Quality Attributes for UX Design and Evaluation

1Azham Hussain, Emmanuel O.C. Mkpojiogu2, Mohd Zabidin Husin3*

1,2,3School of Computing, Universiti Utara Malaysia, 06010 UUM, Sintok, Malaysia
2Department of Computer and Information Technology, Veritas University, Abuja, Nigeria
Corresponding author: *zabidin@uum.edu.my

Article History: Received: 10 November 2020; Revised: 12 January 2021; Accepted: 27 January 2021;
Published online: 05 April 2021

Abstract: This paper utilized a literature survey method to find out the quality attributes (or design factors) that impact on or contribute to user experience in extant literature. The results indicate that there are ten dimensions that model UX. Each of these dimensions has associated quality attributes that contribute to it and influence the UX of interactive applications. The study therefore proposes the use of these dimensions and the related quality attributes in the development and modeling of the UX of interactive systems. Furthermore, these dimensions and attributes can be utilized in the design and evaluation of interactive digital artifacts.

Keywords: Dimensions, design, design factors, evaluation, UX quality attributes

1. Introduction

Software these days has become an essential and integral part of people’s lives; it is one of the most significant delivered products or services used on daily basis (Zarour & Alharbi, 2017). It differs from any other product that people use because it is a developed rather than a manufactured product and this results in it being one of the most complex, labor-intensive, and error-prone products in human history (Kumaresh, 2012). Many software engineers are of the belief that software quality is not enhancing over time (Mann, 2002). Software users often experience code blight, inefficient, ugly, and poorly designed software that results in software dysfunction (Ogheneovo, 2014). As a result of this, users’ involvement in the software process becomes necessary to achieve a better understanding of users’ needs and to result in successful and better performing products (Zarour & Alharbi, 2017). Despite the importance of user involvement in the software process, successful software products necessitate users having positive experience while they use or interact with the software. This is not only determined by the software functionalities and completeness (Hussain et al., 2018; 2019a; 2019b; Mkpojiogu et al., 2018; 2019), but also by the overall user experience when using or interacting with the software product (Zarour & Alharbi., 2017). UX is an emerging research area that is still immature and in its infancy (Law, Schaik, & Roto, 2014). It forms the fifth generation of the HCI domain which have shifted focus, since the 2000s, toward measuring user experience (Law, 2011). UX research has often been criticized for the lack of a commonly agreed definition of the notion of experience. Although UX is widely adopted by academics and practitioners, there is no agreement yet or consensus on its definition or on a theoretical model for its design or measurement. This nonetheless has led to difficulties in categorizing user quality attributes as either pragmatic, hedonic or which ever. Even Requirements Engineers and UX Professionals do not agree whether a user requirement focuses on pragmatic or hedonic quality.

UX is a context-dependent and subjective domain. It has been noted that users’ perception of different product qualities as well as the emotions that arise before, during and after their use of or interaction with a product changes (Minge & Thüring, 2018). This thus makes user experience a dynamic concept. Hence, “user experience is seen as something desirable without defining what [the] something means” (Zarour & Alharbi, 2017), and this has led to difficulty in agreeing on a common UX definition (Law, Roto, & Hassenzahl, 2009). Consequently, the dynamic nature of user experience portends a challenge both to UX design and evaluation activities (Kujala et al., 2013).

UX attributes or criteria are the qualities (latent or manifest) of user experience as perceived by users as they interact with products. They are design factors that impact on or influence the UX of users of interactive systems. Attributes are the respective quality elements that make up or contribute to the user experience in the respective dimensions. Essentially, these are measurable qualities or constructs that are elements of the UX dimensions that make up the model. It is however challenging to find out the appropriate attribute of design factor that impacts on UX. Nonetheless, prior works show the various attributes that contribute to the various dimensions of UX and that influence the user experience of users of interactive applications. This study uncovers these factors or attributes and indicates their relationships with user experience dimensions.

2. Methodology
The method employed in this research is literature survey. This survey of literature was made to discover from literature sources the design factors that influence UX or the quality attributes that contribute to the various dimensions of user experience uncovered in literature. The stages in this survey include: i) downloading past works related to UX design factors or quality attributes; ii) analyzing the downloaded works; iii) extracting UX design factors and quality attributes relating to the various UX dimensions; iv) associating the design factors and quality attributes to UX dimensions; v) proposing the of set design attributes per dimensions. Figure 1 show the research protocol used in this study.

![Research Methodology Diagram](image)

**Figure 1.** Research Methodology

3. **Results**

The tables that follow display the quality attributes (or design factors) related to UX dimensions. There are ten dimensions captured in literature that explain or model user experience. Each of these dimensions has associated design factors or quality attributes.
The Pragmatic dimension consists of ergonomic, performance-related, task-driven, behavioral and goal-oriented qualities. This dimension deals with the product characteristics and targets at the do goals of the users. It is an instrumental and utilitarian dimension and includes quality attributes such as perceived functionality, usability, usefulness, perspicuity, security, simplicity, goodness and other utilitarian (ergonomic) qualities. However, this study streamlined the attributes to three that are more closely associated with the dimension, they include:

1) Functionality: This is the users’ feeling that the software products interacted with is functioning correctly, accurately and completely.
2) Usability: This is the users’ perception that the software product interacted with is easy to use and that their tasks can be carried out effectively and efficiently with minimal or no errors (reliability-in-use).
3) Usefulness: This is the feeling of users that the software product interacted with supports their goals, and their tasks and improves their task (work) performance.

The aesthetic dimension deals with the concept or qualities of beauty, styling, color, form, captivation, harmony, balance, creativity, neatness, originality, calm, hue, brightness, shape, texture, conventional, innovation, perceived layout, visual appealingness and attractiveness, cleanliness, and fascinating, clear, symmetrical, and well organized design, etc. This dimension deals with users’ sense and perception of software artifacts that is beautiful and the qualities that constitute this beauty. The UX quality attributes in this dimension are summarized as follows: classical aesthetics and expressive aesthetics. This two attributes are explained, thus:
Quality Attributes for UX Design and Evaluation

1) Classical Aesthetics: This is the users’ feeling that the organization, arrangement, styling, form and color of the software product’s interface interacted with are tidy, balanced, orderly, and harmonious.

2) Expressive Aesthetics: This is the users’ feeling that the interface of the software product they interacted with is visually beautiful, elegant, interesting, appealing and attractive.

The hedonic dimension deals with users’ ‘self’ or wellbeing. It deals with the person (user), that is, the human being interacting with the product. If is non-instrumental and concentrates on achieving the user’s be-goals (users’ psychological needs and well-being). It is a non-task quality dimension. It focuses at meeting the dreams of users, their transcendent, self-functioning, self-actualization and self-fulfillment needs. It comprise of UX qualities that appeal to the senses of users and provide deep meaning, interest and excitement to them. Such UX qualities include pleasure, stimulation, identification, fun, leisure, enjoyment, amusement, comfort, evocation (provocation of pleasurable/desirable memories), etc. These qualities are summarized as fulfillment, pleasure, symbolism and delightfulness and are explained as follows:

1) Pleasure: This is the users’ feeling that interaction with a software product amuses them and gives them fun, enjoyment and extreme pleasure. It is the extent to which users feel happy or elated while interacting with an application.

2) Delightfulness: This is the users’ wow feeling that interaction with a software product thrills, excites, and delights them.

3) Fulfillment: This is the users’ transcendent feeling that interaction with a software product gives them self-fulfillment.

4) Symbolism: This is the users’ perception that the product offers them some special symbolic identity and thus attaches some special meaning to the product.

Affectivity dimension deals with the feelings, mood, passion, and emotional state and reaction of product interaction. Users as humans have feelings which they express as they use technological artifacts. Most times these expressions of emotions are bipolar (valence) which are aroused or activated by certain emotional design factors. This dimension captures such qualities as happiness, relaxation, pride, joy, love, arousal, curiosity, surprise, courage, interest, anticipation, etc. Since it is a bipolar dimension, the quality of emotions can also be negative such as: anger, disgust, fear, sadness anger, contempt, disgust, distress, fear, guilt, shame and surprise, grief, pain, irritation, exasperation, rage, torment, aggravation, agitation, annoyance, frustration, and fury... The quality attributes in this dimension include valence, dominance (control), arousal and evocation. These attributes are elaborated as follows:

1) Valence: This is the users’ feeling of some form of emotions from a software product they interacted with. This feeling can be bi-polar in nature.

2) Arousal: This is the users’ feeling of arousal or stimulation (activation) from the software product while interacting with it.

3) Dominance: This is the users’ feeling that they are in control of the interaction process while interacting with a software product.

4) Evocation: This is the users’ belief that interaction with the product will evoke or provoke pleasant (good) memories of past interactions.

Pleasure, arousal, and dominance factors were proposed by Mehrabian and Russell (1974) as determinants of emotion (i.e., affect) (Huang et al., 2017; Miniero et al., 2014). Pleasure is the degree to which users feel happy or elated (Eroglu et al., 2003). However, since pleasure is also inherent in evocation, valence and arousal, it is not included in this dimension. Arousal refers to the extent of users’ excitement about an interactive product. Dominance is the level of control that a user has over a given product (Chang et al., 2014; Huang et al., 2017; Mehrabian & Russell, 1974).

Interactivity dimension deals with users’ interaction with technological artifact and include the aspects of UX qualities that deal with users perception about the level of user control, responsiveness, connectedness, and personalization of the product they interact with. The dimension includes four attributes and is as follows:

1) Control: This is the users’ feeling of being in control when interacting with a software product.

2) Connectedness: This is the users’ feeling that they are well connected with others users while interacting with the software product.

3) Responsiveness: This is the users’ feeling that the software product they are interacting with responds well and on time (fast) to them.
4) Personalization: This is the users’ feeling that the software product they are interacting with is part and parcel of them. It is users’ perception that a product is customized and tailored to their personal needs and tastes.

Self-determination dimension comprise of UX qualities that deal with how users’ feel that the interactive product has empowered them to interact with it without external assistance. This dimension is closely related to self-efficacy (users’ perception of their ability to use a product). The following contribute to the dimension: relatedness, stimulation, competence, and autonomy; and are explained as follows:

1) Autonomy: This is the users’ feeling that they are the cause of their own actions within the software product they interact with. That is, the perception of users on how independent they are in interacting with the product (and the capacity of the application to enable such independence).
2) Competence: This is the users’ feeling that they are capable and effective in their actions within the software product they interact with.
3) Stimulation: This is the users’ feeling that they are stimulated and that they derive plenty of enjoyment and pleasure from the software product they interact with.
4) Relatedness: This is the users’ feeling that they are related to and well connected with other users while interacting with the software product.

Engageability dimension includes UX qualities that stimulate user engagement with technology. It deals with users feeling of being involved and immersed with the technological artifact they are interacting with. It captures the level at which users’ attention and interest are captivated and sustained during interaction and the degree of sustenance of users’ interest during interaction. The UX quality attributes in user engagement dimension include: flow, presence and playfulness:

1) Flow: This is the users’ feeling of a state in which they are so involved, absorbed, immersed or engrossed in an activity in the software product they are interacting with to the extent that nothing else seems to matter to them.
2) Presence: This is the users’ feeling of being fully situated in the software product they are interacted with and have the sense of being there in the product.
3) Playfulness: This is the users’ feeling of fun and amusement derived from a lively interaction with a software product.

Sociability dimension includes the facets of UX qualities that deal with how technology mediates between users as they interact with it and with one another. This dimension fosters friendship, group life; sense of belongingness, relationship, kinship, love, flirting, ethics, identity, and ambition. Such quality attributes included in this study are: relationship, socio-cultural, identity, equality and co-presence. The five attributes are explained as follows:

1) Relationship: This is the users’ perception that the software product they are interacting with supports them establishing and maintaining social relationships.
2) Socio-cultural: This is the users’ feeling that the software product they are interacting with meets their social, cultural, and/or religious needs.
3) Equality: This is the users’ feeling of not being discriminated against by others in the software product they are interacting with. It is a feeling that they are treated fairly, equally and equitably in the interaction.
4) Identity: This is the users’ feeling that the software product they are interacting with supports them expressing their identity unreservedly and openly. It is the users’ perception of the product’s ability to meet their need of self-expression.
5) Co-presence: This is the users’ sense of perceiving themselves being in a product with someone (others) while they are interacting, and engaging with the product.

Trust dimension comprises of UX qualities that stimulate trustful perceptions in users before, during and after interaction with technology. These qualities include: credibility, privacy, dependability (reliability), transparency and security. This dimension comprise of the following attributes:

1) Privacy: This is the users’ feeling that while interacting with a software product their privacy is protected and that their details are kept confidential.
2) Security: This is the users’ feeling that they are safe and free from all harm and that their interests are protected while interacting with a software product.
3) Credibility: This is the users’ feeling that the software product they are interacting with has integrity and is reliable.
4) Dependability: This is the users’ feeling that the software product they are interacting with is dependable, unfailing and consistent.
5) Transparency: This is the users’ feeling that the software product they are interacting with is transparent and open.

Ubiquity dimension consists of quality attributes that captures the anywhere, anytime availability perceptions of users of interactive products and how this affects them. The dimension comprises: immediacy, continuity, and locality attributes. Perceived ubiquity is the users’ feeling that an interactive product has the ability to provide ‘anywhere’ and ‘anytime’ personalized usage. The ubiquity dimension comprise of the following attributes:

1) Immediacy: This is the users’ belief that the product they interact with will be promptly available at a given time to them.
2) Continuity: This is the users’ belief that the product they interact with will be always available to them.
3) Locality: This is the users’ belief that the interactive product will be available everywhere to them.

Table 1. UX Dimensions, Attributes and their Associated Metrics

| Dimensions      | Attributes   | Sources                                                                 |
|-----------------|--------------|-------------------------------------------------------------------------|
| Pragmatics      | Functionality| Lew & Olsina (2017); Park et al. (2015)                                  |
|                 | Usability    | Hassenzahl (2018); Santoso et al. (2017)                                |
|                 | Usefulness   | Hassenzahl (2018); Lew & Olsina (2017)                                  |
| Hedonics        | Pleasure     | Park et al. (2015); Minge, Wagner & Kuhr (2016); Takatalo et al. (2008) |
|                 | Delightfulness | Minge, Wagner & Kuhr (2016); Takatalo et al. (2008)                    |
|                 | Fulfillment  | Maslow (1954)                                                           |
|                 | Symbolism    | Vilnai-Yavetz & Rafaeli (2005); Desmet & Hekkert, (2007)                |
| Affectivity     | Valence      | Minge, Wagner & Kuhr (2016); Lew & Olsina (2017); Takatalo et al. (2008) |
|                 | Arousal      | Hassenzahl (2018); Minge, Wagner & Kuhr (2016); Santoso et al. (2017); Takatalo et al. (2008) |
|                 | Dominance    | Takatalo et al. (2008); Sheldon et al. (2001)                            |
|                 | Evocation    | Hassenzahl (2018)                                                       |
| Aesthetics      | Classical    | Tractinsky (1997)                                                       |
|                 | Expressive   | Hassenzahl (2018); Minge, Wagner & Kuhr (2016)                           |
| Self-Determination | Autonomy   | Sheldon et al. (2001)                                                   |
|                 | Competence   | Takatalo et al. (2008)                                                  |
|                 | Stimulation  | Hassenzahl (2018); Sheldon et al. (2001)                                |
|                 | Relatedness  | Sheldon et al. (2001)                                                   |
| Trust           | Privacy      | Lew & Olsina (2017)                                                     |
|                 | Security     | Lew & Olsina (2017)                                                     |
|                 | Credibility  | Lew & Olsina (2017)                                                     |
|                 | Dependability | Lew & Olsina (2017)                                                     |
|                 | Transparency | Lew & Olsina (2017)                                                     |
| Engageability   | Flow         | Takatalo et al. (2008); Olsson (2012)                                   |
|                 | Presence     | Takatalo et al. (2008); Santoso et al. (2017)                           |
Table 1 provides the summary of the UX dimensions and their associated quality attributes (design factors). These attributes influence or contribute to user experience dimensions and to the overall UX.

### 4. Conclusion

In sum, this study employed literature survey to investigate the quality attributes (or design factors) that influence or contribute to user experience in prior literature. The findings reveal that ten major dimensions exit that model UX and each dimension has associated attributes that contribute to it and impact on the user experience of interactive systems. The study thus proposes the utilization of these dimensions and associated quality attributes in the building, modeling, design and evaluation of the user experience of interactive applications and products.

### References

1. Csikszentmihalyi, M. (1990). Flow: The Psychology of Optimal Experience. New York: Harper and Row.
2. Cyr, D., Head, M., & Ivanov, A. (2009). Perceived interactivity leading to e-loyalty: Development of a model for cognitive–affective user responses. International Journal of Human-Computer Studies, 67(10), 850–869.
3. Desmet, P. M. A., & Hekkert, P. (2007). Framework of product experience. International Journal of Design, 1(1), 57–66.
4. Hassenzahl, M. (2018). The Thing and I: Understanding the Relationship Between User and Product. In: Blythe, M., & Monk, A. (eds) Funology 2. Human–Computer Interaction Series. Springer, Cham.
5. Hong, S.J. and Tam, K.Y. (2006). Understanding the adoption of multipurpose information appliances: The case of mobile data services. Information Systems Research, 17 (2), 162-179.
6. Hussain, A., Mkpojiogu, E.O.C. & Hassan, F. (2018). Dimensions and sub-dimensions for the evaluation of m-learning apps for children: A review. International Journal of Engineering & Technology (IJET), 7 (3.20), 291–295.
7. Hussain, A., Mkpojiogu, E.O.C. & Kutar, M. (2019a). The impact of software features’ perceived importance on the perceived performance of software products’ quality elements. Journal of Computational and Theoretical Nanoscience, 16 (5-6), 2135-2140.
8. Hussain, A., Shamala, P., & Mkpojiogu, E.O.C. (2019b). The effect of software features’ perceived importance on the observed performance of software product qualities. Journal of Advanced Research in Dynamical and Control Systems (JARDCS), 11(08-S1), 1076-1082.
9. Kujala, S., Vogel, M., Pohlmeier, A., & Obrist, M. (2013). Lost in time: the meaning of temporal aspects in user experience. In CHI’13 Extended Abstracts on Human Factors in Computing Systems (pp. 559–564). ACM.
10. Kumares, S. (2012). Defect prevention based on 5 dimensions of defect origin. International Journal of Software Engineering & Applications, 3(4), 87–98.
11. Law, E.L. (2011). The measurability and predictability of user experience. In Proceedings of the 3rd ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS). ACM, (pp. 1–10).
12. Law, E.L., Roto, V., Hassenzahl, M., Vermeeren, A., & Kort, J. (2009). Understanding, scoping and defining user experience: a survey approach. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI), (pp.719-728), ACM.
13. Law, E.L-C., van Schaik, P., & Roto, V. (2014). Attitudes towards User Experience (UX) Measurement. International Journal of Human-Computer Studies 72 (6), 526-41.
14. Lew, P. & Olsina, L. (2017). Modeling trust in the mobile user experience: system quality characteristics influencing trust. Future Technologies Conference (FTC), 29-30 Nov., 2017, Vancouver, Canada.
15. Mann, C.C. (2002). Why software is so bad. Technology Review, 105(6), 33-38.
16. Maslow, A. (1954). Motivation and personality. New York: Harper & Row.
17. Minge, M. & Thuring, M. (2018). Hedonic and pragmatic halo effects at early stages of user experience. International Journal of Human-Computer Studies, 109, 13-25.
18. Minge, M., Thuring, M., Wagner, I., & Kuhr, C. (2016). ThemeCUI questionnaire. A modular tool for measuring user experience. Proceedings of the 7th Applied Human Factors and Ergonomics Society Conference, 2016, Switzerland: Springer International Press, pp. 115-128.
19. Mkpojiogu, E.O.C., Hashim, N.L., Hussain, A., & Tan, K.L. (2019). The impact of user demographics on the perceived satisfaction and comfort of use of m-banking apps. International Journal of Innovative Technology and Exploring Engineering, 8(8S), 460-466.
20. Mkpojiogu, E.O.C., Hussain, A., & Hassan, F. (2018). A systematic review of usability quality attributes for the evaluation of mobile learning applications for children. ICAST 2018, AIP Conf. Proc. 2016, https://doi.org/10.1063/1.5055494
21. Ogheneovo, E.E. (2014). Software dysfunction: why do software fail? Journal of Computer and Communications, 2, 25-35.
22. Okaxaki, S., & Mendez, F. (2013). Perceived ubiquity in mobile services. Journal of Interactive Marketing, 27 (2), 98-111.
23. Park, J., Han, S.H., Lee, M., & Jang, H. (2015). A literature survey on UX design properties and principles of smart device design for the disabled.
24. Santos, H., Schrepp, M., Hinderks, A., & Thomaschewski, J. (2017). Cultural differences in the perception of user experience. Mensch und Computer, Tagungsband.
25. Sheldon, K. M., Elliot, A. J., Kim, Y., & Kasser, T. (2001). What is satisfying about satisfying events? Testing 10 candidate psychological needs. Journal of personality and social psychology, 80(2), 325.
26. Takatalo, J., Hakkinen, J., Kästinen, J., & Nyman, G. (2008). Measuring user experience in digital gaming: Theoretical and methodological issues. Electronic Imaging 2007, (6491), 649402–649413.
27. Tojib, D., & Tsarenko, Y. (2012). Post-adoption modeling of advanced mobile service use. Journal of Business Research, 65 (7), 922-928.
28. Tractinsky, N. (1997). Aesthetics and apparent usability: empirically assessing cultural and methodological issues. In Proceedings of the ACM SIGCHI Conference on Human factors in computing systems (pp. 115–122). ACM.
29. Vilnai-Yavetz, I., & Rafaeli, A. (2005). Instrumentality, aesthetics, and symbolism of office design. Environment and Behavior, 37(4), 533–551.
30. Zarour, M. & Alharbi, M. (2017). User experience framework that combines aspects, dimensions, and measurement methods. Cogent Engineering, 4 (1421006).