Modeling User Experience

An integrated framework employing ISO 25010 standard

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Abstract— The concept of user experience has been given much importance in the contemporary human computer interaction research. However, modeling user experience requires quality evaluation schemes that are not restricted to the traditional concepts of usability only, where requirements have generally been task oriented. On the contrary, in addition to modeling of usability (or task oriented) requirements, comprehensive methodologies to model subjective user needs should be put forward. In this paper, we discuss and relate various facets of user experience in order to lay foundation for engineering user experience requirements. In doing so, we propose a model to capture temporal requirements of user experience. We further employ this model and integrate it with the existing ISO 25010 standard to build a comprehensive and flexible user experience modeling framework. The usefulness of the proposed framework is also demonstrated by outlining a general guideline for specifying and evaluating user experience requirements.

Keywords-user experience modeling; user experience temporal requirements; quality in use; user satisfaction.

I. INTRODUCTION

User Experience (UX) is an evolving concept to the extent that we find lack in consensus for its definition [1]. ISO defines UX as a person's perceptions and responses that result from the use or anticipated use of a product, system or service [2]. As established in [3], the fulfillment of user's task-oriented goals (pragmatics) is not the only thing that users seek; rather there are certain underlying hedonic needs that they look and expect the product to fulfill. While pragmatics (or "do-goals") focus towards achievement of user needs that are objective in nature, e.g., task performance, effectiveness, etc., hedonics (or "be-goals") on the other hand, focus on the accomplishment of user needs such as satisfaction, stimulation, evocation, etc. [1]. Also, UX is not restricted to a momentary or instantaneous interaction with a certain product or application. The boundary of UX is wider than a mere user-product interaction, spreading from anticipation of use to actual use and further motivation to use. It is over time, that users adopt certain products [4], retain their usage [4] and then bond themselves with the product/product brand [5]. UX can therefore be investigated during and after, even long after, any interaction [6]. Time dimension or temporal aspects together with the environment (or the context of use) are, therefore, among key factors that influence UX [7].

The "user" part of UX is the key driver towards achieving UX; although, the product itself has to be well-designed to enable the user achieve his pragmatic and hedonic goals. Thus, modeling user experience calls for user-centered designs (UCD); designs that take into account traditional user needs as well as those that are abstract and subjective in nature. Bevan [8] highlights this very approach and discusses that despite the fact that the UCDs have been put into practice, they still lack consistency in their application. He further emphasizes that the UCD processes need exclusive UX professions that should involve teams covering aspects such as ergonomics, cognitive sciences, information quality, etc.

The recent ISO 25010 [9] standard outlines two perspectives of quality: *product* and *in use*. The product quality perspective relates to the core *product* design (internal and external characteristics), while the *in use* aspect of quality relates the user interaction with a product in a specified context of use. Recall, that the concept of UX bounds itself to the user-product interaction in a certain environment (context) as well as pre and post user-product interactions and therefore evolves over time. ISO 25010 therefore can be potentially utilized for modeling UX, by employing product quality (PQ) and quality in use (QinU) for modeling respectively "product" and "user-product interaction" entities of UX. However, if ISO intends usability to cover the whole UX, it needs to encompass all of its aspects [10]. Therefore, as a first step towards modeling UX by employing ISO 25010, we need to assess the extent to which the current standard captures all dimensions of UX.

Although the current ISO 25010 standard does cover under QinU the pragmatics and hedonics aspects of UX and product requirements under PQ, in order to completely capture and model UX, there is a need to integrate the temporal aspects [6] of UX along with its core pragmatics and hedonic dimensions. Using this as our motivation, we propose to define a UX temporal requirements (UXTR) model and integrate it with the existing ISO 25010 quality perspectives to develop a comprehensive and flexible UX modeling framework. The proposed framework and its models, i.e., PQ (P), QinU (pragmatics (P) and hedonics (H)) and temporal (T) (2PHT, for short) will represent a complete picture of UX requirements and thus can be put to use for

 ISBN: 978-1-61208-202-8

instantiating different models for understanding and evaluation purposes. The proposed scheme is compliant with the current ISO standard for quality and is in alignment with recent related research contributions as well.

Ultimately, the contributions of this research are: (a) modeling temporal aspect of UX and (b) devising an integrated and flexible framework for modeling UX.

The rest of this paper is organized as follows: we review the related work in Section II. Sections III and IV, respectively, specify our integrated UX modeling framework and its practical significance for evaluating UX for software applications. We draw our conclusions in Section V.

II. RELATED WORK

UX has gained much attention in the field of human computer interaction (HCI) in recent years. Even though there is a lack of consensus on a unified definition of UX, we still find in contemporary research, various approaches in defining and modeling UX. In an earlier classification [11], *an experience* is understood as something with a definitive beginning and end, with whatever happening in between constituting the UX. According to Bevan [12], user experience can be conceptualized as:

- An elaboration of the satisfaction component of usability.
- Distinct from usability, which conventionally focuses on user performance.
- Broader term for all the user's perceptions and responses, subjective or objective in nature.

In one of our earlier works [13], we have listed and categorized various UX definitions into actors and scenarios, where actors represent the UX touch points that include user, product, designer (organization) and environment, and scenarios represent the interaction phase (interacting, pre-interacting, design, post-interacting) of the UX. In the same research a complete UX evolution lifecycle framework (UXEL) was presented in order to understand the diverse UX dynamics. In doing so, UX building blocks were identified, explaining how they interact in three evolution stages of UX namely: Designed UX, Perceived UX and Actual UX.

As established in Section I that UX involves aspects of both product (PQ) and in-use (QinU) perspectives of quality standard put forward by ISO, it is worth analyzing how the two perspectives have been addressed in contemporary research. For example, Lew et al. [14] draw relationships among usability, information quality (IQ), QinU, and UX. In doing so, they integrate the concepts of PQ, QinU, Actual usability and Actual UX (2Q2U) in a flexible modeling framework to evaluate and improve QinU of web applications (WebApps). Similarly the current ISO 25010 [9] standard divides the concept of system/software PQ into eight characteristics and QinU into five characteristics as shown in Tables I and II respectively. However, in the older version of the standard (ISO/IEC 9126-1), the concepts of PQ and QinU were respectively classified into six and four characteristics. New characteristics and sub-characteristics have been added and/or renamed in the recent version, to enhance descriptiveness.

TABLE I. ISO 25010 PQ MODEL

(Sub)Characteristics	Availability
1. Functional Suitability	Fault tolerance
Functional completeness	Recoverability
Functional correctness	**6. Security**
Functional appropriateness	Confidentiality
2. Performance efficiency	Integrity
Time behavior	Non-repudiation
Resource utilization	Accountability
Capacity	Authenticity
3. Compatibility	**7. Maintainability**
Co-existence	Modularity
Interoperability	Reusability
4. Usability	Analysability
Appropriateness recognizability	Modifiability
Learnability	Testability
Operability	**8. Portability**
User error protection	Adaptability
User interface aesthetics	Installability
Accessibility	Replaceability
5. Reliability	
Maturity	

Hassenzahl et al. [3] model UX in terms of user's pragmatic (or do-goals) and hedonic (or be-goals) goals. Pragmatic goals or pragmatic quality refers to the user's perception about the product quality in its ability to support carrying out certain tasks, for example completing an online transaction, and focuses on the product's usability in making the user achieving do-goals. Hedonics, on the other hand, focus towards accomplishment of user's be-goals, i.e., how happy or satisfied the user feels after achieving his do-goals through using the product. They further state that it is the fulfillment of be-goals over time that the users strive for and that do-goals are a pre-requisite in achieving user's hedonic goals.

Given the current state of research and notions established on UX, it is clear why UX has become the most sought after quality aspect in modern day products. Not only do we expect them to help our tasks done, at the same time we also expect them to be enjoyable to use and make us feel satisfied. In light of [3], we can correlate the current ISO 25010 QinU model with the two dimensions of UX, i.e., pragmatics (do-goals) and hedonics (be-goals). For example, *satisfaction* characteristic can be correlated with hedonic goals (be-goals) of UX and measures of *effectiveness* or *efficiency* can be correlated with the fulfillment of pragmatics (do-goals). But since UX also involves a

 ISBN: 978-1-61208-202-8

TABLE II. ISO 25010 QINU MODEL

(Sub)Characteristics
1. Effectiveness
2. Efficiency
3. Satisfaction
Usefulness
Trust
Pleasure
Comfort
4. Freedom from risk
Economic risk mitigation
Health and safety risk mitigation
Environmental risk mitigation
5. Context Coverage
Context completeness
Flexibility

temporal dimension [7], it is important that while modeling UX requirements, we not only consider its pragmatic and hedonic dimensions, but also take into account its longitudinal aspect.

III. INTEGRATED UX MODELING FRAMEWORK

The aim of our study is twofold: first, modeling the temporal aspect of UX and second: integrate the proposed UXTR model together with the existing ISO 25010 quality model to build a complete UX modeling framework (as shown in Fig. 1). The proposed framework can then be used flexibly to instantiate models for achieving specific objectives.

A. Modeling temporal aspect of UX

Regarding modeling UXTR, Fig. 1.c shows the following two characteristics that collectively constitute our proposed model for longitudinal aspect of UX:

1) Appeal: or "appealingness" (as Hassenzahl [1] calls it) is defined as the degree to which a user gets motivated to get engaged with a certain product. It involves phases where the user associates certain anticipations and expectations from the product use and is not necessarily restricted to the direct intercation with the product. Appeal is further sub-characterized into:

a) Adoption: Defined as the scale that indicates how many users start using a certain product or application in a given time period [4].

b) Retention: Defined as the scale that indicates how many of the users from a given time frame are still using a certain product or application in some later time period [4].

2) Brand Association: Defined as personal liking or attachment with a certain service provider or an organization that manufactures certain product(s), and has certain popularity rate in the market and among various user groups.

Subsections III-B and III-C below, further develop understanding of the two characteristics described above and present reasoning for their inclusion in our proposed UXTR model.

B. Appeal Characteristic

Appeal is a product's attribute that makes it attractive to the user as described above. Product characteristics such as "user interface aesthetics", "soft feel", etc. among others, contribute towards making the product appealing to the end user. On the other hand, appeal has an *in use* aspect which is triggered when the user is actually interacting with the product in a specific context. Achieving a certain task-oriented goal (do/pragmatic goal), for example, that satisfies the user, can attract the user for exploring the product further. Note that appeal here does not refer to the "visual appeal", which has more to do with the outlook or aesthetics of the product. On the contrary, appeal here refers to the desire for further interaction with the product.

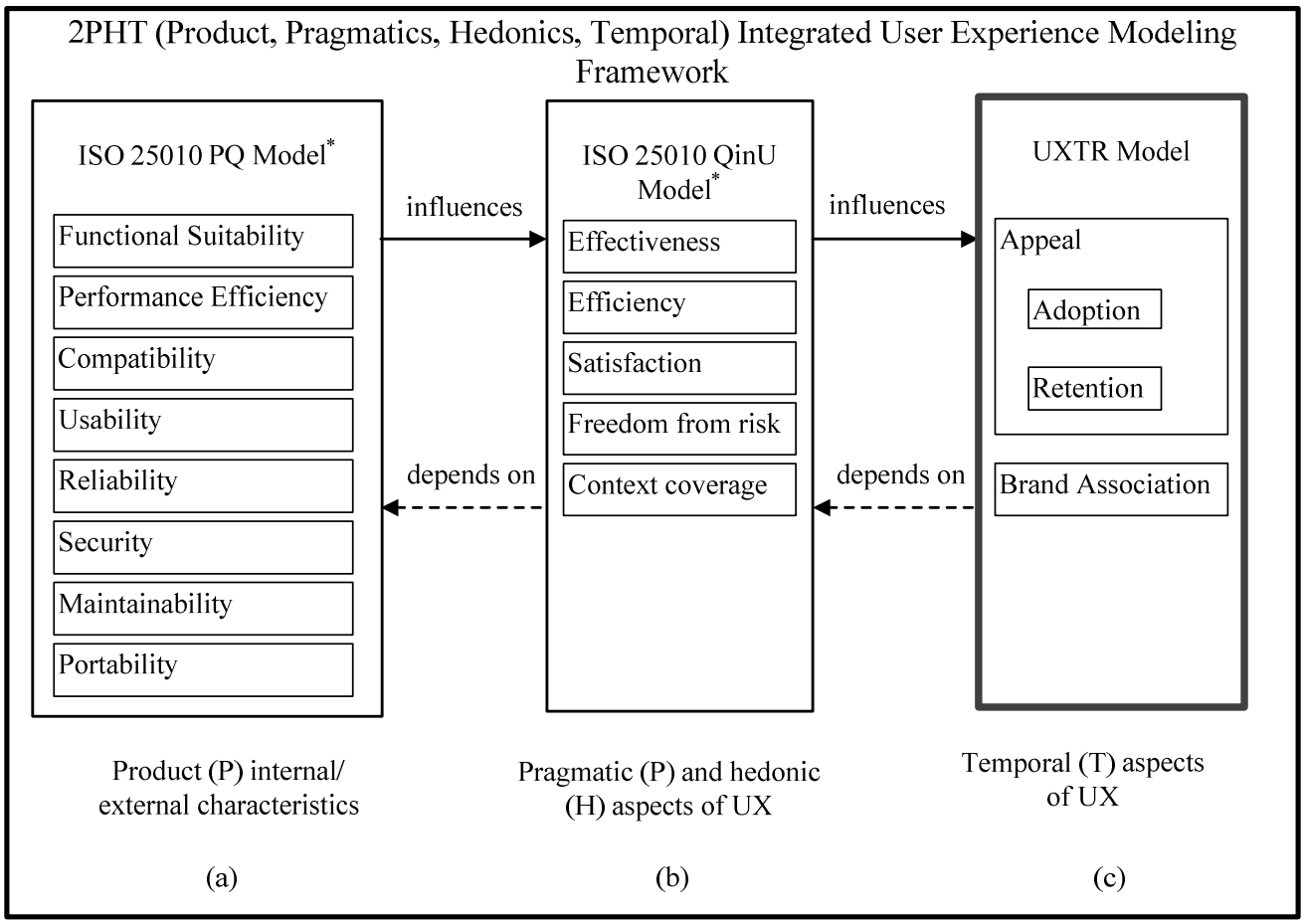
A third perspective of appeal is temporal in nature and is beyond *product* and *in-use* aspects. Take for example, a web-based radio application that is to be launched in near future. There has been a lot of advertisement regarding its potential success among the listeners and fans of music, and this has led to individuals having anticipations about their interaction with the application as soon as it is launched and setting certain expectations in the form of pragmatic and hedonic goals. This pre-interaction phase is still motivating the user towards *adopting* a certain product, although the interaction has not begun yet. This form of appeal is still making the user go through an experience. Similarly, user's post-interaction scenario with the application may involve recounting the earlier experience over a time period and therefore, making him feel compelled to interact and use certain features, thus *retaining* his usage with the application. This example explains how the dynamics of *appeal* (or appealingness) are governed over time, thus making it an integral part of UXTR. This example also explains our classification of *appeal* into *adoption* and *retention* as we have proposed in our UXTR model.

Our proposed addition of *appeal* characteristic to the UX temporal requirements model is in alignment with Hassenzahl's [1] notion that UX changes over time; e.g., a product that was stimulating in the beginning might become less appealing with the passage of time or vice versa. Further, Hassenzahl classifies appealingness into *motivating* and *inviting* (among others). Our sub-characterization of *appeal* into *adoption* and *retention* is based upon this rationale.

C. Brand Association characteristic

Products or services that users interact with are not stand alone entities. Each product or service is designed by a certain organization and targeted for a certain user base. A user-product interaction is not confined to a user's

 ISBN: 978-1-61208-202-8



* For sub-characteristic level details for the characteristics of PQ and QinU models, refer to Tables I and II. Further details can be found in [9].

Figure 1. Proposed 2PHT UX modeling framework

engagement with the product or service, but implicitly encompasses a hedonic relationship (a bond or *association*) between the user and the creator of the product (the *brand*), hence the name *brand association*. Each time a product is interacted with, an unconscious engagement with its brand is there. Likewise, when a certain brand is heard of or a brand name is seen somewhere, an abstract (unconscious) interaction with one of the brand's products takes place. In either case, an *experience* is triggered.

Association with a brand is not only on a moment by moment basis. Loyalty with the brand evolves over time and is therefore, temporal in nature. Since *brand association* results in product bonding (and further product usage), thus affecting the overall UX, this characteristic is included as one of the characteristics of our UXTR model.

D. Integrating UXTR model with ISO 25010 Quality models

As established in the first section, modeling UX involves specification of *product* requirements, the *in-use* requirements covering the pragmatic and hedonic aspect of UX, and finally the *temporal* requirements. As shown in Fig. 1, all the three constituents of modeling UX requirements scheme are presented, whereby, our proposed UXTR model (Fig. 1.c) is integrated with ISO 25010 PQ model (Fig. 1.a) (covering product requirements specification part) and ISO 25010 QinU model (Fig. 1.b) (covering the pragmatic and hedonic dimensions of UX). Together, the three models form our proposed 2PHT UX modeling framework, representing a complete picture of UX requirements.

ISO 25010 states that there exist relationships between the PQ and QinU views of quality whereby the former *influences* the later and likewise the later *depends* on the former (refer to Fig. 1). The same approach is extended towards our proposed UXTR model. We argue that a good QinU will *influence* the temporal aspect of UX which in turn *depends* on the QinU perspective of the UX (as shown in Fig. 1).

Our proposed 2PHT integrated framework is also in line with our earlier work [13] where we define three phases of UX evolution lifecycle (UXEL), namely Designed UX, Perceived UX and Actual UX. The first phase (Designed UX) involves determining UX requirements and involves requirements elicitation processes leading to a UCD. This phase, therefore, relates to the first part of 2PHT, i.e., the PQ (Fig. 1.a). The second phase (Perceived UX) involves the product specific expectations and anticipations based on the advertisements, brand association, peer reviews etc. and therefore relates to the temporal aspects of UX (Fig. 1.c).

 ISBN: 978-1-61208-202-8

The third and last phase of UXEL (Actual UX) involves user interaction with a product in a specific context of use resulting in accomplishment of pragmatic and hedonic goals. The in-use and context specific aspects of this phase relate to the pragmatic and hedonic perspective (QinU) of UX (Fig. 1.b).

IV. INSTANTIATING 2PHT FRAMEWORK FOR SPECIFYING AND EVALUATING UX REQUIREMENTS

The purpose of our proposed UX modeling framework is to consistently evaluate UX from its three perspectives, namely, PQ, QinU and temporal. Through our integrated approach, different non-functional requirements related to UX can be specified in order to meet specific evaluation needs for improving UX. In this section we outline a general guideline for instantiating our proposed 2PHT framework for specifying and evaluating UX requirements.

A. Specifying UX requirements employing 2PHT framework

Utilizing our proposed 2PHT UX modeling framework, we choose "user interface aesthetics" (UIA) (a sub-characteristic of "Usability", refer to Table I) as an example and specify its requirements from PQ and QinU perspectives of UX. Requirements specification from both views (i.e., PQ and QinU) is in alignment with ISO which categorizes a quality construct into a collection of related sub-characteristics providing a convenient breakdown of a quality concept [9].

1) Specifying PQ UIA Requirements

For specifying UIA requirements from the product perspective, the PQ model (Fig. 1.a) of our proposed 2PHT framework can be employed to instantiate the UIA sub-characteristic of *usability*. In light of Pham's [15] categorization of aesthetic design principles, a complete requirement tree for PQ UIA can be specified. For the purpose of demonstration, a generic breakdown (sub-characterization) of the PQ UIA sub-characteristic is shown in Table III.

2) Specifying QinU UIA Requirements

For specifying UIA requirements from the user (or in-use) perspective, the QinU model (Fig. 1.b) of our proposed 2PHT framework can be employed. Further, the QinU model can be supplemented with "Aesthetic Appeal" sub-characteristic under "Pleasure", which is a sub-characteristic of "Satisfaction" (refer to Table II). The reason to add *aesthetic appeal* under the Pleasure sub-characteristic is that aesthetics affects the pleasure and harmony that users experience while interacting with a product [16] and is a strong determinant of user satisfaction [17]. Based on this rationale, a generic breakdown of QinU Aesthetic Appeal is shown in Table IV.

B. Evaluating UX requirements Employing 2PHT Framework

In this sub-section, taking the same example as in subsection IV-A, we outline general principles for practically evaluating UX requirements based on the requirements specified in subsection IV-A. We further lay foundation to observe the resultant PQ and QinU evaluations effect on the longitudinal aspect of UX utilizing our proposed UXTR model (Fig 1.c) of the 2PHT framework. Further, QinU evaluation can involve subjective surveys asking users questions about their interaction with a particular product, whereas the PQ evaluation can be done through manual inspection.

TABLE III. PQ UIA REQUIREMENTS TREE

2PHT.PQ UIA requirements
1 **User Interface Aesthetics** (UIA)
1.1 sub-characteristic 1
1.2 sub-characteristic 2
1.2.1 *attribute 1*
…

1) UIA evaluation from QinU perspective

As per the ISO premise, PQ influences QinU (refer to Fig. 1). Therefore, at first, the current state of UIA of an application can be evaluated during real time user interaction. In order to carry out the subjective evaluation for UIA, the QinU requirement tree specified in Table IV can be mapped with standard subjective questionnaires for usability testing. Users response, for example on a 7-point Likert [18] scale with responses varying from "strongly disagree" to "strongly agree" scale labels, can be used to evaluate the corresponding characteristic/sub-characteristic of *aesthetic appeal*. The overall rank of *aesthetic appeal* can then be calculated by aggregating the scores of its constituent sub-characteristics.

2) UIA evaluation from PQ perspective

For evaluating the UIA from the PQ point of view, different metrics can be developed for objectively quantifying UIA sub-characteristics and attributes. For the purpose of demonstration, we define a metric for "object clarity" (where object can represent text, image, or animation on the UI) that can be treated as a sub-characteristic of PQ UIA requirements outlined in Table III. This metric classification is shown in Table V.

C. PQ and QinU evaluation analysis

Evaluation results for both PQ and QinU perspectives of UIA will set the stage for improvement considerations.

TABLE IV. QINU UIA REQUIREMENTS TREE

2PHT.QinU UIA Requirements
1 Satisfaction
1.1 Pleasure
1.1.1 **Aesthetic Appeal**
1.1.1.1 sub-characteristic 1
1.1.1.2 sub-characteristic 2
1.1.1.2.1 *attribute 1*
…

 ISBN: 978-1-61208-202-8

TABLE V. METRIC CLASSIFICATION FOR PQ UIA EVALUATION

UIA PQ Evaluation metric item	Details
Characteristic/Sub-Characteristic	User Inteface Aesthetics (UIA)
Attribute name	Object clarity
Metric name	Object clarity level
Objective	Determine if the objects on the UI (such as text, image, animation, etc) are visually identifiable
Measurement method	The UI is inspected to determine the object clarity level rating on a scale of 0-3. Observers observe whether objects on the UI are visually identifiable.
Scale	Numerical percentage ratio
Allowed Values	(0) none of the objects on the UI are visually identifiable; (1) few of the objects on the UI are visually identifiable; (2) most of the objects on the UI are visually identifiable; (3) all of the objects on the UI are visually identifiable.

Based on the QinU UIA evaluation, improvement recommendations from the design perspective can be deduced. Improving the design on the basis of improvement recommendations will call for another round of PQ and QinU evaluations to see if the improvement from the PQ perspective also resulted in improvement in the QinU aspect of UX.

D. Evaluating temporal aspect of UX

Once the recommended improvements have been performed on the PQ side and the desired level of QinU has been achieved, we can assess the resultant effect of the improvement on the temporal aspect of UX.

For example, we can examine our proposed UXTR model to specify the temporal requirements. This requirement specification is shown in Table VI. Based on our proposed UXTR model, *adoption* and *retention* sub-characteristics can be measured intrusively or as outlined in [4], to evaluate the *appeal* requirement of the instantiated model. Similarly, the *brand association* characteristic can also be evaluated using subjective surveys. Collectively, the evaluation measures for *appeal* and *brand association* can give a measure for the temporal aspect of UX. Note that, since the temporal aspect evolves over time, evaluating UXTR will span over a specific time period, consisting of multiple rounds of intrusive evaluations focusing on the same group of users.

V. CONCLUSION AND FUTURE WORK

In this paper we have related three perspectives of UX namely: PQ, QinU (Pragmatics and Hedonics) and longitudinal (temporal). In doing so, we have developed an integrated framework called 2PHT for modeling UX by proposing a UXTR model and integrating it with the current ISO 25010 standard. We have provided reasoning for our proposed UXTR model in which we have introduced two concepts of *appeal* and *brand association* as the characteristics defining the longitudinal dimension of UX. We have also characterized the concept of *appeal* into *adoption* and *retention* sub-characteristics and described their importance in light of the current research. A demonstration for a specific requirement tree instantiation and evaluation, based on the proposed framework is also given. The three constituent models (Fig. 1.a, 1.b and 1.c) of our proposed UX modeling framework are intended for modeling UX requirements for software products as a whole and can therefore be used to evaluate and improve UX aspects for different types of software, such as WebApps, for example.

TABLE VI. MODEL COMPOSITION REPRESENTING UXTR

2PHT.UXTR
1. Appeal
1.1. Adoption
1.2. Retention
2. Brand association

Based on this research, our future work focuses on devising a thorough strategy that will involve experience requirements elicitation and recommendation processes combined with our 2PHT UX modeling framework for evaluating and improving UX of software applications with focus on geographic information systems and digital earth applications.

ACKNOWLEDGMENTS

Authors gratefully acknowledge support from the lab of Digital earth and GIS, School of Computer science and engineering, Beijing University of Aeronautics and Astronautics (BUAA/BeiHang), P.R. China.

REFERENCES

[1] M. Hassenzahl, "The thing and I: understanding the relationship between user and product", in Funology: From Usability to Enjoyment, M.A. Blythe, A.F. Monk, K. Overbeeke, P.C. Wright (Eds.) Kluwer Academic Publishers, 2003, 1-12.

[2] ISO DIS 9241-210. "Ergonomics of human system interaction - Part 210: Human-centred design for interactive systems", 2008.

[3] M. Hassenzahl and V. Roto, "Being and doing - A perspective on User Experience and its measurement", Interfaces, vol. 72, 2007, pp. 10-12.

[4] K. Rodden, H. Hutchinson, and X. Fu, "Measuring the user experience on a large scale: user-centered metrics for web applications", Proc. CHI 2010, Atlanta, Georgia, USA, April 10–15, doi: 10.1145/1753326.1753687.

[5] P. Ketola and V. Roto, "Exploring User Experience Measurement Needs", Proceedings of the International Workshop on Meaningful Measures: Valid Useful User Experience Measurement (VUUM), Reykjavik, Iceland, 2008, pp. 23-26.

[6] E. L.-C. Law, V. Roto, M. Hassenzahl, A. P. O. S. Vermeeren, and J. Kort, "Understanding, scoping and defining user experience: a survey approach", Proceedings of the 27th international conference on Human factors in computing systems, Boston, MA, USA, 2009, pp. 719-728, doi: 10.1145/1518701.1518813.

 ISBN: 978-1-61208-202-8

[7] M. Hassenzahl and N. Tractinsky, "User experience - a research agenda", Behaviour & Information Technology, vol. 25 (2), 2006, pp. 91-97, doi: 10.1080/01449290500330331.

[8] N. Bevan, "Creating a UX Profession", Proc. CHI 2005, Portland, Orgeon, USA, 2005, pp. 1078-1079, doi: 10.1145/1056808.1056820.

[9] ISO/IEC 25010 Systems and software engineering — "Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models", 2011.

[10] N. Bevan, "UX, Usability and ISO Standards", Proc. The 26th Annual CHI Conference on Human Factors in Computing Systems, 2008, pp. 1-5.

[11] J. Forlizzi and S. Ford, "The building blocks of experience: an early framework for interaction designers", Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques, New York City, New York, United States, 2000, pp. 419-423, doi: 10.1145/347642.347800.

[12] N. Bevan, "What is the difference between the purpose of usability and user experience evaluation methods?", UXEM'09 Workshop, INTERACT 2009, Uppsala, Sweden, 2009.

[13] M. Q. Abbasi, P. Lew, I. Rafique, and L. Zhang, "User experience evolution lifecycle framework", Proc. International conference on Information, Systems and Engineering (ICISE) 2012, Zurich, Switzerland, 2012, January 15-17, pp. 947-952.

[14] P. Lew, L. Olsina, and L. Zhang, "Quality, Quality in Use, Actual Usability and User Experience as Key Drivers for Web Application Evaluation", Proc. LNCS 6189, Springer, 10th Int'l Congress on Web Engineering (ICWE2010), Vienna, Austria, 2010, pp. 218-232, doi: 10.1007/978-3-642-13911-6_15.

[15] B. L. Pham, "Design for aesthetics: interactions of design variables and aesthetic properties", of SPIE IS&T/SPIE 11th Annual Symposium - Electronic Imaging '99, 1999, pp. 364-371.

[16] G. Lindgaard, "Aesthetics, Visual Appeal, Usability and User Satisfaction: What Do the User's Eyes Tell the User's Brain?", Australian Journal of Emerging Technologies and Society, vol. 5 (1), 2007, pp. 1-14.

[17] T. Lavie and N. Tractinsky, "Assessing dimensions of perceived visual aesthetics of web sites", International Journal of Human-Computer Studies, vol. 60, 2004, pp. 269-298, doi: 10.1016/j.ijhcs.2003.09.002.

[18] T. Tullis and B. Albert, Measuring the User Experience. Collecting, Analyzing and Presenting Usability Metrics., 2008.

 ISBN: 978-1-61208-202-8