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Crowdsourcing towards User Experience Evaluation: An Intelligent User Experience Questionnaire (IUEQ)

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***Abstract*— Smartphones have become one of the leading devices with advanced computing capability. User Experience (UX) design involves in improving customer satisfaction in any product including smart phones. This research aims to promote collaboration among Android smartphone users, who held the highest percentage of market share among the existing popular mobile operating system by the year 2013[1] allowing them to cooperate within the complex, resource expensive and iterative UX design process using a crowdsourcing approach. The paper discusses the encountered challenges with the existing collaborative platforms of achieving collaboration and the techniques which have been taken to overcome those challenges. Further this research discusses on how crowdsourcing can be used in User Interface (UI) design evaluation based on the UX User Centered Design (UCD) matrices; an intelligent system of generating UX questionnaire is presented.**

***Keywords*— Crowdsourcing; Human Computer Interaction; User Experience; User Centered Design, User Experience Questionnaire**

I. INTRODUCTION

In order to be useful any type of product need to be designed by considering the user preferences and its context of use. Poor consideration of user needs often lead software to fail [2]. The process of designing software based on user experience is often known as User Experience (UX) design. The goal of such design work is to support the user in having a positive and productive experience with the software. A cluster of users who exhibit similar behavioral patterns in using the applications is said to be a persona and creating persona is one of the most common UX design evaluation technique. In order to generate persona we use a clustering technique to group individuals based on identified UX factors, product factors, social factors, cultural factors and the context of use [4].

This research paper focuses on generating an intelligent questionnaire to the selected cluster of participants which can be used on the proposed crowdsourcing platform on the three major aspects given below:

- Verification of participation credentials
- Review the participant responses
- Vary the questions based on user context to capture the user preferences

Apart from questions Storytelling has been incorporated in to the questions in order to direct participants to perform certain tasks. Rather than prompting a set of predefined questions the questions will be fired as in a flow of an interview.

The interviews/questionnaires have been implemented in order to capture necessary user preferences for predefined scenarios and this paper mainly focuses on the approach taken to decide on the questions to be fired for each participant based on the persona fitted into. The interviews are held by an autonomous agent embedded into the UIs as an avatar to obtain user judgment. An Experience Sampling Methodology (ESM) [5] has been used to understand areas such as mood, time use and social interactions based on the results captured by interviews and questionnaire; this is discussed further in Section IV.

In order to overcome the noisy responses from the participants of the crowdsourcing platform Expectation Maximization (EM) [6, 7] algorithm is used; the algorithm iteratively refines an initial cluster model[8] to fit the data, determining the probability each element can be associated with a cluster. The algorithm ends when the probabilistic model fits the data. The motivators for the participants in the platform are both intrinsic and extrinsic [9]. Intrinsic based motivators have been incorporated by implementing enjoyment based motivators and community based motivators. Extrinsic motivators such as immediate payoffs for the task completion and social motivations

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such as indirect feedback for each job are implemented and monitored. When it comes to mobile applications the contexts of use vary among different users and the devices they use. This research mainly focuses on generating persona based on three design considerations for mobile: i.e., designing for multiple screen sizes, prioritize contents and minimize user inputs.

This paper is arranged into following structure: Section II presents an overview on user experience; Section III discusses related work while Section IV describes the crowdsourcing platform with implementation architecture. Section V presents the evaluation of user persona and the results whereas Section VI concludes the paper revealing the future stages of this research.

II. User Experience (UX)

A. Overview of User Experience

As stated in the previous section, UX has been embraced mainly by the human computer interaction (HCI) practitioners and research community as an extension to traditional HCI.

Hassenzahl and N. Tractinsky [10] have looked at the UX in three prominent perspectives, which each perspective contributes a facet to understand the users' interactions with technology, while sharing some ideas and arguments with other perspectives as shown in Fig .1.

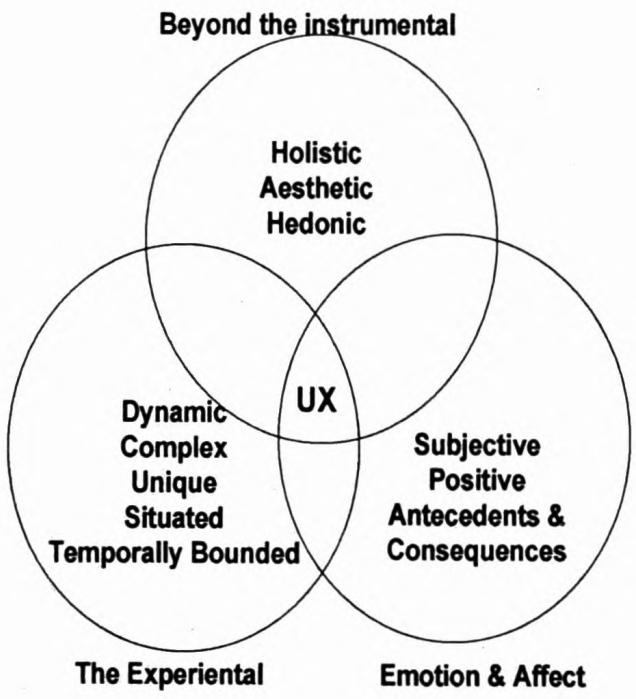

Fig. 1 Facets of UX (Adapted from [10])

UI engineers or designers and the domain experts were asked to define the facts and rules covering the given facets in Fig .1.

B. Elements of UX

Garette [11] visualized UX elements in five planes: strategy, scope, structure, skeleton, and surface, which provide a conceptual framework of user experience. This is a bottom up approach and each plane depends on the planes below it.

C. UX Evaluation Techniques

In UX evaluation following suggestions have been made: 2DES [12], 3E [13], SAM, Emocards, Feedback App, Experience Clip [14] are evaluation methods, which have been used in evaluating emotions by different researchers. Affect Grid [15] allows users to mark their emotional state in a grid. Affective Diary [12] considers psycho-physiological measurements.

Researchers have found that it is crucial to identify the social factors and emotion identification; the questionnaires have been used to identify the social factors such as implicit and explicit requirements [4] etc. Game Experience Questionnaire, Geneva Appraisal Questionnaire (GAQ), ID tool can be considered as such questionnaire based UX evaluation techniques.

AXE [9] is a qualitative method that gives an initial perspective on the user experience for a product. Contextual aware ESM and Aesthetic evaluates product factors. Lavie and Tractinsky [16] have pointed out that users' perceptions consist of two main dimensions, which were termed "classical aesthetics" and "expressive aesthetics". Aesthetic scale has been used to evaluate the two types of aesthetics. Context-aware ESM [5] system detects the current context (e.g. location, time, nearby devices) and when the context fulfills predefined criteria, the system prompts the participant to report their experience.

III. Related Work

This section aims to provide an insight to the similar research approaches carried out on generating questionnaires to evaluate user experience.

Gadiga and Hamborg [17] suggested that IsoMetrics questionnaire can be used as a stand-alone evaluation method, but often questionnaires need to be combined with other quality assessment methods. Manzoor [18] have used a questionnaire of 15 items with five scales to capture the general impression of the user asking questions such as "Do users like or dislike the software?" in five categories[19]: Attractiveness, Efficiency, Perspicuity, Stimulation and Novelty. We also have allowed job creators to define the rule set based on the five categories. The same five

categories have been considered by Laugwitz, Held and Schrepp [20] and in [21].

By evaluating UX over time, a UX curve method [22] has been proposed and they have studied the reasons for the changing user experience under the categories utility, usability, stimulation, identification, beauty, esthetics in interaction and evocation. The researchers have used questionnaires in different phases and have asked questions such as: Is this a good product for you? Do you think that the product has met your expectations? If your friend was planning to purchase a similar kind of a product, how likely is it that you would recommend this product to him/her?

IV. Crowdsourcing Platform

In the following subsections, the crowdsourcing platform, the process of understanding users, UI representation, analysis of the state of the art, ways to prioritize mobile features and the design considerations for are discussed.

Similar to Mechanical Turk [27], the users who are interested in providing their service by co-operating the UCD [28] process using the platform can register themselves with our system as shown in *Fig 2.*

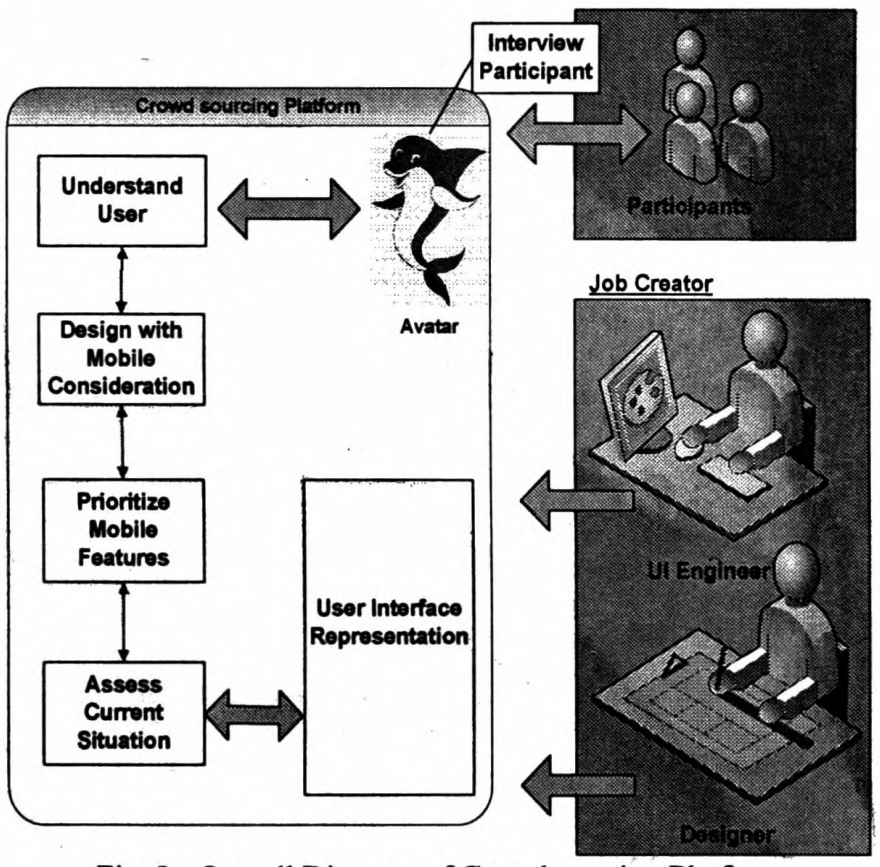

Fig. 2. Overall Diagram of Crowdsourcing Platform

The UI engineers, designers or those who need to get their design evaluated can register with the platform and take the service from the registered-users/participants and validate whether they have designed a satisfactory UI according to the design criteria specified by the UI engineer/s (job creator). A non-player character within the system, an avatar, interacts with the user in a dialogue would capture user context based on the predefined rules, which then can be specified by the UI engineers and designers involved in the UX process using the given template. JESS (version 7.0) was used as the rule engine and forward chaining was used as the inference mechanism so that the avatar will direct the relevant questions to participants.

Characteristics of crowdsourcing process [29], pre-selection of contributors, accessibility of peer contributions, aggregation of contributions and remuneration for contribution are discussed below.

D. Pre-selection of contributors

Pre-selection of contributors is carried out from a group of potential contributors based on the factors [4] specified by job creators as follows.

- User Factors: Values, Emotions, Expectation, Prior Experience, Physical Characteristics, Motor Functions, Personality, Motivation and Skills.
- Product Factors: Usability, Functions, Size, Language, Symbols, Usefulness, Reputation and Adaptivity.
- Social Factors: Pressure of success and fail and Time pressure.
- Cultural Factors: Sex, Fashion, Habits, Norms, Language and Religion.
- Context of use [30, 31, 32]: Time, Place, Activity [33, 34] and Temperature.

E. Motivators

Intrinsic and extrinsic motivators based on enjoyment, community, payments such as immediate and delayed and social motivators [10] are given in TABLE 1 can be selected by the job creators when they create the job.

TABLE I
INTRINSIC AND EXTRINSIC MOTIVATORS SUPPORTED IN THE PLATFORM

Motivation	Feature
Intrinsic Motivation	Ranking – Skill, Specialty
	Recommendation – Skill, From job creator
	Review
	Voting
	Feedback score – Skill, Task Identity, From job creator
	Participant since
Extrinsic Motivation	Hit Base Payment
	Task Completion Base Payment
	Hourly Rate
	After revision of the completed task payment
	Paired work

F. Understand Participants

A cluster of users who exhibit similar behavioral patterns in using the mobile applications are selected such that the behaviors, attitudes and motivations are common to a "type"

regardless of age, gender, education and other typical demographics. Personas will be built by first conducting one-on-one interviews with a wide demographic sample of the targeted audiences involve in the crowdsourcing platform by the avatar as used in Microsoft research [35], which we used as an automated interview approach discussed in the next section.

G. Intelligent User Experience Questionnaire (IUEQ)

The questionnaire is a quick and a widely used approach to assess user experience of any application. IUEQ focuses on generating questionnaires to capture user profile details, and the user, product, social, cultural factors and the context of use [4].

Rather than conducting the manual interviews, we researched on the possibility [36] of generating questionnaires to participants based on user context rather than letting them answering the same set of predefined questions.

These interviews were conducted in different contexts such as respondent's/ end-users of the platform's home, university or place of work. The overall diagram of IUEQ is given in Fig. 3.

Following details were captured during the initial phase.

- Participants' background information
- Why do they use the mobile application on mobile device?
- What features are they using?
- What device is currently being used to access the mobile application?

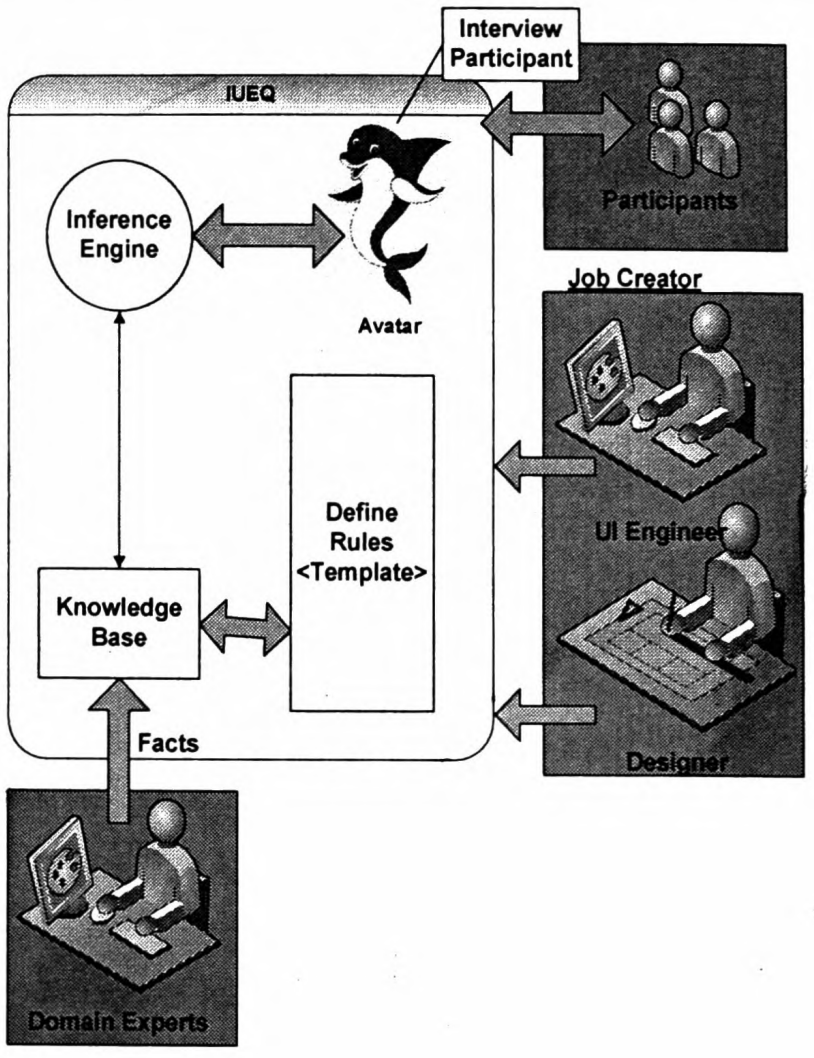

Fig. 3.IUEQ Components and Human Interface

Job creators were given a template to create the rules based on evaluating attractiveness, efficiency, perspicuity, stimulation and novelty [19, 20, 21] as shown in Fig. 4.

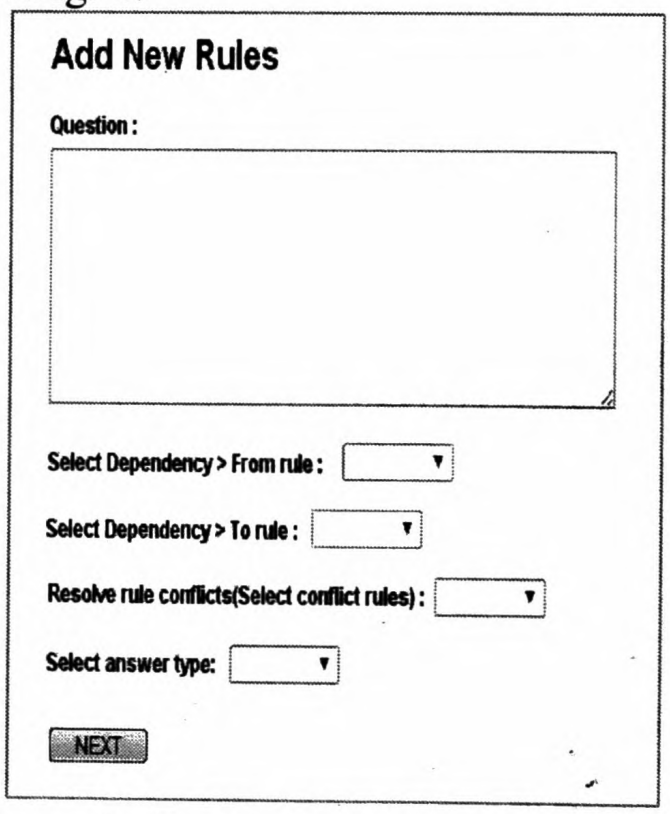

Fig. 4. Template to define new rules

An example of creating rules based on a persona for the tested application and firing of questions is given below.

Persona 1: A casual user who uses most of the smart phone quite often and always have their mobile phone with them.

Persona 2: a power user, an Asian, below 30 years old, a graduate, uses most of the smart phone features; access social media sites often, changes phones quite often and always have their mobile phone with them.features; access social media sites often, changes phones

Sample rules for the initial phase:

Capture User Factors

- How old are you?
- What is your gender?
- What is the highest level of education you have?

Capture Social Factors

- How much work experience you have?
- Where do you work?

Capture context of use

- When and where will users access the site? (User environment and context)

Capture product factors

- What is your preferred language?
- What is the device that you are using?
- What software and/or applications do you use on regular basis?

Validation of user inputs were done cross referencing the user details provided during the registration with the crowdsourcing platform and an instantaneous score of trustworthiness is displayed against each answer to the user.

Alerting choices [5] were provided for job creators as shown in TABLE II.

H. User Scenarios and Test cases

UI engineers and designers were given a template to specify the expected user flows so that the user scenarios can be generated accordingly.

TABLE III
ALERTING CHOICES FOR THE JOB CREATORS

Categories	Considerations	Description
Type of alert	Random	Alerts are delivered randomly.
	Scheduled	Alerts are delivered on specified schedule.
	Event-based	Alerts are triggered when event of interest occurs
Scheduling requirements	Daily time period	Deliver alerts within a specified daily time frame only.
	Number of alerts per day	Deliver a specified number of alerts per day.
	Number of alerts overall	Deliver a specified number of alerts for the study's duration.
Delivery mechanism	Audible	Deliver alerts the participant can hear.
	Tactile	Deliver alerts the participant can feel.

I. User Interface Representation

As in Android SDK UI testing tool [37] an API is provided to embed the design of the UI engineer with the platform where UI engineers can specify the goals, expected persona, user scenarios, measurements [38][39] that they expect to capture, alerting choices for participants and a dashboard for UX evaluation.

J. Challenges

Crowdsourcing involves many challenges such as cheap or volunteer participants of the crowdsourcing platforms tend to generate results that may be less credible compared to professionals; any task achieved through crowdsourcing has certain risks associated with; managing a large pool of participants in a crowdsourcing task is a complex process; intra-crowd collaboration can be challenging; end-to-end commitment of participants can be scarce; privacy challenges and undue openness for sensitive tasks; stolen, recycled or duplicate names for multiple user profiles; and participants may not be sufficiently competent. In order to overcome the challenges in crowdsourcing platforms different techniques have been used by researchers as listed below [40].

- Expectation Maximization Model[40]
- Majority Voting[41]
- Reputation and Trust Modeling[42]
- Validate Trust Worthiness
- Hierarchical Trust Management

V. Evaluation Strategy and Analysis

We integrated the avatar to the android application "Tell Me" and let 30 students from the Open University of Sri Lanka to answer the questions generated by IUEQ. Questions were generated based on 51 rules specified by "Tell Me" UI designers. "Tell Me" is an android application which allows students to find the venue of a lecture by entering their university registration no.

Configuration: Alerting choice was set as "Event – based" where the alerts were supposed to trigger when event of interest occurs.

Step 1: Students were asked to register in the crowdsourcing platform by providing their credentials.

Step 2: Students were asked to download and install the "Tell Me" application.

Step 3: Students were asked to answer the questions raised by the avatar to validate the trustworthiness of inputs.

Step 4: Students were asked to answer the questions raised by the avatar based on user events.

Out of 30 participants 21 participants proved a trustworthiness score of 1 range from 0 to 1 validated cross referencing the registration data, captured GPS data, device details captured using CPU-Z [43]. The group of participants scored a higher trustworthiness score is considered as Group 1 and the remaining as Group 2.

Measurement of user experience based on the questions about the avatar is given in TABLE III which reflects a positive experience for users.

TABLE IIIII
MEASUREMENT OF USER EXPERIENCE OF AVATAR OF TOOL

Category	Items	Measurement Group 1	Measurement Group 2
Attractiveness	Annoying	3	3
	Enjoyable	18	6
	Good	17	4
	Bad	4	5
	Like	21	8
	Unlike	0	1
	Friendly	11	4
	Unfriendly	10	5
Efficiency	Fast	18	6
	Slow	3	3
Perspicuity	Not understandable	0	0
	Understandable	21	9
	Easy to learn	21	9
	Difficult to learn	0	0

VI. CONCLUSION

A number of unique application cases of crowdsourcing platforms can be seen, such as usability testing, natural language processing, photo sales, image tagging etc. This paper has presented such platform where UI engineers and designers can get the collaborative support from the target users for UI design based on user experience. The major focus of this paper has given to the IUEQ which is an intelligent questionnaire generator for the participants. Asking a user to answer a question such as "Do users like or dislike the software?" would only capture a general impression of the user and would lead to false interpretation. Therefore IUEQ focuses on asking a set of questions to come up with an answer for the question. If a user was asked "Do you find an animation in this website?" some users would not know what is an animation is. Therefore IUEQ has given the facility to generate questions based on GUI elements and by considering the user context.

This research, which has successfully completed its first phase, can be further extended to answer the following research questions: How to decide on the population and criteria for fitness evaluation? How to combine computable UI design metrics with subjective user input captured from the crowdsourcing framework to guide evolution? And how often user inputs were asked and how to alleviate user fatigue?

In order to answer those questions as a future extension of the study the implemented HBGA and the platform with IUEQ can be used. With such extended research in return can provide more empirical data and opportunity to analyse the findings so that the developed crowdsourcing solution to UX design in this research can be further enhanced. Consequently with an optimised crowdsourcing solution UI practitioners too can utilize it to improve the UI design process further.

Another future work area would be improvements to IUEQ such as fine-tunning the ESM methodology based on the user inputs, comparative quick assessment with traditional questionnaires and study the effect of the frequency of alerts to mobile application.

This research has investigated a novel use of crowdsourcing to facilitate UX improvement through active user participation from the beginning of the software engineering lifecycle by putting the user in a central role with the ability to influence the UI design process to fit with user traits, preferences and needs. Although the presented evaluation domain of the crowdsourcing solution and the IUEQ limits to higher education due to the resource and time constraints governed this research, the outcome and the developed solutions are sufficiently generic in nature; the findings of this research can easily be applied to a range of different application domains and user scenarios without the need for additional customisation since the proposed solution architecture is loosely coupled with domain constraints. Therefore, we believe that the proposed UX design and improvement approach can be used in the mainstream software development practices and the IUEQ can provide more accurate user evaluations for personalised interfaced design and UX.

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