SYSTEM USABILITY EVALUATION OF THE HEALTHCARE INFORMATION SYSTEM IN SULTAN BIN ABDULAZIZ HUMANITARIAN CITY, RIYADH, SAUDI ARABIA

By **ABRAR YOUSEF ALMUZAINI**

A research project report submitted to the College of Public Health & Health Informatics, King Saud bin Abdulaziz University for Health Sciences.

In partial fulfillment of the requirements for the award of the Master of Health Informatics

King Saud Bin Abdulaziz University for Health Sciences

May 2024

Approval of Project Report

This is to certify that the research project report prepared by ABRAR YOUSEF ALMUZAINI titled "EVALUATION OF SYSTEM USABILITY OF THE HEALTHCARE INFORMATION SYSTEM AT SULTAN BIN ABDULAZIZ HUMANITARIAN CITY, RIYADH, SAUDI ARABIA" has been approved by his/her department as satisfactory completion of the research project report requirement for the degree of Master of Public Health in Health Informatics

(Name and signature)

Dr. Abdulwahhab Oqla Alshammari  June 4, 2024

Supervisor of the Research Project Date

(Name and signature)

Co-supervisor of the Research Project (optional) Date

(Name and signature)

Department Chair Date

(Name and signature)

Assistant Dean, Office of Research - CPHHI Date

(Name and signature)

Dean, CPHHI, KSAU-HS

ABSTRACT

Introduction: Health information systems (HISs) with poor design could be challenging and prone to issues. Analyzing the usability of a system allows the developer to identify and fix user problems. To the best of our knowledge, no published studies have assessed the usability of the healthcare information system (TrakCare 2022) in Sultan bin Abdulaziz Humanitarian City (SBAHC).
Objective: To measure the system acceptance of TrakCare 2022 among healthcare providers in SBAHC. The secondary objective is to identify areas for improvement.
Methods: The study used a mix of quantitative and qualitative methods to assess the usability of TrakCare 2022. The quantitative method was a cross-sectional study to evaluate the system's usability using the system usability scale (SUS), which was distributed online through WhatsApp and email. The qualitative method used semi-structured interviews to identify the advantages and challenges of the TrakCare 2022 system. All data were collected from healthcare providers in SBAHC.
Results: A total of 285 participants participated in the survey, with an average SUS of 53.7, which means marginal acceptability. There was a significant association between the average score and gender, age, specialty, and year of experience. However, in terms of acceptability level, a significant association was found only with users' specialties. According to the semi-structured interview, users found the following advantages of TrakCare 2022: easy to navigate and learn, easy to access to information, and saves time during documentation. The disadvantages were the absence of the search icon, information being located in a separate system, and slow performance and limited log-in. Users suggested adding direct communication between users and more ready-made templates to add value to the system.
Conclusion: Although the TrakCare 2022 system was found to have a SUS score that indicates marginal acceptability, important usability benefits, drawbacks, and suggestions were still noted. Insights into the literature on healthcare information system usability and optimization for improved user satisfaction could be gained by further investigating these usability concerns and putting user recommendations into practice.

Keywords: electronic health record, health information system evaluation, system usability, system usability scale, TrakCare

ACKNOWLEDGMENTS

I would like to express my sincere appreciation to Allah. I am also thankful to my university for giving me the priceless chance to pursue my education and follow my passion. I owe a debt of gratitude to my parents—the great aircraft engineer Yousef and the great teacher Huda. I would also like to thank my brothers and friends for their continuous encouragement and support during this educational endeavor.

My profound gratitude goes to the organization and all the participants who kindly gave their time for this research. Thank you to my supervisor, Dr. Abdulwahab, for his consistence support in my graduation project. Finally, I am grateful to my co-workers whose support and encouragement have been my consistent source of strength. I am thankful to everyone who contributed to my studies. Your contributions are invaluable.

TABLE OF CONTENTS

Table of Contents

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations

HIS = Health information system

IRB = Institutional review board

SBAHC = Sultan bin Abdulaziz Humanitarian City

SUS = System Usability Scale

1. Introduction & Literature Review

Health information systems (HISs) are currently used worldwide because they provide fast and easy access to crucial health information. However, a system with poor usability may be prone to errors and become problematic, resulting in low efficacy and efficiency [1,2]. In contrast, a user-friendly information system can increase productivity, efficiency, and users' acceptance, as well as decrease errors [3,4]. To recognize and address these issues, it is strongly advised to analyze the usability of the system, as it is one of the primary causes of deficiencies [2,4,5]. Usability can be determined through user interactions with the system [6,7]. The literature contains a variety of methods for evaluating the usability of a system through user involvement, such as surveys, user testing, system logs, and interviews [1,8]. However, using a variety of methodologies for evaluating HIS usability is preferable [9].

Conducting a usability analysis allows developers to identify and fix user problems, thus saving money by updating the system instead of implementing a new one [10,11]. To the best of our knowledge, the usability of the healthcare information system in Sultan bin Abdulaziz Humanitarian City (SBAHC) has not yet been assessed. SBAHC is a non-profit rehabilitation hospital and medical facility located in Riyadh City, Saudi Arabia. It has 511 beds and offers surgical and medical rehabilitation services for pediatric and adult populations [12]. Since 2003, SBAHC has used a unified HIS called TrakCare Intersystem, which is updated regularly. TrakCare is a web-based healthcare information system that provides electronic patient records for health organizations. With a single data repository, it offers clinical, administrative, lab, and community care functionality. It allows patient information to be shared securely and seamlessly between all departments. Worldwide, TrakCare is available in different healthcare organizations in over 27 countries [13]. Information system usability enhancements can result

in high user productivity, few errors, and increased system efficacy and efficiency [3,4,14]. Detecting usability issues is important [8,15]. Therefore, this study evaluates the usability of TrakCare version 2022 and identifies issues affecting user usability in SBAHC.

Literature Review

Usability and Its Effects

Individuals' perspectives on technology's utility and satisfaction with a system can affect how the system will perform [16]. According to numerous studies, the qualities of information system usability include user satisfaction, system effectiveness, and simplicity of use. These aspects must be addressed to improve users' experiences with the system [3,17]. Improving the usability of an information system can lead to more productive users, fewer mistakes, and increased efficacy and efficiency of the system. Therefore, it can increase user acceptance and satisfaction [3,14]. On the contrary, some difficulties can arise for healthcare companies because of problems encountered by users [6,18]. Studies have suggested that usability issues in the HIS may contribute to various medical errors, including incorrect prescription dosage entries [3]. Furthermore, the Institute of Medicine has identified the ineffective usability of health information as an obstacle to providing safe and effective services [19,20]. Examples of frequent usability issues with the existing HIS include issues with stability, user control, flexibility, and lack of assistance [21,22]. Apart from this, one of the major issues affecting users' interactions with the system is then inappropriate user interface and system conflict with the clinical process [6,23]. Moreover, the multitude of windows and options and the requirement to use numerous systems make using the HIS even more challenging [21]. Usability issues, such as complex data entry and use, have become major causes for worry for physicians [24,25]. According to earlier research, cognitive effort and time constraints at work

are related to the stress experienced by physicians due to usability issues with the HIS [21]. The usability of HIS affects doctors' health due to strain and causes burnout and poor work outcomes [21,26,27]. In addition, more time pressure is tied to technical issues in information systems [21,28]. In another study, doctors demonstrated higher negative perceptions of HISs when they were poorly constructed and unresponsive and when system breakdowns were frequent [14,29]. Similarly, usability issues such as workflow disruptions and complex documentation have also been increasingly acknowledged among nurse users [26,30]. Studies have shown that nurses experience strain and psychological suffering due to the unreliability or inefficiency of HISs [14,27,31]. Consequently, frustration has been linked to improper system usability for healthcare providers [32]. Thus, it is essential to pay attention to usability issues in health organizations' information systems. Usability problems in a HIS that lead to medical errors are more concerning. Health providers may enter incorrect information due to certain interface issues and may threaten patients [8]. Thus, detecting and fixing usability issues are crucial to avoid impairing user performance [8,15].

Evaluation of System Usability

Several methods have been used to evaluate HISs worldwide, but usability testing is among the most effective and popular methods [33]. Usability tests are carried out throughout system design and before and after implementation. The approaches for evaluating user interfaces can be divided into those that involve experts and those that involve users [8,34]. In an examination with experts, inspectors analyze the software to identify usability issues using heuristics or best practices. In user-involved approaches, professionals ask end users for feedback on the

system's usability through surveys, user testing, system logs, interviews, and other techniques to understand how users use the system's features [1,8]. As users interact with the system, usability can be assessed and examined in several aspects [6,7]. However, usability testing often highlights how satisfactory the user experience is in terms of the users' viewpoint [6,7]. Different studies have assessed HISs using usability surveys [35,36]. The SUS questionnaire is a well-known metric for rating a system's usability among users [37]. This questionnaire has been used as the main instrument to evaluate the usability of healthcare systems in different studies [32,38] It uses a Likert scale in which respondents are asked to rate a statement whether they agree or disagree with it on a scale of 5 or 7 [37,39]. It is a scale with strong face validity and high reliability [40,41]. However, this tool is not diagnostic because it does not determine which part of the system makes it useless [40,42]. Therefore, several studies have combined this scale with different scales or other techniques, such as semi-structured interviews [43]. Evaluating the usability of HISs using a variety of methodologies is preferable [9].

In sum, the literature demonstrates how some issues limit HISs. Usability is one of these issues, as it negatively affects users and system functions. As a result, evaluating a system's usability is crucial to addressing these issues.

1.1 Research Question

What is the usability level of TrakCare 2022 in SBAHC, Riyadh, Saudi Arabia?

1.2 Objectives

Specific Objectives

To measure the system acceptance of TrakCare 2022 among healthcare providers in SBAHC.

1.3.2 Secondary Objectives

To identify the areas affecting the usability of TrakCare 2022 among healthcare providers in SBAHC.

2. Methods

Study Design

The study used a mix of quantitative and qualitative methods to assess the usability of TrakCare 2022. The quantitative method was a cross-sectional study using an online questionnaire, and the qualitative method was a semi-structured interview. The questionnaire was in English, which is a valid and reliable questionnaire for assessing system usability from the users' perspective. The SUS was distributed through email and WhatsApp. After collecting the questionnaire responses, semi-structured interviews were conducted using open-ended questions to identify the negative and positive issues affecting system usability. The data collection for the questionnaire started in October 2023 until January 2024. The qualitative phase began in January 2024 until February 2024.

Study Area/Setting

The study was conducted in SBAHC. The facility used TrakCare InterSystems version 2022 as the healthcare information system. Institutional review board (IRB) approvals were obtained from two IRB boards, the SBAHC and the King Abdullah International Medical Research Center. The participants' consent was obtained before participating in the study, and participation was voluntary. Confidentiality of the participants' information was guaranteed; it would not be shared with anyone other than the research team. All their data were utilized solely for the study.

2.3 Study Subjects

Inclusion criteria

• Clinical staff working at SBAHC, including full- and part-time contracts

• Fluent in English

• Clinical staff using the TrakCare information system (physicians, nurses, pharmacists, nutritionists, dieticians, radiologists, physical therapists, occupational therapists, speech therapists, and other clinicians such as psychologists, social workers, prosthetics, and orthotics)

Exclusion criteria

• Clinical staff not working in SBAHC

• Staff other than healthcare providers

• Not fluent in the English language

• Trainers, interns, and staff

Sample Size

The number of clinical staff working in SBAHC is 996. The sample size was obtained using an online calculator (available at https://www.calculator.net/sample-size-calculator.html) with the following parameters: population size of 996, margin of error of 5%, confidence interval of 95%, and population proportion of 50%. The estimated sample size was ≥ 278.

Sampling Technique

The sample was obtained using a non-probability convenience sampling method. The sample was recruited to participate in the study through an invitation link sent through official email in the organization and WhatsApp, the most popular social media platform used in Saudi Arabia [44]. The survey was constructed in an online form using Microsoft Forms, and participants were required to indicate their agreement to participate in the study by clicking on the "I Agree" icon. For the interviews, convenience sampling was conducted by contacting the staff who participated in the survey and obtaining their agreement to do the interview. According to Saunders the minimum required sample size for semi-structured interviews is between 5 and 25 [45]. Thus, our

target sample was in the range of 5–25 or until saturation was reached. All individuals who participated in the interview signed a consent form before their interviews were audio recorded.

1. Quantitative method

Questionnaire

The first part of the questionnaire covered demographic data and was followed by the SUS survey.

System Usability Scale

An English version of the self-administered online questionnaire was used to achieve the study objectives. The SUS is a tool with strong face validity and high reliability, with a Cronbach's alpha of over 0.90 [40,41]. This scale has 10 items that intend to measure usability, except for item numbers 4 and 10, which focus on the learnability of the system [46]. The items in odd numbers were positive sentences, while the items in even numbers were negative sentences. All items were rated with scores at a range of 5–1, which indicate strongly agree to strongly disagree. After calculating the responses of each item, the final scores for the SUS can range from 0 to 100, with higher scores indicating better usability [40,46]

2. Qualitative method

Semi-Structured Interview

The second method was semi-structured interviews conducted in English and by one interviewer in a quiet and comfortable room. Before starting the interview, the interviewer introduced himself/herself and explained the project topic and the objective of the study. Consent was then obtained from the participants to ensure confidentiality and anonymity. A copy of the consent form is attached in the Appendix.

After introducing the interview process, the researcher began audio recording the interview using a digital recorder and mentioned the date, time, location, and interviewer's name. The researcher

concluded the interview by saying, “The interview has ended.” Each interview did not exceed 30 minutes.

The interview contained the following open-ended questions:

Q1: What do you see as the primary function of TrakCare 2022?
Q2: What do you like about the current TrakCare 2022? (can mention up to three answers) Why?
Q3: What do you not like about the current TrakCare 2022? (can mention up to three answers) Why?
Q4: Is there anything you often look for on TrakCare 2022 that is missing or hard to find?
Q5: Is there any way TrakCare 2022 does not support your current needs?
Q6: Do you want to add anything regarding TrakCare 2022 that you think would add more value?

2.1. Statistical Analysis

Quantitative Method: System Usability Scale

The questionnaire was conducted online using Microsoft Forms. Duplicate or incomplete data were removed. Participants other than clinicians were excluded from the analysis. All data were analyzed using the Statistical Package for the Social Sciences software version 27. The demographic data (age, gender, specialty, and work experience) are presented as frequencies and percentages. Acceptability was determined using Sauro's and Lestarie's approaches [47,48]. A score above 70 was considered acceptable, and a score below 50 was unacceptable. Scores between these were considered marginally acceptable. The chi-square test was used to assess the association between acceptance level and demographic data. A p-value less than or equal to 0.05 was considered statistically significant.

Qualitative Method: Semi-Structured Interview

The interviews underwent quantitative and qualitative analyses. For the participants, information about their age, gender, specialty, contract type, and work experience underwent descriptive analysis of the total number and percentage of each category. For the recorded interviews, speech-to-text transcription was conducted using TurboScribe software. For double checking, a human examiner reviewed the created text using this tool. In analyzing the interview, coding analysis was performed to identify similar themes in the interviews using ATLAS.ti software version 7.9.0. Two assessors labeled the responses based on the pattern or idea; similar labels were coded and grouped into one code using an inductive approach. The results were then presented using a thematic analysis table. After identifying the themes, the quotes, participants' numbers, and IDs were added as columns.

3. Results

3.1 Quantitative method (SUS)

3.1.1 Demographic characteristics of the sample

A total of 285 participants were included in the study. The majority of the participants (189 [73.2%]) were aged 20–40 years, with a predominance of women (157 [60.9%]). Regarding specialty, the clinicians were distributed more or less the same across specializations, with a considerable majority of 63 (24.4%) being nurses. The majority of the participants (255 [98.8%]) had a full-time contract, and more than half (196 [76.0]) had more than two years of work experience in SBAHC (Figures 1 and 2).

3.1.2 Average SUS score and acceptability level

The SUS scores were calculated based on the following: First, each question's value score was changed, as the questionnaire had negative and positive statements. For the odd number questions, the respondents' values were deducted by 1. For the even number questions, the respondents' values were deducted by 5: (Q1 – 1) + (5 – Q2) + (Q3 – 1) + (5 – Q4) + (Q5 – 1) + (5 – Q6) + (Q7 – 1) + (5 – Q8) + (Q9 – 1) + (5 – Q10). The values of all the new questions were summed up, and the total was multiplied by 2.5, yielding a scale of 0–100 [47,49]. That is, a score above 70 was acceptable, that below 50 was unacceptable, and that between this range was considered marginally acceptable. Figure 3 illustrates the score interpretation [47,48].

Table 1 presents the average SUS score and percentage for each statement. Based on the findings after the calculation, the average SUS score was 53.7. As the SUS score was greater than 50 but less than 70, the healthcare system was marginally acceptable. More than half of the participants were within the marginally acceptable level (143 [55.4%]) (Figure 4).

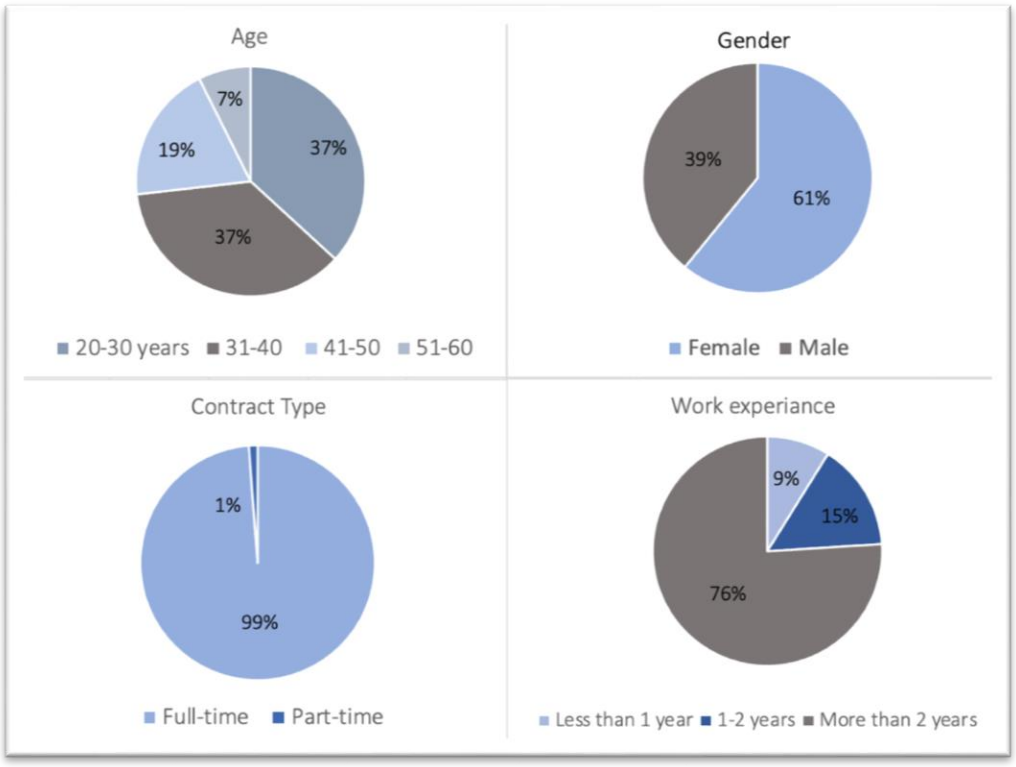

Figure 1. The sample's percentage of each demographic category (age, gender, contract type, and work experience).

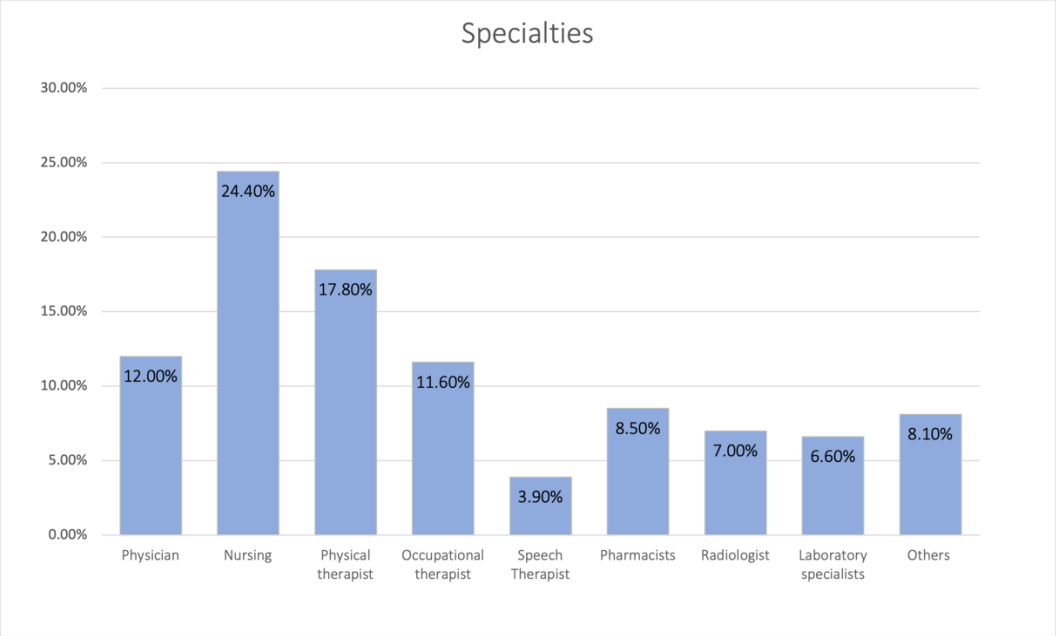

Figure 2. The sample's percentage for each specialty.

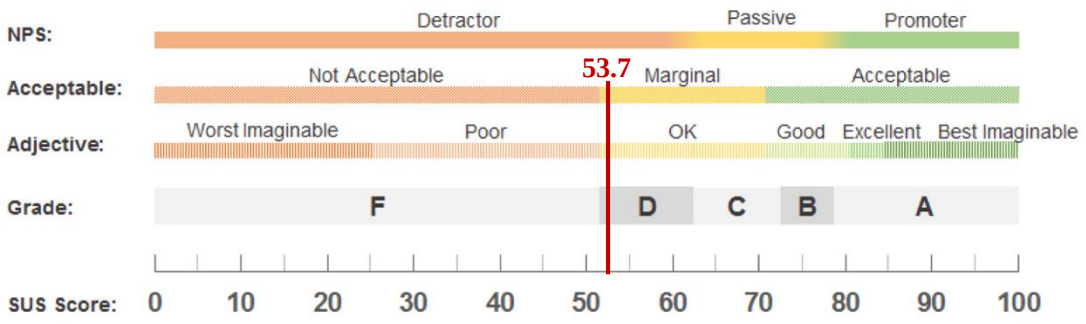

Figure 3. Interpretation of the average SUS score and acceptability level (unacceptable, marginally acceptable, acceptable).

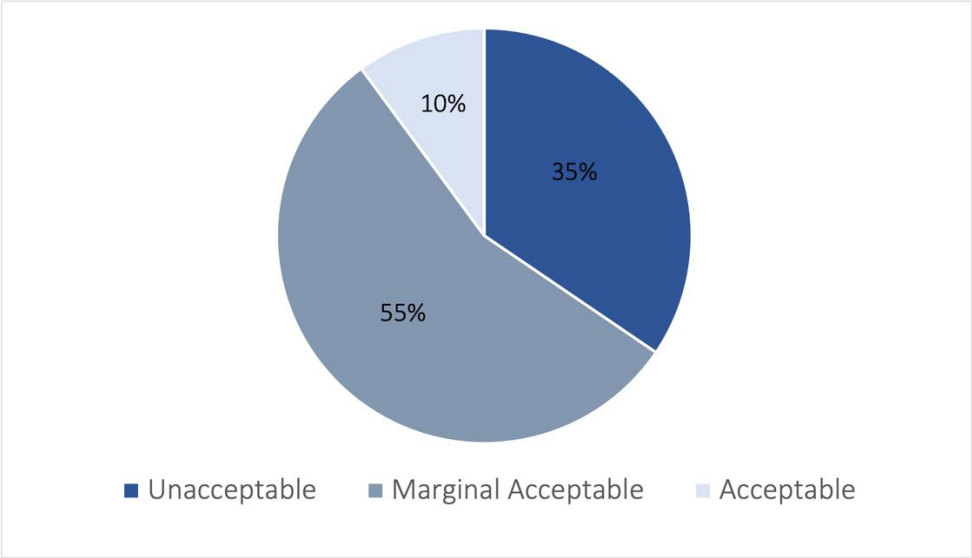

Figure 4. Average acceptability level of all the participants: unacceptable, 89 (34.5%); marginally acceptable, 143 (55.4%); acceptable, 26 (10.1%).

Statement	Strongly disagree (1)	Disagree (2)	Natural (3)	Agree (4)	Strongly Agree (5)	Average SUS score
I would like to use TrakCare frequently.	18 (7%)	64 (24.8%)	76 (29.5%)	49 (19.0%)	51 (19.8%)	3.20
I found TrakCare to be unnecessarily complex,	48 (18.6%)	60 (23.3%)	71 (27.5%)	64 (24.8%)	15 (5.8%)	2.76
I thought that TrakCare was easy to use.	22 (8.5%)	70 (27.1%)	86 (33.3%)	56 (21.7%)	24 (9.3%)	2.96
I think that I will need the support of a technical person to be able to use TrakCare.	53 (20.5%)	84 (32.6%)	53 (20.5%)	40 (15.5%)	28 (10.9%)	2.64
I found the various functions in TrakCare to be well integrated.	23 (8.9%)	83 (32.2%)	85 (32.9%)	48 (18.6%)	19 (7.4%)	2.83
I thought that there were too many inconsistencies in this TrakCare.	26 (10.1%)	78 (30.2%)	87 (33.7%)	48 (18.6%)	19 (7.4%)	2.83
Imagine if many people would learn to use TrakCare quickly.	40 (15.5%)	72 (27.9%)	64 (24.8%)	58 (22.5%)	24 (9.3%)	2.82
I found TrakCare very awkward to use.	59 (22.9%)	82 (31.8%)	73 (28.3%)	32 (12.4%)	12 (4.7%)	2.44
I felt very confident in using TrakCare.	12 (4.7%)	59 (22.9%)	77 (29.8%)	69 (26.7%)	41 (15.9%)	3.26
I needed to learn a lot of things before I could use TrakCare.	28 (10.9%)	83 (32.2%)	58 (22.5%)	61 (23.6%)	28 (10.9%)	2.91

Table 1. The average SUS score and the percentage for each SUS statement.

1.3.3 Association between the participants' characteristics (age, sex, specialties, experience, and contract type) and acceptability level

The association between the participants' characteristics and the acceptability level using the chi-square test revealed a significant relationship between the acceptability level and specialty ($P < .001$) (Table 2). No significant association was found between acceptability and age, gender, and work of experience (chi-square test, $P > .05$).

Characteristics	Category	Unacceptable	Marginally acceptable	Acceptable	P-value
Age	20–30 years	37 (38.9%)	54 (56.8%)	4 (4.2%)	0.055
	31–40	36 (38.3%)	47 (50%)	11 (11.7%)	
	41–50	10 (20%)	33 (66%)	7 (14%)	
	51–60	6 (31.6%)	9 (47.4%)	4 (21.1%)	
Gender	Male	40 (39.6%)	56 (55.4%)	5 (5%)	0.061
	Female	49 (31.2%)	87 (55.4%)	21 (13.4%)	
Specialty	Physician	12 (38.7%)	15 (48.4%)	4 (12.9%)	**< 0.001***
	Nursing	11 (17.5%)	36 (57.1%)	16 (25.4%)	
	Physical therapist	24 (52.2%)	18 (39.1%)	4 (8.7%)	
	Occupational therapist	12 (40%)	17 (56.7%)	1 (3.3%)	
	Speech therapist	3 (30%)	7 (70%)	0	
	Pharmacist	6 (27.3%)	16 (72.7%)	0	
	Radiologist	7 (38.9%)	10 (55.6%)	1 (5.6%)	
	Laboratory specialist	10 (58.8%)	7 (41.2%)	0	
	Other	4 (19%)	17 (81%)	0	
Work experience in SBAHC	Less than 1 year	11 (47.8%)	11 (47.8%)	1 (4.3%)	.206
	1–2 years	18 (46.2%)	18 (46.2%)	3 (7.7%)	
	More than 2 years	60 (30.6%)	114 (58.2%)	22 (11.2%)	

Table 2. Acceptability level of each category and the association between acceptability level and demographic characteristics using the chi-square test.

1.3.4 Association between the participants' characteristics (age, sex, specialties, experience, and contract type) and the SUS score

Figures 5 and 6 illustrate the average scores for each group in each category. The association between the average score and the demographic data is presented in Table 3. The Mann–Whitney U test showed that female healthcare providers had significantly higher acceptability scores. The Kruskal–Wallis test showed a significant association between the acceptability score and age, specialty, and years of experience ($P < .001$, $P < .001$, $P = .048$, respectively). In addition, a pairwise comparison showed that healthcare providers aged 41–50 years had higher average SUS scores than younger age groups. Similarly, the participants with more than two years of experience had a significantly higher acceptable level than those with 1–2 years of experience. In terms of specialty, nurses showed significantly higher acceptability scores than physicians, physical therapists, occupational therapists, radiologists, laboratory specialists, and others (Appendix C).

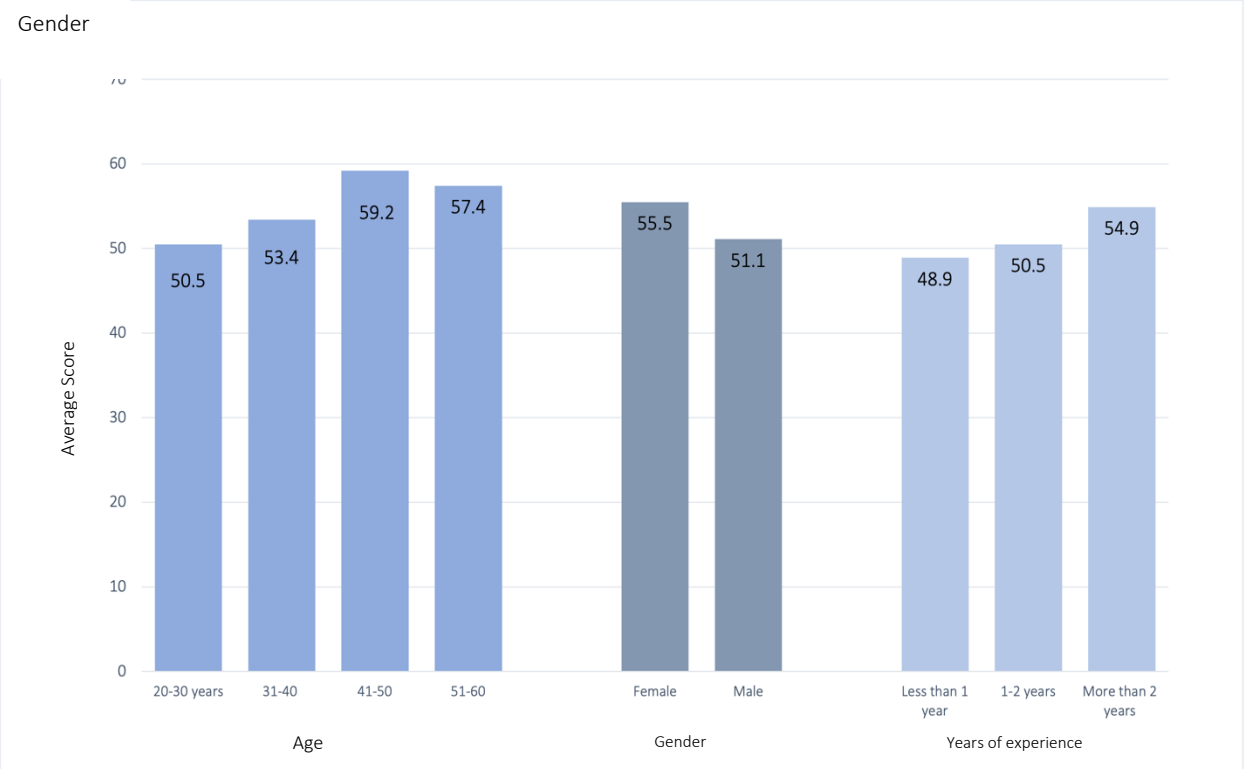

Figure 5. Average SUS score for gender, age, and years of experience.

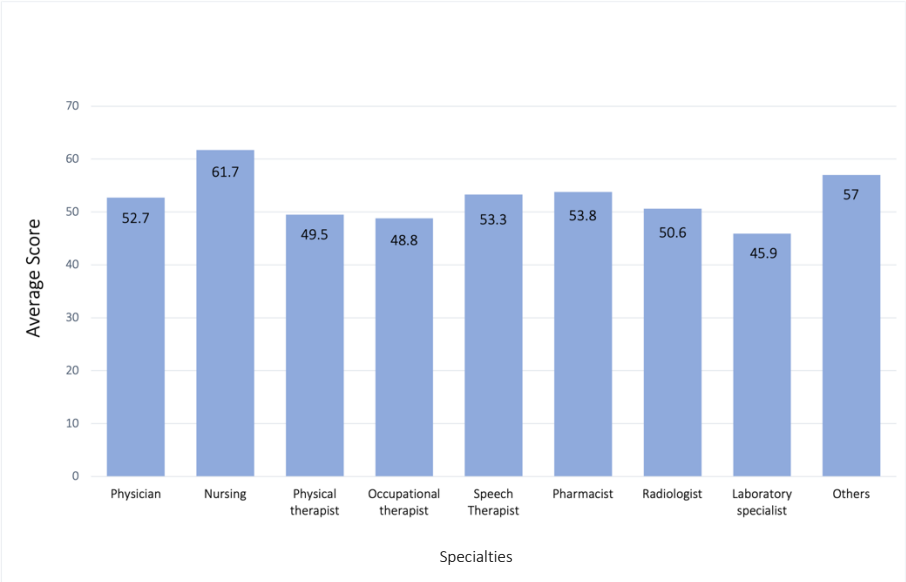

Figure 6. Average SUS score for each specialty.

3.2 Semi-structured interviews

The participants in the study were healthcare providers from SBAHC in Riyadh. A total of 13 participants were interviewed: four nurses (30.76%), four physicians (30.76%), and nine therapists (38.46%). In terms of gender distribution, there were seven men (53.48%) and six women (46.15%). In terms of age, three participants were aged 20–30 years (23.07%), nine were aged 32–40 (69.23%), and one was aged 41–50 (7.69%).

Categories	Number of participants in each category	Percentage
Gender: - Male - Female	- Male = 7 - Female = 6	- **Male** 53.84% - **Female** 46.15%
Specialty - Physician - Nurse - Therapist	- Physicians = 4 - Nurses = 4 - Therapists = 5	- **Physicians** 30.76% - **Nurses** 30.76% - **Therapists** 38.46%
Age - 20–30 - 31–40 - 41–50	- 20–30 = 3 - 31–40 = 9 - 41–50 = 1	- **20**–**30** 23.07% - **31**–**40** 69.23% - **41**–**50** 7.69%

Table 3. Demographic data of the participants in the semi-structured interviews.

1. Primary function

Among the participants, 93% were aware that the primary function of TrakCare 2022 was to record patient information and communicate with healthcare practitioners. They highlighted how the system helps with recording patient information, keeping medical records accessible and protected, and facilitating information sharing across disciplines. Regarding the advantages, disadvantages and users' recommendations with TrakCare 2022. Tables 4, 5, and 6 show the findings from the semi-structured interviews, including the number of participants mentioning each finding.

Advantages	Number of participants	Quote
Easy to navigate and learn	9	*"When you want to access the patient's profile, there is one tab that gives you the active clinical note. When you press it, it gives you comprehensive data about the patient. When you access it, it opens a phase for different areas of investigation and medical reports. And you can navigate it easily." S1.*
Easy access to information	7	*"It's easy to track the history of the patient since first admission until the last admission he is admitted…. Because it's easy for me to compare, like, for example, to see how the patient was and how he is now. To see his functional abilities." S5*
Saves time during documentation	7	*"You can update the previous entries. You can modify them and re-enter them again. So, it is always a good point for the system to allow users to spend less time on the computer."* S12

Table 4. Advantages or TrakCare 2022 based on the semi-structured interview.

Challenges	Number of participants	Quote
Absence of the search icon	8	*"Let's say I want to search about, for example, pain, and I don't know how to do it. Sometimes it's complicated to access some documents, especially documents that are not related to my field. So, searching feature is missed." S5*
Overlooked information located in a separate system	8	*"If the patient had an X-ray, then we'll need the X-ray results. Sometimes, they're not available in the system. We need to go to another system." S4*
Slow performance and limited users logging.	7	*"At the end of the day, it slows down. A lot of people use it. There are limitations in the accessibility. Sometimes, if too many people use TrakCare, it will heavy." S11*
Complex steps for some procedures	5	*"This defect is when you mark multiple labs already seen. When you have multiple labs and you have to open one lab, you have to mark it as seen one by one. You cannot mark all labs as seen simultaneously. You have to check one by one—seen, update, seen, update." S11*

Table 5. Disadvantages of TrakCare 2022 based on the semi-structured interview.

Recommendations	Number of participants	Quote
Add direct communication between disciplines	5	*"…We don't have a direct communication with the primary physician. We need to call nursing to ask for clearance.…So we can request anything from the doctor, who can agree or disagree without communicating verbally with the nurse…also we can apply it to all disciplinary teams. Like, if I need a psychologist because I need to investigate something, or if I observe something, I can do it through the system instead of calling the assigned therapist." S2*
Add more ready-made templates	5	*"Maybe... If we add templates. Let's say in the medical reports. Make it easier, especially in the clinic." S13*

Table 6. User recommendations for TrakCare 2022 from the semi-structured interview.

4. Discussion

4. 1 System usability scale

This study assessed the usability of TrakCare 2022, the HIS of SBAHC in Riyadh. A total of 285 healthcare professionals participated in the study. System usability was measured using the SUS questionnaire. After calculation, the findings revealed that the system was considered marginally acceptable, as the overall score was 53.7, and the score was greater than 50 and less than 70. A similar study was conducted in 2021 in the United Kingdom to assess different electronic health record systems using SUS. The TrakCare intersystem was assessed among 16 organizations, and the median SUS score was 50 (38–55), which is closer to the SUS score in our study [38].

Characteristics such as age, sex, experience, contract type, and specialization were assessed to determine whether there was an association between the usability score and these characteristics. Our findings showed significant differences in the average scores for gender, age, and specialty. However, in terms of acceptability level, significant differences were found for specialty but not for age, gender, and experience. Moreover, nurses' specialties obtained higher scores than other specialties, thus indicating greater system agreement. Some groups in the category obtained higher scores than other groups, and the 41–50 age group received higher scores than the younger groups, with work experience of more than two years. Previous studies have found no association between the usability of the system and sex, indicating that users' sex does not affect the use of electronic health records [36,50]. In contrast, other studies on user usability among nurses found that sex was associated with user acceptance of electronic health systems, as men had more positive attitudes about them than women [51]. This suggests further studies to assess the association between sex and system usability and whether women have more positive attitudes than men. Different studies have suggested that younger users have a more positive attitude toward the system and that they

have more technical skills than older users [51]. In contrast to our study, this could be explained by the fact that older users have more experience and familiarity with the system; thus, they have a more positive attitude toward the system. However, an association was found between user acceptability and specialty. Higher acceptance scores were demonstrated by those with over two years of work experience, indicating that system familiarity and experience favored usability judgments. Moreover, knowledge of and familiarity with the system favorably affected perceived usability. Higher acceptance was demonstrated by nurses compared with other specialties. These findings are consistent with other studies that showed differences between professional groups in user experience in electronic health record systems [52,53]. This could mean that each user specialty sees the system differently depending on the roles and responsibilities within the healthcare organization. This tendency emphasizes how crucial it is to consider both favorable opinions and usability issues when assessing HISs in healthcare settings.

4. 2 Semi-structured Interviews

For the semi-structured interviews, most of the participants conveyed that the system's main purposes were to capture patient information and allow healthcare professionals to communicate with each other. This is in accordance with research on the benefits of electronic health record systems for improving patient care outcomes and facilitating the sharing of information [54]. The participants demonstrated how TrakCare 2022 made it easy for healthcare providers to access previous and current patient health data and allowed faster access to documentation notes from other disciplines. Thus, it promotes interdisciplinary collaboration and comparative case histories, which can contribute to better patient care. Analyzing the data gathered from electronic health records and comparing them over time can help with the evaluation of the provided healthcare services [55]. The participants were satisfied with the special "active clinical note" tab, which

allows easy and simple access to comprehensive patient data. This access eliminates the need to navigate through different pages and screens. They were also satisfied with how different parts were combined onto one page, thus allowing for quick access to all pertinent data and saving time and effort. Users' usability can be negatively affected by multiple navigations between pages, which disrupts healthcare users' workflow and increases the cognitive burden [56,57]. Another advantage of TrakCare 2022 observed by participants is saving time during documentation through the use of ready-made templates. The benefits can save time and improve overall operational efficiency in healthcare by ensuring that all the mandatory documentation will be filled by users. This advantage was noted in a study indicating that customization of templates in electronic health records could save time for users during documentation and improve physicians' satisfaction while giving more time for patient care [58].

While some participants expressed satisfaction with the system in terms of navigation and easy access to health information, others pointed out that the lack of a search engine made it challenging to locate the needed information. User satisfaction may be affected by the time required to retrieve information. Including a search engine in an electronic health record system can improve user satisfaction and reduce the amount of time needed to find the information users need. Improved search capabilities in electronic health records have been found to increase user usability [59]. Another challenge in TrakCare 2022 is related to overlooked or difficult-to-find information. Flipping between pages to obtain various information disrupts clinicians' activity and adds to their cognitive burden [56]. Users encounter delays in locating information (e.g., insurance approvals), need to access separate systems to view radiology images, and face uncertainty about medication availability. This may be due to the information being overlooked or being in a different system. In addition, navigating outpatient and inpatient records and searching for historical data pose

difficulties for users. These problems highlight how important it is to strengthen TrakCare's interface with other systems to improve efficiency and streamline workflow procedures. Prior research has emphasized these problems, stating that limited user usability may result from non-integrated systems, poor interoperability, and a lack of links across various HISs within hospital departments [60,61]. There have been reports that doctors sometimes lack access to patient records that were created in different clinics, hospitals, or even inside their own hospitals. This can lead to frustration, delays in treatment, and even risks to the safety of their patients. While some companies interface with labs, pharmacies, and imaging centers and share information internally, interoperability with outside health systems, vendors, registries, and state and local public health systems remains problematic [62–64]. Two primary obstacles to system access were pointed out: slow system performance and restricted user accessibility. They claimed that the system frequently operates slowly, particularly during busy periods, which results in functionality lags and intermittent lockdowns that could cause data loss. Some blamed these errors on network issues. Customers attempting to log in for everyday operations also had difficulties due to limited simultaneous user accessibility, especially during peak hours. This outcome is consistent with the most negative finding regarding the electronic health record system, namely a network problem, which caused pages to slow down or freeze suddenly. This problem may have more to do with network infrastructure than with the system itself [65]. Adopting electronic health records also has the benefit of increasing accessibility by allowing simultaneous access to patient records [66,67]. These results highlight the necessity of enhancing system capability and performance to guarantee improved workflow and user experience. Furthermore, some participants considered some aspects of the system complex and time-consuming. For example, reviewing test results required multiple clicks, making the user go through more steps while doing tasks involving electronic health

records. This is one of the aspects affecting user usability that limits the time to contact patients and may lead to user frustration [66,68]. Therefore, it is recommended to improve user experience with electronic health records to ensure fewer clicks are needed while using the computer and spending more time with patients [68].

From the users' viewpoint, they recommended adding communication channels between disciplines and more ready-made templates to TrakCare 2022. Improving documentation by including more pre-made templates in keeping with the best practices in research emphasizes the significance of effective documentation [56,69]. Another study suggested using checklists and standard notes for documentation in electronic health records to assist users in entering necessary information quickly instead of relying solely on human recollection, thus undoubtedly saving time [56,69]. Users suggested adding communication channels between clinicians to communicate in relation to patient care. This suggestion could decrease service delays and reduce errors instead of relying on other clinicians to deliver the message. According to various studies, to enhance user experience, healthcare providers should use computer direct messaging features [56,59,68,70]. These suggestions can enhance user experience, effectiveness, and care coordination within healthcare systems.

4.1 Conclusion

In sum, the findings from the quantitative survey method and the qualitative interviews shed light on the acceptability, advantages, and challenges of the TrakCare 2022 system among healthcare professionals. Overall, the average SUS score was 53.7, which is considered marginally acceptable among healthcare providers in SBAHC. Higher acceptance scores were linked to characteristics such as gender, age, year of experience, and specialty. The acceptability level was high among users with more years of experience. These findings highlight the effects of familiarity and experience on usability assessments. Moreover, users emphasized the advantages of the current system: easy access to information, easy navigation and learning, and saving time during documentation. Users faced some challenges with the system, such as the absence of a search icon, information located in different systems, and slow performance and limited users logging. Moreover, users suggested some recommendations that could add more value to the system. These results show the importance of continuous attempts to improve system usability through interventions, such as adding a search icon, ensuring that the system is integrated, adding ready-made templates, improve system speed and concurrent user access, decrease multiple clicking during navigations, and adding direct communication channels between users. Overall, this study adds to the expanding amount of knowledge on healthcare informatics and highlights the factors affecting HIS usability. Healthcare organizations should strive to enhance overall health by implementing the suggested solutions and resolving the identified challenges.

Strengths and Limitations

A strength of this study is its use of two methods to assess system usability, which helps in collecting in-depth information. However, study have done in one organization, administrative

users were excluded, limited specialties were mentioned in the semi-structured interviews, as issues might arise with other specialties.

5. Declarations

5.1 Authors' Contributions

AM and AA designed the study. AM assumed the responsibility of collecting data and interpreting the results. AA helped throughout the study and contributed to reviewing and writing the manuscript. MM supervised work related to TrakCare 2022 and helped in accessing the sample and data collection.

5.2 Scientific and Ethics Approval

Study approval was obtained from the SBAHC, which owns the healthcare information system, on 07/09/2024, with IRB approval number 105-2023-IRB, and from the King Abdullah International Medical Research Center on 03/09/2023, with approval number IRB/2164/23. All the participants gave their consent before participating in the study and were informed that participation was voluntary. The participants were told that their information was confidential and that it would not be shared with anyone. All their data were used solely for the study.

5.3 Sources of Funding

No funding was requested.

6. References

[1] Jaspers MWM. A comparison of usability methods for testing interactive health technologies: methodological aspects and empirical evidence. Int J Med Inform 2009;78:340–53. https://doi.org/10.1016/j.ijmedinf.2008.10.002.

[2] Nabovati E, Vakili-Arki H, Eslami S, Khajouei R. Usability evaluation of Laboratory and Radiology Information Systems integrated into a hospital information system. J Med Syst 2014;38:35. https://doi.org/10.1007/s10916-014-0035-z.

[3] Farzandipour M, Sadeqi Jabali M, Nickfarjam AM, Tadayon H. Usability evaluation of selected picture archiving and communication systems at the national level: Analysis of users' viewpoints. Int J Med Inform 2021;147. https://doi.org/10.1016/j.ijmedinf.2020.104372.

[4] Khajouei R, Abbasi R. Evaluating Nurses' Satisfaction With Two Nursing Information Systems. Comput Inform Nurs 2017;35:307–14. https://doi.org/10.1097/CIN.0000000000000319.

[5] Khajouei R, Farahani F. The evaluation of users' satisfaction with the Social Security Electronic System in Iran. Health Technol (Berl) 2019;9. https://doi.org/10.1007/s12553-019-00347-y.

[6] Teshnizi SH, Alipour J, Hosein M, Haghighi H. Usability Evaluation of Hospital Information System: A Cross-Sectional Study. vol. 42. 2020.

[7] Yen P-Y, Walker DM, Smith JMG, Zhou MP, Menser TL, McAlearney AS. Usability evaluation of a commercial inpatient portal. Int J Med Inform 2018;110:10–8. https://doi.org/10.1016/j.ijmedinf.2017.11.007.

[8] Dias CR, Pereira MR, Freire AP. Qualitative review of usability problems in health information systems for radiology. J Biomed Inform 2017;76:19–33. https://doi.org/10.1016/j.jbi.2017.10.004.

[9] Walji MF, Kalenderian E, Piotrowski M, Tran D, Kookal KK, Tokede O, et al. Are three methods better than one? A comparative assessment of usability evaluation methods in an EHR. Int J Med Inform 2014;83:361–7. https://doi.org/10.1016/j.ijmedinf.2014.01.010.

[10] Corrao NJ, Robinson AG, Swiernik MA, Naeim A. Importance of testing for usability when selecting and implementing an electronic health or medical record system. J Oncol Pract 2010;6:120–4. https://doi.org/10.1200/JOP.200017.

[11] Nielsen J. Usability Engineering. San Francisco, CA: Morgan Kaufmann; 1993. https://doi.org/10.1016/C2009-0-21512-1.

[12] about us. Sultan Bin Abdulaziz Humanitarian City n.d. https://sbahc.org.sa/EN/109.aspx (accessed May 8, 2024).

[13] InterSystems. TrakCare Unified Healthcare Information System. InterSystems n.d. https://www.intersystems.com/uk/trakcare/unified-healthcare-information-system/ (accessed April 25, 2023).

[14] Vehko T, Hyppönen H, Puttonen S, Kujala S, Ketola E, Tuukkanen J, et al. Experienced time pressure and stress: Electronic health records usability and information technology competence play a role. BMC Med Inform Decis Mak 2019;19. https://doi.org/10.1186/s12911-019-0891-z.

[15] RezaeiHachesu P, Pesianian E, Mohammadian M. Evaluating Usability of Radiology Information Systems in Hospitals of Tabriz University of Medical Sciences. Acta Informatica Medica 2016;24:42. https://doi.org/10.5455/aim.2016.24.42-46.

[16] Hariyati RTS, Hamid AY, Eryando T, Hasibuan ZA. Usability and satisfaction of using electronic nursing documentation, lesson-learned from new system implementation at a hospital in Indonesia. Int J Healthc Manag 2020;13:45–52. https://doi.org/10.1080/20479700.2018.1504387.
[17] Lilholt PH, Jensen MH, Hejlesen OK. Heuristic evaluation of a telehealth system from the Danish TeleCare North Trial. Int J Med Inform 2015;84:319–26. https://doi.org/10.1016/j.ijmedinf.2015.01.012.
[18] Mathews A, Marc D. Usability Evaluation of Laboratory Information Systems. J Pathol Inform 2017;8:40. https://doi.org/10.4103/jpi.jpi_24_17.
[19] Chou D. Health IT and Patient Safety: Building Safer Systems for Better Care. JAMA 2012;308:2282. https://doi.org/10.1001/jama.308.21.2282-a.
[20] Roman LC, Ancker JS, Johnson SB, Senathirajah Y. Navigation in the electronic health record: A review of the safety and usability literature. J Biomed Inform 2017;67:69–79. https://doi.org/10.1016/j.jbi.2017.01.005.
[21] Heponiemi T, Kujala S, Vainiomäki S, Vehko T, Lääveri T, Vänskä J, et al. Usability factors associated with physicians' distress and information system-related stress: Cross-sectional survey. JMIR Med Inform 2019;7. https://doi.org/10.2196/13466.
[22] Kjeldskov J, Skov MB, Stage J. A longitudinal study of usability in health care: Does time heal? Int J Med Inform 2010;79:e135–43. https://doi.org/10.1016/j.ijmedinf.2008.07.008.
[23] Farrahi R, Rangraz Jeddi F, Nabovati E, Sadeqi Jabali M, Khajouei R. The relationship between user interface problems of an admission, discharge and transfer module and usability features: a usability testing method. BMC Med Inform Decis Mak 2019;19:172. https://doi.org/10.1186/s12911-019-0893-x.
[24] Heponiemi T, Hyppönen H, Vehko T, Kujala S, Aalto A-M, Vänskä J, et al. Finnish physicians' stress related to information systems keeps increasing: a longitudinal three-wave survey study. BMC Med Inform Decis Mak 2017;17:147. https://doi.org/10.1186/s12911-017-0545-y.
[25] Shanafelt TD, Dyrbye LN, Sinsky C, Hasan O, Satele D, Sloan J, et al. Relationship Between Clerical Burden and Characteristics of the Electronic Environment With Physician Burnout and Professional Satisfaction. Mayo Clin Proc 2016;91:836–48. https://doi.org/10.1016/j.mayocp.2016.05.007.
[26] Kutney-Lee A, Brooks Carthon M, Sloane DM, Bowles KH, McHugh MD, Aiken LH. Electronic Health Record Usability: Associations with Nurse and Patient Outcomes in Hospitals. Med Care 2021;59:625–31. https://doi.org/10.1097/MLR.0000000000001536.
[27] Melnick ER, Harry E, Sinsky CA, Dyrbye LN, Wang H, Trockel MT, et al. Perceived Electronic Health Record Usability as a Predictor of Task Load and Burnout Among US Physicians: Mediation Analysis. J Med Internet Res 2020;22:e23382. https://doi.org/10.2196/23382.
[28] Vainiomäki S, Aalto A-M, Lääveri T, Sinervo T, Elovainio M, Mäntyselkä P, et al. Better Usability and Technical Stability Could Lead to Better Work-Related Well-Being among Physicians. Appl Clin Inform 2017;08:1057–67. https://doi.org/10.4338/ACI-2017-06-RA-0094.
[29] Kaipio J, Lääveri T, Hyppönen H, Vainiomäki S, Reponen J, Kushniruk A, et al. Usability problems do not heal by themselves: National survey on physicians' experiences with EHRs in Finland. Int J Med Inform 2017;97:266–81. https://doi.org/10.1016/j.ijmedinf.2016.10.010.

[30] Kutney-Lee A, Sloane DM, Bowles KH, Burns LR, Aiken LH. Electronic Health Record Adoption and Nurse Reports of Usability and Quality of Care: The Role of Work Environment. Appl Clin Inform 2019;10:129–39. https://doi.org/10.1055/s-0039-1678551.
[31] Wisner K, Lyndon A, Chesla CA. The electronic health record's impact on nurses' cognitive work: An integrative review. Int J Nurs Stud 2019;94:74–84. https://doi.org/10.1016/j.ijnurstu.2019.03.003.
[32] Melnick ER, West CP, Nath B, Cipriano PF, Peterson C, Satele D V, et al. The association between perceived electronic health record usability and professional burnout among US nurses. Journal of the American Medical Informatics Association 2021;28:1632–41. https://doi.org/10.1093/jamia/ocab059.
[33] Ahmadian L, Salehi Nejad S, Khajouei R. Evaluation methods used on health information systems (HISs) in Iran and the effects of HISs on Iranian healthcare: A systematic review. Int J Med Inform 2015;84. https://doi.org/10.1016/j.ijmedinf.2015.02.002.
[34] Nielsen J. Usability inspection methods. Conference companion on Human factors in computing systems - CHI '94, New York, New York, USA: ACM Press; 1994, p. 413–4. https://doi.org/10.1145/259963.260531.
[35] Kaipio J, Kuusisto A, Hyppönen H, Heponiemi T, Lääveri T. Physicians' and nurses' experiences on EHR usability: Comparison between the professional groups by employment sector and system brand. Int J Med Inform 2020;134:104018. https://doi.org/10.1016/j.ijmedinf.2019.104018.
[36] Mkalira Msiska KE, Kumitawa A, Kumwenda B. Factors affecting the utilisation of electronic medical records system in Malawian central hospitals. Malawi Medical Journal 2017;29:247. https://doi.org/10.4314/mmj.v29i3.4.
[37] Lewis JR. Measuring Perceived Usability: The CSUQ, SUS, and UMUX. Int J Hum Comput Interact 2018;34:1148–56. https://doi.org/10.1080/10447318.2017.1418805.
[38] Bloom BM, Pott J, Thomas S, Gaunt DR, Hughes TC. Usability of electronic health record systems in UK EDs. Emerg Med J 2021;38:410–5. https://doi.org/10.1136/emermed-2020-210401.
[39] Brooke J. SUS: A quick and dirty usability scale. Usability Eval Ind 1995;189.
[40] Brooke J. SUS: a retrospective. J Usability Stud 2013;8:29–40.
[41] Bangor A, Kortum PT, Miller JT. An Empirical Evaluation of the System Usability Scale. Int J Hum Comput Interact 2008;24:574–94. https://doi.org/10.1080/10447310802205776.
[42] Jeff Sauro. A Practical Guide to the System Usability Scale: Background, Benchmarks & Best Practices. CreateSpace Independent Publishing Platform; 2011.
[43] Khairat S, Coleman C, Ottmar P, Bice T, Koppel R, Carson SS. Physicians' gender and their use of electronic health records: findings from a mixed-methods usability study. Journal of the American Medical Informatics Association 2019;26:1505–14. https://doi.org/10.1093/jamia/ocz126.
[44] Statista. Most used social media platforms in Saudi Arabia in 2022, by share of users 2022.
[45] Saunders MNK. Choosing Research Participants. Qualitative Organizational Research: Core Methods and Current Challenges, 1 Oliver's Yard, 55 City Road London EC1Y 1SP : SAGE Publications, Inc.; 2012, p. 35–52. https://doi.org/10.4135/9781526435620.n3.
[46] Jeff Sauro. 10 Things to Know About the System Usability Scale (SUS) 2013. https://measuringu.com/10-things-sus/ (accessed May 8, 2024).

[47] Lestari B, Rifiani PI, Gati AB. The Use of the Usability Scale System as an Evaluation of the Kampung Heritage Kajoetangan Guide Ebook Application. European Journal of Business and Management Research 2021;6:156–61. https://doi.org/10.24018/ejbmr.2021.6.6.1113.
[48] Sauro J. 5 ways to interpret a SUS score 2018. https://measuringu.com/interpret-sus-score/. (accessed April 8, 2023).
[49] Ramadhan DW. PENGUJIAN USABILITY WEBSITE TIME EXCELINDO MENGGUNAKAN SYSTEM USABILITY SCALE (SUS) (sTUDI KASUS: WEBSITE TIME EXCELINDO). JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika) 2019;4:139. https://doi.org/10.29100/jipi.v4i2.977.
[50] Rm Kivuva. Usage of electronic medical records among healthcare workers in selected health facilities in Nairobi, Kenya. Department of Sociology and Social Work; University of Naiorobi 2011.
[51] Alrasheeday AM, Alshammari B, Alkubati SA, Pasay-an E, Albloushi M, Alshammari AM. Nurses' Attitudes and Factors Affecting Use of Electronic Health Record in Saudi Arabia. Healthcare 2023;11:2393. https://doi.org/10.3390/healthcare11172393.
[52] Hidefjall P. Drivers and barriers for implementing remote monitoring of patients with cardiac implantable electronic devices in Sweden – a mixed methods study. Int J Healthc Manag 2017;13:1–11. https://doi.org/10.1080/20479700.2017.1397907.
[53] Dwisatyadini M, Hariyati R, Afifah E. The effects of the application of SIMPRO on the completeness and time efficiency of nursing documentation in the outpatient instalation at Dompet Dhuafa Hospital Parung. vol. 332. 2018. https://doi.org/10.1088/1757-899x/332/1/012034.
[54] Vos JFJ, Boonstra A, Kooistra A, Seelen M, van Offenbeek M. The influence of electronic health record use on collaboration among medical specialties. BMC Health Serv Res 2020;20:676. https://doi.org/10.1186/s12913-020-05542-6.
[55] Uslu A, Stausberg J. Value of the Electronic Medical Record for Hospital Care: Update From the Literature. J Med Internet Res 2021;23:e26323. https://doi.org/10.2196/26323.
[56] Alami J, Hammonds C, Hensien E, Khraibani J, Borowitz S, Hellems M, et al. Usability challenges with electronic health records (EHRs) during prerounding on pediatric inpatients. JAMIA Open 2022;5. https://doi.org/10.1093/jamiaopen/ooac018.
[57] Roman LC, Ancker JS, Johnson SB, Senathirajah Y. Navigation in the electronic health record: A review of the safety and usability literature. J Biomed Inform 2017;67:69–79. https://doi.org/10.1016/j.jbi.2017.01.005.
[58] Wei W, Felippi R, Abbasi G, Pinn T, Rose K St., Rana I. The Impact of Electronic Health Record Interventions on Patient Access to Post-Hospital Discharge Prescriptions. Hosp Pharm 2023;58:212–8. https://doi.org/10.1177/00185787221130689.
[59] Hanauer DA, Mei Q, Law J, Khanna R, Zheng K. Supporting information retrieval from electronic health records: A report of University of Michigan's nine-year experience in developing and using the Electronic Medical Record Search Engine (EMERSE). J Biomed Inform 2015;55:290–300. https://doi.org/10.1016/j.jbi.2015.05.003.
[60] van Poelgeest R, Schrijvers A, Boonstra A, Roes K. Medical Specialists' Perspectives on the Influence of Electronic Medical Record Use on the Quality of Hospital Care: Semistructured Interview Study. JMIR Hum Factors 2021;8:e27671. https://doi.org/10.2196/27671.

[61] Ankem K, Turpin J, Uppala V. Physician adoption of electronic health records: a visualisation of the role of provider and state characteristics in incentive programme participation. Information Research. Information Research, 21(2), Paper 715 2016. http://informationr.net/ir/21-2/paper715.html#. YW5OkRpByUk (accessed April 21, 2024).
[62] Jacob JA. On the Road to Interoperability, Public and Private Organizations Work to Connect Health Care Data. JAMA 2015;314:1213. https://doi.org/10.1001/jama.2015.5930.
[63] Meehan RA, Mon DT, Kelly KM, Rocca M, Dickinson G, Ritter J, et al. Increasing EHR system usability through standards: Conformance criteria in the HL7 EHR-system functional model. J Biomed Inform 2016;63:169–73. https://doi.org/10.1016/j.jbi.2016.08.015.
[64] Tutty MA, Carlasare LE, Lloyd S, Sinsky CA. The complex case of EHRs: examining the factors impacting the EHR user experience. Journal of the American Medical Informatics Association 2019;26:673–7. https://doi.org/10.1093/jamia/ocz021.
[65] Yoo S, Lim K, Jung SY, Lee K, Lee D, Kim S, et al. Examining the adoption and implementation of behavioral electronic health records by healthcare professionals based on the clinical adoption framework. BMC Med Inform Decis Mak 2022;22:210. https://doi.org/10.1186/s12911-022-01959-7.
[66] Tsai CH, Eghdam A, Davoody N, Wright G, Flowerday S, Koch S. Effects of Electronic Health Record Implementation and Barriers to Adoption and Use: A Scoping Review and Qualitative Analysis of the Content. Life 2020;10:327. https://doi.org/10.3390/life10120327.
[67] Howard J, Clark EC, Friedman A, Crosson JC, Pellerano M, Crabtree BF, et al. Electronic Health Record Impact on Work Burden in Small, Unaffiliated, Community-Based Primary Care Practices. J Gen Intern Med 2013;28:107–13. https://doi.org/10.1007/s11606-012-2192-4.
[68] Guo U, Chen L, Mehta PH. Electronic health record innovations: Helping physicians – One less click at a time. Health Information Management Journal 2017;46:140–4. https://doi.org/10.1177/1833358316689481.
[69] Shoolin J, Ozeran L, Hamann C, Bria W. Association of Medical Directors of Information Systems Consensus on Inpatient Electronic Health Record Documentation. Appl Clin Inform 2013;04:293–303. https://doi.org/10.4338/ACI-2013-02-R-0012.
[70] AlSadrah SA. Electronic medical records and health care promotion in Saudi Arabia. Saudi Med J 2020;41:583–9. https://doi.org/10.15537/smj.2020.6.25115.

7. Appendix

This section should include all materials and instruments used to conduct the research project.

7.1. Appendix A: Questionnaire (SUS)

Dear Healthcare Provider:
We would like to ask you to participate in a brief survey on the TrakCare 2022 system with healthcare providers in SBAHC. It will take only five minutes of your time to complete the brief and straightforward survey.
The information gathered here will be used to enhance the healthcare information system by finding errors that can affect the system interaction with users.
Please be aware that your participation is voluntary and that your responses to the survey will be anonymous.
By clicking the "Agree" icon, you agree to participate.

Thank you for your assistance.

Part 1: General Information. Part 2: System Usability Scale

What is your age?	○ 20–30 ○ 31–40 ○ 41–50 ○ 51–60 ○ 60+
What is your gender?	○ Male ○ Female
What is your specialty?	○ Physician, Psychiatric ○ Psychologist ○ Nursing, nurse aid, RN, charge nurse ○ Physical therapist ○ Occupational therapist ○ Speech therapist ○ Pharmacist, pharmacy aid, etc. ○ Nutritionist, dietician, etc. ○ Radiologist, radiology technologist, etc. ○ Laboratory specialist, laboratory technologist, etc. ○ Social worker ○ Other……..?
Contract type	○ Full-time ○ Part-time
Work experience in SBAHC	○ Less than 1 year ○ 1–2 years ○ More than 2 years

System Usability Scale (SUS).

Please check the box that reflects your immediate response to each statement. Don't think too long about each statement. Make sure you respond to every statement. If you don't know how to respond, simply check box "3."					
	Strongly Disagree (1)	(2)	(3)	(4)	Strongly Agree (5)
1. I think that I would like to use **TrakCare** frequently.	○	○	○	○	○
2. I found the **TrakCare** unnecessarily complex.	○	○	○	○	○
3. I thought the **TrakCare** was easy to use.	○	○	○	○	○
4. I think that I would need the support of a technical person to be able to use **TrakCare.**	○	○	○	○	○
5. I found the various functions in the **TrakCare** were well integrated.	○	○	○	○	○
6. I thought there was too much inconsistency in this **TrakCare.**	○	○	○	○	○
7. I imagine that most people would learn to use **TrakCare** very quickly.	○	○	○	○	○
8. I found the **TrakCare** very awkward to use.	○	○	○	○	○
9. I felt very confident using the **TrakCare.**	○	○	○	○	○
10. I needed to learn a lot of things before I could get going with **TrakCare.**	○	○	○	○	○

7.2. Appendix B: Consent form

Consent form for the Interview:

Kingdom of Saudi Arabia
Ministry of National Guard - Health Affairs

المملكة العربية السعودية
وزارة الحرس الوطني – الشؤون الصحية

Informed Consent for Cross Sectional Surveys	إقرار موافقة للمشاركة بدراسة مقطعية
Study Title : Evaluation of System Usability of healthcare Information System at Sultan Bin Abdulaziz Humanitarian City, in Riyadh	
Study No. :	
Principal Investigator : Dr. Abdulwahhab Alshammari	
You are requested to participate in research that will be supervised by (Dr. Abdulwahhab Alshammari) in (*king Saud bin Abdulaziz university for Health Sciences*).	أنت مدعو للانضمام طواعية لدراسة بحثية سوف يشرف عليها الدكتور عبدالوهاب الشمري في جامعة الملك سعود بن عبدالعزيز للعلوم الصحية.
This study is about (*Evaluation of System Usability of the Healthcare Information System at Sultan Bin Abdulaziz Humanitarian City, Riyadh, Saudi Arabia*).	هذه الدراسة تهدف إلى دراسة مستوى سهولة استخدام نظام معلومات الرعاية الصحية المستخدم في مدينة سلطان بن عبدالعزيز للخدمات الإنسانية
Your participation is voluntary, and you have the right to not complete this survey without giving any reason and this will not affect your current or future medical care in MNG-HA.	إن مشاركتك في هذه الدراسة طوعية ولك الحق التام في عدم قبول تعبئة الاستمارة أو الانسحاب في أي وقت تشاء بدون ابداء الاسباب ولن يؤثر ذلك على العناية الطبية المقدمة لك حالياً أو في المستقبل في الشؤون الصحية بوزارة الحرس الوطني.
You do not have to sign this information sheet only you can choose to agree/disagree; your acceptance to complete the survey will be interpreted as your informed consent to participate.	لا يجب عليك التوقيع على ورقة المعلومات هذه، فقط عليك الاختيار موافق / غير موافق فمجرد قبولك تعبئة هذا الاستبيان يعتبر بمثابة إقرارك بالموافقة على المشاركة في هذا البحث .
Your responses will be kept anonymous. However, whenever one works with email/the internet there is always the risk of compromising privacy, confidentiality, and/or anonymity. Despite this possibility, the risks to your physical, emotional, social, professional, or financial well-being are considered to be 'less than minimal'.	ستبقى الردود على الأسئلة سرية ومع ذلك، فإن العمل عن طريق البريد الالكتروني والانترنت يبقى هناك احتمال الاختراق خصوصية البيانات وسرية المعلومات، ولكن بالرغم من هذه الاحتمالية تبقى الاخطار البدنية والعاطفية والاجتماعية والمهنية والمالية المترتبة عليك ضمن الحد الادنى من الخطورة.
If you have any questions about the research, please contact (Abdulwahhab Alshammari) (shammaria@ksau-hs.edu.sa)	إذا كان لديك أي اسئلة حول هذا البحث، يرجى الاتصال (د. عبدالوهاب الشمري) (shammaria@ksau-hs.edu.sa)
In case you have any enquiries related to your rights as a research subject you can contact the Institutional Review Board on Tel 8011111 Ext. 14572.	في حال كان لديك الاستفسارات المتعلقة بحقوقك كموضوع بحث يمكنك الاتصال بمجلس المراجعة المؤسسية على هاتف 8011111 تحويلة 14572
☐ Agree to participate. ☐ Disagree to participate	☐ موافق على المشاركة ☐ غير موافق على المشاركة
Version No. : ( )	Version Date: ( )

7.3. Appendix C: IRB Approval Letters

Kingdom of Saudi Arabia
Ministry of National Guard - Health Affairs

المملكة العربية السعودية
وزارة الحرس الوطني - الشؤون الصحية

King Abdullah International Medical Research Center
(KAIMRC)

(84) 94456 1515 irb@ngha.med.sa

National Committee of Bioethics
Registration No.: H-01-R-005

IRB Office

E-CTS Ref. No. **RYD-23-419812-126302**

IRB Approval No.: **IRB/2164/23**
Study Number: **SP23R/188/08**
Study Title: **Evaluation of System Usability of the Healthcare Information System at Sultan Bin Abdulaziz Humanitarian City, Riyadh, Saudi Arabia**
Study Sponsor: **Non Grant**
IRB Approval Date: **03 September 2023**
IRB Review Type: ☑ **Expedited Review** ☐ **Full Board**
Study site(s): **Central Region**

KAIMRC APPROVED IRB

Dear **Dr. Abdulwahhab Oqla Alshammari**
Assistant Professor, Department of Health Informatics, CPHHI, KSAU-HS
Ministry of National Guard – Health Affairs

Sub-Investigator/s : Abrar Yousef Almuzaini

After reviewing your submitted research proposal/protocol and related documents, the **IRB has granted your** submitted research project **approval for one year**. The approval includes the following related documents:

Document/Title	Version	Date
Research Proposal	01	03 September 2023
Data Collection	01	03 September 2023
Inform Consent Form	01	03 September 2023

Terms of Approval:

- **Annual Reports:** Annual and final reports must be submitted to monitoring units for approval.
- **Retention of original data:** The PI is responsible for the storage and retention of original data pertaining to the project for a minimum of five years.
- **Reporting of adverse events or unanticipated problems:** The PI is responsible to report any serious or unexpected adverse events or unanticipated problems, which could involve any risk to participants or others, or any event on incidents that may have an impact on the research or participants.
- **Biological samples:** No biological samples are to be shipped out of the Kingdom of Saudi Arabia without prior IRB approval.
- **Participant incentives:** No financial compensation or gifts to be given to participants without prior IRB approval.
- **Storage of biological samples:** All biological samples collected for the purpose of this research must be stored in the KAIMRC-related repository.
- **Adherence to rules and regulations:** This IRB-approved research study must not contradict any Saudi law including but not limited to the Saudi Law of Ethics of Research on Living Creatures and its Implementing Regulations.
- **Amendments to research proposal:** You will need to submit a request for project amendments to the IRB for review and re-approval.
- **Phone-based surveys:** Prior approval is required from the IRB
- **Bestcare access:** Prior approval is required from the IRB

03 SEP 2023

Prof. Hamdan Al Jahdali
Chairman, Institutional Review Board (**IRB**)
Ministry of National Guard Health Affairs

HJ/BA/AJ

Version 2, 31 July 2023

Full AAHRPP Accreditation

P.O. Box 22490, Riyadh 11426
Tel. 8011111
Telex : 403450 NGRMED SJ
(ORACLE 29795)
HA . Printing Press 17 / 137

ص.ب. ٢٢٤٩٠ الرياض ١١٤٢٦
تلفون: ٨٠١١١١١
تلكس: ٤٠٣٤٥٠

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY

مدينة سلطان بن عبد العزيز للخدمات الإنسانية
SULTAN BIN ABDULAZIZ HUMANITARIAN CITY
لجنة أخلاقيات البحوث الطبية
Institutional Review Board (IRB)

Date: 07 September 2023
IRB No.: 105-2023-IRB

To: **Ms. Abrar Yousef Almuzaini**
MSc: "Evaluation of System Usability of the Healthcare Information System at Sultan Bin Abdulaziz Humanitarian City, Riyadh, Saudi Arabia"
King Saud Bin Abdulaziz University
E-mail: aalmuzaini@sbahc.org.sa

Subject:	Approval for MSc Research No. 101/SBAHC/MSc/RH/2023
Study Title:	"Evaluation of System Usability of the Healthcare Information System at Sultan Bin Abdulaziz Humanitarian City, Riyadh, Saudi Arabia"
Study Code:	101/SBAHC/MSc/RH/2023
Date of Approval:	07/09/2023
Date of Expiry:	6/6/2024
Board approval:	All members

Dear **Ms. Abrar Yousef Almuzaini**,

Your Project has been approved and you have the permission to conduct this study following your submitted documents as follow:

1. Curriculum Vitae for the PI researcher.
2. Letter from researcher's affiliating Organization/College.
3. Letter from the researcher requesting SBAHC participation in the clinical study.
4. Letter from the researcher's supervisor requesting supervision in the clinical study.
5. Research proposal according to SBAHC IRB Guidelines.
6. SBAHC Informed Consent Template.
7. Research Obligatory Agreement. Available upon completion of the other requirements.

You are required to obey by the rules and regulations of the Government of Saudi Arabia, the SBAHC IRB Policies and procedures and the ICH-GCP guidelines. You have to note that this approval mandates responding to IRB's periodic request and surveillance result. Drawing your attention to the following:

- Amendment of the project with the required modification to providing Periodical report for this project specially when study extension is required or expiry before study completion.

7.4. Appendix D. Analysis of the pairwise comparison test between category groups

Age	**20–30**	**31–40**	**41–50**	**51–60**
20–30 years	-			
31–40	ns	-		
41–50	*****	*****	-	
51–60	ns	ns	ns	-

Experience	Less than 1 year	1–2 years	More than 2 years
Less than 1 year	-		
1–2 years	ns	-	
More than 2 years	ns	*****	-

Age	Physician	Nurse	Physical therapist	Occupational therapist	Speech therapist	Pharmacist	Radiologist	Laboratory specialist	Other
Physician	-								
Nurse	*	-							
Physical therapist	ns	*****	-						
Occupational therapist	ns	*	ns	-					
Speech therapist	ns	ns	ns	ns	-				
Pharmacist	ns	ns	ns	ns	ns	-			
Radiologist	ns	*	ns	ns	ns	ns	-		
Laboratory specialist	ns	*	ns	ns	ns	ns	ns	-	
Other	ns	*	*	*	ns	ns	*	*	-

7.5. Appendix E: Curriculum vitae

- **Addressee and Contact:** Riyadh city +966565324620 Abrar-6@windowslive.com

- **EDUCATION** Doctor of Physical Therapy Program (GPA: 4.7) |Princess Nourah bint Abdulrahman University 2011-09 - 2019-02
- **EXPERIENCE**

- Physical Therapist |Sultan bin Abdulaziz Humanitarian City. 2019-10 – Present
- Volunteered as Physical Therapist| Titanium Basketball Team (MSK clinic) 2019-2 - 2019-4 Intern| National Guard Hospital 2018-08 - 2019-02 Intern| Sultan bin Abdulaziz Humanitarian City 2018-05 - 2018-07
- Trainer| George Washington University and Hospital 2017-07 - 2017-08

- **LANGUAGE & SKILLS**

IELTS Score 6 Research Skills. Photoshop Designer. Presentation Skill.

- **COURSES**

- SCI rehabilitation – Speaker (Feb 2024)
- Shirley Rayan Lab Training (2023)
- Running Gait Retraining, Online at Physiopedia (30 Mar 2021).
- Spinal Cord Injury Assessment, Online at Physiopedia (29 Mar 2021).
- ASIA Scale Assessment, Online at AsiaElearn (22 Mar 2021).
- Introduction to Spinal Cord Injury, Online at Physiopedia (24 Oct 2020). Wheelchair Fitting,

- **ACTIVITIES**

- Documentation Completion tracking for therapists users in the health information system in documentation completion project at sultan bin Abdelaziz Humanitarian City.2023-2024.
- Conducting Workshops regarding Wheelchair skills for wheelchair users (Precautions, Functional Outcome, Wheelchair Skills and Transfers Skills). 2023

- **RESEARCH**

Ongoing (Quality of life of Spinal Cord Injury Patients Before and After Rehabilitation).