HCI Practices in Software-Development Environments in Saudi Arabia

Khalid Majrashi[1(✉)] and Areej Al-Wabil[2]

[1] Department of Information Technology, Institute of Public Administration, Riyadh, Saudi Arabia
majrashik@ipa.edu.sa

[2] Center for Complex Engineering Systems, KACST and Massachusetts Institute of Technology (MIT), Cambridge, USA
areej@mit.edu

Abstract. Within the human–computer interaction (HCI) community, there is a wide range of experience and approaches to integrating user research in the software-development life cycle. Independent HCI consulting and contracting is becoming a more prevalent mode of user research globally, but our understanding of the local context in some regions is limited. This paper reports the results of a survey of 65 practitioners working in software-development environments in Saudi Arabia. The survey was conducted in January 2018 and covered a range of aspects: profiles of respondents and their organizations, their perception of usability, user experience and user-centered design, assessment of current HCI activities, and motivation for and obstacles to adopting HCI practice in software-development environments. The results revealed recognition of HCI practices was greater than expected. The adoption of HCI practices in the industry and private sector was greater than in government organizations. The findings also suggested that the most-used HCI activities were prototyping and stakeholder meetings for requirements elicitation. The degree of importance of decision factors for adopting HCI practices and the frequency of obstacles to adoption of the practices varied slightly among government, private, and semi-government organizations. The study results also provided basic information for HCI practitioners and researchers who are interested in appropriating HCI methods to meet local needs. Here, we discuss the results and provide implications for advancing HCI practice in software-development environments in Saudi Arabia.

Keywords: Human–computer interaction · User experience · Usability
User-centered design · Saudi Arabia · Practice

1 Introduction

Interactive systems need to meet the users' needs, values, preferences, and expectations to be accepted. A number of human–computer interaction (HCI) fields have been growing steadily in the technology sectors, such as usability, user experience (UX), and user-centered design (UCD), which are concerned with how to design effective systems that are intended for human use. In the United States (US) and European countries, the

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role of UCD/usability became important in the 1980s and 1990s [1]. However, in many other countries where HCI has not been institutionalized, research suggests that HCI does not play a major role in the information technology (IT) industry and in the development life cycle [1, 2]. Although the topic of HCI in the Arab world has been explored in the academic context [3] and from a research and design perspective [4], HCI practices in professional domains have been inadequately explored in scientific and practitioner forums and infrequently discussed in the literature.

Saudi Arabia has a fast-developing information communication and technology (ICT) sector. Currently, it represents one of the largest telecom and IT markets in the Middle East. According to the Saudi Arabian Communications and Information Technology Commission (CITC), in 2016, spending on this sector reached around US $35 billion, with a growth rate of about 8.3% over 2015 as a result of digital-transformation initiatives adopted by several organizations across the country [5]. Digital services are rapidly growing due to the increase in Internet penetration rates and mobile phone usage. In Saudi Arabia, around 24.1 million people were using the Internet by the end of the second quarter of 2017, representing 76% of the total population, compared with 54.1% in 2012 [6]. There are also 43.63 million mobile phone subscribers, with a penetration rate of 137% [6]. As part of its National Transformation Program, the government has also been improving the IT industry to increase its contribution to the non-oil gross domestic product (GDP) [7].

In 2003, there were 1,650 IT companies in Saudi Arabia, including homegrown businesses, local subsidiaries, and multinationals; however, it is believed that the number of IT companies has increased substantially [8]. In 2003, only a few local IT companies were involved in system development [8], which might be due to organizations and individuals preferring offshore/outsourcing solutions. Currently, there are some signs that organizations have already moved from total reliance on outsourcing to being providers of some solutions and services. This could be due to businesses in Saudi Arabia preferring IT services customized to their local requirements, and this would be achieved by entities located inside the country [8]. In-house development of technology solutions has also been observed in public and private organizations. This could explain why "software developer" is currently one of the most common IT jobs, with the expectation of continued high demand for this specialty [9]. However, with these growth indicators of the software industry, it is still unclear if the human-centered approach is contributing to software product development in Saudi Arabia, as well as whether HCI practices are strengthening the capability of software-development entities to provide competitive solutions to the local, regional, and global markets.

In the public sector, the Yesser e-Government Program was founded in 2005 to support establishing, developing, and managing e-government services in Saudi Arabia [10]. Recent research has highlighted the contributions of the Yesser program toward raising awareness of usability as an important factor for e-government services, and encouraging the development of better and more usable government services [11]. However, the scarcity of HCI research in the local context makes it difficult to understand whether usability practices are taken seriously and applied in software-development environments in the public sector.

Saudi Arabia is one of the countries in which HCI education has been getting increasing attention in the recent years. In Saudi higher education, HCI courses are

offered at many universities. We conducted an informal analysis of a set of IT programs offered in the top 10 Saudi universities [12]. These programs included bachelor and master programs in computer science, software engineering, IT, and information systems. We found that 90% of the universities considered including at least one HCI course in their study plan. The different titles used for the courses included "Human-Computer Interaction," "User-Centered System Design," and "Human-Centered Design and Evaluation." However, not all IT programs seemed to have HCI courses as core courses in their study plans. It is still unclear if there are trends in increased adoption of usability/UX/UCD practices in software-development environments, or indicators of a growing culture of user-centric design methodologies aligned with contributions by IT graduates from the local academic programs.

This paper presents results from a survey of practitioners' perceptions of usability/UX/UCD, and current usability/UX/UCD practices, and decision factors in the adoption of usability/UX/UCD, and the obstacles that are hinder the adoption of usability/UX/UCD in software-development environments in Saudi Arabia.

2 Literature Review

2.1 Investigation of HCI Practice

Previous studies have been conducted to understand specific HCI practices in IT and software-development environments (e.g., Bak et al. [13], Bygstad et al. [14], Gunther et al. [15], Hudson [16], Hussein et al. [17], Ji and Yun [1], Rosenbaum et al. [18], Vredenburg et al. [19], Gulliksen et al. [20], Boivie et al. [21]). These studies had different foci and investigated different aspects, including the profile of HCI practitioners, UCD project profiles, the adoption and perception of specific HCI practices, the effectiveness of UCD/UX/usability methods, and obstacles to and decision factors in the adoption of UCD/UX/usability practices. Some of these prior studies investigated HCI practices in countries in which the field was established and strongly recognized in the software-development process (e.g., Vredenburg et al. [19]), while others inspected the practices in countries in which HCI was still playing a minor role (e.g., Ji and Yun [1]). However, to the best of our knowledge, none of these studies inspected HCI practices in Arab countries, where software-development environments may have different cultural and organizational standards, and societies have different cultural and local requirements of software products.

2.2 Perception of Usability and UCD

Practitioners' perceptions of HCI practices have also been investigated in prior works. Ji and Yun [1] found that both development and User Interface (UI)/usability practitioners generally recognize the importance of usability/UCD, but there is a higher degree of perception among UI/usability practitioners. Vredenburg et al. [19] found that a high percentage of the surveyed UCD practitioners agreed UCD methods had made a significant impact on product development, and improved the usefulness and usability of products developed in their company. Both Ji and Yun's [1] and

Vredenburg et al.'s [19] studies showed the perception that UCD methods are gaining popularity and they will be adopted widely in the future was rated highly by the surveyed UCD/usability practitioners. Similarly, respondents in a study that investigated the adoption of software-development methods and usability in the software industry in Norway believed usability was important for the success of projects in their company [14]. A recent study on current UX and usability practices in Malaysia also drew a similar conclusion, with many of the respondents agreeing that UX and usability are important; however, usability was perceived as more essential than UX [17].

Despite a growing body of literature on HCI design and UCD methodologies in research contexts in the Arab world, our understanding of the practitioners' perspective remains limited.

2.3 Usability and UCD Activities in Practice

Hudson [16] conducted a survey of professionals using HCI and usability e-mail lists. The respondents were asked to rate the frequencies within which a number of user-centered techniques, tools, and methods are employed in the practice. The study results indicated that the most commonly employed UCD techniques included informal usability testing, user analysis/profiling, evaluation of the existing system, low-fidelity prototyping, and expert (heuristic) usability evaluation. Another survey of 100 UCD practitioners about their successes and failures in implementing UCD in their organization confirmed Hudson's finding by showing that the most successful UCD techniques within different organization sizes included usability testing, prototyping, and heuristic evaluation [15]. Similarly, Vredenburg et al. [19] studied the most common UCD methods used in practice and identified iterative design, usability evaluation, task analysis, informal expert review, and field studies as the five most common UCD methods; four of these—iterative design, usability evaluation, task analysis, and field studies—were found to have the most significant impact in practice. The most recent study, conducted by Ji and Yun [1], investigated the frequencies of several UCD/usability techniques employed in projects in Korean IT-development environments. The results indicated that task analysis, evaluation of the existing system, user analysis/profiling, surveys, and heuristic evaluations to be the most commonly used methods.

Although there were some similarities in the findings of the reviewed studies (e.g., heuristic/expert evaluations appeared as used frequently in all studies), some differences still existed. For example, the most commonly used techniques were not always the same. This could be due to various factors such as differences in the profiles of surveyed practitioners and the IT-industry cultures in the different countries. As the studies were inconsistent, perhaps suggesting some differences according to country/culture, to better understand the HCI methods used in the development environments in Saudi Arabia, we sought to conduct a comprehensive survey.

2.4 Obstacles to and Problems with Adopting Usability and UCD

In the early 1990s, it was believed the UCD process was not often used in practice due organizational and technical factors [22], and usability engineering techniques were not employed because they were complex, time-consuming, and expensive [23]. In the

2000s, studies also identified a set of obstacles in the way of adopting UCD/UX practices. Rosenbaum et al. [18] surveyed 134 HCI professionals across three large HCI conferences to investigate organizational approaches and UCD/usability methods to increase the strategic impact of usability within companies. Their study highlighted a set of obstacles to strategic usability engineering/HCI. These obstacles included resource constraints, resistance to UCD/usability, lack of knowledge/understanding about usability, the unproven impact of work on usability, and lack of trained usability/HCI engineers. Ji and Yun [1] also identified a set of hindrances to UCD adoption, including lack of knowledge about usability/UCD, lack of practical usability/UCD methodologies, and concern about increase of development cost and time, and lack of trained usability/HCI engineers, confirming Rosenbaum et al.'s [18] findings. Gunther et al. [15] also showed that resistance to usability activities; unawareness of the value, methods, and processes of usability activities; and time constraints by management and development teams were frequent problems while engaging with development or management groups prior to usability activities. Similarly, Bak et al. [13] identified obstacles to the deployment of usability evaluation in software-development organizations, including the developers' mindset and the resource demands for conducting usability evaluation. Some of the reviewed obstacles (e.g., resource constraints) appeared in different studies; however, the findings were not always consistent and cannot be generalized as whole across different development environments. One aim of the study presented here was to identify the obstacles to adoption of user research (i.e., usability, UX, UCD methods and activities) that are prevalent in software-development environments in Saudi Arabia.

2.5 HCI Practices Outside the US and Europe

HCI practices face challenges across different countries, especially outside the US and Europe. Henry [2] discussed UCD practice in India and believed that HCI in the country is facing the same usability misconceptions that exist in some other parts of the world. However, he highlighted three main myths that he saw as responsible for the most damage to software development in India: "Pretty screens are all you need," "I can design on my own; just give me some guidelines," and "Usability is about testing." Ji and Yun [1] argued that Korea IT-development environments have also experienced similar misconceptions about usability, which led to resistance to adopting rigorous user research or considering UCD/usability studies in the design process.

In Saudi Arabia, the challenges are not clear. As such, the aim of this study was to uncover the challenges facing HCI practice to ensure better development in the field in the local context, with a view toward understanding how this can be generalized to the regional context.

3 Research Method

For the purpose of this study, we used a questionnaire consisting of 48 questions in six sections: respondent's profile, organization profile, perception of usability, UX and UCD; assessment of usability/UX/UCD practice; decision factors for adoption of

usability, UX and UCD; and obstacles to adoption of usability, UX, and UCD. The questions were mostly adapted from related work [1, 15, 16, 19]. Different question formats—such as Likert-type scales and multiple choice—were employed.

In the questionnaire, we provided definitions of "usability," "UX," and "UCD," as shown following, to eliminate possible variances in interpreting these terms:

- Usability is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" [24].
- UX is "a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service" [25].
- UCD is "a highly structured and comprehensive development methodology that takes account of user needs, limitations, and preferences for improving usability into the total user experience" (a definition adopted and modified by Ji and Yun [1]).
- User experience design (UXD) is a *process* that involves techniques and activities to improve the user's experience of a product.
- Usability versus UX: "usability" is an attribute of the system, while "UX" is the user perception that results from multiple factors, including system usability [26, 27]
- UXD versus UCD: "UCD" is a method to achieve ease of use in systems [1], while "UXD" covers traditional usability attributes and emotional, affective, experiential, hedonic, and aesthetic variables [27, 28].

The invitation and questionnaire were distributed in Arabic and English to target a larger population and increase the response rate—around half of the professionals working in the ICT sector in the country are not Saudi nationals [9], so they may not understand Arabic. Around 29% of the respondents used the English version. The questionnaire (both Arabic and English versions) was pre-tested by two HCI researchers and revised based on their feedback, and was further checked by two UX local consultants. No issues were identified by any of the reviewers.

The difficulty of identifying organizations that engage in software-development processes for sampling is one of the most cited challenges in this kind of research [29]. Generally, all organizations in Saudi Arabia involved in software development were defined as the study population, and this included private and public organizations, whether they were professional or non-professional IT organizations. The targeted respondents were IT practitioners with roles in software-development environments in these organizations.

No effort was previously made in establishing a population of organizations that engaged in software development, or that of IT practitioners working in the development environments of these organizations. Hence, we targeted respondents using different channels. The research department at Yesser e-Government Program e-mailed our invitation and questionnaire to 250 IT departments in public organizations through an e-mail list. The invitation and questionnaire were also posted on social media to target more IT practitioners, especially in private organizations that did not provide an accessible mailing list. In the invitation, we highlighted that the required condition for participation was being an IT practitioner with a role in a software-development environment. This description seemed to be effective, as 65 of the total 68 responses were from individuals working at organizations that engage in software development.

The three responses from individuals who were not working at organizations that engage in software development were not included in the analysis.

Besides highlighting the anonymity of responses, to encourage responses, we did not ask respondents to identify the name of their organization, as individuals may have had some concerns about releasing specific information about their organizations. Of the responses, 46.15% were generated in response to the invitation sent via the e-mail list (response rate: 12%), while 53.84% were generated in response to the invitation posted on social media.

To identify if there was more than one response from the same organization, we checked respondents' e-mail addresses for those who used their organization's e-mail servers, and compared respondents' answers to specific questions in the organization profile section. Overall, we were confident that respondents could be from at least 64 different organizations. We also could determine that some of the large organizations, especially in the public sector, were represented in the sample based on the organization e-mail address provided voluntarily by some respondents.

4 Findings and Analysis

4.1 Respondent Profiles

Most respondents were within the age categories 30–39 years old (63.07%) and 21–29 years old (30.76%). Around 27% of the respondents were female. Eighty-seven practitioners were Saudi nationals. All participants selected Arabic as their mother language. Most of practitioners had a bachelor's (53.84%) or master's degree (36.92%). The educational majors of the practitioners were computer science (37), engineering (8), information systems (3), design (3), business (3), user experience (2), computer engineering (2), software engineering (2), information science (1), HCI (1), and other (3). The countries in which respondents received their higher education were Saudi Arabia (50), Western countries (13), and other (8). Eighteen respondents were HCI practitioners. The primary roles for respondents were project manager/leader (23), developer (10), information architect (7), HCI/UX/user researcher (4), usability/UX consultant (2), UX designer (2), usability analyst (1), UI designer (1), web designer (1), and other (14). Practitioner experience was equated with the number of years they had worked in the field; 22 respondents had 5–9 years' experience, 19 had 2–4 years' experience, 15 had 10 or more years' experience, and nine had less than two years' experience.

Table 1 shows the HCI practitioners' and other IT practitioners' knowledge in HCI practices and their engagement in HCI-related activities. In terms of the level of practitioners' knowledge in usability engineering, UXD, and UCD practices, most respondents indicated 4 or more on a seven-point scale ranging from 1, "very poor," to 7, "very good"—76.92%, 87.69%, and 81.53%, respectively. However, not surprisingly, the HCI practitioners' level of knowledge was higher than that of the other IT practitioners. The differences between the two samples were significant for usability engineering practices ($p < 0.05$), as well as for UXD practices ($p < 0.05$) but not significant for UCD practices ($p = 0.09$). In regards to the differences within HCI practices (usability vs. UXD vs. UCD), practitioners seemed to have more statistically

Table 1. Knowledge in and work time on usability, UX, and UCD

Statement	HCI practitioners (n = 18)				IT practitioners (n = 47)			
	M.	Med.	Mode	SD	M.	Med.	Mode	SD
Level of knowledge in usability engineering practice*	5.38	6	6	1.33	4.40	5	5	1.56
Level of knowledge in UX design practice*	5.50	6	6	1.29	4.72	5	5	1.34
Level of knowledge with UCD practice*	5.22	6	6	1.26	4.59	5	6	1.45
Percentage of work time spent on usability or UX activities over the past 12 months	55.00	50	50	29.55	27.31	23	40	21.63

**Rated on a seven-point scale, ranging from 1, "Very poor," to 7, "Very good."*

significant knowledge in UXD practices than UCD, which could be due to the recent global trend in considering UX in software design.

The HCI practitioners worked more on activities related to usability or UX over the past 12 months, and the *t*-test result showed a significant difference between the two samples ($p < 0.01$). However, most HCI practitioners spent only around half of their work time on HCI-related activities, which was less than the time spent on HCI-related activities by HCI practitioners surveyed in a related work [19].

In Table 1, the large standard-deviation (SD) scores for the percentage of work time spent on usability or UX activities could be explained by the variation observed in the sample (i.e., our respondents had different levels of engagement with HCI-related activities, and this could be an indication of the different HCI experiences of our respondents). In this paper, the medians (med.) and modes are sometimes reported beside the means (m.), as in Table 1, as they could help with interpreting the results in a more meaningful way.

In general, the results showed a good understanding of HCI practices and an acceptable degree of engagement with HCI-related activities among many of the HCI and IT practitioners. Hence, their assessment of the usability, UX, and UCD practices in their organizations could be considered.

4.2 Organization Profiles

The survey respondents' organization profiles are shown in Table 2. The diversity in the profiles (e.g., type and category) could be considered as a representation of the broad range of organizations in the country. As shown in Table 2, the organizations used different software-development methods, mostly agile, followed by others developed within the organizations and waterfall.

The results also indicated that most of the software projects conducted in the organizations were internal projects or projects for clients. This confirmed the shift to in-house development within public and private organizations from the large reliance on outsourcing solutions and adaptation of commercial software reported by the CITC

Table 2. Organization profiles*

Type	Government (35), private (19), semi-government (11)
Size	Large: 250 + employees (46), medium: 50–249 (8), small: 10–49 (7), micro: 1–9 (4)
Location	Riyadh (36), other (29)
Category	Education/Training (17), computer/software (12), health/medicine (6), Internet/e-commerce (4), usability/UX (3), finance (3), military (2), other (18)
Development methodology	Agile (26), own method (15), waterfall (14), rapid application development (12), extreme programming (8), rational unified process (4), other (1)
Project types	Internal development (50), development for a client (33), adaptation of commercial software (14)
Product types	Web applications (54), websites (45), mobile applications (44), desktop applications (18), tablet applications (11)

**Numbers in brackets refer to the number of organizations associated with each specific profile.*

[8]. The results further showed different types of products were developed in the organizations, with web applications, websites, and mobile applications dominant.

Half of the HCI practitioners (nine out of 18) worked for private organizations, and the others worked for government and semi-government organizations. This result might indicate that organizations in both public and private sectors have started to recognize the importance of HCI practices.

At the HCI industry level, only three of the HCI practitioners worked at specialized usability/UX companies, suggesting that firms that are specialized in or consult on HCI have a limited presence in the country. In fact, the scarcity of specialized user-research firms—even though a growing trend is slowly emerging—is being observed at a regional context in the Arab world and the local observation is well aligned with this regional context.

4.3 Perception of Usability and UX

Our results on perception of usability and UX suggested that both HCI and IT practitioners recognize the importance of usability and UX (see Table 3). There were no statistically significant results for the degree of perception of usability and UX among HCI and IT practitioners except for one indictor. The degree of agreement with the statement that "UX design practice will have a significant positive impact on software product development within the next five years" was higher among HCI practitioners, and this was statistically significant ($p < 0.05$).

We also analyzed the perception of usability and UX among practitioners working in government (n = 35), private (n = 19), and semi-government (n = 11) organizations. We found that practitioners in private and semi-government organizations mostly recognized the importance of usability and UX in higher degrees compared with practitioners at government organizations, with some statistically significant differences in the results.

Table 3. Perception of usability and UX

Statement	HCI practitioners (n = 18)			IT practitioners (n = 47)			Statistical difference		
	M.	Mode	SD	M.	Mode	SD	*t*	*df*	*p*
Capability in usability is very important in strengthening the competitiveness	5.8	7	1.33	5.7	7	1.41	0.17	33	0.85
Adoption of more user experience activities and techniques to the current software-development methods is necessary	6.11	7	1.40	5.78	6	1.28	0.84	28	0.40
Methodology for improving user experience is required	5.88	6	1.13	6.06	7	1.11	–0.56	30	0.56
Methodology for improving usability is required	6	7	1.02	6.06	7	1.16	–0.21	35	0.83
Client requirement for user experience has increased in Saudi Arabia	5.61	6	0.92	5.34	7	1.50	0.84	47	0.39
Client requirement for usability has increased in Saudi Arabia	5.27	6	0.75	5.19	7	1.46	0.31	58	0.75
User experience design practice will have a significant positive impact on software product development within the next five years	6.55	7	0.70	6.02	7	1.35	2.06	57	0.04
User experience design activities, techniques, and tools will be adopted widely in software-development within the next five years	5.88	6	1.02	5.44	6	1.33	1.42	40	0.16

Statements were rated on a seven-point scale ranging from 1, "Strongly disagree," to 7, "Strongly agree."

4.4 Practice of Usability, UX, and UCD

The results for overall assessment of HCI practices in software product development indicate that usability, UX, and UCD activities and methods had an average rate of employment in software product development (see Table 4). The degree of employment of UCD methods in organizations in Saudi Arabia seemed to be similar to that found by Vredenburg et al.'s 2002 study, which involved participants working primarily in the US and Europe [19].

Generally, HCI practitioners indicated that HCI activities and methods were applied in product development more than IT practitioners (see Table 4). This could be because the HCI practitioners who participated in our study were employed in organizations that already recognized the importance of HCI, resulting in the adoption of more user-centric activities and methods in the software-development life cycle.

Table 4. Overall assessment of usability, UX, and UCD practices

Statement	HCI practitioners (n = 18)			IT practitioners (n = 47)			Statistical differences		
	M.	Mode	SD	M.	Mode	SD	*t*	*df*	*p*
User experience design activities and techniques are widely used in software product development	5.27	6	1.48	4.44	5	1.48	2.01	31	0.05
Usability evaluation methods are widely used in software product development	5.00	5	1.32	4.55	6	1.62	1.13	38	0.26
Usability requirements are often considered in software product development	5.33	6	1.41	4.57	5	1.58	1.87	34	0.06
User-centered design methods are widely used in software product development	5.55	6	0.98	4.53	5	1.63	3.07	51	0.003

Statements were rated on a seven-point scale ranging from 1, "Strongly disagree," to 7, "Strongly agree."

The results also show that the employment of usability, UX, and UCD methods at private and semi-government organizations was higher than at government organizations. For example, responses to the statement "UCD methods are used widely in software product development" were higher among practitioners at private organizations than practitioners at government organizations. The difference between the two groups was statistically significant ($p < 0.05$).

Participants were asked to select the HCI activities/methods used in software-development environments in their organizations from a list of 46 usability, UX, and UCD activities. Definitions of these activities, which were mostly adopted from the literature (e.g., Hudson [16]), were provided to the participants. Participants also had the option of indicating activities not listed in the questionnaire. Table 5 shows the activities and their frequency of use as indicated by HCI and IT practitioners. Respondents from the HCI practitioners' group reported prototyping as the most frequently used method, whereas IT practitioners reported stakeholder meetings as the most common user-research method.

There were different sources of usability, UX, and UCD activities performed in software development. The most employed source mentioned by participants was internal personnel (76.92%), followed by a domestic company (20%), a foreign company (15.38%), a consultant (9.23%), and an academy (7.69%).

Participants who had been involved in activities related to HCI in software-development projects were asked to rate the effectiveness of the usability, UX, and UCD methods. Around 85% of respondents answered the effectiveness-related questions, which can be a good indication of the use of HCI methods in software-development environment. Practitioners mostly rated the methods as effective, in terms of three indictors:

Table 5. Usability, UX, and UCD activities/methods used in software-development environments as indicated by HCI and IT practitioners

No.	Method	Frequency		No.	Method	Frequency	
		HCI prac.	IT prac.			HCI prac.	IT prac.
1	Stakeholder meetings	10	35	24	Metrics analysis	2	8
2	User analysis/profiling	12	26	25	Storyboards	4	5
3	Personas	10	12	26	Brainstorming	9	22
4	Task identification	5	26	27	Sketching	9	20
5	Task analysis	6	22	28	Wire frames	7	9
6	Set usability requirements	6	13	29	Remote usability/UX evaluation	3	4
7	Contextual analysis	2	5	30	Mood boards	1	3
8	Scenarios of use	8	27	31	Pattern libraries	2	2
9	Prototyping	15	34	32	Affinity diagrams	3	2
10	Visual interface design	10	27	33	Accessibility analysis	1	3
11	Navigation design	5	13	34	A/B testing	5	6
12	Heuristic evaluation/Expert evaluation	2	5	35	Service blueprints	3	4
13	Informal usability testing	3	12	36	Consumer journey maps	4	7
14	Formal (e.g., quantitative) usability testing	4	5	37	Ecosystem maps	1	4
15	Usability checklists	3	6	38	Empathy maps	3	2
16	Quantitative survey	2	8	39	Experience maps	4	4
17	Focus groups	3	11	40	Competitive analysis	3	4
18	User interviews	8	25	41	Key performance indicators	3	13
19	Participatory design	2	6	42	Inter-usability testing	0	5
20	Field studies (outside a lab)	5	5	43	User flow	6	11
21	Cognitive walkthrough	3	4	44	Content audits	2	14
22	Card sorting	4	4	45	Sitemaps	4	15
23	Eye tracking	3	6	46	Features roadmaps	3	6

"made a significant positive impact on product development," "improved the usability," and "improved the UX" of the product developed (see Table 6). Generally, HCI practitioners gave the methods higher effectiveness ratings than IT practitioners, with the difference statistically significant for the "improved the UX" indicator.

Table 6. Effectiveness of usability, UX, and UCD methods as indicated by HCI and IT practitioners

Statement	HCI practitioners (n = 18)			IT practitioners (n = 47)			Statistical differences		
	M.	Mode	SD	M.	Mode	SD	*t*	*df*	*p*
Usability/User experience/ User-centered design methods have made a significant positive impact on product development	6.05	7	1.16	5.60	6	1.12	1.38	54	0.17
Usability/user experience/ user-centered design methods have improved the usability of the product developed	5.94	7	1.10	5.50	6	1.10	1.40	54	0.16
Usability/user experience/ user-centered design methods have improved the user experience of the product developed	6.16	7	0.92	5.47	6	1.10	2.29	54	0.02

Statements were rated on a seven-point scale ranging from 1, "Strongly disagree," to 7, "Strongly agree."

4.5 Decision Factors in Adoption of UX/UCD

Participants were asked to rate the importance of seven decision factors in the adoption of usability/UX/UCD practices on a seven-point scale. We analyzed the responses from practitioners working at government, private, and semi-government organizations (see Table 7). Based on the analysis, all seven factors seemed to be important to the adoption of HCI practices. "Improvement in client satisfaction," "improvement in user satisfaction," and "improvement in product usability/UX" were the three most important factors for government organizations. They were also highly important factors for private and semi-government organizations alongside the "impact on sales or profits" factor.

Table 7. Decision factors in adoption of usability/UX/UCD for three types of organizations

Statement	Government (n = 35)			Private (n = 19)			Semi-government (n = 11)		
	M.	Mode	SD	M.	Mode	SD	M.	Mode	SD
Improvement in client satisfaction	6.11	7	0.96	5.89	6	1.24	5.81	6	1.16
Improvement in user satisfaction	6.28	7	0.85	6.31	7	1.45	5.72	6	0.90
Improvement in product usability/UX	6.02	6	0.95	6.15	7	1.30	5.72	5	1.009
Impact on sales or profits	5.34	7	1.55	6.00	7	1.15	5.90	7	1.13
Savings in development time	5.02	7	1.75	5.89	7	1.24	5.27	4	1.19
Savings in development cost	5.02	7	1.70	5.68	5	1.10	5.09	4	1.30
Management support	5.68	6	1.23	5.52	6	1.12	5.72	6	1.42

Statements were rated on a seven-point scale from 1, "Not at all important," to 7, "Extremely important."

The results shown in Table 7 also indicate that "savings in development time" was more important for private organizations than government organizations, while "management support" was perceived as a more important factor for government and semi-government organizations than private organizations. "Saving in development cost" seemed more important for private organizations than government or semi-government organizations.

4.6 Obstacles to Adoption

Respondents were asked identify the obstacles to or problems in the adoption of usability, UX, and UCD activities in the software-development life cycle in their organizations. The obstacles to adoption of usability, UX, and UCD and the frequency with which these were selected are shown in Table 8.

Table 8. Obstacles to adoption of usability/UX/UCD activities in government, private, and semi-government organizations

Obstacle	Gov. (n = 35)	Private (n = 19)	Semi-gov. (n = 11)	Overall
Lack of understanding/knowledge about usability/user experience/ user-centered design	29 (82.85%)	8 (42.11%)	6 (54.55%)	48 (73.85%)
Lack of practical user experience design methodology	17 (48.57%)	5 (26.32%)	9 (81.82%)	29 (44.62%)
Concerns about updating current development environment or method	15 (42.85%)	9 (47.37%)	3 (27.27%)	25 (38.46%)
Concerns about increase of development cost	18 (51.42%)	13 (68.42%)	9 (81.82%)	38 (58.46%)
Concerns about increase of development time	16 (45.71%)	12 (63.16%)	8 (72.73%)	34 (52.31%)
Lack of trained human-computer interaction engineers or specialists	19 (54.28%)	10 (52.63%)	7 (63.64%)	34 (52.31%)
Lack of support from management	15 (42.85%)	9 (47.37%)	6 (54.55%)	28 (43.08%)

The results suggest there are many issues in the way of the adoption of HCI activities in software development in public and private organizations in Saudi Arabia. Lack of understanding or knowledge about usability, UX, or UCD, and the lack of trained HCI professionals or specialists were the most two mentioned obstacles in government organizations. Concerns about increases in development cost and time were the most significant barriers to adopting HCI methods for private organizations, as well as for the majority of semi-government organizations. Lack of practical user experience design methodology did not seem to be a significant obstacle for private organizations but was a major problem for many semi-government and government organizations.

5 Discussion and Implications

This study aimed to reveal the current status of HCI practices in software-development environments in Saudi Arabia as the first survey of its kind in the country, as well is in the Arab world, as far as we are aware. One of the key findings of this study is that practitioners' knowledge of HCI practices is higher than expected. The study also reveals important information about the most commonly used software-development methods (e.g., agile, internally developed methods, and waterfall), and the most developed product types (web applications, websites and mobile applications) in software-development environments. This information can be used by HCI researchers who are interested in appropriating and integrating HCI practices into software-development methods in local contexts. Additionally, the results suggest it would be beneficial to investigate further the methods developed internally within the organizations so as to determine ways to adapt HCI techniques and activities to suit these software-development methods. Based on the findings, the local HCI community could also promote HCI practices at the different organizations with an aligned focus on web and mobile usability and UX.

In the public sector, although the Yesser e-Government Program has promoted usability as an important factor for e-government services [11], as mentioned previously, our study results show that practitioners at government organizations value the importance of usability and UX to a lesser degree than practitioners at private and semi-government organizations. Additionally, our results identify lack of understanding or knowledge about usability, UX, or UCD as the most significant obstacle to adopting HCI practices in government organizations, and we found that the adoption of usability, UX, and UCD practices was higher in private and semi-government organizations than in government organizations. Hence, the findings of this study suggest that Yesser needs to continue raising awareness of and promoting HCI practices in government organizations. It also needs to encourage IT managers in government organizations to support the adoption of HCI practices. This is because "management support" was identified as an important decision factor for HCI-practice adoption in software-development environments in government organizations. Our findings also highlight the need for programs such as Yesser to consider shifting paradigms from influencing individuals to influencing projects and products by establishing HCI best practices and requirements for government IT projects. Moreover, our results underscore the importance of encouraging IT managers in government sectors to integrate HCI methods into the development process to institutionalize HCI practices in software-development environments in government sectors.

The lack of trained HCI professionals or specialists was also mentioned as an obstacle to the adoption of HCI practices by survey respondents of more than half of all organizations, and across all types of organizations in the sample. Hence, HCI training programs would need to be considered for practitioners. For developers, as Seffah [30] suggested, the educational programs could be provided in their language and cultural context to help them understand and master human-centered design. In addition, these results emphasize the need to consider adding core HCI courses to academic curricula in Saudi universities to the existing IT programs or to develop specialized or advanced

degree HCI programs to address the needs of technologists interested in HCI or UX design as a profession.

Concerns about increases in software-development cost and time were identified as main obstacles to the adoption of HCI practices across the different organization types, but mostly by private and semi-government organizations. This finding is aligned with the global context, as these two factors (cost and time) were also identified as obstacles to the adoption of HCI-related methods in related work [1, 19]. The cost–benefit trade-off also seemed to play a role in the adoption of usability, UX, and UCD methods (mostly in private and semi-government organizations), and this result is similar to findings by Vredenburg et al. [19]. Finally, lack of practical user experience design methodology was another problem in the way of HCI adoption in government and semi-government organizations. Together, these results suggest that the local HCI community should raise the awareness of the many low-cost and time-effective techniques (e.g., usability/UX heuristic evaluation) and practical HCI methods that can be used during software product development.

Table 9 is adapted from Ji and Lun [1] to show the top 10 usability, UX, and UCD methods identified in our study and other related work.

Table 9. Top 10 usability, UX, and UCD methods

Rank	Our study results	Ji and Yun [1]	Vredenburg et al. [19]	Hudson [16]
	Saudi Arabia	Korea	US and Europe	US and other countries
1	Prototyping	Task analysis	Iterative design	Informal usability testing
2	Stakeholder meetings	Evaluation of existing system	Usability evaluation	User analysis/profiling
3	User analysis/ profiling	User analysis/ profiling	Task analysis	Evaluation of existing system
4	Visual interface design	Surveys	Informal expert review	Low-fidelity prototyping
5	Scenarios of use	Heuristic/Expert evaluation	Field studies (contextual inquiry)	Expert (heuristic) usability evaluation
6	User interviews	Scenarios of use	Focus groups	Task identification
7	Task identification	Navigation design	Formal heuristic evaluation	Navigation design
8	Brainstorming	Usability checklists	Prototype without user testing	Scenarios of use
9	Sketching	Focus-group interviews	User interviews	Set usability requirements
10	Task analysis	Lab usability testing	Surveys	Visual interface design

In Table 9, seven of the top 10 methods used in the context of Saudi Arabia were identified within different contexts including the Korean IT-development environment [1], practitioners from US and Europe [19], and respondents from the US and 14 different countries [16]. However, an important observation from Table 9 is that evaluation methods such as usability testing and expert/heuristic evaluation were not among the top 10 methods used in the Saudi context. This suggests further investigation is needed of the reasons behind the limited use of HCI evaluation methods in the local context.

6 Advancing HCI in Software-Development Environments in Saudi Arabia

We highlight five elements that we believe should be considered in the way of advancing HCI in the software-development environments in Saudi Arabia (see Fig. 1). These elements were developed based on our results, discussion, and review of previous HCI development strategies in the IT industry (e.g., Smith et al. [31], Mayhew [32]). In practice, as Smith et al. [31] pointed out, all elements can occur in parallel; however, the main issue is ensuring there is enough feedback between the elements.

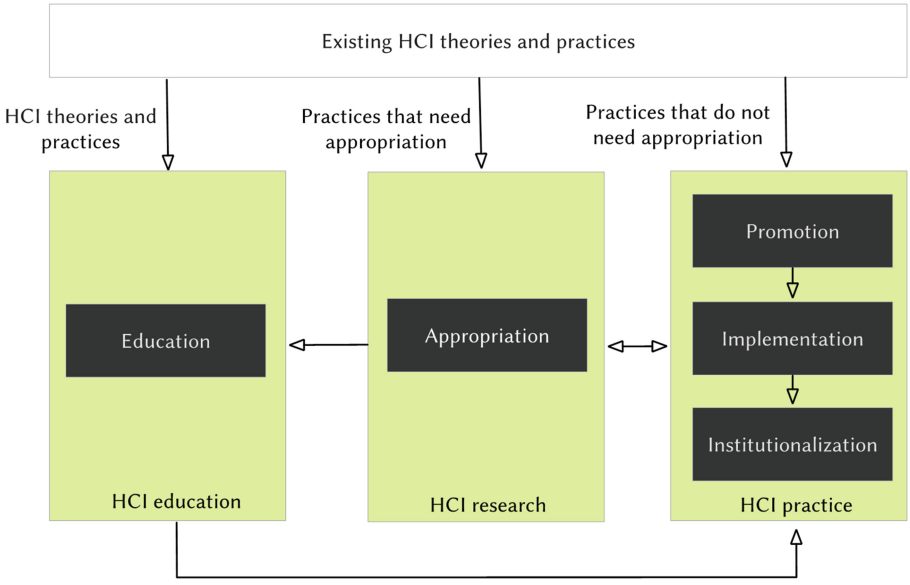

Fig. 1. Five elements in the development of HCI practices in Saudi Arabia

The five elements are explained in detail following:

- Education: a deep understanding of HCI will be the main player in adopting HCI in the development environment. This understanding will come only through formal education, which means the local HCI community should encourage educational institutions to take a major role in advancing HCI in the country.
- Appropriation: HCI methods developed in Western countries may not be appropriate to the local contexts (e.g., sociocultural and organizational structures) in Saudi Arabia, resulting in the need for localization of methods for local needs. Local HCI researchers should identify the local requirements and appropriate HCI methods to meet these requirements. Academics should consider efforts for appropriating HCI methods and embedding scientifically approved localized methods in HCI curricula.
- Promotion: the local HCI community should increase awareness of HCI practices, including of techniques that do not need appropriation and methods that have been adapted for local needs. Their task at this level is to influence the *individuals* (e.g., IT managers) at organizations that have not yet recognized the importance of HCI. In the public sector, the Yesser e-Government Program can play a role in increasing awareness of HCI practices.
- Implementation: the focus at this stage should be on influencing the *projects* at the organizations that have already recognized the importance of HCI by encouraging the use of HCI practices suitable to each specific project. At this stage, training programs should be provided if needed.
- Institutionalization: at this level, the focus should be on influencing the development *process* (e.g., by encouraging the integration of HCI practices with the standard development methodology in the organizations that have already seen the value of HCI practices in some projects). By this point, the local HCI community should have a good understanding of the local requirements, the methodologies used in development environments, and the organizations' cultures to enable it to provide insights into how HCI methods can be integrated into the organizations' development processes.

7 Conclusion

This paper has reported the results of a survey on usability, UX, and UCD practices in Saudi Arabia. Overall, the degree of awareness of HCI practices was found higher than anticipated. The results also show that the usage of HCI methods at private and semi-government organizations was more than at government organizations. Lack of understanding or knowledge about usability, UX, or UCD, and lack of trained HCI professionals or specialists were identified as the main obstacles to the adoption of HCI practices in government organizations, while concerns about an increase in development cost was the main obstacle to adoption in private and semi-government organizations. Most HCI methods used in software-development environments in Saudi Arabia were similar to those identified in previous surveys, but there seemed to be a limitation in the use of the HCI evaluation methods. Finally, five elements were

suggested to advance HCI practices in software-development environments in Saudi Arabia: education, appropriation, promotion, implementation, and institutionalization. Further work is still required to confirm the results of our study and to reveal any other problems and practices of HCI in IT-development environments in Saudi Arabia.

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