185$, $t = 4.683$, $p < 0.001$); thus, H1 was supported. H2 determined the association between user interface esthetics and behavioral intention towards e-commerce applications. The results reported that user interface esthetics are significantly associated with behavioral intention towards e-commerce applications ($\beta = 0.606$, $t = 17.813$, $p < 0.001$); thus, H2 was supported. H3 aimed to highlight the significant and positive relationship between learnability and behavioral intention towards e-commerce applications. Statistically, a significant and positive relationship was found between learnability and behavioral intention towards e-commerce applications ($\beta = 0.088$, $t = 1.987$, $p = 0.023$). Given that the p -value is close to the conventional 0.05 significance threshold and the t -value slightly exceeds the critical value of 1.96 (based on 10,000 bootstrap subsamples), this finding should be interpreted as marginally significant but supportive of H3. H4 was developed to investigate the influence of operability on behavioral intention towards e-commerce applications. The results reported a significant influence of the operability of e-commerce applications on behavioral intention towards e-commerce applications ($\beta = 0.127$, $t = 2.729$, $p = 0.003$); thus, H4 is supported. H5 evaluated whether behavioral intention towards e-commerce influences self-reported continued usage intentions. The results revealed that the self-reported continued usage intentions of e-commerce applications stem from behavioral intentions ($\beta = 0.268$, $t = 9.695$, $p < 0.001$). Hence, H5 was supported. In addition to the direct paths, the research model evaluated the moderation of trust between behavioral intention and self-reported continued usage intentions of e-commerce applications.

The results shown in Table 3 and Figure 2 revealed that trust significantly moderates the relationship between behavioral intention and self-reported continued usage intentions of e-commerce applications ($\beta = 0.159$, $t = 4.222$, $p < 0.001$). Hence, H6 was supported.

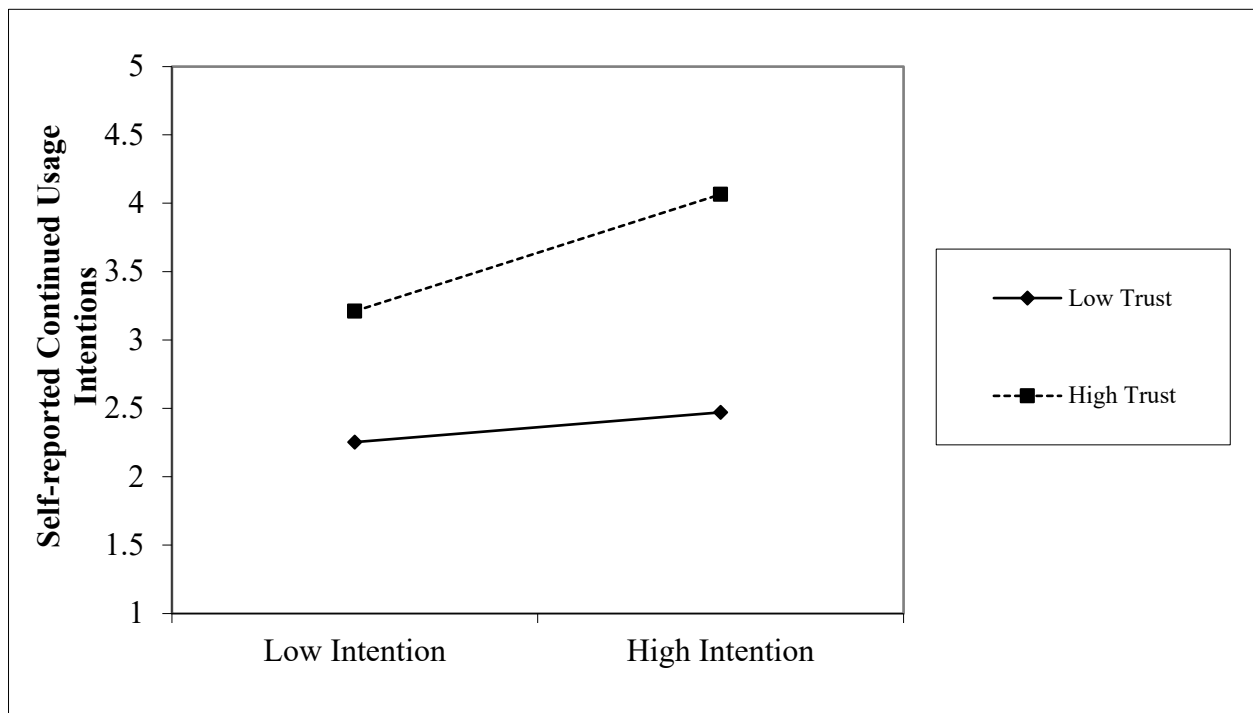


Figure 2. Moderation effects of trust on the BI and self-reported continued usage intention relationship. Source: Developed by the authors.

Table 4 shows the results of predictive power. The predictive power of the PLS-SEM was determined using PLS-predict. For BI, among the three items, two (BI1 and BI3) had PLS-SEM_RMSE values lower than the LM_RMSE benchmarks, indicating medium predictive accuracy. For SCUI, all three items (SCUI1, SCUI2, SCUI3) had PLS-SEM_RMSE values lower than the corresponding LM_RMSE values, indicating high predictive accuracy. The PLS-SEM_RMSE values for SCUI ranged from 0.389 to 0.438, and the LM_RMSE values ranged from 0.421 to 0.467. Overall, the model demonstrates satisfactory predictive power for both endogenous constructs.

Table 4. PLS-predict.

MV	Q ² Predict	PLS-SEM_RMSE	LM_RMSE	PLS-IA_RMSE
BI1	0.275	0.824	0.877	−0.053
BI2	0.109	1.029	0.957	0.072
BI3	0.462	0.971	0.989	−0.018
SCUI1	0.681	0.412	0.445	−0.033
SCUI2	0.624	0.438	0.467	−0.029
SCUI3	0.703	0.389	0.421	−0.032

BI: Behavioral intention, SCUI: Self-reported continued usage intentions. Source: Table by authors.

5. Discussion

This study applied an HCI usability framework to explore the factors associated with e-commerce adoption within a sample of Bahraini users. While the model supports several relationships consistent with prior research, its primary contribution lies in providing

exploratory evidence of the relative importance of specific HCI sub-characteristics, most notably user interface aesthetics, and in examining the trust mechanism within this configuration for a sample in the Gulf region. Given the sampling constraints, these findings should be interpreted as preliminary insights rather than confirmatory conclusions. The following discussion interprets these findings while acknowledging the study's methodological boundaries. In this era of globalization, development of and global access to the internet have brought about a technological revolution that is growing rapidly [11] and transforming the entire business landscape. Globalization and the increase in technological advancement have replaced traditional business models, which are physical businesses with more technology-oriented or digital business models, such as online startups and particularly E-commerce platforms [48], which are growing rapidly and transforming society [11,91]. E-commerce has made it easy for consumers to order goods and services at any time from anywhere they prefer. Similarly, it has made it easier for business owners and entrepreneurs to access global markets, expand their operations, and find sales opportunities worldwide. Moreover, the exponential growth of e-commerce in GDP helped countries enhance their economic growth [92]. Beyond the direct consumer-facing aspects of HCI, the successful adoption and sustained competitive advantage of digital business models also depend on organizational capabilities, particularly the integration of artificial intelligence and the digital literacy of managerial personnel, which enable small and medium-sized enterprises to navigate digital transformation and build sustainable competitive advantage [93–96]. However, the increasing diversity of customer preferences directs the attention of e-commerce owners to improving the usability of their applications [48] by focusing on all the concepts of HCI while designing mobile applications [49] because many users have never interacted with them [42] or have found them difficult to use.

HCI has become more important nowadays as people are more inclined towards digital systems or applications and rely on them [17]. Therefore, it is essential to determine the success and failure of HCI and particularly to highlight the factors contributing to its usability. The usability of a system satisfies the users by enhancing their user experience. Thus, this research has determined the factors contributing to the usability of e-commerce applications and highlighted their influence on behavioral intentions associated with self-reported continued usage intentions. Additionally, it examined the moderating role of trust between behavioral intention and self-reported continued usage intentions. The first four hypotheses were developed to determine the influence of HCI usability sub-characteristics on behavioral intention towards e-commerce applications. The first hypothesis aimed to investigate the relationship between appropriate recognizability with a sub-characteristic of HCI usability, and the behavioral intention of Bahraini individuals towards e-commerce applications. The results emphasize that the behavioral intention of Bahraini individuals is significantly associated with the appropriate recognizability of e-commerce applications, thus supporting H1. The findings are in line with the prior research by Shah and Chiew [52], who also argued that the system's appropriate recognizability is associated with its usability. Similarly, Bimantara and Rochimah [31] noted that applications must be more recognizable to meet users' needs. Therefore, e-commerce application developers in Bahrain must include self-explanatory elements in their apps to make them understandable and intuitive, thereby potentially enhancing the behavioral intention of users within this demographic segment. The second hypothesis was developed to investigate the relationship between user interface aesthetics, with a sub-characteristic of HCI usability, and the behavioral intention of Bahraini individuals towards e-commerce applications.

The results highlighted that the user interface aesthetics of e-commerce applications are important for enhancing behavioral intention; thus, H2 is supported, and these findings are supported by the research by Pratama and Mutiara [43], which also showed the importance

of user interface esthetics for user satisfaction. The improvement in interface esthetics is important to enhance users' usability and satisfaction [16]. Therefore, developers must consult with marketing practitioners to make e-commerce applications more attractive and fascinating. Within this sample, attractive applications were associated with greater user engagement. Notably, the effect size for user interface esthetics ($\beta = 0.606$) was the largest among all HCI sub-characteristics examined, suggesting that visual appeal may serve as a primary gateway to user engagement in e-commerce contexts. This differential magnitude warrants theoretical interpretation. One possible explanation is that in consumer-facing applications, hedonic qualities such as visual appeal may precede or even outweigh purely utilitarian usability attributes in shaping initial adoption intentions. This aligns with the notion that users often form rapid, affect-driven judgments about digital interfaces before engaging with functional features. Practically, this implies that investments in interface design, including color schemes, typography, visual hierarchy, and overall esthetic coherence, may yield higher returns in user acquisition than improvements to functional usability alone, particularly for first-time users.

Application developers must ensure the learnability of their applications during development [53]. They can include the complete business profile of the company [57] or add an effective recommender system [48] to enhance user satisfaction and acceptability. Therefore, the third hypothesis aimed to determine the influence of the learnability of e-commerce applications on users' behavioral intentions. The results provided marginal support for this hypothesis ($\beta = 0.088$, $p = 0.023$), indicating that learnability is associated with behavioral intention, though this relationship should be interpreted with caution given the borderline p -value. The findings align with the study by Pratama and Mutiara [43], who noted that learnability is a crucial factor in enhancing user experience.

The fourth hypothesis was developed to determine the influence of the operability of e-commerce applications on the behavioral intention of individuals. The results supported the hypothesis, and the findings highlighted that the behavioral intention of Bahraini individuals towards using e-commerce applications originates from operability. These findings are supported by [16], who noted that operability is the most important among other sub-characteristics of usability in enhancing user satisfaction and behavioral intention [58] among new users. The effect sizes for learnability ($\beta = 0.088$) and operability ($\beta = 0.127$) were notably smaller than those observed for user interface esthetics. This differential magnitude warrants interpretation. One possible explanation is that while learnability and operability are foundational for sustained system use, particularly for complex tasks, they may be taken for granted by users who already possess basic digital literacy. In a sample characterized by young, educated adults (78% aged 25–35), these functional attributes may represent baseline expectations rather than differentiating factors. In contrast, for novice, older, or less digitally proficient user segments, learnability and operability might carry greater weight in shaping behavioral intention. This suggests that the relative importance of HCI sub-characteristics may be contingent on user demographics—a proposition that future research should examine through moderated analyses across diverse population segments.

The penultimate hypothesis was developed to determine the influence of behavioral intention on self-reported continued usage intentions for e-commerce, and the results reported that self-reported continued usage intentions stem from behavioral intention, thus H5 was supported. The findings align with the research by Yaqub et al. [97], who argued that the self-reported continued usage intentions of mobile-commerce applications are associated with the behavioral intention of users. Consistent with the measurement approach, these findings reflect self-reported continued usage intentions rather than objectively observed usage patterns. While this finding aligns with the established technology acceptance literature, its interpretation within the HCI-usability framework offers additional nuance.

The effect size ($\beta = 0.268$) suggests that while behavioral intention is a necessary precursor to self-reported continued usage intentions, it is not sufficient. Other factors, such as habitual use, switching costs, positive prior experiences, or the presence of competing applications, may intervene between intention and sustained behavior. Moreover, in the context of self-reported intentions (as measured in this study), the intention–behavior gap may be particularly pronounced, as intentions do not always translate into actual behavior when measured cross-sectionally. Future research employing longitudinal designs or objective usage data could more precisely estimate the translation of HCI-driven intentions into actual continued use over time.

The last hypothesis was developed to determine the moderating effect of trust on the relationship between behavioral intention and self-reported continued usage intentions of e-commerce applications among Bahraini individuals. The results supported the hypothesis and highlighted that trust strengthens the influence of behavioral intention on self-reported continued usage intentions towards e-commerce applications. Prior research by Kivijärvi and Pärnänen [16] supported these findings, claiming that trust is important in predicting user satisfaction and enhancing the e-commerce experience. Therefore, among respondents in this sample, trust in an application was associated with stronger translation of behavioral intention into self-reported continued usage intentions.

These findings support the applicability of the ISO/IEC 25010-based HCI-usability model to e-commerce contexts. The framework's sub-characteristics, when considered collectively, explain approximately 48.6% of the variance in behavioral intention ($R^2 = 0.486$), suggesting that the model captures relevant drivers of user intention within this sample. Notably, user interface esthetics emerged as the strongest predictor ($\beta = 0.606$), indicating that within this demographic segment, visual appeal may be a particularly salient determinant of behavioral intention. This finding extends the ISO/IEC 25010 framework by suggesting a differential weighting of sub-characteristics in consumer-facing versus enterprise software contexts.

6. Conclusions and Implications

In conclusion, this research explored the influence of HCI usability on behavioral intentions toward e-commerce applications within a sample of Bahraini users. The four sub-characteristics of HCI usability were used to highlight the influence of HCI usability on the behavioral intention and self-reported continued usage intention of e-commerce applications. Moreover, the role of trust was investigated as a moderator in the relationship between behavioral intention and self-reported continued usage intentions. Given the demographic skew of the sample (predominantly young, male, and educated), these findings should be interpreted as exploratory and specific to this demographic segment rather than broadly generalizable to the entire Bahraini population. The data gathered from Bahraini individuals revealed that most sub-characteristics of HCI usability are significantly associated with behavioral intention toward e-commerce applications, with learnability demonstrating a marginally significant relationship. Furthermore, the findings underscore that trust strengthens the influence of behavioral intention on the self-reported continued usage intentions of e-commerce applications. Overall, within the limitations of this sample, this research highlights the critical role of HCI in relation to behavioral intention and self-reported continued usage intentions toward e-commerce applications. In addition, it provides valuable insights for marketing practitioners, application developers, and policymakers.

6.1. Theoretical Implications

Technological advancements have changed the shopping patterns and experiences of customers. Nowadays, people mostly prefer shopping online through different mobile-based e-commerce applications. However, many users do not rely on them due to a lack of trust or difficulty in using them. Moreover, to cope with the users' needs, software systems have become more complex and aim to provide an interactive experience to the users by including value-added features [42]. Similarly, concerning the lack of behavioral intention and usage of e-commerce applications in Bahrain, the government is considering e-commerce an important economic driver, and companies are aiming to update their strategies [5] by focusing on the HCI usability. Therefore, this research has highlighted the influence of HCI usability on the behavioral intention and self-reported continued usage intentions for e-commerce applications among Bahraini individuals. Furthermore, it highlighted the moderating role of trust in the relationship between behavioral intention and self-reported continued usage intentions. The main focus of the research was to develop a comprehensive model based on HCI usability to determine the factors leading to self-reported continued usage intentions of e-commerce applications among Bahraini individuals. Thus, it has provided several theoretical and practical implications. Theoretically, it has expanded the literature on HCI usability, including its sub-characteristics that include appropriateness, recognizability, user interface esthetics, learnability, and operability, behavioral intention towards e-commerce applications, and the self-reported continued usage intentions of e-commerce applications in the Kingdom of Bahrain. The findings highlight that self-reported continued usage intentions of e-commerce applications depend on behavioral intention, which originates from the usability of human–computer interaction. Therefore, researchers focusing on HCI usability can get valuable insights from this research. In addition, this research significantly differs from the prior studies, as they mainly focused on determining the significance of HCI usability in enhancing user experience or satisfaction. Thus, this research fills the gap by indicating that HCI usability is also important in influencing new users.

6.2. Practical Implications

In terms of practical implications, this research has helped e-commerce application developers and marketing managers of e-commerce startups and companies design effective strategies to increase their user base through enhancing the usability of the applications because the installation of expensive equipment for customer service or development of retail markets is more expensive than the maintenance of e-commerce websites [98] or applications. Besides enhancing the user experience [24], the improvement in HCI will enable owners to understand consumer behavior [25]. Therefore, the e-commerce application developers in Bahrain must consult with the marketing practitioners and focus on the appropriateness, recognizability, user interface esthetics, learnability, and operability of e-commerce applications to increase the behavioral intention and self-reported continued usage intentions. Attractive, usable, and intuitive e-commerce applications draw users and enhance their intention to engage with the platform. Furthermore, the research has directed policymakers' attention towards ensuring trust for users.

7. Limitations and Recommendations

This study provides insights into HCI usability and e-commerce adoption in Bahrain but is subject to several limitations that outline avenues for future research. First, the sample exhibits a significant demographic skew, with 78% male and 78% aged 25–35 years. This concentration limits representativeness and threatens external validity, as the perspectives of female users, older adults, and other demographic groups are substantially underrepre-

sented. Therefore, the findings should be treated as exploratory insights from a specific demographic segment rather than population-level conclusions. The English-only questionnaire may have further excluded non-proficient English speakers. Future studies should employ stratified random sampling and bilingual instruments to enhance generalizability and allow for subgroup analyses (e.g., by age, gender, nationality). Second, the cross-sectional design precludes definitive causal inferences. While we hypothesize relationships based on theory, the data only reflect associations at a single point in time. A longitudinal design measuring intention prior to observed or self-reported future behavior is needed to test the intention–behavior causal pathway robustly. Third, despite employing procedural remedies and statistical tests (Harman’s test, Full Collinearity VIFs) that suggest CMB is not a pervasive issue, the reliance on self-reported data from a single source remains a potential limitation. Future research could incorporate objective usage metrics or multi-source data. Fourth, the deletion of three items from the user interface esthetics (UIA) construct due to negative loadings raises concerns about the cross-contextual validity of these specific items or the conceptualization of esthetics for this sample. Future work should qualitatively explore perceptions of app esthetics in the Gulf region to refine this measurement. Fifth, the study relies exclusively on self-reported measures of behavioral intention and self-reported continued usage intentions. While this approach is common in technology acceptance research, it captures perceived intentions rather than objectively observed usage behavior (e.g., application log data). Consequently, the findings should be interpreted as reflecting users’ self-assessed dispositions toward e-commerce applications rather than confirmed behavioral outcomes. Future research could complement self-report data with objective usage metrics to strengthen causal claims regarding the intention–behavior link. Sixth, this study combined appropriateness and recognizability into a single composite construct, whereas the ISO/IEC 25010 standard treats them as distinct sub-characteristics. While this decision was informed by prior empirical applications and the conceptual overlap between these dimensions in the context of e-commerce, it precludes the examination of their independent effects. Future research should measure appropriateness and recognizability separately to determine their unique contributions to behavioral intention. Finally, the HCI-usability model focused on a core set of sub-characteristics. Future research could extend it by integrating other relevant factors, such as accessibility, privacy concerns, or cultural dimensions of technology acceptance, and test it in other national contexts within or beyond the MENA region.

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Institutional Review Board Statement: An ethical assessment form for this study was submitted to the Ethics Committee of the Research Center at the Arab Open University–Bahrain on 20 March 2025. The study was designed and conducted in accordance with the IRB-HSBS Informed Consent Guidelines of the Arab Open University–Bahrain and adhered to the ethical principles outlined in the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study. A written informed consent form was included at the beginning of the questionnaire. Prior to participation, all respondents were provided with a comprehensive information sheet detailing the

purpose, procedures, and ethical considerations of the research. Participation was entirely voluntary, and individuals proceeded only after reviewing the information and having any questions addressed. All participants were adults (aged 18 years and above) residing in Bahrain. Written informed consent for publication was not required, as no identifiable personal data were collected.

Data Availability Statement: The datasets for this article are not publicly available due to restrictions set by the data holder. Requests to access the datasets should be directed to the authors. The data presented in this study are available on request from the corresponding author.

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References

1. Qin, Z.; Wang, G.; Deng, W.; Hao, Y. *Introduction to E-Commerce*; Springer Nature: Singapore, 2024.
2. Silitonga, D.; Rohmayanti, S.A.A.; Aripin, Z.; Kuswandi, D.; Sulisty, A.B.; Juhari. Edge Computing in E-Commerce Business: Economic Impacts and Advantages of Scalable Information Systems. *ICST Trans. Scalable Inf. Syst.* **2023**, *11*, 4375. [[CrossRef](#)]
3. Matar, A.; Abdeldayem, M.M.; Aldulaimi, S.H. The Growing Digitalization of E-Commerce in the MENA Region: Consumer Behavior and Shift towards Digital Payment Methods. In *2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETIS)*; IEEE: New York, NY, USA, 2024; pp. 1–5.
4. Ahmed, J.R.A.; Hamdan, A.; Dhia, A. The Impact of Electronic Customer Relationship (E-CRM) Activities on Customer Loyalty in Bahrain E-Commerce Sector. In *Business Development via AI and Digitalization*; Springer Nature: Cham, Switzerland, 2024; Volume 1, pp. 501–512.
5. Maaitah, Q. Review of E-Commerce Legal Framework in Bahrain: Under the Perspective of Local and Global Consumer Protection. *Kuwait Int. Law Sch. J.* **2018**, *6*, 61–85. [[CrossRef](#)]
6. Qahtani, H.A.; Sankar, J.P. Impact of Socio-Economic Dynamic of SMEs and Large Enterprises in GCC. *J. Infrastruct. Policy Dev.* **2024**, *8*, 5310. [[CrossRef](#)]
7. Taqi, M.; Babu, M.R. The Role of Startups in Transformation of the Bahrain Economy. In *Navigating the Technological Tide: The Evolution and Challenges of Business Model Innovation*; Springer Nature: Cham, Switzerland, 2024; pp. 66–78.
8. Algherbal, E.A.; Hijazi, H.I.; Al-Ahmadi, H.M.; Abdullah, M. Analysis of Changes in In-Store and Online Shopping Frequencies Due to the COVID-19 Pandemic: A Case Study from Bahrain. *Sustainability* **2024**, *16*, 4996. [[CrossRef](#)]
9. Shannaq, B.; Saleem, I.; Shakir, M. Maximizing Market Impact: An In-Depth Analysis of the Market Penetration Strategy and Its Effective Tools for Sales Growth and Brand Expansion in the E-Commerce Markets of Oman and Bahrain. In *The AI Revolution: Driving Business Innovation and Research*; Springer Nature: Cham, Switzerland, 2024; pp. 277–291.
10. Aziz, W.A. Unveiling the Catalysts That Ignite Consumer Inclination Towards Online Shopping Platforms. In *2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETIS)*, Manama, Bahrain, 28–29 January 2024; IEEE: New York, NY, USA, 2024; pp. 416–425.
11. AlSada, A.; Al Hashimi, M.; Alsayed, N.; Aldhaen, E. The Impact of E-Commerce on SME Sustainability During Crisis Time: Customer Perception. In *Artificial Intelligence, Internet of Things, and Society 5.0*; Springer Nature: Cham, Switzerland, 2023; pp. 495–512.
12. Akbar, M.; Sankar, J.P.; Ramayah, T.; Alkashami, M. Modeling Artificial Intelligence-Enabled Teaching Continuance Intentions in Higher Educational Institutions Using the Expectation Confirmation Model (ECM). *Cogent Educ.* **2025**, *12*, 2479401. [[CrossRef](#)]
13. Kosch, T.; Karolus, J.; Zagermann, J.; Reiterer, H.; Schmidt, A.; Woźniak, P.W. A Survey on Measuring Cognitive Workload in Human-Computer Interaction. *ACM Comput. Surv.* **2023**, *55*, 283. [[CrossRef](#)]
14. Nicolescu, L.; Tudorache, M.T. Human-Computer Interaction in Customer Service: The Experience with AI Chatbots—A Systematic Literature Review. *Electronics* **2022**, *11*, 1579. [[CrossRef](#)]
15. Tabone, W.; de Winter, J. Using ChatGPT for Human-Computer Interaction Research: A Primer. *R. Soc. Open Sci.* **2023**, *10*, 231053. [[CrossRef](#)]
16. Kivijärvi, H.; Pärnänen, K. Instrumental Usability and Effective User Experience: Interwoven Drivers and Outcomes of Human-Computer Interaction. *Int. J. Hum.-Comput. Interact.* **2023**, *39*, 34–51. [[CrossRef](#)]

17. Kheder, H.A. Human-Computer Interaction: Enhancing User Experience in Interactive Systems. *Kufa J. Eng.* **2023**, *14*, 23–41. [\[CrossRef\]](#)
18. Hilken, T.; Chylinski, M.; Keeling, D.I.; Heller, J.; de Ruyter, K.; Mahr, D. How to Strategically Choose or Combine Augmented and Virtual Reality for Improved Online Experiential Retailing. *Psychol. Mark.* **2022**, *39*, 495–507. [\[CrossRef\]](#)
19. Heller, J.; Mahr, D.; de Ruyter, K.; Schaap, E.; Hilken, T.; Keeling, D.I.; Chylinski, M.; Flavián, C.; Jung, T.; Rauschnabel, P.A. An Interdisciplinary Co-Authorship Networking Perspective on AR and Human Behavior: Taking Stock and Moving Ahead. *Comput. Hum. Behav.* **2023**, *143*, 107697. [\[CrossRef\]](#)
20. Smink, F.R.E.; van Hoeken, D.; Hoek, H.W. Epidemiology of Eating Disorders: Incidence, Prevalence and Mortality Rates. *Curr. Psychiatry Rep.* **2012**, *14*, 406–414. [\[CrossRef\]](#)
21. Poushneh, A.; Vasquez-Parraga, A.Z. Discernible Impact of Augmented Reality on Retail Customer's Experience, Satisfaction and Willingness to Buy. *J. Retail. Consum. Serv.* **2017**, *34*, 229–234. [\[CrossRef\]](#)
22. Zainal, F.Y.; Hamdan, A.M.M. The Impact of E-Commerce on the Development of Entrepreneurship: Literature Review. In *Emerging Trends and Innovation in Business and Finance*; Springer Nature: Cham, Switzerland, 2023; pp. 319–329.
23. Setiawan, D. The Impact of Economic Policy on E-Commerce Growth and Consumer Behavior: Lessons from the COVID-19 Pandemic. *J. Strateg. Mark. Appl. Econ.* **2025**, *1*, 20–25. [\[CrossRef\]](#)
24. Yang, J.; Cao, C.; Ye, C.; Shi, Y. Effects of Interface Design and Live Atmosphere on Consumers' Impulse-Buying Behaviour from the Perspective of Human-Computer Interaction. *Sustainability* **2022**, *14*, 7110. [\[CrossRef\]](#)
25. Li, Y.; Zhong, Z.; Zhang, F.; Zhao, X. Artificial Intelligence-Based Human-Computer Interaction Technology Applied in Consumer Behavior Analysis and Experiential Education. *Front. Psychol.* **2022**, *13*, 784311. [\[CrossRef\]](#)
26. Kourgiantakis, M.; Dimou, I.; Ferreira, M.R.; Ntoa, S.; Margetis, G. HCI in E-Commerce. In *Human-Computer Interaction in Various Application Domains*; CRC Press: New York, NY, USA, 2024; pp. 264–293.
27. Hassan, H.M.; Galal-Edeen, G.H. From Usability to User Experience. In *2017 International Conference on Intelligent Informatics and Biomedical Sciences (ICIIBMS), Okinawa, Japan, 24–26 November 2017*; IEEE: New York, NY, USA, 2017; pp. 216–222.
28. Duan, S. Systematic Analysis of User Perception for Interface Design Enhancement. *J. Comput. Sci. Softw. Appl.* **2025**, *5*, 1–9. [\[CrossRef\]](#)
29. Tan, H.; Sun, J.; Wang, W.; Zhu, C. User Experience & Usability of Driving: A Bibliometric Analysis of 2000–2019. *Int. J. Hum.-Comput. Interact.* **2021**, *37*, 297–307. [\[CrossRef\]](#)
30. Zaki, T.; Islam, M.N. Neurological and Physiological Measures to Evaluate the Usability and User-Experience (UX) of Information Systems: A Systematic Literature Review. *Comput. Sci. Rev.* **2021**, *40*, 100375. [\[CrossRef\]](#)
31. Bimantara, I.M.S.; Rochimah, S. Usability Characteristics Evaluation on Food Delivery Service Applications Using ISO/IEC 25010 Quality Model. In *2023 14th International Conference on Information & Communication Technology and System (ICTS), Surabaya, Indonesia, 4–5 October 2023*; IEEE: New York, NY, USA, 2023; pp. 1–6.
32. ISO 9241-210; Ergonomics of Human-System Interaction—Part 210: Human-Centred Design for Interactive Systems. International Organization for Standardization: Geneva, Switzerland, 2019.
33. ISO/IEC 25010; Systems and Software Engineering—Systems and Software Quality Requirements and Evaluation (SQuaRE)—System and Software Quality Models ISO/IEC 25010. International Organization for Standardization: Geneva, Switzerland, 2011.
34. Ahmed, A.; Alnimer, R. Alternative Dispute Resolution for E-Commerce Disputes. In *Sustainable Data Management*; Springer Nature: Cham, Switzerland, 2025; pp. 415–428.
35. Moh'd, S.; Gregory, P.; Barroca, L.; Sharp, H. Agile Human Resource Management: A Systematic Mapping Study. *Ger. J. Hum. Resour. Manag. Z. Pers.* **2024**, *38*, 345–374. [\[CrossRef\]](#)
36. Hooda, A.; Gupta, P.; Jeyaraj, A.; Giannakis, M.; Dwivedi, Y.K. The Effects of Trust on Behavioral Intention and Use Behavior within E-Government Contexts. *Int. J. Inf. Manag.* **2022**, *67*, 102553. [\[CrossRef\]](#)
37. Sabukunze, I.D.; Arakaza, A. User Experience Analysis on Mobile Application Design Using User Experience Questionnaire. *Indones. J. Inf. Syst.* **2021**, *4*, 15–26. [\[CrossRef\]](#)
38. Pushpakumar, R.; Sanjaya, K.; Rathika, S.; Hussein Alawadi, A.; Makhzuna, K.; Venkatesh, S.; Rajalakshmi, B. Human-Computer Interaction: Enhancing User Experience in Interactive Systems. *E3S Web Conf.* **2023**, *399*, 04037. [\[CrossRef\]](#)
39. Ilhan, A.E. Design Approaches to Improve User Experience: An Example of a Mobile App Prototyping Process. *Int. J. Hum. Comput. Stud.* **2025**, *203*, 103569. [\[CrossRef\]](#)
40. Guerino, G.C.; Valentim, N.M.C. Usability and User Experience Evaluation of Natural User Interfaces: A Systematic Mapping Study. *IET Softw.* **2020**, *14*, 451–467. [\[CrossRef\]](#)
41. Issa, T.; Isaias, P. *Sustainable Design*; Springer: London, UK, 2015.
42. Miraz, M.H.; Ali, M.; Excell, P.S. Adaptive User Interfaces and Universal Usability through Plasticity of User Interface Design. *Comput. Sci. Rev.* **2021**, *40*, 100363. [\[CrossRef\]](#)

43. Pratama, A.A.; Mutiara, A.B. Software Quality Analysis for Halodoc Application Using ISO 25010:2011. *Int. J. Adv. Comput. Sci. Appl.* **2021**, *12*, 383–392. [[CrossRef](#)]
44. Alharoon, D.; Gillan, D.J. The Relation of the Perceptions of Aesthetics and Usability. *Proc. Hum. Factors Ergon. Soc. Annu. Meet.* **2020**, *64*, 1876–1880. [[CrossRef](#)]
45. Gordieiev, O.; Kharchenko, V.; Kate, V. Usable Security Versus Secure Usability: An Assessment of Attributes Interaction. In *ICT in Education, Research and Industrial Applications, Kyiv, Ukraine, 15–18 May 2017*; Integration, Harmonization and Knowledge Transfer; Springer: Berlin/Heidelberg, Germany, 2017; pp. 1–14.
46. Lun, L.; Zetian, D.; Hoe, T.W.; Juan, X.; Jiaxin, D.; Fulai, W. Factors Influencing User Intentions on Interactive Websites: Insights from the Technology Acceptance Model. *IEEE Access* **2024**, *12*, 122735–122756. [[CrossRef](#)]
47. Sibarani, A.J.P. Usability and User Satisfaction Rate Evaluation on E-Learning Application from Student's Perspective Using Nielsen Usability Method. *J. Infotel* **2021**, *13*, 120–127. [[CrossRef](#)]
48. Trinh, T.; Nguyen, V.-H.; Nguyen, N.; Nguyen, D.-N. Product Collaborative Filtering Based Recommendation Systems for Large-Scale E-Commerce. *Int. J. Inf. Manag. Data Insights* **2025**, *5*, 100322. [[CrossRef](#)]
49. Abbiss, A.; Soloniewicz, B.; Jordan, C.; Connolly, C.; Wiegand, C.; Dutkiewicz, C.; Mahmoud, M. Modern HCI for Mobile Applications, Study and Challenges. In *2021 International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, NV, USA, 15–17 December 2021*; IEEE: New York, NY, USA, 2022; pp. 1969–1975.
50. Pu, L.; Quan, Z. A CIMS-Based Decision Support System for e-Commerce: Boosting Real-Time and Effective Digital Marketing. *J. Supercomput.* **2025**, *81*, 229. [[CrossRef](#)]
51. De Angelis, M.; Volpi, L.; Giusino, D.; Pietrantonio, L.; Fraboni, F. Acceptability and Usability of a Digital Platform Promoting Mental Health at Work: A Qualitative Evaluation. *Int. J. Hum.-Comput. Interact.* **2025**, *41*, 1246–1259. [[CrossRef](#)]
52. Shah, U.E.M.; Chiew, T.K. A Systematic Literature Review of the Design Approach and Usability Evaluation of the Pain Management Mobile Applications. *Symmetry* **2019**, *11*, 400. [[CrossRef](#)]
53. Bayomi, H.; Sayed, N.A.; Hassan, H.; Wassif, K. Application-Based Usability Evaluation Metrics. *Int. J. Adv. Comput. Sci. Appl.* **2022**, *13*, 84–91. [[CrossRef](#)]
54. Bhandari, U.; Chang, K.; Neben, T. Understanding the Impact of Perceived Visual Aesthetics on User Evaluations: An Emotional Perspective. *Inf. Manag.* **2019**, *56*, 85–93. [[CrossRef](#)]
55. Lee, S.M.F.; Zhang, A.; Au, N. User Experience of an Augmented Reality Heritage App: An Experience Economy Model. *Tour. Recreat. Res.* **2025**, *50*, 727–742. [[CrossRef](#)]
56. Faizal, S.; Sankar, J.P.; Menon, N.; Abdalla, R.; Pattali, S. Factors Influencing Hotel Decision-Making through Digital Platforms in South Asia. *Cogent Soc. Sci.* **2024**, *10*, 2407933. [[CrossRef](#)]
57. Sudirjo, F.; Nurdiani, T.W.; Boari, Y.; Kraugusteeliana, K.; Kurniawan, R. Digital Marketing and Sales Support For Hydroponic MSME Growth Through Mobile Based E-Commerce Design. *J. Ekon.* **2023**, *12*, 1750–1756.
58. Yan, H.; Zhang, H.; Su, S.; Lam, J.F.I.; Wei, X. Exploring the Online Gamified Learning Intentions of College Students: A Technology-Learning Behavior Acceptance Model. *Appl. Sci.* **2022**, *12*, 12966. [[CrossRef](#)]
59. Sankar, J.P. Social Media on Buying Behavior—An Impact Study. *Eur. J. Bus. Soc. Stud.* **2019**, *7*, 53–66.
60. Sadiq, S.; Kaiwei, J.; Aman, I.; Mansab, M. Examine the Factors Influencing the Behavioral Intention to Use Social Commerce Adoption and the Role of AI in SC Adoption. *Eur. Res. Manag. Bus. Econ.* **2025**, *31*, 100268. [[CrossRef](#)]
61. Imtiaz, S. The Studies of Unified Theory of Acceptance and Use of Technology (UTAUT) in M-Commerce Context. *Int. J. Form. Commun. Technol. Digit. Conver.* **2018**, *3*, 42–56.
62. Maulidina, P.R.; Sarno, R.; Sungkono, K.R.; Giranita, T.A. Using Extended UTAUT2 Model to Determine Factors Influencing the Use of Shopee E-Commerce. In *2020 International Seminar on Application for Technology of Information and Communication (iSemantic), Semarang, Indonesia, 19–20 September 2020*; IEEE: New York, NY, USA, 2020; pp. 493–498.
63. Yassierli, Y.; Vinsensius, V.; Mohamed, M.S.S. The Importance of Usability Aspect in M-Commerce Application for Satisfaction and Continuance Intention. *Makara J. Technol.* **2019**, *22*, 149. [[CrossRef](#)]
64. Pramudito, D.K.; Rudin; Ginting, R.U.B.; Sekianti, A.; Sepria Baresi, I. Analysis of E-Commerce User Acceptance of Technology-Based Loan Application Features Using The UTAUT Model. *J. Inf. Teknol.* **2023**, *5*, 36–42. [[CrossRef](#)]
65. Cao, P.T. E-Commerce Behavioral Intention of Vietnam Gen Z by Using the UTAUT2 Model. *J. Adv. Manag. Res.* **2025**, *22*, 323–337. [[CrossRef](#)]
66. Sim, J.J.; Chia, Z.Y.; Chin, Y.L.; Lee, M.Q.; Chiam, V.T.S.; Wong, K.L.; Choong, C.K.; Loh, S.H.; Yeap, K.H. Trust in Vendor and Perceived Effectiveness of E-Commerce Institutional Mechanisms in M-Commerce Adoption: A Revised UTAUT Model. In *2018 8th IEEE International Conference on Control System, Computing and Engineering (ICCSCE), Penang, Malaysia, 23–25 November 2018*; IEEE: New York, NY, USA, 2019; pp. 10–15.
67. Marinković, V.; Đorđević, A.; Kalinić, Z. The Moderating Effects of Gender on Customer Satisfaction and Continuance Intention in Mobile Commerce: A UTAUT-Based Perspective. *Technol. Anal. Strateg. Manag.* **2020**, *32*, 306–318. [[CrossRef](#)]

68. Kartikasari, Y.; Sunaryo, S.; Yuniarinto, A. The Intention to Use E-Commerce to Purchase Green Cosmetics with a Modified UTAUT2 Approach. *J. Appl. Manag.* **2021**, *19*, 605–615. [\[CrossRef\]](#)
69. Salimon, M.G.; Kareem, O.; Mokhtar, S.S.M.; Aliyu, O.A.; Bamgbade, J.A.; Adeleke, A.Q. Malaysian SMEs M-Commerce Adoption: TAM 3, UTAUT 2 and TOE Approach. *J. Sci. Technol. Policy Manag.* **2023**, *14*, 98–126. [\[CrossRef\]](#)
70. Abdallah, N.; Iqbal, H.; Alkhazaleh, H.; Ibrahim, A.; Zeki, T.; Habli, M.; Abdallah, O. Determinants of M-Commerce Adoption: An Empirical Study. *J. Theor. Appl. Inf. Technol.* **2020**, *98*, 1479–1489. [\[CrossRef\]](#)
71. Ngubelanga, A.; Duffett, R. Modeling Mobile Commerce Applications' Antecedents of Customer Satisfaction among Millennials: An Extended TAM Perspective. *Sustainability* **2021**, *13*, 5973. [\[CrossRef\]](#)
72. Candra, D.G.A.; Nuruzzaman, M.T.; Uyun, S.; Sugiantoro, B.; Pratiwi, M. Analysis of Factors Affecting the Students' Acceptance Level of E-Commerce Applications in Yogyakarta Using Modified UTAUT 2. *Int. J. Inform. Dev.* **2023**, *12*, 326–337. [\[CrossRef\]](#)
73. Goswami, A.; Dutta, S. E-Commerce Adoption by Women Entrepreneurs in India: An Application of the UTAUT Model. *Bus. Econ. Res.* **2017**, *6*, 440. [\[CrossRef\]](#)
74. Realpe-Muñoz, P.; Collazos, C.A.; Hurtado, J.; Granollers, T.; Velasco-Medina, J. An Integration of Usable Security and User Authentication into the ISO 9241-210 and ISO/IEC 25010:2011. In *International Conference on Human Aspects of Information Security, Privacy, and Trust*; Springer: Cham, Switzerland, 2016; pp. 65–76.
75. Pärnänen, K. What Makes a Satisfying User Experience in the Context of Human-Computer Interaction? Master's Thesis, Aalto University, Espoo, Finland, 2016.
76. Palmatier, R.W.; Jarvis, C.B.; Bechko, J.R.; Kardes, F.R. The Role of Customer Gratitude in Relationship Marketing. *J. Mark.* **2009**, *73*, 1–18. [\[CrossRef\]](#)
77. Venkatesh, V.; Thong, J.Y.L.; Xu, X. Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Q.* **2012**, *36*, 157–178. [\[CrossRef\]](#)
78. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User Acceptance of Information Technology: Toward a Unified View. *MIS Q.* **2003**, *27*, 425–478. [\[CrossRef\]](#)
79. Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to Use and How to Report the Results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24. [\[CrossRef\]](#)
80. Kock, N. Common Method Bias in PLS-SEM: A Full Collinearity Assessment Approach. *Int. J. e-Collab.* **2015**, *11*, 1–10. [\[CrossRef\]](#)
81. Sarstedt, M.; Hair, J.F.; Pick, M.; Liengaard, B.D.; Radomir, L.; Ringle, C.M. Progress in Partial Least Squares Structural Equation Modeling Use in Marketing Research in the Last Decade. *Psychol. Mark.* **2022**, *39*, 1035–1064. [\[CrossRef\]](#)
82. Memon, M.A.; Ramayah, T.; Cheah, J.H.; Ting, H.; Chuah, F.; Cham, T.H. PLS-SEM Statistical Programs: A Review. *J. Appl. Struct. Equ. Model.* **2021**, *5*, 1–14. [\[CrossRef\]](#)
83. Henseler, J.; Schuberth, F. Partial Least Squares as a Tool for Scientific Inquiry: Comments on Cadogan and Lee. *Eur. J. Mark.* **2023**, *57*, 1737–1757. [\[CrossRef\]](#)
84. Hair, J.F.; Sarstedt, M.; Ringle, C.M.; Gudergan, S.P. *Advanced Issues in Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed.; SAGE Publications Inc.: Thousand Oaks, CA, USA, 2023.
85. Wong, K.K.K.-K. Partial Least Squares Structural Equation Modeling (PLS-SEM) Techniques Using SmartPLS. *Mark. Bull.* **2013**, *24*, 1–32.
86. AlHammadi, M.Y.; Almheiri, M.; Yatiban, A.; Islam, R.; Sultana, S. Airport Service Performance at Abu Dhabi International Airport. *Probl. Perspect. Manag.* **2023**, *21*, 517–530. [\[CrossRef\]](#)
87. Hair, J.F.; Sarstedt, M.; Hopkins, L.; Kuppelwieser, V.G. Partial Least Squares Structural Equation Modeling (PLS-SEM): An Emerging Tool in Business Research. *Eur. Bus. Rev.* **2014**, *26*, 106–121. [\[CrossRef\]](#)
88. Darsono, N.; Yahya, A.; Muzammil, A.; Musnadi, S.; Anwar, C.; Irawati, W. Consumer Actual Purchase Behavior for Organic Products in Aceh, Indonesia. In *Proceedings of the 1st Aceh Global Conference (AGC 2018)*; Atlantis Press: Dordrecht, The Netherlands, 2019; pp. 265–275.
89. Hair, J.F.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M.; Danks, N.P.; Ray, S. *An Introduction to Structural Equation Modeling*; Springer Publication: Cham, Switzerland, 2021.
90. Fornell, C.; Larcker, D.F. Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *J. Mark. Res.* **1981**, *18*, 39–50. [\[CrossRef\]](#)
91. Hair, J.F.; Ringle, C.M.; Sarstedt, M. PLS-SEM: Indeed a Silver Bullet. *J. Mark. Theory Pract.* **2011**, *19*, 139–151. [\[CrossRef\]](#)
92. Costa, P.; Rodrigues, H. The Ever-Changing Business of e-Commerce-Net Benefits While Designing a New Platform for Small Companies. *Rev. Manag. Sci.* **2024**, *18*, 2507–2545. [\[CrossRef\]](#)
93. Verbivska, L.; Zhuk, O.; Ievsieieva, O.; Kuchmiiiova, T.; Saienko, V. The Role of E-Commerce in Stimulating Innovative Business Development in the Conditions of European Integration. *Financ. Credit Act. Probl. Theory Pract.* **2023**, *3*, 330–340. [\[CrossRef\]](#)
94. Mikalef, P.; Gupta, M. Artificial Intelligence Capability: Conceptualization, Measurement Calibration, and Empirical Study on Its Impact on Organizational Creativity and Firm Performance. *Inf. Manag.* **2021**, *58*, 103434. [\[CrossRef\]](#)

95. Nasiri, E.; Khalilzad, M.; Hakimzadeh, Z.; Isari, A.; Faryabi-Yousefabad, S.; Sadigh-Eteghad, S.; Naseri, A. A Comprehensive Review of Attention Tests: Can We Assess What We Exactly Do Not Understand? *Egypt. J. Neurol. Psychiatry Neurosurg.* **2023**, *59*, 26. [[CrossRef](#)]
96. Sousa, M.J.; Rocha, Á. Digital Learning: Developing Skills for Digital Transformation of Organizations. *Future Gener. Comput. Syst.* **2019**, *91*, 327–334. [[CrossRef](#)]
97. Cimino, A.; Corvello, V.; Troise, C.; Thomas, A.; Tani, M. Artificial Intelligence Adoption for Sustainable Growth in SMEs: An Extended Dynamic Capability Framework. *Corp. Soc. Responsib. Environ. Manag.* **2025**, *32*, 6120–6138. [[CrossRef](#)]
98. Afiat, M.N.; Rijal, S. Analysis of the Use of E-Commerce in Improving Entrepreneurial Business Competitiveness. *J. Minfo Polgan* **2023**, *12*, 468–479. [[CrossRef](#)]

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