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USER EXPERIENCE IN ONLINE CONSUMER MEDIA

The principles of successful user experience in online consumer media

Bachelor's Thesis
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Abstract

User experience is a relatively novel concept that is defined as a comprehensive experience of a user encountering a system. User experience, abbreviated as UX, has both conscious and unconscious dimensions and it involves both concrete aspects concerning usability and system ergonomics as well as more abstract, emotional properties, such as fun and enjoyment. Apart from these qualities that define the value of a user experience for the user, there are also business benefits to be leveraged and ethical dilemmas to be considered when defining a good user experience.

Due to the development of electronic and mobile systems and the ensuing large-scale changes in the ways people interact with one another as well as manage their businesses, it has become more and more topical to understand and meaningfully measure user experience. The number of channels present in online consumer media is ever increasing, and with a growing overlap with service design, user experience is bound to define the outcome of a customer journey more and more prominently.

The field of research concerning user experience struggles with divergence and the resulting lack of standard frameworks and practices. Despite this divergence, a myriad of both qualitative and quantitative evaluation methods and measurement scales have been developed and deployed with meaningful results. New data gathering methods, such as physiological and neurological methods, are being developed and new ways of quantifying qualitative data are being innovated, which are bound to improve the capacity of UX evaluation in both business and research.

In this thesis, I explore the existing literature concerning the field of user experience design and aim to answer the following questions: 1) What is user experience? 2) What makes a user experience a good one? 3) How can the success of a user experience be measured? 4) What kind of principles can be appointed to successful user experience design?

Keywords user experience, user experience design, user experience measures, user experience practices, consumer media, product development, service design

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1. Introduction

In the recent decades, the way people interact with one another, go about their daily errands as well as manage their businesses has been revolutionized twice in a major way. First by the emergence of electronic computer systems, and again when the Internet found its first extra-military and -university applications. Since these universal reforms, online applications and systems everywhere have been under constant development and expanded their reach into almost every segment of our lives. As a result of this development, an ever-growing number of channels are currently used in the interaction between consumers and service providers instead of a traditional single channel (Jang & Yi, 2019; Lemon & Verhoef, 2016), and a growing overlap of service design (SD) and user experience design (UXD) in customer journey management has emerged (Roto et al., 2021).

Along with this development in the tech industry as well as the shift from organization- to customer-centered service design and development across industries, better design and benchmarking processes of user experiences (UX) have become topical focus points in reaching for more successful holistic orchestration of the customer journey and experiences (Vermeeren et al., 2015; Roto et al., 2021). This paradigm shift is especially visible in the suboptimal results produced by traditional approaches to channel-independent and process-centric UXD (Dominguez et al., 2021).

Over the recent decades, the notion of UX has progressed to encompass all aspects of a user interacting with a system (Fanfarelli et al, 2018; Li & Zhu, 2018), but remained a strongly divergent field of study (Law, 2011; Rajanen et al., 2017; Roto et al., 2021). In advancing the field and implementations of UXD, agreement upon standard frameworks (Law, 2011) and effectively adopting novel methods of managing and designing UX – such as incorporating users in iterative user experience development (Vermeeren et al., 2015; Law, 2011; Roto et al., 2011; Zaki & Islam, 2021) and continuously measuring the UX both qualitatively as well as quantitatively (Albert et al., 2004; Ebel et al., 2021) – are essential.

This thesis reviews previous research and literature concerning past efforts and frameworks regarding UX and answers the following questions:

1. **a) What is user experience?**
   b) What makes a user experience a good one?
   c) How can the success of a user experience be measured?

2. **What kind of principles can be appointed to successful user experience design?**

The literature used in this review was gathered using four academic paper search engines (ProQuest, EBSCO, JSTOR, Google Scholar) using various search terms related to UX and its research, measurement and design (see Table 1). The resulting articles were screened and accepted based on the relevance of the articles' titles and keywords for the research questions. This screening yielded 26 viable papers and 2 books, which were reviewed. The review of this literature is supported by 7 websites with accessibility standards and user experience definitions. The search and screening processes of source material is summarized in the table below (Table 1).

Search terms	**Engine**	**Relevant papers**	**Screened papers**	**Accepted papers**
user experience/UX user experience design/UX design/UXD user experience measuring /UX measuring user experience evaluation /UX evaluation user experience development /UX development	EBSCO	238	65	7
	Google Scholar	264	79	14
	JSTOR	153	46	4
	ProQuest	229	23	1

Table 1: Summary of the search and screening process of source material

This thesis will progress as follows: The second section will go through the many facets as well as the origins of the notion of user experience. Connections with other related fields and concepts are also illustrated. In the third section, a more thorough view on the aspects of a good user experience is synthesized. In the fourth section, measuring and predictability of UX are discussed and in the fifth section, five principles for successful user experience design are gathered. Finally, a discussion of the themes reviewed in this thesis is synthesized, after which the references and tables used are listed.

2. Defining user experience

2.1. The origin and development of UX as a field of study

The field of user experience design (UXD) took its first steps in the 1960's with the inception of information technology, which lead to the fields of interaction design and human-computer interaction (HCI) in the 1980's (Li & Zhu, 2018; Roto et al., 2021). At first, the main goal of these fields was to produce tools for more efficient interaction between humans and computers from a purely utilitarian and pragmatic standpoint (Yu et al., 2020; Zaki & Islam, 2021).

This excluded much of the psychology that is present in UX today. A major step towards including psychological aspects in UX was taken at the turn of 1980's and 1990's, when user acceptance factors were widely researched in the HCI community due to the emerging trend of customer centricity (Albert et al., 2004; Lemon & Verhoef, 2016). Since then, the notion UX coined in the 1990's has developed in conjunction with HCI. This development has been largely parallel, even so closely that they have still at times been considered the same field of study among UX practitioners over the last two decades (Vermeeren et al., 2015). However, the progress on the research of UX measures has been slow, which suggests that the HCI community has remained reluctant to accept and adopt UX measures (Law, 2011).

After the turn of the millennium, the emphasis of HCI shifted from pure usability towards the more comprehensive UX, which had grown to include both the practical and emotional experience in its scope. This led to the rise of qualitative approaches alongside with the previously used quantitative methods (Law, 2011; Zaki & Islam, 2021).

Along with the shift from product development towards service design in the IT industry and further to more user-centered and holistic approaches over the last two decades, there has been an equal shift towards including more abstract emotional qualities – such as aesthetic appeal, fun and "wow-effect" – in the scope of UX (Law, 2011; Roto et al., 2011; Roto et al., 2021; Vermeeren et al., 2015). Furthermore, the terms *user* and *customer* have become increasingly synonymous in modern day service design (Roto et al., 2021), which has further contributed to the need of understanding UX on a more comprehensive and profound level.

Indeed, the amount of research on UX has increased greatly along with the impending realization of the importance of UX in the IT and business communities (Law, 2011). The shift towards user-centricity, however, has not diminished the meaning of usability as a part of UX, and for instance, different versions of the Web Content Accessibility Guidelines (WCAG) as well as the ISO accessibility standards have set technical requirements for product developers since 1999 (ISO, 2019; W3C, 1999).

Additionally, the increase of interactive channels enabled by readily accessible high-speed internet and evolving mobile technologies has been a significant factor affecting the development of UX (Lemon & Verhoef, 2016; Roto et al., 2021). Before the turn of the millennium, a lot of HCI as well as UX research and development had been done on the terms of a single channel (Jang & Yi, 2019), considering the use of a single device in a single scenario. Over the course of the last two decades, both UX research and practices have had to adapt to the multi-channel environment brought about by the emergence of mobile devices and interchangeability of interaction channels (Lemon & Verhoef, 2016; Roto et al., 2021).

Although researchers and practitioners alike agree on the importance of UX (Ebel et al., 2021; Volentine et al., 2021), different interpretations of the term have existed throughout its history (Ebel et al., 2021; Lanius et al., 2021; Law, 2011; Volentine et al., 2021).

2.2. Existing definitions

Since the emergence of the term UX in the 1990's, its definition has developed from the purely utilitarian HCI to a thorough and universal notion of are human being's experience of using a product – both practical and emotional (Ebel et al., 2021; Fanfarelli et al., 2018; Jang & Yi, 2019; Law, 2011; Vermeeren et al., 2015). However, the definitions offered by the scientific community diverge (Fanfarelli et al., 2018; Rajanen et al., 2017), and many scholars agree that there has for long existed a struggle to outline consistent parameters and practices for UX (Lanius et al., 2021; Law, 2011). In this subsection, a collection of definitions presented by the referenced papers is reviewed and a collective definition of UX is gathered.

In their paper from 2018, Fanfarelli et al. define UX as derivative of the universal definition of human experience. As such, according to the authors, "UX is not simply aesthetics, usability, functionality or efficiency", like in the early HCI. It instead refers to a more complicated result

of interactions that happen when a human uses a product that involves e.g., cognitive, emotional and social dimensions (Fanfarelli et al., 2018).

Similarly, Jang and Yi (2019) gather that UX is a multidisciplinary research topic that comprises of HCI, design, information systems and the emotional and sensory response in the user. Due to the universality of experience in its both practical and psychological dimensions, the authors emphasize that the inclusion of context is integral when considering the user, product and usage environment. Consequently, Jang and Yi (2019) highlight the fact that the definitions of UX fluctuate per discipline.

Further emphasizing the emotional dimension of UX, Law (2011) presents that UX is a complex cognitive psychological, social and physiological process with emotion as the key concept, rooted in the James-Lange Theory of Emotion (James, 1884). Highlighting the difference between usability and UX, Law (2011) notes that the definition of UX in the usability standard ISO 9241-110:2006 (referred to incorrectly by Law as ISO 9241-110:2010) is too imprecise and abstract.

In the newer ISO 9241-210:2010 standard (ISO, 2010), however, UX was defined as follows:

> *"[UX] is the overall perception of a user towards using a system resulting from their attitude, emotion, behavior, beliefs and psycho-physiological responses regarding the system's expected use while usability refers to the capability of a system that helps to attain the system goals by the intended users to perform the required tasks with effectiveness, satisfaction and efficiency within a specific context."*

In this definition of UX, the presence of abstract emotional and experiential concepts is a notable advance from the previous standard mentioned by Law (2011), which indeed involved mostly pragmatic usability concepts (ISO, 2006). However, since the deployment of this new ISO standard, further renewed versions have been published and the UX definition offered by the current ISO 9241-210:2019 standard (ISO, 2019) is even broader.

In a conference paper by Roto et al. (2011), a panel of UX scholars and practitioners found that the notion of UX is a subset of the general concept of experience. However, it is more specific, and it concentrates on the experience of interacting with the system whereas usability acts as a merely contributing factor to the overall UX (Roto et al., 2011). The panel emphasizes the

uniqueness of each experience to an individual as well as the influence of prior experiences, expectations and cultural or social context. The authors also note that a user experience is not limited to active, personal usage, but the user can also be encountered by a system even when they do not actively use it themselves.

In an interview study from 2015, Vermeeren et al. found that UX researchers define user experience as a both conscious and subconscious phenomenon of human perception and cognition in relation to using a system. The interviewed scholars highlighted the differences between UX and usability as well as other similar disciplines. Additionally, the authors present that UX has both momentary and long-term dimensions (Vermeeren et al., 2015). This temporal aspect of UX is also noted in studies by numerous other scholars (Jang & Yi, 2019; Law, 2011; Zaki & Islam, 2021).

In their study from 2017, Rajanen et al. found that geography affects perceptions of the definitions of both UX and usability: older UX communities in Denmark, Finland and France found the emotional and abstract dimensions of UX equally or more important than usability, whereas younger UX communities in Malaysia and Turkey found the usability aspects of UX more important. Despite the difference, all participants of the study valued user-centricity equally highly (Rajanen et al., 2017).

From these definitions presented in the reviewed literature, we can gather that over the last two decades, the notion of UX has indeed developed into a largely universal concept of a human experiencing a system. Although the definitions offered by scholars displayed some minor differences in emphasis compared to the views of UX practitioners (Law, 2011), both groups seem to agree on the universality of the concept (Ebel et al., 2021; Roto et al., 2011; Zaki & Islam, 2021). Despite this wide unanimity across communities, “even seasoned professionals often lack the vocabulary to describe a discipline in which they partake on a daily basis” (Lanius et al., 2021) and some scholars still argue that “we are far from having a coherent understanding of what user experience actually is” (Lanius et al., 2021) due to the complex and abstract nature of UX (Lanius et al., 2021; Law, 2011).

2.3. The relation of UX and other notions

In this subsection, the relationships between UX and other closely related notions and scientific disciplines are reviewed. These notions and disciplines are bolded with their possible abbreviations and summarized in a table (Table 2) at the end of the subsection in the same order.

While UX was initially considered to be synonymous with **human-computer interaction (HCI)** due to their common roots in the **usability** of computer systems (Roto et al., 2021; Yu et al., 2020), they developed into vastly different disciplines. Usability has always been a major part of UX (Ebel et al., 2021), but the key difference is the exclusion of the psychological dimension in the concept of usability (Fanfarelli et al., 2018; Law, 2011). Furthermore, UX has extended its scope far beyond usability and includes even the most abstract and subjective dimensions of human experience (Ebel et al., 2021; Vermeeren et al., 2015), whereas HCI has remained in the more practical realm of human computer interaction and continues to develop more efficient interaction technologies (Zaki & Islam, 2021).

A concept often confused with user experience is the measure of **user satisfaction**. The key difference here is the fact that user satisfaction is by nature a quantifiable measure, whereas user experience is a concept (Law, 2011). One of the goals of a positive and meaningful user experience is, however, user satisfaction (Lemon & Verhoef, 2016). **User-centered design (UCD)**, in turn, encompasses the methods and tools commonly used in creating these positive and meaningful user experiences (Ebel et al., 2021).

Technical communication (TC) emerged somewhat alongside UX and shares numerous similarities with it but has been developed for a different purpose. The purpose of TC lies in the effective communication of technical information to make complex systems usable and understandable. This has had most applications in technical industries, and while it is naturally user centric, it does not concentrate on the psychological dimension of experience (Lanius et al., 2021).

Although originating from entirely separate fields of research, UXD and **service design (SD)** have developed into an increasingly overlapping whole (Roto et al., 2021). This is due to the dramatic increase in digital channels in service delivery along with the emergence of mobile devices and the increasing interactivity of traditionally passive channels (Lemon & Verhoef,

2016; Roto et al., 2021; Jang & Yi, 2019). In the IT industry, this has in turn led to the transition towards orchestrating service journeys more and more holistically through multiple touch points within large, singular IT systems (Lemon & Verhoef, 2016; Roto et al., 2021). Over the course of the last decade, the distinction between SD and UX has hence diminished, and practitioners of both disciplines adopt methods and approaches from SD and UXD in their work (Roto et al., 2021). Despite the growing overlap, SD remains as the umbrella concept that fits the "fine focus" of UXD inside more holistic SD projects (Roto et al., 2021).

In the following table (Table 2), the reviewed notions and disciplines are summarized and their key aspects in relation to UX clarified.

Notion/Discipline	**Origin**	**Definition**	**Similarities with UX**	**Differences to UX**	**References**
User Experience (UX)	HCI, psychology	The overall perception and response of a human interacting with a system	Not applicable	Not applicable	Law, 2011
Human-Computer Interaction (HCI)	Need to develop ways to interact with information technology	The interaction between a human and a computer	Usability of information systems	Excludes the psychological dimension	Law, 2011; Roto et al., 2021
Usability	HCI	The ease and efficiency of using a system	Focus on ease of use	Excludes the psychological dimension	Ebel et al., 2021
User Satisfaction	Need to measure the success of a service or a product	The degree of satisfaction of the user towards a product or a service	Concerns positive user experience	Quantitative; UX is largely qualitative	Ebel et al., 2021; Law, 2011; Lemon & Verhoef, 2016
User-Centered Design (UCD)	Customer-centricity that emerged in the 2000's	The methods of making a user-centric system	Focus on user-centricity	Encompasses methods for making better UX	Ebel et al., 2021; Li & Zhu, 2018
Technical Communication (TC)	Need to communicate technical information to machine users	The communication of technical information to the user	Focus on user-centricity, similar testing methods	Encompasses methods for making UX, excludes psychological dimension	Lanius et al., 2021
Service Design (SD)	Shift from products to services in the business world	The design of services	Focus on user-centricity, use of information systems	Encompasses the whole design of a service, not only user interaction	Roto et al., 2021

Table 2: Summary of the reviewed UX related notions' relationships with UX

3. Aspects of a successful user experience

Thus far, it can be deducted that the ultimate goal of any UX is to induce a positive interaction that leads up to customer satisfaction and the ensuing benefits to business. In the reviewed literature, there was a crude categorical dichotomy of desirable qualities of UX: **1) the experiential, contextual and more abstract value** and **2) the pragmatic and more technical usability** (Law, 2011; Li & Zhu, 2018). Both categories have their own potential for utility and benefits for both the user and the service provider (Franco, 2010; Lemon & Verhoef, 2016; Zaki & Islam, 2021). In this section, the desirable dimensions of user experience as well as a number of factors affecting them are reviewed by the two categories, after which the business benefits of successful UX as well as UX related ethical questions are discussed.

3.1. Abstract experiential value

The fact that the aim of every consumer decision is ultimately a satisfying experience was introduced to the scientific community of marketing already in the 1950's (Lemon & Verhoef, 2016). Since then, the awareness of the importance as well as the role of a positive consumer and user experience has only increased (Roto et al., 2021). In a study by Boetsch et al. (2011), the authors found that feelings have more impact in consumer decision making than many concrete factors. While these notions are only complementary to the fact that positive experiences universally contribute to the positive experience of living life itself, they act as evidence of the intrinsic value of a positive user experience.

In the reviewed literature, mentions of a myriad of abstract qualities of an experientially positive experience can be found. Some are recurrent across studies, while some are more specific to the context of the study or interaction. For instance, some of the most recurring desirable abstract qualities are *aesthetic, comfortable, engaging* and *reliable* (Fanfarelli et al., 2018; Frederico et al., 2021; Jang & Yi, 2019) whereas *safety*, *social benefit* and *content diversity* are some of the more rarely mentioned, more context specific qualities (Frederico et al., 2021; Jang & Yi, 2019).

The factors themselves that lead to these qualities seem to be, however, hard to generalize (Frederico et al., 2021). This is due to the fact that every kind of user experience has their own unique properties and – outside the concrete setting, circumstances and ergonomics of a system

– the abstract emotional and cognitive experiences of the user are ultimately subjective (Ebel et al., 2021; Frederico et al., 2021; Roto et al., 2011; Vermeeren et al., 2015). The same factor that contributes to a positive experience for some could prove to be a negative factor for another user or in another context (Frederico et al., 2021; Vermeeren et al., 2015). In their article, Roto et al. (2011) identifies three categories for the factors that explain the subjectivity of UX: the **1) context, 2) system** and **3) user** related factors of an interaction. **Context** related factors have to do with the situation and circumstances around the experience, such as urgency or reasons of interaction; **system** related factors concern the qualities of the system and finally; **user** related factors include the attitudes, expectations and state of mind of the user (Roto et al., 2011). In the formation of the user related factors, the significance of the temporal aspect of UX is recognized among multiple scholars and practitioners: past experiences and information significantly influence the attitudes and expectations a user has towards using and experiencing a system (Roto et al., 2011; Zaki & Islam, 2021).

Despite this subjectivity, no studies found factors with significant ambiguity and most of the reviewed material stated confidence in the measurability and predictability of UX (Ebel et al., 2021; Law, 2011; Zaki & Islam, 2021). It can thus be concluded that while the subjectivity of the overall user experience does induce undeniable unpredictability relevant for both UX research and development, it does not render the user experience entirely unmeasurable or unpredictable.

3.2. Usability

The second category of UX qualities encompasses the older, purely utilitarian side of UX. These qualities contribute to the degree of usability in the UX and comprise of largely concrete circumstances and system ergonomics (Law, 2011; Li & Zhu, 2018). The qualities as well as the factors contributing to these qualities are indeed much more inambiguous compared to the qualities of the first category due to the absence of strictly abstract concepts or experiences (Ebel et al., 2021; Law, 2011). Despite easier measurability, the exact appropriate qualities of this category are also defined by the unique properties of different contexts and thus, only some generalizations can be made (Ebel et al., 2021; Law, 2011; ISO, 2019).

Fanfarelli et al. (2018) proposes three components of the practical side of UX: **1) usability**, **2) adaptability** and **3) efficiency.** The first component, **usability**, refers to all concrete ergonomic

factors affecting the interaction with the system, such as *intuitiveness*, *ease of navigation* and *straightforwardness of design*. These are complemented by smaller scale factors, such as font size and style, colors used in a graphical user interface (Jiang et al., 2019), as well as auxiliary factors such as user training and manuals (Fanfarelli et al., 2018; Mckay, 2013). The second component, **adaptability**, translates to the malleability of the interface. This refers to the temporal aspect of user experience by considering the potentially changing needs of the user and the ability of the system to adapt to those changes (Fanfarelli et al., 2018). The third component, **efficiency**, refers not only to the rate at which desired results can be produced, but also to the appropriateness of the interface. For a system to have satisfying efficiency, it should be needed for its task and have the relevant and appropriate functions to fulfill its task (Fanfarelli et al., 2018; Jang & Yi, 2019; Zaki & Islam, 2021).

Despite the comprehensiveness and applicability of the framework presented previously, defining the degree of usability in a bad user experience can also prove useful, since a system that fails to satisfy user requirements or provide an adequately user-friendly experience is obsolete (Zaki & Islam, 2021). In their book from 2013, McKay appoints four qualities as the enemies of good UI and UX: 1) unnatural, 2) technological, 3) mechanical and 4) hard learnability.

Another closely usability related concept is accessibility defined in the ISO 9241-210:2019 standard for accessibility guidelines. Whereas usability concentrates on the above-mentioned aspects the concept of accessibility means the absence of barriers and presence of functions necessary for interaction to be possible (ISO, 2019; W3C, 2022).

3.3. Business benefits of a good UX

In addition to the utility and value to the user, the reviewed literature presents numerous benefits to be realized from developing and maintaining a good UX for the product developer or the service provider.

In their paper, Franco (2010) lists several reasons why a positive UX causes decreases in costs as well as increases in revenue. Decreasing costs happens by enabling more efficient self-service as well as more efficient live service through sped up interaction processes or even removing the need for live customer service altogether. Investing in UX practices also saves costs in product and service development as well as maintenance (Volentine et al., 2021).

Increasing revenue, on the other hand, comes from the improvement the overall customer experience and thus increasing the customer lifetime value as well as word of mouth (Franco, 2010; Lemon & Verhoef, 2016; Zaki & Islam, 2021).

A positive user experience is also a strong positive brand message, which affects consumer decisions directly (Boetsch et al., 2011). Furthermore, a positive user experience improves the competitive advantage of interactive products and when integrating UX practices directly to business and product development functions, positive UX becomes a tool for sustainable competitive advantage and user attraction (Li & Zhu, 2018; Saad et al., 2021). The application of UX efforts is also statistically positively correlated with business success (Volentine et al., 2021).

3.4. Ethical dilemmas of UXD

Along with the positive development in the field of UX, a potentially malicious method of subtle influencing has been identified. In their case study, Portmann (2022) found that the UX design has an effect on what kind of audience an online platform attracts and facilitates. Furthermore, technology and its design impact the participation structures by defining what is possible and encouraged in interactions between humans and systems, and thus enables the active inventing, modifying and crafting of audiences by service providers. The methods of committing to this sort of active audience crafting vary from subtle choices of language all the way to the structural design and functional capabilities of an online platform. The threats of this practice lie in the possibility to manipulate and direct user behavior, potentially causing harmful, unintended or misinformed decisions.

Crafting an audience is not only possible for the service provider, but also somewhat equally to the users of the platform (Portmann, 2022). Over the course of the last two decades, audiences have turned from passive recipients to active contributors along with the emergence of social media and other content distributing platforms, which makes the users capable of crafting their own audience.

4. Measuring and predicting user experience

As recognized in the previous section, the qualities that lead up to a good and meaningful UX – while at times largely technical and easily quantifiable – can as well be fuzzy, abstract and elusive. Nevertheless, it is necessary to be able to measure and evaluate UX and efforts made in its development in order to understand whether the system accurately satisfies the users' requirements for its task (Zaki & Islam, 2021).

There have been multiple attempts to map the field of UX research in the last two decades (Lanius et al., 2021; Law, 2011). These mapping studies most often conclude that the field is incredibly multidisciplinary and – somewhat consequently – that the field needs converging due to the lack of standard parameters and consistent practices within the field (Lanius et al., 2021). This lack of standards and consistency has led to the fact that many UX researchers still do not fully understand what kind of methods are used in UX measurement (Lanius et al., 2021).

In addition, there has for long been clear tension between "camps" of scholars favoring either qualitative or quantitative methods in UX research, likely due to the heterogeneity of the origins of UX that are in both HCI and psychology (Law, 2011). Despite the doubts towards quantifying certain UX qualities, data-driven analysis and UX solutions are well anticipated among practitioners and scholars alike (Ebel et al., 2021; Zaki & Islam, 2021).

In this section, the divergence between qualitative and quantitative measurement is first discussed. Next, the most common methods of UX evaluation and measurement as well as their respective limitations are reviewed, and finally, notes on the predictability of UX are gathered.

4.1. Qualitative versus quantitative – Measuring the unmeasurable?

In the field of UX research, the most common approaches are qualitative due to the inherent difficulties in quantifying certain aspects of UX and especially defining the distinction between quantifiable and non-quantifiable qualities (Ebel et al., 2021; Law, 2011).

Qualitative data undeniably preserves most of the information and research data as well as guides design decisions more accurately when it comes to studying a largely non-quantifiable

construct such as the user experience, but not without limitations (Law, 2011). The lack of frameworks for UX qualities limits the ability to collect and study large amounts of data, which leads to case studies being the most viable qualitative UX studies (Jiang et al., 2019). The lack of frameworks is indeed a severe limitation, as the amount of interaction channels is ever-increasing and studying them meaningfully will require the capacity to include more than one channel in a study (Jiang et al., 2019). To overcome this limitation, quantifying qualitative concepts – at least to some extent – is necessary (Jiang et al., 2019; Law, 2011).

There has indeed been a calling for numeric measures for studying UX for a long time (Jiang et al., 2019; Law, 2011). However, significantly different opinions on the justification and empirical practicality of the reduction of UX to quantifiable constructs exist across the UX research community (Law, 2011). This has led to the formation of holistic and deductionist "camps" within the UX research community. The "holistic camp" defies the measurability of UX and conducts mainly qualitative studies, while the "deductionist camp" embraces the modeling of UX and includes both measurement and structural models in their studies (Lanius et al., 2021; Law, 2011).

While this sort of divergence is understandable, the debate will likely be inconclusive due to the variance in possible applications and the consequent impossibility of generalization. It would be more useful to agree on a common ground of ensuring sufficient validity and meaningfulness of measures, despite the method used. After all, producing meaningful results is the goal of every measure, and eclectic approaches with cross-validating methods – both qualitative and quantitative – have proved useful and accurate in past studies (Ebel et al., 2021; Law, 2011).

4.2. Methods of measurement

With usability as an inherent part of UX, most UX research involves usability testing and some UX measurement tools are directly adapted from quantitative usability measurement (Lanius et al., 2021; Law, 2011). Abstract qualities of UX, however, are vastly different in their nature and measuring both categories in a meaningful way requires different methods and data (Law, 2011). Due to the varying natures of UX qualities, both qualitative and quantitative methods are often used eclectically as triangulating methods in order to measure both dimensions of UX and confirm each other's results (Li & Zhu, 2018; Law, 2011). Nevertheless, evaluation

measures are rarely absolutely accurate since the collected data, application and technology affect the results through their circumstantial limitations (Zaki & Islam, 2021).

4.2.1. Qualitative methods

In the past, qualitative methods have been successfully implemented in measuring UX qualities in both the first and second category – qualities affecting 1) experiential and 2) usability value of UX, respectively (Ebel et al., 2021; Law, 2011). In measuring the abstract qualities of the first category, mostly qualitative methods have been used due to the evident difficulty of quantifying abstract experiences (Law, 2011; Zaki & Islam, 2021).

The qualitative methods have been used with both explicit and implicit data gathered from laboratory, naturalistic and field settings (Ebel et al., 2021; Jang & Yi, 2019). While implicit data (e.g., notes on user behavior) does sometimes reveal behavior undetected by explicit data (e.g., group discussion), the most meaningful aspects of a system for the user are represented most accurately in explicit data (Li & Zhu, 2018). In addition, UX research data collected in laboratory settings has yielded different results than data collected in field settings, which indicates that the data collected in the field is the more valuable and accurate (Ebel et al., 2021; Jang & Yi, 2019). Gathering data directly from natural system usage situations, however, proves more difficult the closer to truly natural circumstances a study gets (Lemon & Verhoef, 2016).

The qualitative methods used the most in the reviewed literature are listed in the table below (Table 3) with examples.

Method	Example
Interview; open-ended	Interviewing study participants and taking notes of the ensuing discussion (Zaki & Islam, 2021; Volentine et al., 2021)
Survey; open-ended	Gathering study participants responses with a survey with open-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Questionnaire; open-ended	Gathering study participants responses with a questionnaire with open-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Diary study	Writing diary entries concerning a user experience (Zaki & Islam, 2021)
Think-aloud method	Observing and taking notes of a user tasked with the use of a system and thinking aloud (Volentine et al., 2021)
Expert evaluation	Tasking an expert with the evaluation of a prototype of a system (Volentine et al., 2021)
Observation of user; moderated	Observing a user tasked with using a system with tasks and researcher presence (Volentine et al., 2021)
Observation of user; unmoderated	Observing a user tasked with using a system without researcher presence or tasks (Volentine et al., 2021)
Group discussion	Collecting notes of a group discussion between study participants (Frederico et al., 2021)

Table 3: Summary of qualitative data gathering methods mentioned in reviewed literature

4.2.2. Quantitative methods

Quantitative methods are most used with usability testing because of its easy and viable applied ability through user performance measures (Ebel et al., 2021; Law, 2011). For example, the overall usability of a system could be measured by time on task and error frequency, although they would not provide accurate insights to the reasons behind the results (Law, 2011; Zaki & Islam, 2021). This sort of a quantitative method is usually combined with qualitative methods to find the reasons behind the result (Law, 2011).

Despite the distrust towards quantifying abstract experiences in the UX research community (Law, 2011), neurological and physiological measures have been successfully used to quantifiably measure the abstract side of UX (Zaki & Islam, 2021). The most commonly used neurological methods include brain wave analysis (EEG) and muscle activity monitoring,

while the most common physiological measures include monitoring of facial expression, heart rate variability, galvanic skin response as well as eye tracking.

The neurological measures have been most used in studying the emotional experiences and while it has been available for a relatively short time, it already demonstrates a significant advancement in the possibility to quantify abstract experiences (Zaki & Islam, 2021). The physiological measures have been most useful in usability assessment by providing data previously invisible in qualitative usability studies (Zaki & Islam, 2021). These methods require exceptional attention to ensure their meaningfulness and validity, so they are rarely used by themselves and usually act as complements in studies that employ multiple other methods (Law, 2011; Zaki & Islam, 2021).

The quantitative methods used the most in the reviewed literature are listed in the table below with examples.

Method	**Example**
Survey; closed-ended	Gathering study participants responses with a survey with closed-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Questionnaire; closed-ended	Gathering study participants responses with a questionnaire with closed-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Quantitative UI assessment	UI assessed programmatically by analyzing e.g., binary sequences of screenshots or text hierarchies (Jiang et al., 2019)
Physiological analysis	Monitoring and analyzing heart rate variability or tracking eye movements (Zaki & Islam, 2021)
Neurological analysis	Monitoring and analyzing brain waves (Zaki & Islam, 2021)
Usage data analysis	Capturing and analyzing usage data from a system (Lanius et al., 2021)
User performance measure	Gathering and analyzing error frequency data (Zaki & Islam, 2021)

Table 4: Summary of quantitative data gathering methods mentioned in reviewed literature

4.3. Predictability

The prediction of UX it's a very novel concept, which has not yet seen many applications. According to Law (2011), however, predicting UX is possible within an acceptable margin of error. The main questions around the predictability of UX have to do with the accuracy of UX analysis based on the UX factors of an incomplete prototype of a system (Law, 2011). Additionally, the inherent subjectivity of effects of the temporal dimension of UX makes predicting an experience a very elusive goal (Roto et al., 2011; Zaki & Islam, 2021). For an already finished product or service, however, predicting user behavior is far simpler and can be conducted with a simple user satisfaction survey (Li & Zhu, 2018).

5. Principles of successful user experience design

In the reviewed literature, a variety of rules, steps, strategies and tools are proposed for successful user experience development on both practical and managerial levels. Although they bear resemblance, this variability seems to display the lack of standard UX frameworks and practices – in practice. In this section, principles most recurrently proposed in reviewed literature are gathered and presented from the perspectives of the product development, service design, UX evaluation and UX measuring processes.

5.1. Know the end user

To successfully develop a user centric product or service, both the design and maintenance should be approached differently than traditional systems (Albert et al., 2004; Cooper, 2004). An important aspect about user centricity is knowing the end user (Ebel et al., 2021; Fanfarelli et al., 2018; Franco, 2010). Building a universally fitting system for everyone is not viable, and likely results in at least a slightly inconvenient product for everyone (Franco, 2010; Gruen et al., 2002). The end users need to be consulted thoroughly and the market environment needs to be known for a product development to hit its mark and result in a usable, adaptable, efficient and pleasing product or service for an existing user segment (Albert et al., 2004; Cooper, 2004; Ebel et al., 2021; Fanfarelli et al., 2018; Frederico et al., 2021; Roto et al., 2021).

5.2. Design iteratively

A business developing a product or service likely does not have all the information it needs to finish a product (Albert et al., 2004). This is why one should first develop a minimum viable product (MVP) to test the concept, and then consult the end users before adding the next feature (Saad et al., 2021). Similarly, the development should not stop after launching the product or service, but instead continue to improve the product to better address user needs (Albert et al., 2004; Ebel et al., 2021; Fanfarelli et al., 2018; Li & Zhu, 2018; Roto et al., 2021) and keep up with competition (Franco, 2010; Saad et al., 2021; Vermeeren et al., 2015).

5.3. Involve users in design

If viable, users should be involved in a participatory design process. Developing with constant end user contribution brings the end users' needs and ideas forward and ensures that they remain in focus (Ebel et al., 2021; Frederico et al., 2021; Saad et al., 2021; Zaki & Islam, 2021) as well as readily provides timely feedback on the prototype (Fanfarelli et al., 2018; Frederico et al., 2021), which significantly contributes to the creation of an inherently appropriate, efficient and needed user experience (Ebel et al., 2021; Fanfarelli et al., 2018; Saad et al., 2021). Furthermore, the involvement of users in development statistically increases user satisfaction and experience engagement while decreasing the call for changes (Ramos-Vega et al., 2021).

5.4. Ensure expert collaboration

The development of an optimal UX requires collaboration among the businesses internal design, IT and brand processes as well as user interaction experts (Franco, 2010). No single person can handle all of them, so there will be several people or even teams of people working on the product or service that need to be able to communicate effectively (Franco, 2010; Lanius et al., 2021). Without efficient communication between these teams and people, all groups will make uninformed decisions and the resulting design will not hit its mark providing a meaningful and usable user experience and the resources spent on the UX efforts made will be inefficient (Franco, 2010; Lanius et al., 2021).

5.5. Evaluate often

Along with communication the product or service developers will need to have the actual information to relay to one another. During the development this information is produced through frequent evaluation of a prototype or an iterative design and after the product or service launch, the measuring and testing should continue appropriately to further improve the product or service and its fit to its users (Albert et al., 2004; Ebel et al., 2021; Volentine et al., 2021). At least usability testing and gap analysis should be included in the measures to ensure usability and the match between the product or service and the user (Albert et al., 2004; Ebel et al., 2021; Volentine et al., 2021). Evaluations should be conducted in between different stages of the development and with steady intervals after the product or service launch (Albert et al., 2004; Ebel et al., 2021; Volentine et al., 2021).

6. Discussion

This thesis reviewed previous research and literature concerning past research efforts, frameworks and practices in the field of user experience design. According to the literature, the field is still largely divergent and in need of standard frameworks and practices (Law, 2011).

User experience is defined as the universal and comprehensive experience that occurs when a human interacts with the system (Fanfarelli et al., 2018; Li & Zhu, 2018; Roto et al., 2011). This includes both the practical dimension of usability as well as the abstract dimension of emotional and cognitive response.

A good user experience is characterized by experiential meaningfulness and value as well as sufficient usability, adaptability and efficiency (Fanfarelli et al., 2018; Zaki & Islam, 2021), but also concrete benefits for business (Franco, 2010; Lemon & Verhoef, 2016) and ethics (Portmann, 2022) can function as a basis for a good user experience. In this literature review, the following principles were identified to contribute to a successful user experience design. These principles have to do with 1) knowing the end user, 2) iterative design, 3) participatory design processes, 4) functional expert collaboration and 5) sufficient measuring of the user experience during, in between and after all development phases.

Although the field is divergent in questions concerning the measurability of certain qualities of user experience, a myriad of both qualitative and quantitative approaches, methods and frameworks have been deployed with meaningful results in studies with various contexts and applications (Law, 2011). The applicable methods vary from a simple user satisfaction survey or questionnaire from a natural setting (Jang & Yi, 2019) all the way to neurological and physiological methods – such as brain wave analysis, heart rate monitoring or eye tracking – in a laboratory setting (Zaki & Islam, 2021).

The main limitations of this thesis are due to the fact that the modern concept of user experience has only been established for three decades and the resulting relative scarcity of research and literature in the field (Law, 2011). Although recurrent parallel subjects were discussed in the reviewed literature (for instance, concerning the definition UX), a fairly heterogeneous sample of contexts and cases was demonstrated. Additionally, the theme of accessibility was only marginally discussed, although comprehensive regulations exist

concerning accessibility in the laws of numerous countries, including the law of European Union (The Finnish Ministry of Social Affairs and Health, 2022).

The most prominent further research prospects proposed in the reviewed literature have to do with the advancing of standard frameworks (Roto et al., 2021), application of data driven UX measures in more specific or entirely new contexts (Ebel et al., 2021), advancing the quantifying capability of qualitative data in the field and advancing methods of UX predictability (Law, 2011). As a relatively novel a field of study, the field of user experience provides an abundance of potential for future research.

First and foremost, the need for standard frameworks for qualitative data and its quantitative analysis should be addressed (Law, 2011). In order to most efficiently make use of the large amount of qualitative data available, numeric methods for analyzing the data needs to be developed to overcome the limitations set by the current capability of processing qualitative data in UX research (Jiang et al., 2019; Law, 2011). Additionally, the advancement of neurological and physiological UX measures would be greatly beneficial for almost all UX evaluation and research. By complementing other methods and enabling a more eclectic approach, the utilization of new measuring technology would provide better accuracy for the analysis (Zaki & Islam, 2021).

7. References

Albert, Goes, & Gupta. (2004). GIST: A Model for Design and Management of Content and Interactivity of Customer-Centric Web Sites. MIS Quarterly, 28(2), 161. https://doi.org/10.2307/25148632

Boetsch, T., Bieger, T., & Wittmer, A. (2011). A Customer-Value Framework for Analyzing Airline Services. Transportation Journal, 50(3), 251–270. https://doi.org/10.5325/transportationj.50.3.0251

Cooper, A. (2004). The inmates are running the asylum: Why high-tech products drive us crazy and how to restore the sanity. SAMS.

Dominguez, A., Florez, J., Lafuente, A., Masneri, S., Tamayo, I., & Zorrilla, M. (2021). A Model for User Interface Adaptation of Multi-Device Media Services. IEEE Transactions on Broadcasting, 67(3), 606–618. https://doi.org/10.1109/tbc.2021.3064221

Ebel, P., Orlovska, J., Hünemeyer, S., Wickman, C., Vogelsang, A., & Söderberg, R. (2021). Automotive UX design and data-driven development: Narrowing the gap to support practitioners. Transportation Research Interdisciplinary Perspectives, 11, 100455. https://doi.org/10.1016/j.trip.2021.100455

Fanfarelli, J. R., McDaniel, R., & Crossley, C. (2018). Adapting UX to the design of healthcare games and applications. Entertainment Computing, 28, 21–31. https://doi.org/10.1016/j.entcom.2018.08.001

Franco, A. (2010). Web 3.0: Distraction, Evolution or Revolution? Information Management, 20(6).

Frederico, C. S., Pereira, A. L. S., Marte, C. L., & Yoshioka, L. R. (2021). Mobile application for bus operations controlled by passengers: A user experience design project (UX). Case Studies on Transport Policy, 9(1), 172–180. https://doi.org/10.1016/j.cstp.2020.11.014

Gruen, D., Rauch, T., Redpath, S., & Ruettinger, S. (2002). The Use of Stories in User Experience Design. International Journal of Human-Computer Interaction, 14(3-4), 503–534. https://doi.org/10.1080/10447318.2002.9669132

ISO - International Organization for Standardization. (1999). ISO 13407:1999. ISO. https://www.iso.org/standard/21197.html

ISO - International Organization for Standardization. (2006). ISO 9241-110:2006. ISO. https://www.iso.org/standard/38009.html

ISO - International Organization for Standardization. (2010). ISO 9241-210:2010. ISO. https://www.iso.org/standard/52075.html

ISO - International Organization for Standardization. (2019). ISO 9241-210:2019. ISO. https://www.iso.org/standard/77520.html

James, W. (1884). What is an Emotion? Mind, 9(35).

Jang, J., & Yi, M. Y. (2019). Determining and validating smart TV UX factors: A multiple-study approach. International Journal of Human-Computer Studies, 130, 58–72. https://doi.org/10.1016/j.ijhcs.2019.05.001

Jiang, Z., Yin, H., Luo, Y., Gong, J., Yang, Y., & Lin, M. (2019). Quantitative Analysis of Mobile Application User Interface Design.

Lanius, C., Weber, R., & Robinson, J. (2021). User Experience Methods in Research and Practice. Journal of Technical Writing and Communication, 51(4), 350–379. https://doi.org/10.1177/00472816211044499

Law, L.-C. (2011). The Measurability and Predictability of User Experience (pp. 1–10). EICS '11: Proceedings of the 3rd ACM SIGCHI symposium on Engineering interactive computing systems.

Lemon, K., & Verhoef, P. (2016). Understanding Customer Experience Throughout the Customer Journey. Journal of Marketing: AMA/MSI Special Issue, 80(6), 69–96.

Li, Y., & Zhu, L. (2018). Optimization of user experience in interaction design through a Taguchi-based hybrid approach. Human Factors and Ergonomics in Manufacturing & Service Industries, 29(2), 126–140. https://doi.org/10.1002/hfm.20765

Mckay, E. N. (2013). UI is communication : how to design intuitive, user centered interfaces by focusing on effective communication. Elsevier, Morgan Kaufmann.

Portmann, L. (2022). Crafting an audience: UX writing, user stylization, and the symbolic violence of little texts. Discourse, Context & Media, 48. https://doi.org/10.1016/j.dcm.2022.100622

Rajanen, D., Clemmensen, T., Iivari, N., Inal, Y., Rızvanoğlu, K., Sivaji, A., & Roche, A. (2017). UX Professionals' Definitions of Usability and UX – A Comparison Between Turkey, Finland, Denmark, France and Malaysia. Human-Computer Interaction – INTERACT 2017, 218–239. https://doi.org/10.1007/978-3-319-68059-0_14

Ramos-Vega, M. C., Palma-Morales, V. M., Pérez-Marín, D., & M. Moguerza, J. (2021). Stimulating children's engagement with an educational serious videogame using Lean UX co-design. Entertainment Computing, 38, 100405. https://doi.org/10.1016/j.entcom.2021.100405

Roto, V., Law, E., Vermeeren, A., & Hoonhout, J. (2011). "UX White Paper – Bringing Clarity to the Concept of User Experience." Outcome of Dagstuhl Seminar on Demarcating User Experience, Germany. http://allaboutux.org/uxwhitepaper

Roto, V., Lee, J.-J., Lai-Chong Law, E., & Zimmerman, J. (2021). The Overlaps and Boundaries Between Service Design and User Experience Design. Designing Interactive Systems Conference 2021. https://doi.org/10.1145/3461778.3462058

Saad, J., Martinelli, S., Machado, L. S., de Souza, C. R. B., Alvaro, A., & Zaina, L. (2021). UX work in software startups: A thematic analysis of the literature. Information and Software Technology, 140, 106688. https://doi.org/10.1016/j.infsof.2021.106688

The Finnish Ministry of Social Affairs and Health. (2022). The European Accessibility Act. The Finnish Ministry of Social Affairs and Health. https://stm.fi/en/the-european-accessibility-act

Vermeeren, A. P. O. S., Roto, V., & Väänänen, K. (2015). Design-inclusive UX research: design as a part of doing user experience research. Behaviour & Information Technology, 35(1), 21–37. https://doi.org/10.1080/0144929x.2015.1081292

Volentine, R., Specht, A., Allard, S., Frame, M., Hu, R., & Zolly, L. (2021). Accessibility of environmental data for sharing: The role of UX in large cyberinfrastructure projects. Ecological Informatics, 63, 101317. https://doi.org/10.1016/j.ecoinf.2021.101317

W3C. (1999). Web Content Accessibility Guidelines 1.0. W3.org. https://www.w3.org/TR/WAI-WEBCONTENT/

W3C. (2022). Web Content Accessibility Guidelines (WCAG) Overview. Web Accessibility Initiative (WAI). https://www.w3.org/WAI/standards-guidelines/wcag/

Yang, K. (2019). Redesigning An Online Store User Interface: A User-Centered Design Approach. Journal for Advancement of Marketing Education, 27(Special Issue).

Yu, F., Ruel, L., Tyler, R., Xu, Q., Cui, H., Karanasios, S., Nguyen, B. X., Keilbach, A., & Mostafa, J. (2020). Innovative UX Methods for Information Access Based on Interdisciplinary Approaches: Practical Lessons from Academia and Industry. Data and Information Management, 4(1), 74–80. https://doi.org/10.2478/dim-2020-0004

Zaki, T., & Islam, M. N. (2021). Neurological and physiological measures to evaluate the usability and user-experience (UX) of information systems: A systematic literature review. Computer Science Review, 40, 100375. https://doi.org/10.1016/j.cosrev.2021.100375

8. Appendix

Table 1: Summary of the search and screening process of source material

Search terms	Engine	Relevant papers	Screened papers	Accepted papers
user experience/UX user experience design/UX design/UXD user experience measuring /UX measuring user experience evaluation /UX evaluation user experience development /UX development	EBSCO	238	65	7
	Google Scholar	264	79	14
	JSTOR	153	46	4
	ProQuest	229	23	1

Table 2: Summary of the reviewed UX related notions' relationships with UX

Notion/Discipline	Origin	Definition	Similarities with UX	Differences to UX	References
User Experience (UX)	HCI, psychology	The overall perception and response of a human interacting with a system	Not applicable	Not applicable	Law, 2011
Human-Computer Interaction (HCI)	Need to develop ways to interact with information technology	The interaction between a human and a computer	Usability of information systems	Excludes the psychological dimension	Law, 2011; Roto et al., 2021
Usability	HCI	The ease and efficiency of using a system	Focus on ease of use	Excludes the psychological dimension	Ebel et al., 2021
User Satisfaction	Need to measure the success of a service or a product	The degree of satisfaction of the user towards a product or a service	Concerns positive user experience	Quantitative; UX is largely qualitative	Ebel et al., 2021; Law, 2011; Lemon & Verhoef, 2016
User-Centered Design (UCD)	Customer-centricity that emerged in the 2000's	The methods of making a user-centric system	Focus on user-centricity	Encompasses methods for making better UX	Ebel et al., 2021; Li & Zhu, 2018
Technical Communication (TC)	Need to communicate technical information to machine users	The communication of technical information to the user	Focus on user-centricity, similar testing methods	Encompasses methods for making UX, excludes psychological dimension	Lanius et al., 2021
Service Design (SD)	Shift from products to services in the business world	The design of services	Focus on user-centricity, use of information systems	Encompasses the whole design of a service, not only user interaction	Roto et al., 2021

Table 3: Summary of qualitative data gathering methods mentioned in reviewed literature

Method	Example
Interview; open-ended	Interviewing study participants and taking notes of the ensuing discussion (Zaki & Islam, 2021; Volentine et al., 2021)
Survey; open-ended	Gathering study participants responses with a survey with open-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Questionnaire; open-ended	Gathering study participants responses with a questionnaire with open-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Diary study	Writing diary entries concerning a user experience (Zaki & Islam, 2021)
Think-aloud method	Observing and taking notes of a user tasked with the use of a system and thinking aloud (Volentine et al., 2021)
Expert evaluation	Tasking an expert with the evaluation of a prototype of a system (Volentine et al., 2021)
Observation of user; moderated	Observing a user tasked with using a system with tasks and researcher presence (Volentine et al., 2021)
Observation of user; unmoderated	Observing a user tasked with using a system without researcher presence or tasks (Volentine et al., 2021)
Group discussion	Collecting notes of a group discussion between study participants (Frederico et al., 2021)

Table 4: Summary of quantitative data gathering methods mentioned in reviewed literature

Method	Example
Survey; closed-ended	Gathering study participants responses with a survey with closed-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Questionnaire; closed-ended	Gathering study participants responses with a questionnaire with closed-ended questions (Zaki & Islam, 2021; Volentine et al., 2021)
Quantitative UI assessment	UI assessed programmatically by analyzing e.g., binary sequences of screenshots or text hierarchies (Jiang et al., 2019)
Physiological analysis	Monitoring and analyzing heart rate variability or tracking eye movements (Zaki & Islam, 2021)
Neurological analysis	Monitoring and analyzing brain waves (Zaki & Islam, 2021)
Usage data analysis	Capturing and analyzing usage data from a system (Lanius et al., 2021)
User performance measure	Gathering and analyzing error frequency data (Zaki & Islam, 2021)