A theoretical model for understanding user experience in mobile application interaction

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Abstract: Over the past decade, the global spread of mobile devices and specific applications have boosted the interest in user experience (UX) evaluation. Most existing models, designed for stable systems, do not fully address the fragmented, variable, and routine-embedded nature of mobile interactions. To address this gap, this paper proposes a new model that extend and adapt CUE framework to the specificities of mobile interactions. Its novelty lies in integrating product, user, and context characteristics to explain their causal roles in shaping perceptions, satisfaction, attachment, and behavioral intentions. The model also introduces a longitudinal perspective. It can thus be observed how user experience shifts from the initial familiarization and exploration to dependence and loyalty. This model thus provides a practical base for empirical research, guiding future longitudinal studies and offering a contribution to mobile-specific evaluation tools.

Keywords: User Experience, Mobile Application, Theoretical Model, Longitudinal Evaluation.

Model teoretic pentru înțelegerea experienței utilizatorului în interacțiunea cu aplicațiile mobile

Rezumat: În ultimul deceniu, răspândirea globală a dispozitivelor mobile și a aplicațiilor specifice au stimulat interesul pentru evaluarea experienței utilizatorului (UX). Majoritatea modelelor existente, concepute pentru sisteme stabile, nu abordează în mod adecvat natura fragmentată, variabilă și integrată în rutina zilnică a interacțiunilor mobile. Pentru a răspunde acestui decalaj, articolul propune un nou model care extinde și adaptează cadrul CUE la specificul interacțiunilor mobile. Noutatea sa constă în integrarea caracteristicilor produsului, utilizatorului și contextului pentru a explica rolurile lor cauzale în modelarea percepțiilor, satisfacției, atașamentului și intențiilor comportamentale. Modelul introduce, de asemenea, o perspectivă longitudinală, permițând observarea modului în care experiența utilizatorului evoluează de la familiarizare și explorare inițială până la dependență și loialitate. Astfel, modelul oferă o bază practică pentru cercetări empirice, orientând studiile longitudinale viitoare și contribuind la dezvoltarea unor instrumente de evaluare specifice mediului mobil.

Cuvinte-cheie: Experiența utilizatorului, Aplicații mobile, Model teoretic, Evaluare longitudinală.

1. Introduction

Rapid technological advances and constantly changing user expectations are factors that contribute to the increasing importance of continually evaluating the experience resulting from the interaction between users and mobile applications. Permanent improvements in hardware resources (processing power, sensors, connectivity) have led to the large-scale adoption of complex interactive professional applications, which are now integrated into everyday life. However, for many users, the mobile ecosystem is more than a simple tool for solving tasks; it is also an expression of hedonic aspects, including emotions, personal values, preferences, and contextual meanings. (Chen & Zhu, 2011). Mobile UX complexity arises from the device constraints and highly variable contexts, where factors such as movement, multitasking, and environmental conditions constantly influence interactions (Chang et al., 2014).

The dynamic nature of mobile apps creates interactions shaped by time, place, mood, and the user's context. The initial experience may be driven by novelty and appealing features, but over time, the success depends on adaptability, efficiency, and lasting value. If an application fails to meet changing user needs or to maintain a high level of utility, it risks being abandoned. Although a wide range of models and frameworks have been proposed for UX evaluation, achieving an "overall UX" remains a major challenge, both conceptually and methodologically. Moreover, one of the main limitations lies in the lack of consensus on the optimal methodology for evaluating

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mobile UX (Lu, Qu & Chen, 2025). Although various tools have been developed, ranging from usability scales and acceptance models to qualitative, quantitative, and mixed-methods approaches, many are too generic or fail to capture the diversity and dynamics of real user experiences (Pribeanu, 2014; Bitar et al., 2021). The automated approaches to UX evaluation can streamline testing but often fail to capture the emotional and motivational nuances, and are therefore typically used in conjunction with traditional methods (Abuaddous et al., 2022). A solution based on longitudinal methods better reflects the dynamics of UX in interaction with mobile applications, but their high costs, extended duration, and complexity of implementation limit their wide applicability. Unlike the longitudinal research, the cross-sectional studies are more logistically efficient but generally limited in terms of external validity.

To address this limitation, this paper presents a new theoretical model for mobile UX evaluation, providing both a multidimensional and longitudinal perspective that support the continuous optimization of user experience. To meet this objective, the research is organized around the following questions:

- RQ 1: What are the main pragmatic and hedonic factors that shape the perception and user experience in mobile application interaction?
- RQ 2: How can these factors be integrated into a unified theoretical model that explains the causal relationships shaping mobile UX?
- RQ 3: In what way does a longitudinal perspective enhance the understanding of user experience evolution over time?

The rest of this paper is organized as follows. Section 2 reviews models and frameworks for UX evaluation, highlighting their limitations for mobile applications. Section 3 presents a new theoretical model, detailing its main components. Section 4 discusses its position in relation to established approaches and highlights its distinct contributions. Finally, Section 5 concludes the paper and highlights future research directions.

2. Research background

2.1. UX approach

Strictly pragmatic dimensions such as usability cannot fully capture the user experience, requiring an extension of the traditional evaluation paradigm by introducing subjective, affective, and contextual dimensions (Hassenzahl, 2003). Thus, the focus has shifted from efficiency and functionality to the ability of a product to elicit positive emotions, promote attachment, and provide subjective value. In this view, digital products have shifted from simple tools to carriers of affective and symbolic experience. The lack of a consensual definition of UX has led to multiple emerging approaches. Some authors describe user experience as a broad and general notion (Forlizzi & Battarbee, 2004), while others define it more precisely by distinguishing it from "simple experience" (Roto, 2007; Law et al., 2009). Moreover, Roto (2007) argues that UX necessarily involves interaction with a product, service, or system, whereas Law et al. (2009) frame it as a narrower domain of "experience," applicable to products, systems, and services mediated through interfaces. Norman (2013) expanded the concept beyond individual products to include all points of contact with companies and brands, emphasizing its holistic and organizational nature. Nielsen Norman Group later defined UX as "all aspects of the end-user's interaction with the company, its products, and services," a perspective that integrates emotional, cognitive, and contextual dimensions (Norman & Nielsen, 2018). Other approaches emphasize different facets of UX, such as sensory and perceptual aspects (Shedroff, 2023), holistic experience as opposed to task-oriented perspectives (Alben, 1996), or its evaluative and emotional character (Hassenzahl, 2008).

According to ISO (2019) standard, user experience is defined for the first time in a temporal perspective as a set of emotional and cognitive responses to using a product, encompassing usefulness, usability, and efficiency over time. Similarly, Desmet (2002) and Hassenzahl (2008) consider the emotional nature of UX as a momentary feeling produced during the interaction with

the product, which influences its adoption and use. Nevertheless, emotions alone cannot fully explain a long-term attachment, as they have a limited duration (Kajiwara & Jin, 2012). Hassenzahl and Tractinsky (2006) considered UX as being shaped by the user's internal state, the system's characteristics, and the interaction context. This view was further formalized by Law et al. (2009), who consider UX developing around three pillars: user, system, and context. This results in the subjective and dynamic nature of UX, which can manifest as instantaneous, episodic or cumulative experiences (Roto et al., 2011).

2.2. UX theoretical models

2.2.1. Product-centered models

The models that emphasize aesthetics, functionality, and the generation of positive emotions during interaction are specific to this category. It generally provides guidance and evaluation criteria for the design of products whose intrinsic characteristics influence UX. In his approach, Alben (1996) considered UX quality to be defined by criteria that include user understanding, usefulness, usability, aesthetics, adaptability, and lifecycle considerations. Another model proposed by Jääskö and Mattelmäki (2003) involves evaluating UX early in the product development process. In this case, a clear distinction is made between product-related qualities (e.g., visual appearance, interface, functionality) and contextual qualities (e.g., cultural, social, and emotional factors that shape perception).

2.2.2. User-centered models

This category provides analytical tools for assessing user actions during product interaction, offering developers means to assess user-relevant aspects of experience and optimize products accordingly. The multifunctional nature of mobile platforms often generates cognitively and behaviorally demanding forms of interaction. Models such as Technology Acceptance Model (TAM) (Davis, 1989) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) are used to explain technology acceptance, especially on the dimensions of perceived usefulness and ease of use. In a holistic assessment of mobile applications, however, these models fail to reflect the hedonic and emotional dimensions of UX. Starting from this hypothesis, Van der Linden et al. (2024) emphasize the need to integrate the necessary non-instrumental and affective components. In his model, Norman (2004), conceptualized UX on three levels, visceral, behavioral and reflective, thus integrating the affective and cognitive dimensions into a holistic framework for designing usable and engaging products. The pragmatic–hedonic model (Hassenzahl, 2007) distinguishes between instrumental qualities that support task-oriented goals (“do-goals”) and non-instrumental qualities that fulfill identity-related and experiential aspirations (“be-goals”). Since these dimensions are independent, the products may succeed pragmatically without generating a positive emotional response, revealing gaps between designer intentions and user perceptions.

2.2.3. Interaction-centered models

The models in this category relate to the user experience through the relationship between the user and the product within a social context, abandoning the classic approaches seen through the lens of the user (user-centered) or the product (product-centered). According to Forlizzi and Battarbee (2004), the user-product interaction is the primary connection between the designer's intentions and the user's actual behavior. Experience is seen as an expression of the interaction among the user, the product, and the social context. Three types of user-product interactions are proposed: fluent, when actions are automatic and natural; cognitive, when learning or adaptation is required; and expressive, when the user personalizes or builds a relationship with the product. This type of interaction leads to three levels of experience: the current experience seen as a permanent flow of self-reflection during the interaction; a distinct, delimited, memorable experience with emotional and behavioral impact; co-experience lived and socially negotiated, through sharing with

others. In this construct, the role of the emotions is to guide intentions, organizing the mode of interaction, and providing value to the obtained results.

The CUE model (Thüring & Mahlke, 2007) places user-system interaction at the center of UX, going beyond the efficiency-focused approaches. It defines UX as a dynamic interaction of instrumental qualities (utility, usability), non-instrumental qualities (aesthetics, identity), and emotional responses, which dynamically influence each other during the interaction. The CUE model thus provides an integrated perspective on experience, combining all the elements mentioned above to influence user preferences. The model proposed by Hassenzahl and Tractinsky (2006) offers a holistic view of UX by integrating user states, system characteristics and context, treating the affective and instrumental factors as equally important. From the model's perspective, the interactive products should be designed for ease of use and efficiency as well as for positive and memorable experiences that enhance well-being and encourage a long-term engagement. Karapanos (2009) emphasizes the temporal dimension of user experience, as an evolutionary process that unfolds in three phases: orientation, incorporation and identification, driven by familiarity, functional dependency and emotional attachment. The model shows us that the value of a product is explained by initial impressions, but also by how it becomes useful, integrated into everyday life and loaded with personal and social meanings.

2.3. Limitations of the existing UX models

A common limitation of the established UX evaluation models is their poor ability to adequately capture the longitudinal and multimodal aspects of UX. In many cases, they neglect how important aspects such as changing motivations, attachment, and recurring frustrations develop over the life cycle of the mobile applications, influencing how they are used (Karapanos et al., 2009; Chen & Zhu 2011). The popular approaches often fail to provide an extended understanding of the interaction between the pragmatic, hedonic, and affective dimensions and how they contribute to maintaining user satisfaction. Most current models lack a comprehensive perspective, focusing on narrow aspects such as functional features, design, or immediate emotions. The CUE model (Thüring & Mahlke, 2007) marked a significant step forward by proposing a comprehensive framework that integrated the instrumental, non-instrumental, and emotional aspects of user experience. Despite this progress, the model's perspective was largely static, conceptualizing UX as an outcome of the interaction between user, system, and context, limiting its ability to explain the temporal dynamics and evolution of the user satisfaction over time.

One of the most famous frameworks in UX research, the pragmatic-hedonic model (Hassenzahl, 2008) provides conceptual clarity by distinguishing between pragmatic and hedonic qualities. While distinct at a conceptual level, in practice, these dimensions interact closely, shaping user experience through their dynamic balance. Some authors demonstrate that there is often a compromise between the pragmatic efficiency and the hedonic pleasure, depending on context, objectives, and time (Van der Linden et al., 2022). While these approaches acknowledge that perceptions shift with experience, it does not tell us how these changes occur over time, leaving the temporal evolution underexplored. In their interaction-centered model, Forlizzi and Battarbee (2004) emphasize the situated, social, and emotional nature of the user experience. They introduce the notion of scalability, whereby micro-experiences accumulate into larger experiential trajectories. Even though it offers an exhaustive perspective on UX, there are criticisms regarding its operational clarity, as it cannot be fully translated into measurable constructs or predictive models. This limitation makes it difficult to operationalize this framework and apply it consistently in empirical research or practical evaluation (Law et al., 2009; Roto et al., 2011). Despite its longitudinal nature, the model proposed by Karapanos et al. (2009) does not clearly explain how pragmatic and hedonic perceptions interact in its three phases (orientation, incorporation, and identification). It also does not explain how contextual changes (e.g., changes in task demands or social environments) shape these trajectories (Minge & Thüring, 2018; Lallemand et al., 2015). These limitations may be synthesized as: lack of temporal perspective; approaching pragmatic and hedonic dimensions as separate entities; gap between theoretical complexity and available methodological tools.

Initially developed and validated for static systems and stable usage contexts, most models are limited in UX evaluation of mobile applications, where the variation in physical, social, and technological conditions is constant (Korouthanassis et al., 2007; Mahmoud et al., 2021). Thus, the need for a new evaluation model becomes necessary, capable of explicitly integrating the context, emotional attachment and temporal evolution of the experience in using mobile devices. Additionally, it must reflect the full spectrum of emotional responses, both positive and negative, to provide a more comprehensive understanding of the user-application interaction.

3. Research model

Building from the CUE model proposed by model (Thüring & Mahlke, 2007), a new UX model with application in the mobile application evaluation will be presented below. This new model aims to address the limitations of the static models, introducing a dynamic and longitudinal perspective on UX. The core element of the model is the dynamic and temporal nature of the user experience, which evolves from the initial interaction through familiarization and consolidation, to the stable form of functional and emotional attachment. The emphasis on emotions as an integral part of the experience follows the path opened by CUE, differing from it only in the methodology. Beyond dealing only with punctual reactions, the new model treats emotion as a mediating factor in the transition between the experience stages, shaping the risk of abandonment or the consolidation of attachment. The product features and user attributes directly shape the quality and satisfaction of the interaction, personalizing how the app's functionalities and value are perceived.

This model extends and adapts CUE to the specificities of the mobile interactions by introducing both context, and physical, social and technological factors. As a result, the user experience becomes a dynamic construct shaped by situational factors such as location, connectivity, social presence, or device ecosystem. Therefore, the contextual variability has a direct influence on the perceptions of usability, functionality, and hedonic value. The proposed model (Fig. 1) presents an integrated view of UX outlining the causal relationships between the pragmatic dimensions (usability, functionality), hedonic qualities (attractiveness, stimulation), as well as the affective and social processes that emerge through the ongoing mobile interactions. The following section details the model and illustrates how its components interact to explain the temporal evolution of user experience in mobile contexts.

3.1. Product characteristics

Starting from the conceptual reference provided by, the product is seen as the sum of its functional and non-functional characteristics. The "Product characteristics" component encompasses a set of technical and design attributes that define how a mobile application works and is perceived in use, acting as determinant factors of the interaction quality, shapes and impacts the pragmatic evaluations and hedonic judgments, as illustrated in Figure 1. The component "Product characteristics" is defined through six dimensions: usability, functionality, structural clarity, functional feedback, technical performance and sensory characteristics. Usability and functionality reflect pragmatic qualities and structural clarity addresses the cognitive and affective aspects of presentation, while the functional feedback, technical performance and sensory characteristics determine the continuity and efficiency of use.

3.2. User characteristics

The link between the dimension of user characteristics and the evaluation of instrumental and non-instrumental qualities arises from the subjective and context-dependent nature of the experience. The initial perceptions and the subsequent reactions are shaped primarily by the psychological and motivational profile of the individual. Extending this view, several authors consider the user characteristics as a central dimension in UX models. Minge & Thüring (2018) in meCUE model consider user motivations, traits and attitudes as part of the factors that influence the perceptions of usability, aesthetics and emotions. The pragmatic-hedonic model further explores

how user experience is shaped by expectations and goals. The user's main goals include fulfilling tasks ("do-goals") as well as identity or experiential aims ("be-goals"). Accordingly, the perceived value of the product reflects how well it addresses both dimensions (Hassenzahl, 2007). Karapanos et al. (2009) show that the differences in motivation and personality influence the speed of the transitions across UX lifecycle stages (orientation, incorporation, identification), shaping both persistence of use and the emergence of the emotional attachment.

At the user level, we can thus distinguish three categories of characteristics that influence UX: affective (motivation), anticipatory cognitive (expectations), and stable dispositional (personality). In the proposed model, these dimensions serve as an initial filter through which the user approaches the application, and what results influence the quality of the interaction, the formation of the pragmatic and hedonic perceptions, and the evolution towards familiarization, functional dependence, and emotional attachment. The external factors, such as digital experience, technological affinity, and demographic characteristics, extend the user profile and provide a contextual framework for interpreting interactions.

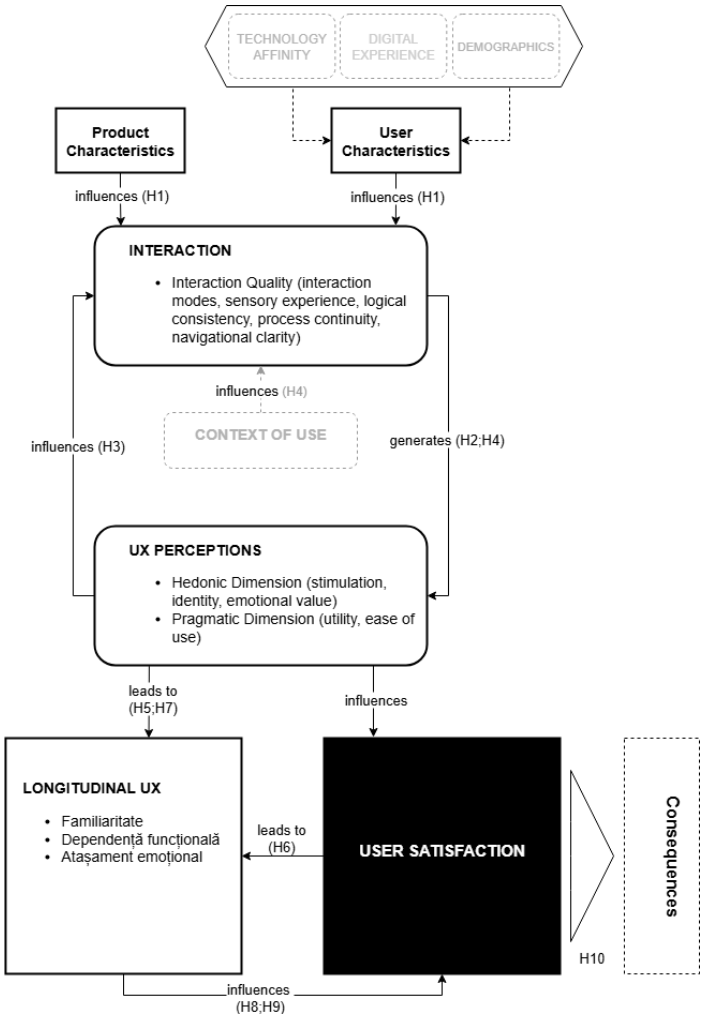

Figure 1. Proposed research UX model for mobile application (Source: own research)

3.3. Interaction

The interaction component symbolizes the point of contact between users and the application, where functionalities intersect with users' behaviors, expectations and resources resulting in perceptions of coherence, fluidity and control in use. In the proposed model, interaction is a multidimensional construct centered on quality, shaped by information exchange dynamics, including interaction modes and sensory experiences. The interaction modes describe how users

navigate the application, including gestures, menus, and feedback. The sensory experience covers how the visual, sound, and touch design impact the appeal and emotional response.

This view is supported by models such as Jovanovic et al. (2014) and Dong et al. (2019), which describe interaction as a prerequisite for multisensory experience where feedback, clarity, and control mediate user perceptions and emotions. The CUE model proposes a mechanism in which the product qualities are accessed and the affective responses are generated, shaping the overall satisfaction. This suggests that the user experience evolves through the way interaction is perceived, experienced, and integrated in daily digital activity. Thus, the interaction is considered a multidimensional process, cognitive, sensory, behavioral, and emotional, whose quality depends on the interface consistency, the continuity of actions, and the system's ability to provide anticipatory guidance (feedforward) and clear responses (feedback). In the proposed model, the interaction quality acts as a pivot, shaping both pragmatic and hedonic perceptions. This approach overcomes the limitations of other solutions that treat the interaction only as a mediator between the instrumental and non-instrumental evaluations, or reduce it to a simple means to achieve goals.

3.4. Context of use

The context component influences the external and situational conditions of the user-application interaction. This plays a particularly important role in a mobile environment, where interactions occur in dynamic and often unpredictable environments. The CUE model highlights the impact of the external conditions on evaluations of the instrumental and non-instrumental qualities, whereas the longitudinal models show that the progression from familiarization to integration and emotional attachment is significantly influenced by everyday usage situations (Karapanos et al., 2009). In some cases, the experience is considered to be inseparable from its social and physical context. The environmental factors (lighting, noise, crowding), the mobility factors, the network stability, and the device type each shape the interaction quality (Forlizzi & Battarbee, 2004). In the proposed model, the context provides a direct influence on the interaction quality and overall user experience across two complementary dimensions. The situational context is the first dimension, defined by the concrete conditions of use, such as those that can facilitate or disrupt the action coherence. The temporal (longitudinal) context is the second dimension, illustrating how the experience evolves as the application becomes integrated into daily routines. This approach shows how changing motivations, expectations, and behaviors continually reshape the perceptions of the interaction quality over time.

3.5. UX perceptions

Typically, UX evaluation treats user perception as a subjective process of interpreting the interaction with a system. Together, the system and user characteristics create a series of meanings that shape the subsequent emotional reactions and attitudes. Several theoretical approaches describe perception as a bridge between interaction and overall satisfaction (Thüring & Mahlke, 2007; Hassenzahl, 2008). The main limitation of these models is the ignoring of temporal transformations and the mutual influence between perceptions and the subsequent interactions. To overcome this gap, some authors propose a longitudinal approach in their research, considering perception as an evolutionary process (Karapanos et al., 2009; Chen, Koh & Wong, 2022). Initially, the perception of usefulness, clarity and ease of learning is assessed, which generates acceptance. In the next phase, the interest in the system and emotional involvement are supported by hedonic qualities. In the final phase there is a convergence between the hedonic and pragmatic perception that results in a stable experience, influenced by the dynamic context and individual differences. Building on these ideas, the model proposes a reconceptualization of the perception as a dynamic, bidirectional process, influenced by the quality of the interaction and the evolution of the experience. The novelty is explained in the simultaneous integration of both temporality in perception formation and recognizing that user perceptions are not simply passive results of the interaction, but also become active factors that shape the future interactions.

3.6. Longitudinal UX

This dimension transforms the user-application relationship into an evolutionary process, independent of the changes in the pragmatic and hedonic perceptions. This process can be assessed through the following characteristics: (i) familiarity or the reduction of uncertainty and the consolidation of the pragmatic perceptions; (ii) functional dependence or the integration of the application into daily routines and the increase of the instrumental relevance; and (iii) emotional attachment, which reflects the internalization of the symbolic and identity value. This approach follows the stages described by Karapanos et al. (2009): orientation, incorporation, and identification. Over time, the initial evaluations do not predict later experiences. Aesthetics or stimulation, although relevant in the early phase, lose their significance over time, being replaced by reliability, consistency and personal value (Van der Linden et al., 2024).

Without a temporal perspective, UX models risk providing a fragmented view of the experience, unable to explain the reasons behind satisfaction, loyalty or abandonment. In the proposed model, the longitudinal effects are driven by two main sources: UX perceptions and user satisfaction. The pragmatic and hedonic perceptions encourage familiarization and exploration, and their consolidation supports the functional dependency by integrating routine. The positive experiences subsequently allow the emotional attachment, attributing personal and identity value to the application. The satisfaction is only a reflexive mechanism in this context. When stable, it accelerates stage transitions and strengthens retention. When expectations differ from the perceived performance, it can limit progress, leading to stagnation or abandonment. In conclusion, the perception and satisfaction configure the temporal effects, shaping the trajectory of the user experience in a framework that explains both retention and abandonment.

3.7. User satisfaction

Satisfaction is the ultimate user response. It arises from the integration of the pragmatic and hedonic perceptions with the longitudinal experiences, including familiarity, functional dependence, and emotional attachment. It is the result of the overall appreciation of the experience reflecting how UX perceptions consolidate and evolve, influencing the current perceptions and the future usage intentions. Satisfaction functions both as a retrospective indicator of experience quality and as a predictor of loyalty, retention, and recommendation. Unlike the other formative components of the model, the satisfaction has a reflective nature, synthesizing perceptions and emotions into an integrated evaluation. It encompasses the fulfillment of the needs, the pleasure experienced, the perceived value relative to effort, and the intention for future use. Therefore, the satisfaction cannot be treated as a simple outcome outside a unified UX framework.

3.8. Consequences

The final stage of the processes described above is represented by the “consequences” dimension. This is not a proper component of the model, but rather a state that emerges from the cumulative experience with the application over time. Consequences refer to the satisfaction, continued use, loyalty and recommendation that emerge as integrated results of the product characteristics, user profile, context, interaction and evolving perceptions. As behavioral and affective indicators, “consequences” emphasize the sustainability of the user experience by integrating routine, functional dependence and emotional attachment. From an applied perspective, the consequences provide a series of operational indicators for the continuous optimization of the evaluation process. First, satisfaction is monitored using standardized tools and contextual feedback. Next is the analysis of usage behaviors. The final step is to assess the emotional attachment and recommendation intention. In an iterative design process, these indicators help correct discrepancies between expectations and performance. They also maintain a balance between the pragmatic and hedonic dimensions. Beyond the retrospective results, the “consequences” serve as sustainability and self-regulation mechanisms in the user experience. They provide developers with practical guidance for the ongoing improvement of the mobile applications.

4. Model contribution

The proposed model adds value by correlating and extending the existing concepts with a focus on the unique aspects of the mobile applications. A major contribution is the longitudinal dimension of the model, which proposes to examine the temporal transformation of the experience, from the initial familiarization and exploration to the functional dependence and emotional attachment. The models developed to explain the technology adoption, such as the Technology Acceptance Model (TAM) (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), remain primarily confined to an instrumental perspective, without addressing the hedonic dimensions or the temporal transformation of the experience. Although these models have added dimensions such as the hedonic motivation (UTAUT 2) and affective variables (TAM), they still do not represent the fragmented, context-dependent, and routine-integrated interactions of the mobile applications. As Schomakers et al. (2022) notice, this type of model explains only a limited proportion of the variance in behavioral intention. Since the hedonic motivation, trust, and prior experience have a more significant impact than the utilitarian constructs, the models tailored to the dynamic, context-sensitive character of the mobile applications are necessary.

An important conceptual progress has been made by the models that recognize the evolutionary character of user experience, although several limitations remain in evaluating UX in mobile applications. For example, CUE integrates instrumental and emotional components, but remains essentially descriptive and does not explain how the satisfaction is maintained over time. In the model proposed by Karapanos (2009) there is a temporal dynamic of UX, but the mechanisms that link the pragmatic and hedonic perceptions are missing, and how users adapt to the technical constraints of the mobile environments is not explained.

To address this gap, the model presented in this paper proposes a holistic, longitudinal framework that integrates the mobile-specific factors, such as mobility, network instability, and fragmented interactions (and sometimes multitasking), with the emotional processes. Unlike the existing longitudinal approaches, it specifies the explicit causal relationships between the pragmatic and hedonic perceptions, familiarization, functional dependence, and emotional attachment. The model thus describes overall UX and also clarifies the mechanisms leading to loyalty and behavioral intentions, offering a solid basis for future empirical research. To better illustrate the key aspects introduced in this article, Table 1 compares the proposed model with popular UX frameworks, highlighting their main objective, key limitations, and specific contributions.

Table 1. Comparison between the Proposed Model (PM) and popular UX Models
(Source: own research)

Model	Main Focus	Key Limitations	PM Contribution
TAM (Davis, 1989)	Usefulness & ease of use as predictors of adoption	Instrumental, static, no hedonic or temporal dimension	Moves beyond adoption to theorize dynamic UX transformation
UTAUT / UTAUT2 (Venkatesh et al., 2003; 2012)	Broader adoption factors (performance, effort, social, facilitating, hedonic motivation, habit)	Adoption-oriented, limited in loyalty/attachment explanation	Adds explicit longitudinal processes and causal links
Pragmatic–Hedonic Model (Hassenzahl, 2008)	Differentiates pragmatic vs. hedonic qualities	Conceptual, lacks long-term explanatory mechanisms	Explains the relationship between pragmatic and hedonic perceptions over time
CUE (Thüring & Mahlke, 2007)	Integrates instrumental and emotional components	Descriptive, does not explain satisfaction	Extends toward temporal dynamics and contextual adaptation
meCUE (Minge &Thüring,2018)	Multidimensional UX evaluation	Measurement-oriented, weak on longitudinal	Integrates temporal progression and mobile-

	(instrumental, emotional)	and contextual aspects	specific context
Forlizzi & Battarbee (2004)	Narrative trajectories of experience	Lacks causal structure, not suited for mobile use	Provides testable hypotheses for fragmented, real-world UX
Karapanos et al. (2009)	Phases of UX over time (orientation, incorporation, identification)	Descriptive phases without causal explanation	Connects phase transitions with satisfaction and loyalty
Proposed Model	Holistic, longitudinal UX for mobile applications	Conceptual, requiring validation through longitudinal, experimental, and cross-contextual studies	Causal framework integrating pragmatic, hedonic, emotional, and contextual factors

5. Conclusions and future directions

For UX evaluation, the most common models often fail to fully address the specific challenges introduced by the mobile environment. The proposed model extends the existing frameworks, addressing their limitations. Its ongoing nature shows how perceptions evolve from initial exploration to functional dependence and emotional attachment. The model integrates product, user, and context factors into a unified structure, resulting in a holistic approach to the mobile experience. Unlike the established models, it explicitly defines the causal relationships between pragmatic and hedonic perceptions. Its design also supports the operational potential for the empirical validation.

Building on the model described above, this paper answers the research questions formulated at the beginning of the article to advance the field of HCI. The study proposes a new model that identifies the pragmatic (utility, ease of use, efficiency) and hedonic (aesthetics, expressiveness, symbolic value) factors as the main shapers of the perceptions in the mobile interaction (RQ1). By further integrating these factors, the model specifies that they causally influence familiarity, which in turn leads to functional dependence and, subsequently, emotional attachment (RQ2). A longitudinal perspective clarifies how these sequential causal links determine the evolution of perceptions across distinct use phases. Ultimately, this process leads to long-term outcomes, such as sustained satisfaction, loyalty, and retention (RQ3).

Beyond the theoretical contribution, the model suggests clear directions for future research. First, an empirical validation of its hypotheses through longitudinal studies and advanced statistical methods is needed. These include MANOVA, SEM, and mediation and moderation analyses. In this way, the dynamic relationships between perceptions, emotional processes, and behavioral outcomes can be investigated. Such validation provides a quantitative evidence of the consistency and generalizability of the model across contexts and user groups. This intention will be materialized in a future article that will apply the proposed model to the longitudinal evaluation of user experience with the Moodle mobile application. The goal is to validate its practical applicability and to illustrate, using real usage data, how the UX dimensions evolve over time in relation to the contextual factors, user satisfaction, and emotional engagement.

Another important objective is the development and refinement of the evaluation tools for mobile applications. The main challenge that will need to be overcome relates to the fragmented nature of their use and their ubiquitous integration into users' daily lives. Combining subjective methods (questionnaires, self-reports) with behavioral and usage data can lead to a more comprehensive evaluation of the user experience. From these perspectives, the proposed model could evolve from theory to an empirically validated tool, influencing the mobile application research and design.

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