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Enhancing User Experience in E-Government Services: A Study on Service Quality in Saudi Arabia

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ABSTRACT

User experience (UX) and e-government have been the focus of recent research, including studies on factors influencing UX. However, most existing research has not presented a consolidated framework of the most significant UX factors in the e-government government field, especially in Saudi Arabia. Moreover, government agencies strive to increase the number of users and improve the UX of the services provided, by imposing a set of standards that must be followed during the designing and developing of government services. To achieve the government's goals, this study aims to propose a comprehensive framework includes the most important factors affecting UX in Saudi e-government services. This research is based on a qualitative interpretive approach to data collection and analysis. Data was collected using open-ended and semi-structured interviews, along with an extensive literature review. The Analytical Hierarchy Process (AHP) was then used to rank the proposed factors. We found that effectiveness and perceived usefulness factors are critical effect on UX. While aesthetic and branding factors are important, they are considered less critical compared to functional aspects.

Keywords: User Experience, E-government, Usability, E-service, UX Evaluation

Introduction

The world has witnessed substantial and rapid growth in Information Technology (IT), which has greatly enhanced the delivery of government services. Information and Communication Technology (ICT) is considered the backbone of most such services, playing a vital role in streamlining government processes and establishing network structures to cater to diverse user needs [1]. Moreover, dramatic changes in how citizens interact with their governments have led to significant developments in their expectations [2]. Increasingly, countries worldwide are realizing the benefits of e-government and are aiming to provide the full range of government services online. Governments are leveraging e-services to reduce costs, enhance service delivery for citizens, and improve effectiveness and efficiency across the public sector [3,4].

An understanding of User Experience (UX) is currently playing a vital role in diverse domains. In e-government particularly, it can contribute toward positive or negative achievements by supporting hostile or cooperative relationships between governments and users (citizens and non- citizens) or by motivating or demotivating people to use the services [5]. While e-government initiatives have been undertaken worldwide, their success is dependent not only on government support, but also on citizens' acceptance, use and adoption of services provided through these initiatives [6,7]. Accordingly, governments globally seek to improve the UX of their e-services. Besides, studying, measuring, evaluating, and improving UX is essential for the success of any technical product [8]. In general, positive UX is the key to the acceptance of e-services [9]. To achieve this goal and enhance

positive UX in e-government services, it is important to identify the most critical e-government UX factors and determine how they can be evaluated.

Despite the strong interest in UX in both academia and industry, there is no agreement on its dimensions and fundamental characteristics. The authors in [10] observed that the usage of e-government services varies significantly between countries, with study in [11] noting lower acceptance rates of these services in developing economies. Additionally, socio-economic differences can influence cross-cultural perceptions of service quality [12]. The research in [13] found that users have varying definitions of technological terms such as 'technology readiness,' which can impact their evaluations of e-service quality. Moreover, an earlier Gartner's evaluation [1]of Saudi Arabia's e-services indicated that online services vary widely between countries, leading to differing development plans and making cross-country or cross-project comparisons unreliable. Therefore, government e-service quality measures must be tailored to the specific region or service being evaluated.

Another research highlights the limited research on user perceptions of e-government service quality in Arab countries, specifically Saudi Arabia [11] (the focus of this study). According to the E-Government Development Index (EGDI) [2]published by the United Nations, Saudi Arabia has ranked 31st in 2022 compared to 43rd in 2020. Despite this notable progress by world standard, Saudi Arabia e-government services is still much far behind among many countries. Chutimaskul*, et al.* [14] state that service usage is driven by the degree to which users' needs can be met online. Therefore, without understanding users' perceptions of e-government in terms of service quality (as a main factor of UX), there is insufficient data for agencies to make necessary improvements. Consequently, this study aims to explore the quality of e-government services in Saudi Arabia.

We aim to conduct a comprehensive literature review on e-government service quality. In this context, this paper tries to answer the following questions: 1) What are the key factors influencing UX of Saudi e-government services?; 2) How do these factors impact UX for these services and adoption? ; and 3) What methodologies have been most effective in assessing UX for e-government service?. The method is based on a qualitative approach in three steps: 1) Identification and content analysis of related articles on e-government service quality; 2) Interviews with specialists to analyze the e-government service quality factors; and 3) development and validation of the final conceptual framework based on quantitative analysis and expert reviews.

This paper opens with the literature review related to this research (see Section 2). Subsequently, it provides the conceptual framework for e-government quality services (see Section 3). The methodology is presented in Section 4 and results and discussion are discussed in Section 5. Finally, the paper concludes with final remarks, comprising contributions, limitations, and proceeding steps (see Section 5).

1. Related Work

This section reviews and discusses the literature related to the research area. First, we present the concepts of e-government and e-services. Second, we examine UX frameworks in several studies. Finally, we discuss the evaluation of UX and clarify any difficulties encountered.

1.1 E-government and E-services

Significant and rapid growth in information technology usage has enhanced government services worldwide. E-government or electronic government is known by various terms such as online government, e-Gov, digital government, or connected government [15]. The Organization for economic Co-operation and Development (OECD) defines e-government as "*the use of information and communication technologies, and particularly the Internet, as a tool to achieve better government*" [16]. Alternatively, Okunola [4] defines it as "*the use of computing technologies to improve interaction within government administrations, between a government and its citizens, a government and businesses and between governments*." The literature offers several definitions which overlap to some extent. Despite their differences, these definitions share the meaning that e-government is the provision of information and services "*through electronic means to the public (citizens and non-citizens) and private organizations*" [4]. The term first appeared in the mid or late 1990s [17,18]. Nowadays, almost all governments

[1] Gartner (2007) Saudi Arabia e-Gov Progress Assessment Report, Riyadh KSA: Yesser Program

[2] https://publicadministration.un.org/egovkb/en-us/About/Overview/-E-Government-Development-Index

around the world, whether of developed or developing countries, have official websites or e-government portals delivering online/e-services [19].

ICT is considered the backbone of most of the services provided by governments. It has a substantial role in improving government processes and is responsible for providing network structure to deliver various services to diverse users [1] with effectiveness and efficiency [20]. E-government provides several e-services including online banking, credit card services, bill payment, e-filing and e-ticketing [21]. In addition, it delivers effective services related to issuing and renewing passports, identity cards, and driving licenses, producing birth certificates, administering admission to higher education, identity management, and marriage licensing [22]. E-government portals also provide users with applications which include information provisioning with the availability of submitting online and/or downloading [23]. Such e-government services can be categorized into four types, depending on whether they are delivered to citizens, businesses, employees, or other governments [24,25].

Given this variety of services provided, there is no doubt that e-government services have great importance and many benefits, as noted by several studies. First, they provide local access points for the public (citizens and non-citizens) and private organizations [4,26]. Other benefits identified in Carter and Bélanger [27] involve saving time and cost in administrative processes [1] and the fact that services can be delivered anywhere and anytime [28]. Information technologies also enhance data consistency [29], thus reducing common errors [21]. Furthermore, adopting e-government improves operational efficiency, enhances service quality, and removes barriers to government services [30], while ensuring the availability of the necessary documents and information for future reference [28]. E-government strengthens the relationship between governments and citizens, as it helps each government to understand better the wants and needs of its citizens [31]. Websites including e-government portals give users access to the most up-to-date and accurate content related to the services provided [32]. The Digital Government Authority illustrates the benefits of some e-government services by distinguishing government-specific from user-specific benefits[3], stating that e-government services allow accurate assessment of the resources and capabilities available to each government unit, in addition to serving larger numbers of people while transitioning to "*a green, environmentally friendly system of government*". Accordingly, if there are any deficiencies in the services provided by e-government, citizens will be unable to enjoy the expected benefits of these services [33-35]. This study accepts the OECD definition of e-government and focuses on the government-to-citizen type.

1.2 UX Frameworks

Due to the large number of studies in the UX field, where researchers have made different contributions according to their disciplines, reviewing the related literature can be expected to reveal several definitions and diverse explanations of the UX concept. The main role of the International Organization for Standardization (ISO) is to provide business organizations worldwide with technical standards [24]. The international standard on the ergonomics of human system interaction, ISO 9241-210, defines UX as "*a person's perceptions and responses that result from*

Authors	Factors	Research Context
Miki [36]	Expectation, Perceived quality, Perceived value, Satisfaction, Complaints, and Loyalty	No specific context
Okunola [4]	Website Quality, Information quality, Ease of use, Trustworthiness, Barriers, and Benefits	NIS E-government website
Rico-Olarte, *et al.* [37]	Emotion, Effectiveness, Efficiency, Satisfaction, Freedom from risk, and Context coverage	No specific context

[3] https://www.my.gov.sa/wps/portal/snp/content/mobileGovernment

Kim, *et al.* [38]	User value: Utilitarian value, Hedonic value, and Aesthetic value Usability: Ease of use, Learnability, and Wearability	Wearable devices
Kamau, Njihia and Wausi [5]	Efficiency, Effectiveness, Operability, Learnability, User error protection, Accessibility, Citizen engagement, Responsiveness, Transparency, and Balancing of interests	E-government website

Table 1. the table shows the UX frameworks in the literature in terms of UX factors and research context.

the use and/or anticipated use of a product, system or service" [30]. Human Computer Interaction (HCI) researchers and practitioners were divided on the ISO definition. Some of them accepted the standard, while others proposed their own definitions, based on their previous knowledge and experience [14]. Hassenzahl and Tractinsky [31] earlier defined UX as *"A consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organizational/social setting, meaningfulness of the activity, voluntariness of use, etc.)."* It concentrates on users' inner emotions and expectations regarding a system, as it clearly describes the factors influencing UX. The [31] and Roto [32] consider UX to be the outcome of three elements: context, user, and service.

In a series of research papers, Miki [36] has developed a framework for evaluating usability and UX, mainly based on ISO 9241-11 and the American Customer Satisfaction Index (ACSI). ACSI, the only national cross-industry measure of customer satisfaction in the United States[4], is widely used to evaluate customer satisfaction with government systems, industries and their services [36]. Essentially, the researcher used the ISO 9241-11 usability evaluation framework as a basis for their proposed framework, consisting of two objective measures (effectiveness and efficiency) and one subjective measure (satisfaction). They integrated ISO 9241-11 with the six indices of ACSI to build his UX framework. Specifically, they added the subjective measures of perceived quality, perceived value, complaints, and loyalty to the original framework and subsequently extended the proposed framework to consider other factors such as influence by other people [39], but did not apply it to examine real applications.

Okunola [4] based an alternative model on previous research and literature on e-government services, service quality, and e-government adoption and satisfaction. These resources enabled the researcher to compile a detailed list of metrics related to user experience in e-government. The key variables identified were utilized to develop a UX model that includes six measures influencing user experience in e-government services which are website quality, information quality, ease of use, trustworthiness, barriers, and benefits. The researcher tested several hypothesized relationships to determine their strength. However, the model was applied in a single context: the e-government services of the Nigerian Immigration Service. Furthermore, although UX involves users' feelings and emotions, this model did not incorporate any emotional factors.

Table 2. The table presents summary of the UX components in [37,38,39].

Authors	**UX components**
Hassenzahl and Tractinsky [40]	User's internal state (predispositions, expectations, needs, motivation, mood, etc.) The characteristics of the designed system (e.g., complexity, purpose, usability, functionality, etc.) The context (or the environment) within which the interaction occurs (e.g., organizational/social setting, meaningfulness of the activity, voluntaries of use, etc.)
Roto [41], and Roto	System (product, object, service…) Context (physical, social, task …)

[4] https://www.theacsi.org/about-acsi

and Kaasinen [39]	User (needs, expectations, experience …)

A more recent study in Rico-Olarte, López and Kepplinger [37] based a novel UX framework on three sources: ISO 9241-210 [42], the SQuaRE standards for Quality Measure Elements, and measurement of quality in use, in addition to relevant studies in psychophysiology. First, the researchers declared that both user and system are relevant to the UX ISO standard. In particular, the user's internal and physical states and six properties of the system (brand image, performance, presentation, interactivity, functionality and assistance) should be considered. They grouped the properties of the system according to the quality requirements set forth in ISO 25020 and explained that the quality requirements measurement included assessment of the process, internally and externally, and when the system was in real use. Moreover, the researchers focused on the quality requirements of the system in use, namely effectiveness, efficiency, satisfaction, freedom from risk, and context coverage, based on ISO 25022. Additionally, there were quality sub-requirements for three of these requirements. From the user perspective, the user's states (internal and physical) are represented by physical and psychological responses. The researchers suggested that these states should be collected by psychophysiological methods, as well as separate measures of physiological signals and psychological events.

Additionally, Kim, Yoon, Hwangbo and Ji [38] built a systematic framework to help in the design and evaluation of wearable devices. The proposed framework takes into consideration three aspects of user values, namely design space, evaluation factors, and context of use. Each of these aspects comprises subcategories. The context of use includes user type, device type, task type, and environment. The design space consists of physical and functional factors. Meanwhile, the researchers classified the UX evaluation factors into the dimensions of user value and usability [38]. Specifically, the user value dimension was divided into utilitarian value, hedonic value, and aesthetic value, while usability comprised ease of use, learnability, and wearability. Two methodologies were used to test the applicability of the proposed framework: expert evaluation (heuristic method) and user evaluation by questionnaire. These were applied to a case study of two types of wearable devices: head mounted devices and smart watches. As the framework comprises only three factors for each of usability and user value, it is not comprehensive and lacks contextual consideration.

Kamau, Njihia and Wausi [5] explored factors affecting UX on an e-government website from a public value perspective, using the iTax website in Kenya as a case study, and identified ten factors: Efficiency, Effectiveness, Operability, Learnability, User error protection, Accessibility, Citizen engagement, Responsiveness, Transparency and Balancing of interests. The researchers claimed that UX and content should drive website design, an approach known as user-centered design (UCD). Table 1 summarizes the previous studies in various UX frameworks in different research contexts.

This study adopts the approach of Hassenzahl and Tractinsky [40], defining UX in terms of three high-level components: context, user, and service quality, due to its generality and capability to cover all the aforementioned aspects. Other studies [38,39] have taken these three components as a starting point, then tried to identify a set of attributes that are close to a suitable level of abstraction. Table 2 summarizes the UX components in [37,38,39]. However, this study only targets the service quality in depth.

1.3 UX Evaluation

Evaluation is a significant process that should be performed periodically to assess the e-services being provided. UX evaluation research is considered to be an area with rich scope for studies going beyond the concept of usability evaluation. An important distinction is that usability measures, such as numbers of clicks or errors, are objective [43], whereas UX is subjective [21]. Hence, usability measures are not sufficient for UX; rather, there is a need to know how users feel about products, systems, or services [43]. Moreover, there are different ways to measure UX [43] and even a debate about whether or not UX is measurable at all [44].

In light of ongoing disputes about UX evaluation, developing a consensus on a UX framework is premature, however, researchers and ad hoc groups have proposed a number of frameworks [36]. Roto*, et al.* [45] state that among the many models proposed by researchers such as Hassenzahl [46] and Mahlke and Thüring [47], the only consensus is that UX has both pragmatic (utility and usability) and hedonic (emotional) aspects [48]. Despite the

importance of theoretical frameworks such as the Technology Acceptance Model (TAM), Legris*, et al.* [49] highlight limitations of these models such as their failure to take account of all significant factors, arguing that they explain only about 40% of technology usage. While such models are useful, they are not conclusive and suffer from the absence of important factors such as both human and social changes [49-51]. Thus, additional variables are required for a better understanding of users' decisions to adopt a technology or not [52]. It is possible for these new variables "*to be grounded in emotional, social, and goal-directed behavior research*" Partala and Saari [52]. Law and Van Schaik [53] explain the necessity of specific measures for UX that would allow benchmarking and the selection and iteration of the most suitable design solutions.

The literature reports diverse UX evaluation methods, which some authors categorize as involving either self-reported, observational, or physiological measurements [54]. The most common of these is the first category, where users report their own experience and perspective of a service, system, or product by means of questionnaires, interviews, thinking aloud, emoji cards, etc. In observational evaluation, an expert observes users as they interact with the service, often through performance evaluation. Finally, physiological measurements track biological data, such as eye movement, heart rate variability, blood volume pulse, and more [55]. Some researchers have combined multiple methods, often from different categories, to enhance the results of UX evaluations [56]. A systematic review of UX studies in Inan Nur, B. Santoso and O. Hadi Putra [55] showed that self-reported methods were most frequently implemented, accounting for 95% of the studies reviewed. Among these, about 84% used questionnaires to evaluate UX, according to Maia and Furtado [48], while Rico-Olarte, López and Kepplinger [37] recommend the use of questionnaires to investigate users' pleasure. The second most commonly used measure of UX is observational, with a score of 37%, while physiological measurement (14%) is used least often. With the coming of new and sophisticated products, systems, and services that provide high-level functions, designing and evaluating usability and UX have become more complex and difficult [36]. Additionally, the success conditions of services become harder to achieve as competition becomes global [57]. According to Olsson [51], UX challenges can be divided into two kinds: first, designing a pleasurable, engaging, and stimulating UX that is appropriate to the user's context. Second, evaluating UX and the overall acceptability of the applications or services. Furthermore, software is distinct from other products due to its intellectual nature, leading to a different development process than manufactured goods. This distinction makes software one of the most widely used, complex, and error-prone types of products in human history [58]. Furthermore, UX comprises different perspectives and several aspects, which make it challenging and complex to evaluate [37]. Moreover, it is inherently variable, adapting to the context in which it is used, user characteristics, and the external environment. As a result, UX evaluation should occur both before and after the interaction, not solely during the interaction with the product, service, or system.[43]. Noting all of these considerations, Mashapa and van Greunen [59] the evaluating and understanding UX is a tough task [48].

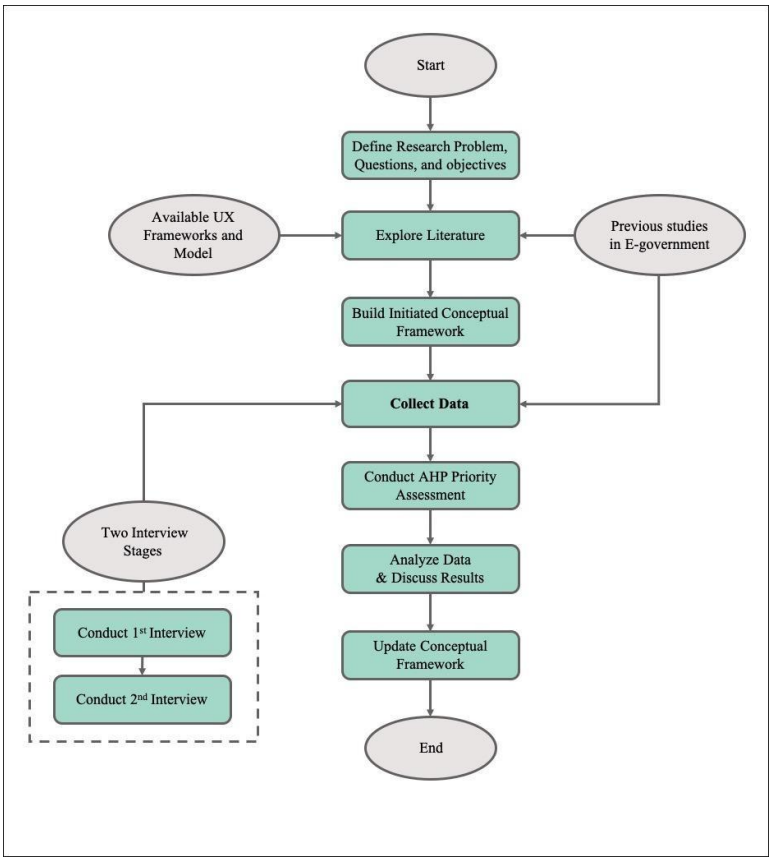

Figure 1. the figure shows the research process flowchart.

2. Conceptual Framework

Figure 1 presents the flowchart of the research process. Based on the gaps identified in previous studies (see Section 2), a framework that encapsulates service quality for evaluating e-government user experiences in Saudi Arabia was proposed. The online service quality directly impacts customer satisfaction and individual decisions, exerting either a positive or negative influence on user satisfaction and subsequent usage of an e-service [6]. Table 3 outlines the service quality factors along with their corresponding assessment techniques.

Table 3. the table shows the proposed factors of service quality along with their respective evaluation methods.

Category	Factor	Evaluation Methods		
		Self-reported	**Observational**	**Physiological**
Service Quality	• Information quality • Ease of use • Efficiency • Effectivity • Learnability • Perceived value • Aesthetics • Satisfaction • Trustworthiness • Image	• Questionnaires • Interviews • Think aloud • Emoji cards • Heuristic evaluation	• Performance evaluation • Interaction record	• Galvanic skin response • Blood volume pulse • Eye tracking • Heart rate variability

Information quality encompasses the accuracy, integrity, relevancy, consistency, validity, accessibility, reliability, availability, precision, and completeness of e-government service content [4,60]. The study in [61] emphasizes its role in producing and delivering service information, with [62] adding output timeliness and format, [63] including understandability, and [64] introducing sufficiency and freedom from bias. The authors in [65]

found information quality to strongly predict e-government service acceptance and adoption in the UK. Many ICT studies emphasize its significance [10], while others highlight the poor information quality on numerous government websites as a hindrance to adoption [66].

Ease of use can also affect the service quality, and it refers to how effortlessly a user perceives a specific service to be, or how easily they can use it with minimal effort. It has been confirmed as effective in users' evaluation of e-government services [67]. Various scholars have identified ease of use as an important indicator of adoption, user acceptance, and motivation in regard to new technology [68,69]. Additionally, efficiency is a critical factor in e-service design, often assessed by time on task or the effort required for completion. The authors in [70] differentiate between cognitive effort (e.g. deciding necessary actions) and physical effort (e.g. required physical activity), while in [71] validated that enhanced efficiency reduces cognitive effort, resulting in a more positive UX. On the other hand, effectiveness of e-services directly impact UX [72]. The UX 5E evaluation model in [73] identifies effectiveness as one of its five factors: engaging, easy to learn, effective, error tolerant and efficient. Therefore, the effectiveness of a service and its efficiency determine its performance.

Learnability is another crucial factor, referring to users' to easily understand and utilize a system [8]. Designers should improve the clarity and reliability of their systems, or services to facilitate user learning. Offering clear user guidance patterns expands learnability and declines the mental workload, resulting in a better user experience [74]. Moreover, the perceived value is an importance factor for an e-service, denoted by how easily users achieve their goals compared to using traditional face-to-face services [4]. In the relevant study, it was found that UX predictors accounted for 38.2% of explained variance in perceived usefulness [75]. Perceived usefulness and ease of use have been confirmed as fundamental to the effective evaluation of e-governance online services by citizens [4]. When considering UX, some researchers assume that perceived value is a subjective measure of effectivity and that perceived quality is a subjective measure of efficiency [39].

Chen, *et al.* [76], aesthetics, the pleasure derived from looking at a service or system without evaluating its utility, is assumed that stimulate citizens' cognitive and emotional experience. It is also argued that aesthetics plays a significant role in building relationships between users and services, closely related to established users' viewpoints, such as loyalty [77]. Aesthetics strongly influence user satisfaction [78], thus affecting the UX of e-government services positively or negatively. Factors such as color, design, and shape contribute to the aesthetics of these services, making aesthetics a crucial consideration. As claimed by to Delone and McLean [61], user satisfaction plays a critical role in the widespread adoption and consumption of e-government services. It encompasses the user's comfort, pleasure, and acceptance derived from consumption of content and from interaction with a mobile application. Generally, satisfaction measures assess users' attitudes to the use of a service in a specified context of use. Thus, numerous studies have confirmed a direct relationship between user satisfaction and UX effectiveness [79].

Additionally, perceived trust in e-government services significantly influences their acceptance, adoption, and subsequent satisfaction by users, as it affects the perceived level of risk [80]. Citizens tend to trust governments perceived as efficient, open, transparent, and responsive, which are key indicators of trustworthiness [81]. Thus, it is crucial to address criteria such as privacy and security to manage trust levels among service users [82], as privacy and security are often seen as major barriers to e-government adoption and diffusion [83]. Finally, image is another important factor, refers to "*the belief of a group important to an individual that a certain behavior should be implemented and implementation of this behavior by the individual can persistently enhance the quality of internal works of the organization*" [84].

3. Methodology

The research utilized qualitative methodology which begins with an in-depth review of the literature (see Section 2), followed by the construction of a conceptual framework (see Section 3). Once the data is collected from various literature sources and analyzed, the proposed framework is utilized as a mirror to ensure consistency with the findings or to identify any discrepancies. This validation step involved interviewing several UX Subject Matter Experts (SMEs) to assess and evaluate the proposed framework. Finally, priority assessment was conducted using the Analytic Hierarchy Process (AHP) method.

3.1 Interview

The interviews in this research were conducted in two phases, with both phases (phase I and II) involving the same 8 UX SMEs, 50% were male and 50% were female participants, aged between

Table 4. The table presents demographic information on Interviewees

Interviewee Code	Interview Duration in Phase I	Interview Duration in Phase II	Gender	Current Job Title	Nationality	Years of Experience
A	25 minutes	35 minutes	Male	UX consultant	Saudi	More than 10
B	40 minutes	54 minutes	Female	Senior design consultant	Non-Saudi	5-10
C	23 minutes	32 minutes	Male	Lecturer and PhD student	Saudi	5-10
D	20 minutes	40 minutes	Male	UI/UX designer/ product manager	Non-Saudi	5-10
E	44 minutes	50 minutes	Female	Digital general manager	Non-Saudi	More than 10
F	50 minutes	55 minutes	Female	Senior design thinking	Saudi	5-10
G	45 minutes	53 minutes	Female	UX consultant	Saudi	More than 10
H	25 minutes	30 minutes	Male	Digital general manager	Non-Saudi	More than 10

30 and 38 years. A structured interview guide was created to address the aspects of the study's objectives, confidentiality assurances, participant rights, and the researcher's obligations. This guide encompassed outlining the study's purpose, including the interview process, and ensuring the confidentiality of the interview. It was made clear to interviewees that there were no correct or incorrect answers, and they had the option to refuse to answer any questions. To delve into participants' perceptions of conceptual framework of e-government service in Saudi Arabia, the researchers formulated a series of sub-questions. Pilot interviews were undertaken with three PhD students at King Saud University to assess the relevance of the research questions and to evaluate the interview guide. Certain questions were adjusted following their feedback and suggestions.

The interviews were conducted and recorded online through Zoom software[5] in May-June 2023. Participants were informed that recording the interview was preferred to aid analysis. With the consent of all participants, the interviews were tape-recorded. Every interview involved a different participant, but the protocol was always the same. Specifically, the interviewer always asked the same questions and in the same order. The interviewer aimed to speak as little as possible, and on average, they spoke for 10.0% of the interview duration, while guiding participants to stay on track, ensuring key points were covered, and providing prompts to help interviewees answer relevantly. Table 4 provides demographic information for both phases.

[5] https://zoom.us/

Gender distribution was balanced for participation in the experiments. Ensuring gender balance is crucial, as potential differences between males and females in the perception of UX can arise from varying strategies of information processing [85]. In terms of nationality and years' experiences, the interviewers were from different nationalities, and had an average of 5-10 years in Saudi government e-services. The interview durations for male and female interviews differed significantly, with statistically significant difference ($p < 0.05$, according to a one-tailed t-test). This aligns with the observation that regardless of cultural and national differences, women generally speak and assess situations in more detail than men [86].

During phase I, the interviews focused on the proposed factors outlined in the conceptual framework (see Section 3), as well as the initial design of assessment tests for these factors using AHP method, more details presented in section 4.2. In phase II, the focus shifted to evaluating the methods within the same conceptual framework. While some interview questions were predetermined, others were open-ended, allowing the researcher to explore specific themes or responses further. Following each interview, the interviewer requested participants to review the recordings to verify their responses and perspectives. While four interviewees listened to the recordings, the others did not. Subsequently, the transcripts and summaries of the interviews were shared with the two participants who had not heard their responses. This measure aimed to prevent bias and ensure data validity. AHP comprises several steps to determine the priorities among a set of factors. First, a pairwise comparison should be made using the decision matrix to determine the importance of one factor over another. With the decision makers' and experts' help (the interviewees), the decision matrix is constructed by comparing each criterion in the row to the criteria in the column using the proposed comparison scale. Next, the results are normalized. Subsequently, eigenvectors are calculated, along with the Consistency Index (CI) based on the eigenvalue. Finally, the Consistency Ratio (CR) is computed to validate the consistency of the comparisons. These steps are elaborated upon in detail in the following subsections.

Table 5. The table presents the code for each factor, making it easier to reference the names of the factors.

Factors	Codes
Information Quality	C_1
Ease of Use	C_2
Efficiency	C_3
Effectivity	C_4
Learnability	C_5
Perceived Value	C_6
Aesthetic	C_7
Satisfaction	C_8
Trustworthiness	C_9
Image	C_{10}

3.2 Construction of Pairwise Comparison Matrix

For readability, each factor assigned a unique code as depicted in Table 5. The initial step in the AHP process was to build a pairwise comparison matrix for each suggested factor. Each factor *ci* in the row, where *i* represents the index for each factor, was compared to the factors in the column using the comparison scale, as presented in [88]. Results of the comparison were described in terms of integer values from 1 to 9, where a higher number indicated that the chosen factor was deemed more important than the factor it was being compared to.

Table 6. This table shows the mean of eight comparison matrices, each filled by a different interviewee.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	**Total**
C_1	1.00	0.69	2.00	0.27	1.00	0.24	3.91	0.34	0.69	4.31	**14.47**
C_2	1.44	1.00	2.15	0.41	5.48	0.79	4.24	1.44	2.88	4.31	**24.15**
C_3	0.50	0.25	1.00	0.25	0.33	0.33	4.00	0.22	0.32	0.41	**7.62**

C_4	3.66	2.21	4.00	1.00	3.91	1.19	4.22	2.45	4.31	3.91	**30.87**
C_5	1.00	0.18	3.00	0.26	1.00	0.22	2.45	0.50	0.25	4.73	**13.59**
C_6	4.16	1.44	3.00	0.79	4.64	1.00	5.48	1.00	2.45	4.47	**28.44**
C_7	0.26	0.24	0.25	0.24	0.38	0.18	1.00	0.14	0.26	3.00	**5.94**
C_8	2.91	0.69	4.64	0.79	2.00	1.00	6.96	1.00	1.64	5.23	**26.88**
C_o	1.44	0.35	3.11	0.23	3.94	0.41	4.16	0.27	1.00	3.46	**18.37**
C_{10}	0.23	0.23	2.45	0.26	0.22	0.23	0.33	0.19	0.29	1.00	**5.43**
Total	**16.61**	**7.29**	**25.60**	**4.50**	**22.90**	**5.59**	**36.76**	**7.56**	**14.09**	**34.84**	

This study conducted eight comparison matrices, with each matrix filled by one interviewee. Since the objective was to obtain a collective judgment of the group rather than individual prioritizations, we required an aggregate individual judgment rather than aggregated individual priority. Consequently, a consolidated matrix was constructed by calculating the geometric mean of the eight matrices using equation (1). The results are shown in Table 6.

$$c_{ij=}\sqrt[n]{a1_{11}.a2_{11}.a3_{11}\dots an_{ij}} \quad (1)$$

where n is the number of interviewees, a represents the factor values for each matrix, i represents the index of the row, and j represents the column index.

Normalization is essential in the context of the AHP method because it ensures that the values within the matrix are on a consistent scale, making them comparable and facilitating the calculation of priorities or weights for each factor. To normalize the results, we use column-wise normalization in which each value in the column was divided by the sum of its column and then the total of each column must be equal to *1.00*. This can be calculated by the following equation:

$$\grave{\chi}_{ij} = \frac{\chi_{ij}}{\sum_i \chi_{ij}} \quad (2)$$

Where χ_{ij} is the value in row i and column j showed in Table 6 and $\sum_i \chi_{ij}$ is the total of each column of Table 6. Table 7 shows the matrix after normalization besides the weights/average/priority vector (also called Eigen vector) were derived by computing the average of each row.

3.3 Calculation of Consistency Ratio (*CR*)

Since the comparisons rely on personal judgments, some inconsistency may arise [89]. To ensure consistency in these judgments, a final step known as consistency verification is performed,

Table 7. The table illustrates the normalization of the consolidated matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	**Total**	**Weights/Average**
C_1	0.06	0.10	0.08	0.06	0.04	0.04	0.11	0.05	0.05	0.12	**0.71**	**0.07**
C_2	0.09	0.14	0.08	0.09	0.24	0.14	0.12	0.19	0.20	0.12	**1.41**	**0.14**
C_3	0.03	0.03	0.04	0.06	0.01	0.06	0.11	0.03	0.02	0.01	**0.41**	**0.04**
C_4	0.22	0.30	0.16	0.22	0.17	0.21	0.11	0.32	0.31	0.11	**2.14**	**0.21**

C_5	0.06	0.03	0.12	0.06	0.04	0.04	0.07	0.07	0.02	0.14	**0.63**	**0.06**
C_6	0.25	0.20	0.12	0.18	0.20	0.18	0.15	0.13	0.17	0.13	**1.71**	**0.17**
C_7	0.02	0.03	0.01	0.05	0.02	0.03	0.03	0.02	0.02	0.09	**0.31**	**0.03**
C_8	0.18	0.10	0.18	0.18	0.09	0.18	0.19	0.13	0.12	0.15	**1.48**	**0.15**
C_o	0.09	0.05	0.12	0.05	0.17	0.07	0.11	0.04	0.07	0.10	**0.87**	**0.09**
C_{10}	0.01	0.03	0.10	0.06	0.01	0.04	0.01	0.02	0.02	0.03	**0.33**	**0.03**
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**		**1.00**

Which is one of the key advantages of the AHP. This step measures the consistency of the pairwise comparisons by calculating the consistency ratio (CR). The CR is determined by comparing the consistency index (CI) to the random index (RI) for matrices of the same order. To calculate the consistency ratio (CR), first calculate principal eigenvalue (λ_{max}), which obtained in multiple steps, First step, multiply the right of judgement matrix (Table 6) by the priority vector or eigenvector (weight). Second step, dividing all the elements of the new vector by their respective priority vector element obtaining a new vector $\boldsymbol{\lambda_n}$ **,** results presented in Table 9. First and second steps are done by the following equation:

$$\lambda_n = \sum_{k=1}^{n} c_{ik}.w_{kj} \,/w_{ij}$$

Where n represents the number of the factors, c_i represents the value of each row in Table 6 and w_j represents the weight of each column in Table 7. The third step is to measure λ_{max} which results by taking the average of all $\boldsymbol{\lambda_n}$ as indicated in following equation:

$$\lambda_{max} = \frac{\sum_{k=1}^{n} \lambda_k}{n}$$

Table 8 presents values of λ_n and λ_{max} **.** Finally, we calculate CR by the following formula:

$$CR = \frac{CI}{RI}$$

Where *RI* is the Random Inconsistency Index the *RI* for *n = 10* is *1.49* , as presented in [90] and *CI* can be calculated as:

$$CI = \frac{(\lambda_{max} - n)}{n - 1}$$

$$CI = \frac{(11.17 - 10)}{10 - 1} = 0.13$$

$$CR = \frac{0.13}{1.49} = 0.09$$

Table 8. The table shows λ_n for n factors and presents λ_{max}.

Factors	Consistency Measure $= \lambda_n$
C_1	11.17
C_2	11.58
C_3	10.87
C_4	11.18
C_5	11.18
C_6	11.32
C_7	11.03
C_8	11.06
C_0	11.64
C_{10}	10.63
λ_{max}	**11.17**

Since *CR* is 0.09 ≤ 0.1, the pairwise comparisons are consistent within the acceptable level recommended by Saaty and Vargas [88] . This indicates that the obtained results are valid and reliable.

In this study, multiple validation methods were applied to AHP. Initially, assessments were obtained from designated participants recognized as UX experts (interviewees). Subsequently, evaluations were conducted collectively by a group rather than individuals, aiming to attain consensus. Finally, validation was confirmed through *CR* value, where a value of ≤ 0.1 indicated acceptable consistency. Conversely, if the *CR* value exceeded *0.1*, it signaled a requirement for a reassessment of subjective judgments.

4. Results and Discussion

The inductive approach was adopted in this research due to its flexibility and alignment with the research objectives. The inductive analysis method aims to formulate a theory or model that elucidates the fundamental framework of experiences or processes discernible within the textual data [91]. This method involves interpreting the interviewees' opinions and thoughts to highlight important aspects and critical points within their accounts [92].

Earlier sections detailed the assessment procedure for the proposed framework, which includes two separate rounds of interviews, each with specific objectives. The initial round concentrated on updating and prioritizing factors through the AHP technique. The subsequent round assessed the proposed methods within the framework, finalized factors, and recommended evaluation methods. In this section we present the results of the interviews, followed by a detailed discussion and analysis.

4.1 First Round of Interviews (Proposed Factors)

The eight interviews in the first round discussed the suggested service quality factors, each lasting between 20 and 50 minutes (see Table 4). The interviewees provided several valuable insights and comments on the proposed framework. Subsequently, a priority assessment test for the factors was conducted using the AHP tool, based on the experts' perspectives. This test was repeated to integrate additional factors suggested by the experts during their interviews.

As the main goal of the interviews was to examine the proposed factors, the first question, following an initial discussion of the factors (including their meaning, importance, and related topics), concerned the possibility of adding other important factors to the framework. The interviewees' responses varied: 25% agreed that the framework covers all the important factors, while 75% disagreed, highlighting the importance of other factors such as “user’s goal and behavior”. By "user goal" factor, they referred to understanding the user's objective in using the service, such as creating a new account in Tawakkalna[6] or scheduling the second dose of the COVID-19 vaccine. Additionally, they suggested incorporating “user age and technological maturity” factor (user generation) into the

[6] https://ta.sdaia.gov.sa/index-en.html

framework. These factors significantly impact user experience, as user age often influences the suitability of proposed solutions. E-government services target all citizens and non-citizens, making it challenging to design a one-size-fits-all solution. Therefore, the interviewees recommended creating different service designs for the same service to ensure accessibility and usability for all segments of the population.

In addition, 50% of the interviewees highlighted the importance of the "help and documentation" factor, emphasizing that users need guidance and support for new services. Moreover, “accessibility” was another critical factor mentioned, as users with disabilities should have easy access to the provided services. They expressed that even though some of the factors may overlap, by clarifying the meaning of each factor, it becomes evident that all mentioned factors are essential, especially in the field of e-government in Saudi Arabia.

All interviewees mentioned the challenges they face with Saudi government services. When stakeholders decide to convert paper-based (manual) services to electronic services (digital transformation), they often do not consider the user. They believe the primary goal is to make the services work and be usable, but this approach is flawed. Any electronic service must be user-friendly, as the primary purpose of converting the service to an electronic format is to save users' time and effort. The second challenge is that when a new service is launched, it is not tested by real users (citizens). Instead, it is tested by the workers within the same government department, which does not yield reliable results. Additionally, they suggested renaming the "Image" factor to "Branding and Identity" to make it more meaningful to the reader in Saudi Arabia.

4.2 Second Round of Interviews (Evaluation Methods)

In the first round, the researcher led a deep discussion about the proposed factors. In the second round, the interviewees were asked for their opinions on the suggested categories of evaluation methods (self-reported, observation, and physiologic), each lasted between 30 to 55 minutes. 62.5% of the interviewees emphasized that these categories are appropriate and explain the different evaluation methods well. They noted that self-reported, observation, and physiologic categories are all available and used in Saudi government. However, 37.5% of the interviewees agreed but highlighted that the physiologic category is rarely utilized due to its high cost.

When asked about the evaluation methods in each category, 37.5% of the interviewees indicated the methods were sufficient and represented their types well. However, 62.5% suggested adding more methods under performance evaluation, such as task flow, heat maps, or user behavior analysis. Additionally, they emphasized that some methods in the observation category are expensive and difficult to use. Furthermore, all interviewees (100%) agreed that the term "physiologic" is misleading and suggested replacing it with "biological" to make it more understandable for readers.

The experts were then asked about their familiarity with the proposed methods, specifically which category was the most well-known and which evaluation method was most widely used in the UX field in the Saudi e-government context. 100% of the interviewees stated that the best-known category is self-reported methods. However, 37.5% thought that the most used method is questionnaires, while 62.5% believed that no single method could evaluate UX comprehensively. They noted that experts in this field do not use just one method to evaluate all UX aspects for every system, or service. The evaluation process is complex and must consider various factors, such as the evaluation objectives, budget, and timeframe. Therefore, mixed methods are typically used to evaluate services, or systems. For example, questionnaires might be used to evaluate satisfaction, and session recordings to assess learnability. This is in line with previous research that evaluators mostly use mixed methods, and interviews are one of UX evaluation tools used to gather more information on UX aspects that are hard to measure due to their subjective nature, in addition to clarifying user behavior in specific contexts [61].

4.3 Discussions

This research ensured validity through multiple methods, namely triangulation and transferability. Triangulation involves using distinct methods, such as various data sources within a design [93]. Therefore, data was collected from multiple sources, including interviews, documents, and scholarly articles. Moreover, the triangulation of multiple research instruments helps avoid bias. On the other hand, the transferability method contributed to achieving external validity by presenting the findings during the interviews to a group of UX specialists from different nationalities. These specialists (in the first round of interview) confirmed that the proposed framework could be applied outside Saudi Arabia and could be useful in other contexts. According to

Golafshani [94] validity is sufficient to establish reliability in qualitative research, where reliability is a consequence of validity; thus, reliability is achieved when validity is proven [94].

Four factors were suggested in the first round of interviews: user need, digital generation, help and documentation, and accessibility. The first step to designing a government service is to study the user segment. Understanding who will use a service and what they need from it is essential for building satisfactory services. Considering user needs aligns with findings from previous studies that emphasize the importance of understanding these needs. These studies highlighted the differences between the traditional TAM, which focuses on usability assessment, and UX approaches, which integrate a wide range of factors to address users' needs, desires, and emotional experiences [98].The digital generation concept classifies individuals into distinct categories according to their age. Incorporating this concept aligns with multiple studies indicating that these defined age groups exhibit different behaviors in adopting and using e-services [95]. Given that e-

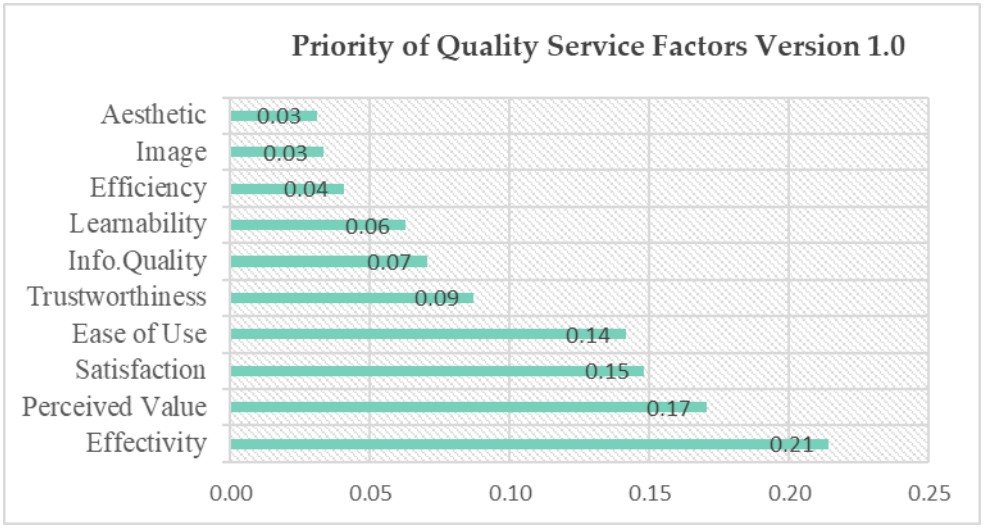

Figure 2. The figure displays the prioritized the proposed service quality factors.

government services are aimed at the entire population, including citizens and non-citizens of all ages, designers of e-services encounter the challenge of meeting the diverse needs of various generations. Age plays a crucial role in influencing the UX in e-government services, making it essential for designers and developers to consider this factor. As underscored in previous research, this is particularly important as individual factors such as demographics and age group can influence users' perceptions of usefulness and ease of use [74], which aligns closely with the findings in this research.

As a factor in the proposed framework, incorporating help and documentation is supported by prior research and practical applications. For example, Harsh Gorasia[7] noted that companies globally dedicate substantial resources to creating user manuals and documentation, for their users. Inexperienced users require assistance to navigate their usage, and even expert users may need support with updates and new features. Offering help and documentation remains essential even when services are well-designed for ease of use. The Nielsen Norman Group[8] proposes a variety of methods for help and documentation, offering valuable resources for designers and developers.

Accessibility, or making information accessible to users with disabilities, is significant for legal and ethical reasons [74]. The inclusion of accessibility as a factor in the framework is supported by prior research, which

[8] The Nielsen Norman Group claims that since 1998, it has been a leading voice in the user experience field, conducting groundbreaking research, evaluating interfaces of all shapes and sizes, and guiding critical design decisions to improve the bottom line.

emphasized that e-government portals must employ engagement techniques that facilitate input from citizens and provide accessibility options for individuals with disabilities Sivaji, *et al.* [96]. In fact, according to the Authority of People with Disabilities, people with disabilities constitute an estimated 7.1% of Saudi Arabia's total population[9]. Therefore, it is crucial that a significant number of individuals with diverse disabilities are not excluded from e-government services. This underscores the imperative for governments to design services that are

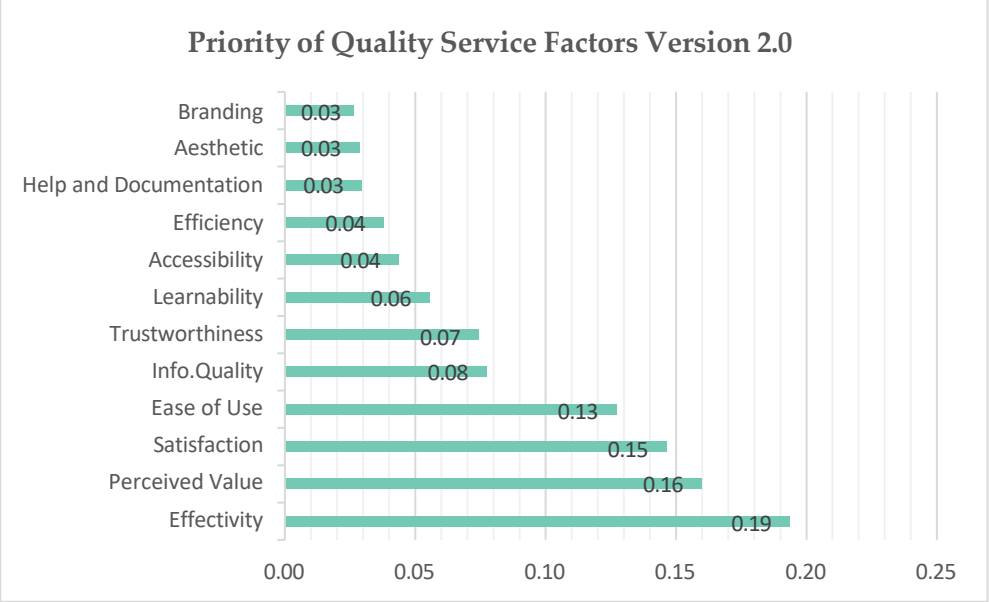

Figure 3. The figure displays the prioritized service quality factors after the experts added new factors.

inclusive of all users. Making e-government services accessible will improve user satisfaction and hence enhance UX. The accessibility factor is thus critical and should be included in UX evaluations.

Following the interviews, the framework was not reduced but expanded to include additional factors. Based on feedback from the interviewees, it was agreed that "user needs" and "digital generation" should be categorized under the "user category" rather than the "service quality category." Since this fall outside the scope of our study, we will not include them in the framework. However, the factors of "help and documentation" and "accessibility" were recommended for inclusion within the service quality category. This ensures that the study remains aligned with its central focus while acknowledging the importance and rationale of each factor as determined through the interview process. By including help and documentation, and accessibility, we aim to address a broader range of user interactions and expectations. This will enhance the framework's applicability and keep it in line with current and emerging user-centered design trends.

Additionally, each interviewee participated in an AHP test, where they expressed their personal judgments to prioritize the proposed service quality factors within the Saudi e-government context (See Table 3) based on their individual knowledge and experience. Figure 2 illustrates the service quality factors and their priority weights. “Effectivity” emerges with the highest weight at 21%, whereas “image” and “aesthetics” each received a score of 3%, jointly representing the lowest priority. “Perceived value” secured the second position with a score of 17%, followed by “ease of use” and “satisfaction”, which each scored 15% and were therefore ranked third and fourth respectively. The CR value of 0.09, as reported in Section 4, indicates that these AHP results are valid and reliable, given that the CR value is below the acceptable threshold of 0.1, demonstrating consistency in the pairwise comparisons used to derive these priority weights.

These results highlight the relative importance of various factors in service quality, with “effectivity” factor being paramount, indicating that users prioritize the effectiveness of the service in meeting their needs. The low scores for “image and “aesthetics” suggest that while visual appeal and brand perception are important, they are

[9] https://apd.gov.sa/en

considered less critical compared to functional aspects like “perceived value” and “ease of use”. The strong scores for “perceived value , “ease of use”, and “satisfaction” emphasize the importance of a service being not only functional but also user-friendly and fulfilling user expectations. Following the incorporation of new factors suggested by the experts during the interviews, the AHP test was conducted again, giving a better result, with a CR value of 0.06. Figure 3 depicts the prioritized factors with the addition of the new evaluation methods.

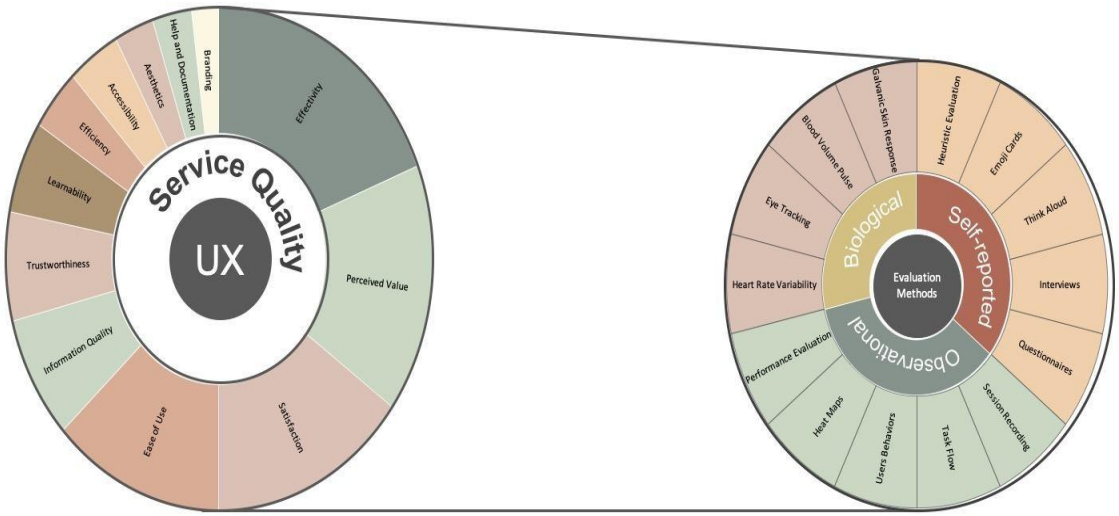

Figure 4. Updated framework including the factors and their corresponding

factors. As observed, the highest factor remains effectiveness, followed by perceived usefulness, while the lowest factors are aesthetic, branding and help and documentation. The improved CR value, being below the acceptable threshold of 0.1, indicates that the revised AHP results are even more consistent and reliable.

The addition of "help and documentation" ranks among the lowest alongside aesthetics and branding. This aligns with previous studies that have shown that while elements like visual appeal and branding can enhance user engagement, they are generally considered less critical compared to functional attributes (e.g. effectiveness and usefulness) [97]. This emphasises the idea that users place greater value on how well a service performs and its utility over its aesthetic appeal and brand image. Moreover, effectiveness and perceived usefulness remain pivotal in determining user satisfaction, which aligns with previous studies]98[. The inclusion and subsequent ranking of accessibility, prioritized higher than aesthetics, branding, and help and documentation, highlight the evolving focus on ensuring services are usable by a broader audience, including those with disabilities. Figure 4 shows the validated results for UX influencing factors in addition to the general categories of evaluation methods.

5. Conclusion

The research has built a comprehensive framework of factors that affect UX in the Saudi Arabian e-government context, including suggested methods to evaluate UX using these factors. Following a review of the relevant literature to identify the factors most strongly related to UX and Saudi e-government, these factors and the associated evaluation methods were incorporated into a framework, which was then tested by conducting interviews with experts in UX and e-services. The main contribution of this study is addressing a gap in the literature, as there has been little to no research that integrates factors with their evaluation methods into one consolidated and empirically validated framework for e-government in Saudi Arabia. The results indicate that the "effectiveness" factor, followed by "perceived value," are considered the most important factors in Saudi e-government. On the other hand, aesthetics, branding, and help and documentation are the lowest-ranked factors.

Alongside, this study and its results have significant and obvious implications for the Saudi Data and Artificial Intelligence Authority (SDAIA)[10], the Digital Government Authority, other government organizations, and those

[10] https://sdaia.gov.sa/ar/default.aspx

who are responsible for designing, developing, and evaluating these services. This research provides a practical checklist for the most essential UX factors for Saudi e-government services. In addition, by helping to determine the relative importance of the various factors, the outcome of the study provides ways to save designers time and effort. Finally, by identifying the most important methods used in UX evaluation, it offers guidance and help to e-service evaluators. These features have the potential to be very helpful for any current or future project related to e-government services.

Based on this study's findings, the following topics for future research are suggested. First, including proposed factors in a maturity model to enhance the development level of the provided services. Second, determining exactly when each factor should be evaluated (e.g. during the development cycle). Third, for the future the researchers suggested extending the framework to enable its use for different services or applications. Finally, establishing specific measures for each factor to facilitate the use of the framework during the evaluation process.

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