User Experience (UX) with mobile devices: a comprehensive model to demonstrate the relative importance of instrumental, non-instrumental and emotional components on user satisfaction.

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User Experience (UX) with mobile devices: a comprehensive model to demonstrate the relative importance of instrumental, non-instrumental and emotional components on user satisfaction.

Despite growing interest in User Experience (UX), the empirical testing of UX models, particularly the interdependence of UX dimensions and their impact on user satisfaction, remains limited. This study fills this gap by examining a UX model for smartwatch and smartphone users through an online survey and Partial Least Squares regression analysis. Our findings reveal that both instrumental and non-instrumental qualities, alongside the emotions elicited by mobile devices, are interconnected and crucial to users. Notably, instrumental qualities tend to elicit negative emotions, whereas non-instrumental qualities elicit predominantly positive emotions. The observed relationships among various UX factors and user satisfaction underscore the significance of the proposed UX model and, more broadly, highlight the importance of UX research in deciphering the psychological processes encountered when individuals interact with technology.

Keywords: user experience, smartphone, smartwatch, instrumental qualities, non-instrumental qualities, emotional reactions,

1. Introduction

Smart and mobile technologies, such as smartwatches and smartphones, have spread exponentially. They are enjoying tremendous popularity, to the point of addiction for some people (Koul & Eydgahi, 2017; Kulviwat et al., 2009). However, despite the widespread popularity of these devices, understanding the experience with these and their overall impact on individuals and society remains a challenge (Shaw et al., 2018).

Smartwatches and smartphones are true computing devices. These electronic gadgets offer users a wide variety of functionalities. These include communication functions and third-party applications, push notifications, playing and recording media files, and monitoring health and activity (Liu et al., 2017; Ogbanufe, & Gerhart, 2018; Basha et al., 2022; Li et al., 2022). Smartwatches and smartphones are perceived as hybrid objects between computing devices and fashion accessories (Hedman & Gimpel, 2010; Nascimento et al., 2018; Cho et al., 2019).

However, even if smartphones are today well-known to most people, smartwatches are still relatively new. More research on these devices are particularly needed to understand their implications. Current studies mainly focus on the design, accuracy, and optimization of smartwatch algorithms (Cvetkovic et al., 2018; Raptis et al., 2022). Studies adopting the user perspective remain rare (Nascimento et al., 2018). Yet, despite being a popular innovation, nearly one-third of users stopped using their smartwatch within a year because they found it less useful and interesting (Chuah, 2019; Attig, & Franke, 2020; Talukder et al., 2019). These findings call for more user-centered studies to better identify their specific technological experiences and to explain the processes leading to device abandonment.

Research on information and communication technology usage heavily relies on models of technology acceptance, such as the Technology Acceptance Model (TAM) (Davis, 1989), TAM 2 and TAM 3 (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). These models, focusing on perceived usefulness and ease of use, however, are somewhat limited in explaining the current use of smartphones and smartwatches. While these models have been applied to the study of smartphones (Hubert et al., 2017; Kim, 2014; Park, & Chen, 2007; Ma et al., 2016) and smartwatches (Al-Emran, 2021; Al-Emran et al., 2020; Choi, & Kim, 2016; Chuah et al., 2016; Krey et al., 2019), they do not fully capture the breadth of user experiences. The specific characteristics of smartphones and smartwatches demand a broader perspective. It is essential to include hedonic and emotional aspects to gain a comprehensive understanding of user experience, indicating the necessity to extend beyond models focusing solely on instrumental uses.

1.1 The UX approach

The term User Experience (UX) was first used in the 1990s by Norman and has since gained widespread acceptance among professionals and researchers (Scapin et al., 2012). The UX approach aims to be inclusive, covering all aspects of the user's subjective experience when confronted with a technological system (Norman et al., 1995). Despite its widespread success, the field of User Experience (UX) has not yet established a universally accepted and rigorously defined framework, as acknowledged by several leading UX researchers and specialists (Gross & Bongartz, 2012; Lallemand et al., 2015; Zarour & Alharbi, 2017). Consequently, there remains a scarcity of empirical UX studies and standardized methodologies.

Nonetheless, the essence of the UX approach can be summarized into four fundamental premises. The first one is that user experience is inherently subjective. The second one is that UX approach strives for a holistic perspective that incorporates non-instrumental and hedonic dimensions, such as perceived aesthetic or symbolic aspects of technologies, beyond traditional focuses on effectiveness and efficiency (Bongard-Blanchy et al., 2015; Goh & Karimi, 2014; Hassenzahl, 2006). The third one is that the UX approach aims for a greater inclusion of emotional reactions, treating emotions as first-order factors when studying the consequences of technological uses (van der Heijden, 2004). Finally, the fourth premise is the fact that user experience is inherently dynamic and evolves over time (Minge & Thüring, 2018). For example, Karapanos et al. (2009) developed a UX model indicating that the user experience of an iPhone fluctuates over time: early stages of use are primarily driven by learning needs and stimulus cravings, and more advanced stages of use are driven by utilitarian needs and emotional attachment to the device.

1.2 The CUE Model and the integration of emotional aspects

In UX research, several models have been proposed (e.g. Deng et al., 2010; Forlizzi & Battarbee, 2004; Hassenzahl, 2003; Hassenzahl & Tractinsky, 2006; Karapanos et al, 2009; Law et al., 2009; Yogasara et al., 2011). Among these, the Components of User Experience model (CUE-model) proposed by Thüring and Mahlke (2007) is certainly one of the most comprehensive models. It has been used as a basis for several types of technologies (Aranyi & Schaik, 2016; Gross & Bongartz, 2012), as it integrates the different key factors of the user experience and models the relative influence of different UX aspects (Thüring & Mahlke, 2007).

According to the CUE model, user characteristics, context and system properties are the factors that shape the interaction between a user and a technological system. From this interaction stems user experience, which is described as a subjective result. In the CUE model, user experience is defined by three distinct components: (1) Perceived Instrumental Qualities, (2) Perceived Non-Instrumental Qualities and (3) Emotional Reactions. Instrumental Qualities refer to all factors related to task performance. These factors have been extensively studied in TAM models, through Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) dimensions. Non-instrumental Qualities relate to more personal goals. They refer to individual desires and needs. In the model, they are defined by the appreciation of aesthetic, symbolic and motivational aspects (Thüring & Mahlke, 2007). Aesthetic aspects (AA) account for the different sensual dimensions (e.g. visual, haptic or acoustic) of a product. The symbolic aspects (SA) refer to the communicative and associative attributes of an object. The communicative attributes allow to inform others of belonging to a certain social group, and the associative attributes allow to establish personal meaning and the value given to the system. The third category refers to Motivational Aspects (MA) and is based on the inherent nature of a system to stimulate its use. With respect to the Emotional Reactions component, the model posits that several types of emotions can be provoked by Instrumental and Non-Instrumental Qualities. They can be characterized in terms of valence and arousal (Russell, 1980). Finally, the CUE model postulates that these three components will all have an impact on an overall evaluation, such as user satisfaction.

It should be noted, however, that this model, like other UX models, suffers from a lack of empirical validation: few UX research studies have tested the model. The panel of technologies, populations and contexts in these studies are relatively small, and the methods used are diverse and difficult to compare. Therefore, conclusions about the value of the CUE model require further empirical work.

1.3 The research model

To address the need for empirical UX studies and finely grasp the user experience with smartphones and smartwatches, the CUE model has undeniable qualities. Its descriptive nature allows to determine the respective influence of instrumental qualities, non-instrumental qualities, and emotional reactions on user experience consequences. However, the model does not precisely describe the relationships between the subcomponents. This was instead tested by Van der Linden et al. (2019) in a research focused on tablet use. The authors showed that the subcomponents of Instrumental Qualities as well as the subcomponents of Non-Instrumental Qualities, positively impacted Perceived Enjoyment, the only one emotional responses authors studied. They also demonstrated that all the sub-dimensions of the 3 components, except for Aesthetic Aspects, had a significant impact on Satisfaction.

In our study focused on smartwatch and smartphone usage, we will test the links between components and subcomponents using the same model proposed by Van der Linden et al. (2019). However, while the influence of the Aesthetic Aspects on Satisfaction was found to be insignificant in their study on tablets, this link will nevertheless be tested in our study. We assume that aesthetic aspects may be relevant because smartphones and smartwatches are considered as more personal technologies than tablets, or because they are for some fashion accessories. Moreover, our study will not limit the emotional reactions to pleasure alone, but will extend the research to other positive emotions and negative emotions that have not been included previously. Our hypotheses are the following and are summarized in Fig. 1:

- H1: Within instrumental qualities, Perceived Ease of Use positively influences perceived usefulness.
- H2.1: Within non-instrumental qualities, Aesthetic Aspects positively influence Symbolic Aspects.
- H2.2: Within non-instrumental qualities, Aesthetic Aspects and Symbolic Aspects positively influence Motivational Aspects.
- H3: Positive emotions mediate the positive relationship between instrumental qualities and satisfaction
- H4: Negative emotions mediate the positive relationship between non-instrumental qualities and satisfaction

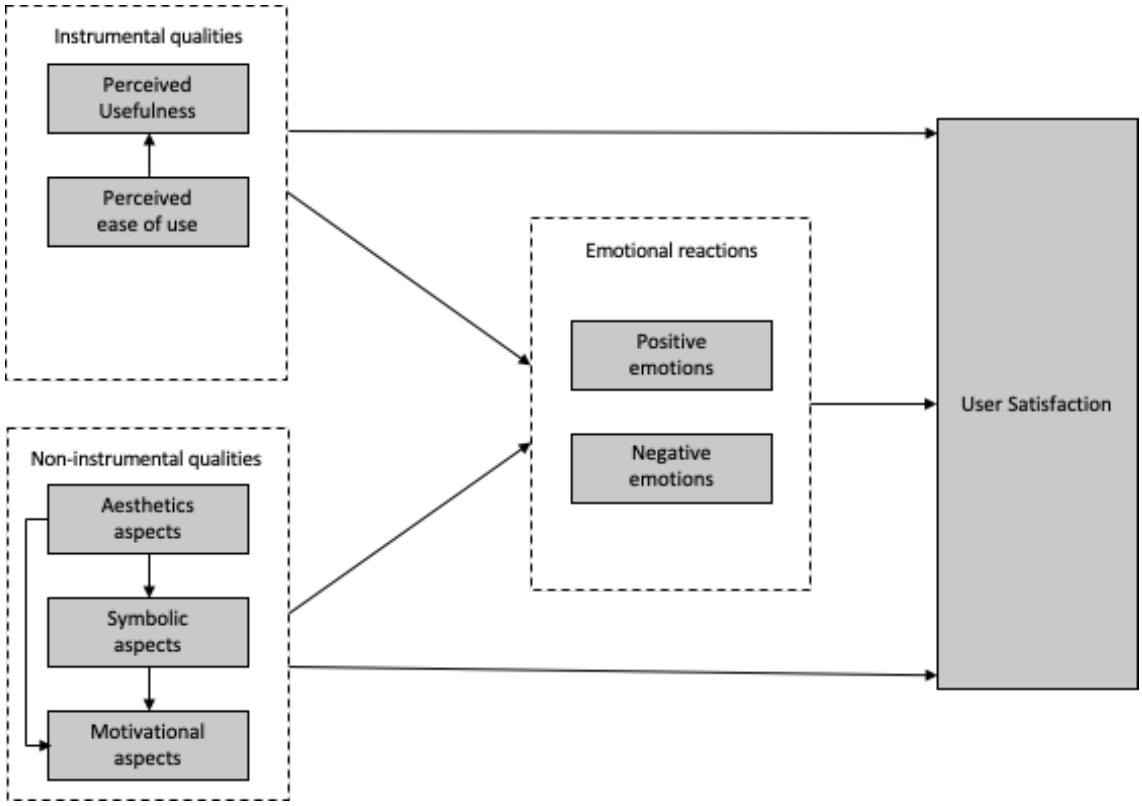

Figure 1. Research model for UX with smartwatch and smartphone

2. METHOD

2.1 Procedure and Participants

The study was carried out by distributing an online questionnaire to young university students in Belgium and France, and on social networks in technology dedicated groups. Before participation, an information message about the objectives, the target population (people with a smartwatch or a smartphone), as well as the anonymous and voluntary character were presented.

The participants' characteristics are presented in Table 1. For smartwatch users, a total of 259 people completed the questionnaire. 59.3% identified themselves as female, and 40.7% as male. The average age of the respondents is 35.6 years (SD = 14.9 years). The great majority of respondents declared using a smartwatch every day. In detail, 80.7%

declared to use their watch every day, 10.8% a few times a week, 2.3% once a week, 3.5% only a few times a month, and 2.7% declared never use it.

For smartphone users, 459 people completed the entire questionnaire. Of these participants, 85.2% identified as female and 14.8% as male. The average age of the respondents is 21.7 (SD = 4.4). Regarding their smartphone, users indicate that they have owned the device for an average of 36.6 months (SD = 31.9). The vast majority also report using the smartphone daily. 98.7% said they use their smartphone every day, 1.1% a few times a week, and 0.2% once a week.

Table 1. Characteristics of respondents

	Smartwatch	Smartphone
Number of respondents (n)	259	459
Language (%)		
French	62.2	99.1
English	37.8	0.9
Gender (%)		
Female	59.3	85.2
Male	40.7	14.8
Age (years)		
Mean	35.6	21.7
SD	14.9	4.4
Time of ownership (months)		
Mean	20.9	36.6
SD	18.5	31.9
Frequency of use (%)		
Every day	80.7	98.7
A few times a week	10.8	1.1
Once a week	2.3	0.2
A few times a month	3.5	0.0
Never	2.7	0.0

A comparison of smartwatch and smartphone respondents indicates that smartphone respondents are relatively younger and female than smartwatch respondents. This could be due to the dissemination method, as the smartphone are mainly psychology university students. In addition, concerning technology use results indicate that smartwatches were acquired more recently than smartphones. The data also indicate that the frequency of use of smartphones is higher overall than that of smartwatches.

2.2 Measurement

Data collection was conducted using a bilingual questionnaire, available in both French and English. Initially, the questionnaire aimed to gather data on ownership of smartwatches and smartphones. Based on the responses regarding device ownership, participants were directed to either the smartwatch or smartphone section of the questionnaire. It was structured such that no participant could complete both sections. In the subsequent parts, respondents were instructed to focus on the device they deemed most significant in their lives, ensuring responses were specific to a single device. In the second part, participants were asked to specify the types of devices they owned. Questions were asked about the brand, duration of ownership, and frequency of use. The third part aimed to collect information about participants user experience. To do so, different validated scales adapted to the investigated technologies were used - see Table 2. More specifically, scales aiming to measure instrumental qualities (perceived usefulness and perceived ease of use), non-instrumental qualities (aesthetic aspects, symbolic aspects), and emotional reactions (positive and negative) stemmed from the MeCUE questionnaire published by Minge et al. (2016) for the English version, and by Lallemand and Koenig (2017) for the French version. These scales were chosen because of their reliability, validity and widespread acceptance for various types of technologies. However, the MeCUE scale measuring engagement was not retained. Another scale closer to the Motivational aspects, theorized by Thüring and Mahlke (2007) has been used. The scale measuring motivational aspects (cf. non-instrumental quality) was adapted from the stimulation scale published by Schrepp et al. (2017). This scale was also used for the same purpose in Van der Linden et al. (2019). Finally, the satisfaction scale was adapted from the Wixom and Todd (2005) scale, because of their applicability to mobile technology, validity and few number of items. All proposed scales were adapted to specify the assessed technology, and asked respondents to complete a 7-step Likert scale, ranging from 1: "Strongly disagree" to 7: "Strongly agree".

Finally, a fourth part was designed to collect demographic information. It asked participants about their age, gender, and language spoken.

Table 2: Items used to study smartwatch user experience.

Dimensions	Item	
Instrumental qualities		
Perceived usefulness	PU1	The function of my smartwatch are exactly right for my goals
	PU2	I consider my smartwatch extremely useful
	PU3	With the help of my smartwatch, I will achieve my goals
	PU4	My smartwatch is useful
Perceived ease of use	PEOU1	My smartwatch is easy to use.
	PEOU2	It is quickly apparent how to use my smartwatch
	PEOU3	The operating procedures of my smartwatch are simple to understand
	PEOU4	My smartwatch is simple to use
Non-instrumental qualities		
Aesthetic aspects	AA1	My smartwatch is creatively designed
	AA2	My smartwatch looks attractive
	AA3	My smartwatch is stylish
	AA4	My smartwatch is aesthetic
Symbolic aspects	SA1	My smartwatch enhances my standing among peers
	SA2	By wearing my smartwatch, I would be perceived differently
	SA3	My friends could be quietly envious of my smartwatch
	SA4	My smartwatch highlights me
Motivational aspects	MA1	My smartwatch is valuable
	MA2	My smartwatch excites my curiosity
	MA3	My smartwatch is interesting
	MA4	My smartwatch is motivating
	MA5	My smartwatch stimulates my desire to use it
Emotional reactions		
Positive emotions	PosE1	My smartwatch exhilarates me
	PosE2	When using my smartwatch, I feel cheerful
	PosE3	My smartwatch relaxes me
	PosE4	My smartwatch calms me
Negative emotions	NegE1	My smartwatch angers me
	NegE2	My smartwatch frustrates me
	NegE3	My smartwatch makes me tired
	NegE4	My smartwatch annoys me.
UX consequences		
Satisfaction	SAT1	All things considered, I am very satisfied with my smartwatch
	SAT2	Overall, my smartwatch is very satisfying

3. RESULTS

Statistical analyses were performed using SPSS 26 for descriptive analyses and SmartPLS 3.2.9 for internal consistency and path coefficient calculations. To meet the objectives, the Partial Least Squares method (PLS Method) was used. This method has the advantage of being able to test complex models with smaller samples. It is particularly appropriate for theoretical model testing and predictive analysis, especially when the focus is on regression coefficients and percentage of variance explained rather than model fit (Chin, 1998, 2009; Lacroux, 2011). In addition, unlike traditional structural equation modeling, the PLS method is based on analysis of variance and not analysis of covariance.

The first step in analyzing the results generated by SmartPLS involves testing the validity of the measurement instruments. Next, descriptive analyses of the concepts are presented, and finally the relationships considered in the model are tested.

3.1 Validity of measurement instruments

The confirmatory analyses identify the convergent validity of each dimension. Table 3 summarizes the indicators of the UX model dimensions for smartwatch and smartphone users. Convergent validity was assessed by examining the composite reliability and average extracted variance (AVE) for each dimension. All the extracted variances (AVE) exceeded the minimum value of 0.50 (Fornell & Larcker, 1981), and all composite reliability index values exceeded the minimum value of 0.60. Second, all Cronbach's alphas are also above the recommended reliability level (0.70).

For discriminant validity, the square root of the AVE for each construct must be greater than the correlation values between any two dimensions. The inter-dimensional correlation matrices (see Table 4) demonstrated that all values, both for smartwatch and smartphone, met these discriminant validity recommendations. In sum, the validity of the measurement instruments is attested for the study of UX with a smartwatch and with a smartphone.

Table 3. Quality Indicators for Measurement Scales - Smartwatch and Smartphone

Dimensions	USE OF A SMARTWATCH			USE OF A SMARTPHONE		
	AVE (> .50)	Reliability composite (> .60)	Cronbach's alpha (> .70)	AVE (> .50)	Reliability composite (> .60)	Cronbach's alpha (> .70)
Instrumental qualities						
Perceived usefulness	.627	.870	.849	.556	.832	.732
Perceived ease of use	.824	.949	.801	.688	.898	.848
Non-instrumental qualities						
Aesthetic aspects	.699	.901	.849	.723	.912	.870
Symbolic aspects	.682	.895	.845	.634	.874	.808
Motivational aspects	.524	.846	.771	.503	.835	.752
Emotional reactions						

Positive emotions	.701	.904	.859	.622	.868	.799
Negative emotions	.693	.900	.852	.842	.842	.757
UX consequences						
Satisfaction	.871	.931	.852	.844	.916	.816

Table 4. Correlation between variables - Smartwatch and Smartphone

	PU SW	PU SP	PEOU SW	PEOU SP	AA SW	AA SP	SA SW	SA SP	MA SW	MA SP	PosE SW	PosE SP	NegE SW	NegE SP	SAT SW	SAT SP
PU	**.792**	**.745**														
PEOU	.414*	.497*	**.908**	**.830**												
AA	.318*	.468*	,300*	.341*	**.836**	**.850**										
SA	.242*	.204*	.103	.084	.340*	.363*	**.826**	**.797**								
MA	.482*	.459*	.198*	.254*	.277*	.459*	.552*	.415*	**.724**	**.709**						
PosE	.567*	.504*	.267*	.305*	.484*	.655*	.549*	.474*	.623*	.599*	**.837**	**.789**				
NegE	.377*	.390*	.145*	.195*	.298*	.438*	.472*	.340*	.492*	.519*	.627*	.608*	**.832**	**.918**		
SAT	-.302*	-.223*	-.485*	-.179*	-.153*	-.126*	.074	.048	-.088	-.105*	-.115	-.085	.056	.029	**.933**	**.918**

Note: The square root of the sampling variance estimate is shown in bold in the diagonal values; SW = smartwatch; SP = smartphone; * < .05;

3.2 Descriptive analyses

The descriptive analyses of the UX dimensions are presented in Table 5 for smartwatches and for smartphones users.

Table 5. Descriptive analyses (mean and standard deviation) for smartwatch and smartphone users

Dimensions	SMARTWATCH M	SD	SMARTPHONE M	SD
Instrumental qualities				
Perceived usefulness	5.79	.90	5.57	.81
Perceived ease of use	5.98	.95	6.18	.74
Non-instrumental qualities				
Aesthetic aspects	5.28	1.17	5.00	1.13
Symbolic aspects	3.38	1.36	2.67	1.20
Motivational aspects	5.29	.96	4.25	1.05
Emotional reactions				
Positive emotions	3.44	1.34	3.76	1.01
Negative emotions	1.97	.99	3.37	1.03
UX consequences				
Satisfaction	6.07	.88	5.50	.96

The results for smartwatch users show that the Instrumental Qualities get relatively high mean scores. The scores are respectively 5.79 (SD = .90) for Perceived Usefulness and 5.98 (SD = .95) for Perceived Ease of Use. This indicates that users consider their device to be beneficial and functional. For the Non-Instrumental Qualities, the mean scores indicate more diversity. The average scores for Aesthetic and Motivational Aspects are moderately high, while the score for Symbolic Aspects is low. Indeed, the scores obtained are 5.28 (SD = 1.17) for Aesthetic Aspects, and 5.29 (SD =

.96) for Motivational Aspects, while the score for Symbolic Aspects is 3.38 (SD = 1.36). This indicates that the aesthetic and motivational values are well recognized, while the symbolic value is not very present in the users' eyes. Concerning Emotional Reactions, the scores indicate that smartwatches generate moderate positive emotions, and weak negative emotions. The average scores are 3.44 (SD = 1.34) for positive emotions and 1.97 (SD = .99) for negative emotions. Therefore, it can be stated that smartwatches do not generate strong emotions. Finally, the average Satisfaction score is 6.07 (SD = .88), which represents a high score and indicates a high level of satisfaction.

The results for smartphones indicate that instrumental qualities score high. The results are 5.57 (SD = .81) for Perceived Usefulness and 6.18 (SD = .74) for Perceived Ease of Use. These results reflect the utilitarian appreciation and effortless use of this type of technology. The mean scores for non-instrumental qualities indicate results as well. The scores for Aesthetic and Motivational Aspects are 5.00 (SD = 1.13) and 4.25 (SD = 1.05) respectively. They can be considered as moderate and attest an average interest in these aspects. The score for the Symbolic Aspects is 2.67 (SD = 1.20) and suggests that the symbolic value is little recognized by the users. The scores for positive and negative emotional reactions are similar to each other. The score for negative emotions is 3.76 (SD = 1.01), and 3.37 (SD = 1.03) for positive emotions. They are moderately high and show that smartphones generate tempered emotions. Finally, the Satisfaction score is 5.50. It shows that users are well satisfied with their device.

The descriptive statistics for the two types of technologies indicate a relatively similar appreciation of the different UX dimensions. Indeed, the scores of instrumental and non-instrumental Qualities show high scores for Perceived Usefulness and Perceived Ease of Use, medium scores for Aesthetic and Motivational Aspects, and low scores for Symbolic Aspects. Satisfaction scores are also relatively similar. On the other hand, the scores for emotional reactions to the smartphone and to the smartwatch are similar for positive emotions but differ for negative emotions: the score for smartwatch is slightly lower than for smartphone.

3.3 Test of the research model

The UX model with smartwatches

The results of the PLS method regressions analyses for smartwatches are presented in Table 6.

Intra-component relationships. Within the Instrumental Qualities component, the direct effect of Perceived Ease of Use on Perceived Usefulness ($\beta = .453$, $p < .001$) was found to be significant, and confirms the link that has been extensively tested in the TAM models. Within the Non-Instrumental Qualities component, Aesthetic Aspects had a direct effect on Symbolic Aspects ($\beta = .396$, $p < .001$) and an indirect effect on Motivational Aspects ($\beta = .222$, $p < .001$). In addition, Symbolic Aspects also had a direct effect on Motivational Aspects ($\beta = .560$, $p < .001$). This confirms the intra-component structures theorized earlier and found by Van der Linden et al. (2019).

Impact on Emotional Reactions. The impact of instrumental and non-instrumental qualities is to be distinguished according to Positive and Negative Emotions. First, for the Instrumental Qualities, the perceived Ease of Use shows no direct ($\beta = -.044$, $p > .05$), indirect ($\beta = .023$, $p > .05$) or total ($\beta = -.021$, $p > .05$) effect on Positive Emotions. In contrast, Ease of Use showed significant direct ($\beta = -.426$, $p < .001$) and total ($\beta = -.488$, $p < .001$) effects on Negative emotions, and an indirect effect ($\beta = -.062$, $p > .05$) that was not significant. This suggests that altering the utility value and ease of use only generates negative emotions among smartwatch users, and that improving these dimensions does not generate positive emotions. Then for the non-instrumental Qualities, Aesthetic Aspects have an indirect ($\beta = .197, p < .01$) and total ($b = .157, p < .05$) effect on Positive Emotions, but no direct effect ($\beta = -.040, p > .05$). However, Aesthetic Aspects have no direct ($\beta = -.025, p > .05$), indirect ($\beta = .045, p > .05$), and total ($\beta = .020, p > .05$) effects on Negative Emotions. Symbolic Aspects have a direct ($\beta = .206, p < 0\ .001$), indirect ($\beta = .292, p < .001$), and total ($\beta = .498, p < 0\ .001$) effect on Positive Emotions, and only direct ($\beta = .129, p < 0\ .001$) and total ($\beta = .113, p < 0\ .001$) effects on Negative Emotions. The indirect effect of Symbolic Aspects on Negative Emotions being non-significant ($\beta = -.015, p > 0\ .05$). Motivational Aspects had a direct effect ($\beta = .522, p < .001$) on Positive Emotions, and had no significant direct effect ($\beta = -.028, p > .05$) on Negative Emotions. Overall, these results suggest that Non-Instrumental Qualities generate more Positive Emotions than Negative Emotions. Consequently, it is possible to state that Instrumental Qualities are more related to Negative Emotions, while Non-instrumental Qualities are more related to Positive Emotions.

Impact on Satisfaction. Perceived Ease of Use has a direct ($\beta = .235, p < 0\ .001$), indirect ($\beta = .219 = p < .001$) and total effect on Satisfaction. Perceived Usefulness has a direct ($\beta = .325, p < .001$), and total ($\beta = .325, p < .001$) effect on Satisfaction, but no indirect effect ($\beta = .018, p > .05$). Non-instrumental Qualities influence Satisfaction, but not all sub-dimensions. Aesthetic Aspects have a direct ($\beta = .131, p < .01$) and total ($\beta = .150, p < .01$) effect, but of indirect effect ($\beta = .019, p > .05$). Symbolic Aspects had an indirect effect ($\beta = .128, p < .01$), but no direct ($\beta = -.092, p > .05$) or total effect ($\beta = .036, p > .05$). Since the total effect is non-significant, it is not possible to state that Symbolic Aspects impact Satisfaction. Motivational Aspects have a direct ($\beta = .283, p < .001$) and total ($\beta = .273, p < .001$) effect on Satisfaction but no indirect effect ($\beta = -.010, p > .05$). Finally, Positive Emotions had no direct effect ($\beta = -.028, p > .05$) on

Satisfaction, whereas Negative Emotions had a significant direct effect (β = -.146, p < .05). This latter result indicates that unlike the other UX variables, Negative Emotions have a negative impact on Satisfaction.

In summary, the elements most related to satisfaction are in order: Perceived Ease of Use, Perceived Usefulness, Motivational Aspects, Aesthetic Aspects, and Negative Emotions. Positive emotions and Symbolic Aspects are not related to user satisfaction.

Table 6. Model of smartwatch and smartphone use. Results of direct, indirect and total effects

	USE OF A SMARTWATCH			**USE OF A SMARTPHONE**		
	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect
Instrumental Qualities						
PU → PosE	.052		.052	.169**		.169**
PU → NegE	-.136		-.136	-.159		-.159
PU → SAT	.325**	.018	.344**	.125	.043	.168*
PEOU → PU	.453**		.453**	.549**		.549**
PEOU → PosE	-.044	.023	-.021	-.067	.093**	.025
PEOU → NegE	-.426**	-.062	-.488**	-.142	-.087	-.229**
PEOU → SAT	.235**	.219**	.454**	.183**	.120**	.304**
Non-Instrumental Qualities						
AA → MA		.222**	.222**		.163**	.163**
AA → SA	.396**		.396**	.338**		.338**
AA → PosE	-.040	.197**	.157*	.029	.105**	.134*
AA → NegE	-.025	.045	.020	-.042	.036	-.006
AA → SAT	.131**	.019	.150**	.313**	.014	.327**
SA → MA	.560**		.560**	.482**		.482**
SA → PosE	.206**	.292**	.498**	.059	.251**	.310**
SA → NegE	.129*	-.015	.113*	.125	-.020	.106
SA → SAT	-.092	.128**	.036	-.011	.020	.010
MA → PosE	.522**		.522**	.522**		.522**
MA → NegE	-.028		-.028	-.041		-.041
MA → SAT	.283**	-.010	.273**	.062	.032	.094
Emotional Reactions						
PosE → SAT	-.028		-.028	.044		.044
NegE → SAT	-.146*		-.146*	-.221**		-.221**

Note: *$p < .05$; **$p < .01$

The UX model with smartphones

The results of the PLS method regressions for smartphones users are presented in Table 6.

Intra-component relationships. The results within the Instrumental Qualities component indicate a direct effect of Perceived Ease of Use on Perceived Usefulness (β = .549, p < .001). This is consistent with the relationship widely tested in TAM models.

Results within the Non-Instrumental Qualities component indicate that Aesthetic Aspects have a direct effect on Symbolic Aspects (β = .338, $p < .001$) and an indirect effect on Motivational Aspects (β = .163, $p < .001$). They also indicate that Symbolic Aspects have a direct effect on Motivational Aspects (β = .482, $p < .001$). These results confirm the intra-component structures theorized previously.

Impact on Emotional Reactions. As before, the impact of the instrumental and non-instrumental qualities dimensions is to be distinguished in terms of Positive and Negative Emotions. Regarding the impact of instrumental qualities, Ease of Use does not seem to have an effect on Positive Emotions. Indeed, the direct (ß = -.067, $p > .05$) and total (ß = .067, $p > .05$) effect are non-significant. Although the indirect effect (ß = .093, $p < .01$) is found to be significant, the low beta value and the cancellation of the effect at the time of effect calculation suggest that it is a random error. The direct effect of Perceived Usefulness on Positive Emotions, on the other hand, was significant (ß = .169, $p < .001$). Also, Perceived Ease of Use has a total effect (ß = -.229, $p < .001$) on Negative Emotions. Although the direct and indirect effects are insignificant, the addition of these effects appears to be sufficient to achieve a significant total effect. The direct effect of Perceived Usefulness on Negative Emotions is negative. In sum, the effects of Instrumental Qualities on Emotional Reactions suggest that these qualities moderately generate emotions, and preferentially negative emotions.

Impact on satisfaction. The observation of the results shows that the Instrumental Qualities dimensions influence Satisfaction. Perceived Ease of Use has a direct ($b = .183$, $p < .01$), indirect ($b = .120$, $p < .01$), and total ($b = .304$, $p <.001$) effect on Satisfaction. Then, although the direct ($b = .122$, $p > .05$) and indirect ($b = .043$, $p > .05$) effects of Perceived Usefulness on Satisfaction are insignificant, there is still a significant total effect ($b = .168$, $p < .05$). It is therefore possible to affirm that perceived

Usefulness impacts Satisfaction. The effects of the non-instrumental Qualities on Satisfaction vary according to the sub-dimensions. Aesthetic Aspects have a direct ($b = .313$, $p < .001$) and total ($b = .3273$, $p < .001$) effect on Satisfaction, but no indirect effect ($b = .014$, $p > .05$). Symbolic Aspects had no direct ($b = -.011$, $p > .05$), indirect ($b = .020$, $p > .05$), or total ($b = .010$, $p > .05$) effect on Satisfaction. Similarly, the Symbolic Aspects had no direct ($b = .062$, $p > .05$), indirect ($b = .032$, $p > .05$), or total ($b = .094$, $p > .05$) effect on Satisfaction. Finally, the Emotional Reactions component has an impact on Satisfaction. However, this impact is to be distinguished according to the type of emotions. Positive Emotions have no direct effect ($b = .044$, $p > .05$) on Satisfaction, unlike Negative Emotions which have a direct effect ($b = -. 221$, $p < .001$). This latter result indicates that unlike the other UX variables, Negative Emotions have a negative impact on Satisfaction. In summary, the items most related to Satisfaction are in order: Aesthetic Aspects, Perceived Ease of Use, Negative Emotions, and Perceived Usefulness. Positive Emotions, Symbolic aspects, and Motivational Aspects are not related to user satisfaction.

4. DISCUSSION

This research represents a pioneering effort to test a User Experience (UX) model among smartwatch and smartphone users, with a twofold objective. First, it seeks to fill the gap in empirical UX research by validating the efficacy of a UX approach, to model the interplay between various UX components and factors, and to propose a standardized method for UX assessment. Second, it aims to thoroughly investigate the experiences of smartwatch and smartphone users, focusing on critical factors influencing their satisfaction and adoption.

To fulfil these objectives, we conducted a questionnaire-based study. This was followed by descriptive and partial least squares regression analyses to evaluate our UX factors and model across both smartwatch and smartphone users.

Overall, this research highlights the relevance of our model and approach, as well as the profound ubiquity of smartwatches and smartphones as personal devices. It emphasizes the critical need to delve into user experiences, shedding light on the psychological and societal shifts they catalyse.

4.1 Relevance of the model's components, and factors.

This study's findings corroborate Thüring and Mahlke's (2007) initial conceptualization of three foundational elements in user experience: Instrumental Qualities, Non-Instrumental Qualities, and Emotional Reactions. The validation of these components highlights the significance of adopting a UX framework that encompasses non-instrumental aspects and emotional responses for a more profound understanding of a user perceptions concerning smart technologies.

The descriptive analysis of UX factors reveals a strong positive sentiment towards instrumental qualities (perceived usefulness and ease of use), signifying a certain level of maturity in smartwatch and smartphone development. Additionally, the favourable evaluation of non-instrumental factors underscores the significance of aesthetics and motivational aspects. However, the results also indicate a reduced focus on symbolic aspects, prompting a reassessment of research predominantly concentrated on technology's symbolic meanings. In a context where aesthetics and functionality are paramount to users, the relevance of symbolic attributes is being questioned, thus challenging the contemporary symbolic significance ascribed to technology (e.g., Nieroda et al., 2018).

Moreover, the presence of both positive and negative emotional reactions to smartwatches and smartphones is a testament to the profound connection users have with these smart devices. The existence of these emotional reactions highlights the integral role that smart devices play in users' lives. These devices are not simply utilitarian objects but have evolved into personal companions that accompany users throughout their daily activities. The several emotional responses illuminate the complexity of a user experience, moving beyond unidimensional evaluations to reveal a more nuanced relationship between users and their technology.

4.2 Relevance of the model's intra- and inter-component relationships

The outcomes of both intra- and inter-component analyses validate the relevance of the hypothesized links and model, shedding light on the underlying psychological dynamics at play.

The examination of intra-component effects reveals that the significant coefficients for each theorized link robustly support our hypotheses. Notably, within the instrumental quality component, our findings align with established technology acceptance theory principles, emphasizing the pivotal role of perceived ease of use in enhancing perceived usefulness. Similarly, the meaningful connections identified within the non-instrumental quality component suggest a cognitive progression from sensory experiences to interpretative and then to conative aspects. These insights corroborate the findings of Van der Linden et al. (2019) and tackle a notable gap in the original CUE model, which did not account for these intricate relationships.

Regarding the inter-component connections, our study validates the influence of both instrumental and non-instrumental qualities on emotional reactions. This aspect has been relatively overlooked in traditional technology acceptance frameworks, where emotions are typically seen as precursors to instrumental qualities, exemplified by the impact of perceived pleasure on ease of use in models like TAM 3 (Venkatesh & Bala, 2008). However, our findings reveal that the importance of these relationships varies with the specific technologies, UX factors, and elicited emotions, leading to impacts that range from pronounced to negligible.

4.3 Influence on User Satisfaction

The impact on user satisfaction reveals a differentiated effect of the various components. Instrumental qualities, such as usefulness and ease of use, exert a significantly stronger influence on satisfaction compared to non-instrumental qualities. Additionally, while negative emotions distinctly affect satisfaction, positive emotions appear to have a negligible impact. This pattern underscores users' expectations for high performance and usability in their devices, suggesting that deviations from these instrumental expectations are perceived more critically than shortcomings in non-instrumental qualities. These findings align with Hassenzahl et al.'s (2010) theoretical framework, which posits that instrumental qualities are hygienic, meaning they are essential, whereas non-instrumental and emotional qualities serve a stimulating role, enhancing appreciation and encouraging use.

4.4 Smartphone and smartwatch results comparison

When comparing our UX model outcomes for smartphones and smartwatches, we find a notable consistency across both types of devices. Only three smartphone-related effects—namely, the links between perceived usefulness and positive emotions, symbolic aspects and negative emotions, and motivational aspects and satisfaction—differ by becoming non-significant in contrast to smartwatch results. These disparities might reflect the distinct importance these aspects hold in users' interactions with these different types of devices.

Further analysis of the strength of comparable relationships within the two models reveals that these variances do not indicate a fundamentally different pattern, thus affirming the robustness and applicability of the proposed model across a range of devices. This consistency supports the model's foundational strength and its capacity to provide stable insights into user experience across diverse technological platforms.

4.5 Practical Applications and Implications

This study represents a significant contribution to both UX practitioners and researchers by providing a comprehensive exploration of a UX model. The model elucidates a diverse array of components and factors that play a crucial role in determining technology satisfaction. Such insights not only aid UX practitioners in identifying critical areas for enhancement but also enable marketers to craft strategies that bolster user engagement.

The study underscores the importance of integrating hedonic features into device development. Following Hassenzahl's (2018) insights, it's evident that these features not only enhance the user experience but also foster a deeper emotional bond between the user and the device. This strategy is paramount in cultivating enduring user engagement and loyalty, emphasizing the need for devices that resonate on both functional and emotional levels.

Additionally, by delving into how instrumental and non-instrumental factors can provoke both positive and negative emotional responses, this study helps researchers to gain a richer understanding of the user-technology relationship. This understanding is essential for crafting technologies that are not only user-centric but also emotionally attuned, paving the way for innovations that genuinely enhance human well-being and foster meaningful connections with technology.

Furthermore, the development of a robust questionnaire for assessing various UX dimensions across a spectrum of smart devices marks a methodological advancement. The validation of scales across smartwatches and smartphones demonstrates their applicability for other technological devices, offering a standardized approach for UX measurement that facilitates comparative analyses across different technologies.

The study also introduces an advanced analytical framework for understanding the UX, emphasizing the importance of calculating direct, indirect, and total effects. Neglecting to account for any type of effect may result in overestimating or underestimating the significance of each relationship, potentially skewing the insights into the psychological dynamics at play during user-technology interactions.

Through these insights, this study advocates for a more empathetic and emotionally intelligent approach to technology development, highlighting the transformative potential of UX research in shaping the future of human-technology interaction.

4.6 Limitations and Future Directions

This study significantly advances our understanding of user experience and smart device usage, yet it acknowledges several limitations that underscore the necessity for further exploration and refinement.

While the study sheds light on intra- and inter-component links within the UX model, it does not explore the potential interactions between instrumental and non-instrumental qualities, nor the potential interactions between positive and negative emotions. Delving deeper into these connections could offer invaluable insights and meaningful future research.

Moreover, the study focuses on a select set of instrumental, non-instrumental, and emotional factors. Extending the research to other UX factors could unveil new insights and enhance the richness of the UX model.

The unintentional gender imbalance among participants could potentially have influenced the findings and interpretations of the study. Since user needs and preferences may vary between genders, future studies should strive for more equitable gender representation to provide a comprehensive overview of user experiences across the spectrum. Similarly, incorporating variables such as user age, culture, and technology proficiency can reveal how each of these variables can impact User Experience, and thereby lead to more inclusive research that cater to a broader audience.

Another notable oversight is the study's disregard for the temporal dynamics of user experience. It fails to account for how users' perceptions and the importance of different dimensions might evolve over time or through various stages of technology adoption. A more dynamic understanding of UX, considering these temporal shifts, is crucial for capturing the full spectrum of user interaction with technology.

Additionally, the study's approach to UX does not explore how indirect knowledge or societal perceptions of devices may shape the user experience. Investigating the influence of second-hand experiences or external viewpoints on UX offers a fertile ground for expanding our understanding of how user experience is influenced beyond direct interaction with technology.

Concerning the questionnaire, the generalizability of the scales used for assessing user experience has not been fully established beyond this study. Future research is encouraged to test these scales across different samples, contexts, and technological devices to ensure their robustness and wider relevance. This step is crucial for validating the tool's applicability in a broader context.

Despite these limitations, the adaptability and applicability of the UX model and questionnaire to a wide range of users, interactive systems, and usage contexts remain an exciting avenue for further research. Addressing the limitations mentioned here will not only enhance the current UX model but also pave the way for a more inclusive, nuanced, and comprehensive exploration of user experience research in the coming years. This ongoing effort will undoubtedly contribute to our evolving understanding of human-technology interaction, highlighting the continuous need for adaptive and forward-thinking research in the UX domain.

In conclusion, our investigation not only validates crucial aspects of the UX model but also broadens our understanding of how these elements interact to affect user satisfaction. The insights derived from this study provide UX practitioners and researchers with valuable knowledge to study, innovate and enhance the design and functionality of smart technologies. This, in turn, contributes to enriching the user experience in our constantly evolving digital landscape.

Disclosure statement

The authors report there are no competing interests to declare.

Ethics

This research has been approved by the Ethic committee from the Faculty of Psychological Science and Education of the Université libre de Bruxelles. Reference number: 104/2019:

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References

Al-Emran, M. (2021). Evaluating the use of smartwatches for learning purposes through the integration of the technology acceptance model and task-technology fit. *International Journal of Human–Computer Interaction*, *37*(19), 1874-1882.

Al-Emran, M., Al-Maroof, R., Al-Sharafi, M. A., & Arpaci, I. (2022). What impacts learning with wearables? An integrated theoretical model. *Interactive learning environments*, *30*(10), 1897-1917.

Andone, I., Błaszkiewicz, K., Eibes, M., Trendafilov, B., Montag, C., & Markowetz, A. (2016, September). How age and gender affect smartphone usage. In *Proceedings of the 2016 ACM international joint conference on pervasive and ubiquitous computing: adjunct* (pp. 9-12).

Aranyi, G., & Van Schaik, P. (2016). Testing a model of user-experience with news websites. *Journal of the Association for Information Science and Technology*, *67*(7), 1555-1575.

Attig, C., & Franke, T. (2020). Abandonment of personal quantification: A review and empirical study investigating reasons for wearable activity tracking attrition. *Computers in Human Behavior*, *102*, 223-237.

Basha, N. K., Aw, E. C. X., & Chuah, S. H. W. (2022). Are we so over smartwatches? Or can technology, fashion, and psychographic attributes sustain smartwatch usage?. *Technology in Society*, *69*, 101952.

Bölen, M. C. (2020). Exploring the determinants of users' continuance intention in smartwatches. *Technology in Society*, *60*, 101209.

Bongard-Blanchy, K., Bouchard, C., Bonnardel, N., Lockner, D., & Aoussat, A. (2015). User experience dimensions in product design: a consolidation of what academic researchers know and what design practitioners do. *Journal of Design Research*, *13*(2), 107-124.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern methods for business research*, *295*(2), 295-336.

Chin, W. W. (2009). How to write up and report PLS analyses. In *Handbook of partial least squares: Concepts, methods and applications* (pp. 655-690). Berlin, Heidelberg: Springer Berlin Heidelberg.

Cho, W. C., Lee, K. Y., & Yang, S. B. (2019). What makes you feel attached to smartwatches? The stimulus–organism–response (S–O–R) perspectives. *Information Technology & People*, *32*(2), 319-343.

Chuah, S. H. W. (2019). Wearable XR-technology: literature review, conceptual framework and future research directions. *International journal of technology marketing*, *13*(3-4), 205-259.

Chuah, S. H. W., Rauschnabel, P. A., Krey, N., Nguyen, B., Ramayah, T., & Lade, S. (2016). Wearable technologies: The role of usefulness and visibility in smartwatch adoption. *Computers in Human Behavior*, *65*, 276-284.

Cvetković, B., Szeklicki, R., Janko, V., Lutomski, P., & Luštrek, M. (2018). Real-time activity monitoring with a wristband and a smartphone. *Information Fusion*, *43*, 77-93.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Deng, L., Turner, D. E., Gehling, R., & Prince, B. (2010). User experience, satisfaction, and continual usage intention of IT. *European Journal of Information Systems*, *19*(1), 60-75.

Forlizzi, J., & Battarbee, K. (2004, August). Understanding experience in interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques* (pp. 261-268).

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics

Gupta, M., Sinha, N., Singh, P., & Chuah, S. H. W. (2020). Gender differences in the wearable preferences, device and advertising value perceptions: smartwatches vs. fitness trackers. *International Journal of Technology Marketing, 14*(2), 199-225.

Goh, J. C. L., & Karimi, F. (2014). Towards the development of a 'user-experience'technology adoption model for the interactive mobile technology. In *HCI in Business: First International Conference, HCIB 2014, Held as Part of*

HCI International 2014, Heraklion, Crete, Greece, June 22-27, 2014. Proceedings 1 (pp. 620-630). Springer International Publishing.

Gross, A., & Bongartz, S. (2012, October). Why do I like it? Investigating the product-specificity of user experience. In *Proceedings of the 7th Nordic conference on human-computer interaction: Making sense through design* (pp. 322-330).

Hassenzahl, M. (2018). The thing and I: understanding the relationship between user and product. *Funology 2: from usability to enjoyment*, 301-313.

Hassenzahl, M. (2006). Hedonic, emotional, and experiential perspectives on product quality. In *Encyclopedia of human computer interaction* (pp. 266-272). IGI Global.

Hassenzahl, M., Diefenbach, S., & Göritz, A. (2010). Needs, affect, and interactive products–Facets of user experience. *Interacting with computers*, *22*(5), 353-362.

Hassenzahl, M., & Tractinsky, N. (2006). User experience-a research agenda. *Behaviour & information technology*, *25*(2), 91-97.

Hedman, J., & Gimpel, G. (2010). The adoption of hyped technologies: a qualitative study. *Information Technology and Management*, *11*, 161-175.

Hubert, M., Blut, M., Brock, C., Backhaus, C., & Eberhardt, T. (2017). Acceptance of smartphone-based mobile shopping: Mobile benefits, customer characteristics, perceived risks, and the impact of application context. *Psychology & Marketing*, *34*(2), 175-194.

Karapanos, E., Zimmerman, J., Forlizzi, J., & Martens, J. B. (2009, April). User experience over time: an initial framework. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 729-738).

Kim, S. H. (2014). A study on adoption factors of Korean smartphone users: A focus on TAM (Technology Acceptance Model) and UTAUT (Unified Theory of Acceptance and Use of Technology). *Advanced Science and Technology Letters*, *57*(1), 27-30.

Koul, S., & Eydgahi, A. (2017). A systematic review of technology adoption frameworks and their applications. *Journal of technology management & innovation*, *12*(4), 106-113.

Krey, N., Chuah, S. H. W., Ramayah, T., & Rauschnabel, P. A. (2019). How functional and emotional ads drive smartwatch adoption: The moderating role of consumer innovativeness and extraversion. *Internet Research*, *29*(3), 578-602.

Kulviwat, S., Bruner II, G. C., & Al-Shuridah, O. (2009). The role of social influence on adoption of high tech innovations: The moderating effect of public/private consumption. *Journal of Business research*, *62*(7), 706-712.

Lacroux, A. (2011). Les avantages et les limites de la méthode «Partial Least Square»(PLS): une illustration empirique dans le domaine de la GRH. *Revue de gestion des ressources humaines*, (3), 45-64.

Lallemand, C., & Koenig, V. (2017, September). How Could an Intranet be Like a Friend to Me? Why Standardized UX Scales Don't Always Fit. In *Proceedings of the European Conference on Cognitive Ergonomics* (pp. 9-16).

Lallemand, C., Koenig, V., Gronier, G., & Martin, R. (2015). Création et validation d'une version française du questionnaire AttrakDiff pour l'évaluation de l'expérience utilisateur des systèmes interactifs. *European Review of Applied Psychology*, *65*(5), 239-252.

Law, E. L. C., Roto, V., Hassenzahl, M., Vermeeren, A. P., & Kort, J. (2009, April). Understanding, scoping and defining user experience: a survey approach. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 719-728).

Li, T., Xia, T., Wang, H., Tu, Z., Tarkoma, S., Han, Z., & Hui, P. (2022). Smartphone app usage analysis: datasets, methods, and applications. *IEEE Communications Surveys & Tutorials*.

Liu, X., Chen, T., Qian, F., Guo, Z., Lin, F. X., Wang, X., & Chen, K. (2017, June). Characterizing smartwatch usage in the wild. In *Proceedings of the 15th annual international conference on mobile systems, applications, and services* (pp. 385-398).

Ma, Q., Chan, A. H., & Chen, K. (2016). Personal and other factors affecting acceptance of smartphone technology by older Chinese adults. *Applied ergonomics*, *54*, 62-71.

Minge, M., & Thüring, M. (2018). Hedonic and pragmatic halo effects at early stages of user experience. *International Journal of Human-Computer Studies*, *109*, 13-25.

Minge, M., Thüring, M., & Wagner, I. (2016, September). Developing and validating an English version of the meCUE questionnaire for measuring user experience. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 60, No. 1, pp. 2063-2067). Sage CA: Los Angeles, CA: SAGE Publications.

Nascimento, B., Oliveira, T., & Tam, C. (2018). Wearable technology: What explains continuance intention in smartwatches?. *Journal of Retailing and Consumer Services*, *43*, 157-169.

Nieroda, M. E., Mrad, M., & Solomon, M. R. (2018). How do consumers think about hybrid products? Computer wearables have an identity problem. *Journal of Business Research*, *89*, 159-170.

Norman, D., Miller, J., & Henderson, A. (1995, May). What you see, some of what's in the future, and how we go about doing it: HI at Apple Computer. In *Conference companion on Human factors in computing systems* (p. 155).

Ogbanufe, O., & Gerhart, N. (2018). Watch it! Factors driving continued feature use of the smartwatch. *International Journal of Human–Computer Interaction*, *34*(11), 999-1014

Park, Y., & Chen, J. V. (2007). Acceptance and adoption of the innovative use of smartphone. *Industrial management & data systems*, *107*(9), 1349-1365.

Raptis, D., Papachristos, E., Bruun, A., & Kjeldskov, J. (2022). Why did you pick that? A study on smartwatch design qualities and people's preferences. *Behaviour & Information Technology*, *41*(4), 827-844.

Russell, J. A. (1980). A circumplex model of affect. *Journal of personality and social psychology*, *39*(6), 1161.

Scapin, D., Senach, B., Trousse, B., & Pallot, M. (2012, January). User experience: Buzzword or new paradigm?. In *ACHI 2012, The Fifth International Conference on Advances in Computer-Human Interactions*.

Schrepp, M., Hinderks, A., & Thomaschewski, J. (2017). Design and evaluation of a short version of the user experience questionnaire (UEQ-S). *International Journal of Interactive Multimedia and Artificial Intelligence, 4 (6), 103-108.*

Shaw, H., Ellis, D. A., & Ziegler, F. V. (2018). The Technology Integration Model (TIM). Predicting the continued use of technology. *Computers in Human Behavior*, *83*, 204-214.

Talukder, M. S., Chiong, R., Bao, Y., & Hayat Malik, B. (2019). Acceptance and use predictors of fitness wearable technology and intention to recommend: An empirical study. *Industrial Management & Data Systems*, *119*(1), 170-188.

Thüring, M., & Mahlke, S. (2007). Usability, aesthetics and emotions in human–technology interaction. *International journal of psychology*, *42*(4), 253-264.

Van der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS quarterly*, 695-704.

Van Der Linden, J., Amadieu, F., Vayre, E., & Van De Leemput, C. (2019). User experience and social influence: A new perspective for UX theory. In *Design, User Experience, and Usability. Design Philosophy and Theory: 8th International Conference, DUXU 2019, Held as Part of the 21st HCI International Conference, HCII 2019, Orlando, FL, USA, July 26–31, 2019, Proceedings, Part I 21* (pp. 98-112). Springer International Publishing.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, *39*(2), 273-315.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information systems research, 16*(1), 85-102.

Yogasara, T., Popovic, V., Kraal, B., & Chamorro-Koc, M. (2011). General characteristics of anticipated user experience (AUX) with interactive products. In *Diversity and unity: Proceedings of IASDR2011, the 4th World Conference on Design Research* (pp. 1-11). Delft University of Technology.

Zarour, M., & Alharbi, M. (2017). User experience framework that combines aspects, dimensions, and measurement methods. *Cogent Engineering*, *4*(1), 1421006.