The role of kiosks on health services: a systematic review

Eva Oliveira
2AI, School of Technology, IPCA, Barcelos, Portugal
INESC-TEC, Porto, Portugal
Braga, Portugal
eoliveira@ipca.pt

Paulo Pacheco
Departamento de informática, Universidade do Minho, Braga, Portugal
Braga, Portugal
pauloaalexandre19933@gmail.com

Fátima Santos
Departamento de informática, Universidade do Minho, Braga, Portugal
Braga, Portugal
jacinta7 santos@gmail.com

João Coimbra
Internal Medicine Service, Porto University Hospital Center, Porto, Portugal
joao.coimbra@chsj.min-saude.pt

John Stamper
Carnegie Mellon University, USA
USA
jstamper@cs.cmu.edu

António Coelho
INESC-TEC, Porto, Portugal
acelhim@fc.up.pt

Hugo Paredes
INESC-TEC, Porto, Portugal
Porto, Portugal
hparedes@utad.pt

Joana Alves
2AI, School of Technology, IPCA, Barcelos, Portugal
INESC-TEC, Porto, Portugal
Braga, Portugal
a19428@alunos.ipca.pt

Nuno Feixa Rodrigues
2AI, School of Technology, IPCA, Barcelos, Portugal
INESC-TEC, Porto, Portugal
Braga, Portugal
nfr@ipca.pt

Abstract—Introduction: Emergency department visits have increased substantially, leading to a significant rise in waiting time for patients. Several kiosk-based solutions have been introduced to reduce waiting times in healthcare facilities and to increase efficacy and user satisfaction. Purpose of the Study: This systematic review aims to identify the most effective self-service kiosk features for collecting patients’ health information and to evaluate their acceptability among elderly and less educated populations, despite not being the focus, there is potential in the development of the system interface to facilitate the perception and understanding of those with less digital literacy. Methods: We conducted a systematic review of studies on diagnosis, replacement of face-to-face consultation, and triage kiosks published between January 2009 and March 2023 in the databases PubMed, IEEE Xplore, Web of Science, Cochrane Library, ScienceDirect, and Scopus. Results: The eight analyzed studies included 2,298 participants in total, with participants aged between 16 and 94 years. Most studies provided kiosk assistance. Elderly patients demonstrated the capability and willingness to participate in technological interventions. Conclusion: User interface elements were the most critical features in health kiosk design, followed by clear communication and patients’ understanding of the benefits associated with kiosk use. The high levels of kiosk acceptance and satisfaction observed indicate a significant opportunity for the introduction of self-service kiosks in various healthcare contexts.

Keywords— Health Kiosk; Self-Service Kiosk; Emergency Departments; Primary Health Care; Effectiveness; Systematic Review

I. INTRODUCTION (HEADING 1)

Self-service kiosks have been used in a variety of healthcare areas and for different purposes, noteworthy for administrative processes, screening, triage, health diagnoses and replacement of face-to-face consultations [6]. The triage kiosks in particular serve as a pre-consultation tool, allowing healthcare professionals to assess a higher number of patients in less time [5]. One study demonstrated that placing kiosks in the waiting room allowed patients to use their waiting time more productively by providing relevant information to be used later in the health delivery process [7]. Concerning diagnostic systems, they facilitate the diagnosis of common diseases by performing a set of pre-established physiologic and mental tests. Data obtained are then compared with the information available in the kiosk workstation [8, 9].

Public places have been used for health kiosks, particularly for population screening or control, as a form of health surveillance of elderly communities [5]. This approach has been increasingly sought after in places with poor access to electricity, transportation, communication and shortage of doctors, medicines and other resources, replacing face-to-face consultation [10]. Despite the potential reported in the literature for using self-service kiosks to improve several healthcare processes, there is no systematic review on the subject. Here, we undertake a literature review aiming to identify and characterise self-service kiosk’s efficacy features that improve health information collection to reduce health professionals’ workload and patient’s waiting times. Moreover, we also assess kiosks acceptability by the elderly and less educated population as these are well-known population with increase technology resistance [11,12]. The results of this study identifies relationships between studies, offering a more concrete interpretation of the efficacy features of kiosks in health services. A 2023 study focused on e-triage interventions and their impact on triage efficiency using Kiosks in Emergency Departments [24].

II. METHODS

A. Search strategy

This systematic review was conducted using the PubMed, IEEE Xplore, Web of Science, Cochrane Library, ScienceDirect, and Scopus databases, considering only articles published between January 2009 and October 2019. The search terms included "hospital kiosks," "public health
kiosk,” "health kiosk,” "healthcare kiosk,” "systematic review kiosk,” "hospital kiosk and medication,” and "urgency kiosk.” Boolean operators were used among the terms to obtain more accurate search results. The chosen keywords were related to kiosks in the health sector. Newspapers and books were also considered for analysis. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed [13], but the protocol was not registered on the PROSPERO repository.

B. Inclusion and exclusion criteria

Studies of self-service kiosks were included from the fields of clinical diagnosis, triage, and replacement of face-to-face consultation. Only English-language articles were considered. Review articles and studies without abstracts were not included. Studies related to management, information, prevention, and telemedicine were excluded during the selection process as they do not focus on collecting patient health information. Pediatric care was not considered because it is exclusively intended for an underage population. Articles addressing specific pathologies or those that did not provide full text or relevant results for the study were excluded during the screening process.

C. Study selection

Two reviewers (JS and PP) collected data and analyzed it independently. Articles that met the criteria were then reviewed by two more reviewers. Each reviewer classified the articles based on the main aspects of this research to obtain the relevant articles for the final review. Any differences of opinion were resolved through discussion and consensus meetings.

D. Data extraction

Two reviewers (JS and PP) independently extracted a set of information from the studies, using the CASP (Critical Appraisal Skills Programme) [14] checklist to support extraction. Throughout this process, both reviewers verified the methodological quality of the studies by assessing the limitations referenced by them to identify possible risks of bias.

E. Data items

The extraction variables taken from each study were: (1) Domain (the process that the kiosk will perform), (2) Area (location of the kiosk), (3) Country (the country where the kiosk was tested), (4) Study period (length of the kiosk test period), (5) System Objective (purpose of the kiosk), (6) Architecture (characteristics of the system architecture), (7) Population (characteristics of the population that used the kiosk), (8) Study parameters (metrics used to evaluate the kiosk), and (9) Results (effects of the application of the kiosk).

System architecture refers to the type of system implemented, the description of the biosensors and their connectivity, and the use and presence of a touchscreen. The population variable contains the number of participants who used the kiosk and their average age or age range. It also includes the presence of assistance in the use of the kiosk or patient referral.

III. RESULTS

A. Study Selection

According to the defined search strategy, we identified a total of 1438 studies from the database search and 11 studies from other sources (newspapers and books). After removing duplicates (n = 820) and rejecting studies after abstract review (n = 499), we obtained 130 studies on healthcare kiosks. Applying exclusion criteria (n = 97), we obtained 33 studies. After reviewing the full articles, more studies were rejected due to a lack of relevant results for the study (n = 25). In the final analysis, we considered a total of 8 studies for the systematic review. A summary of this selection is shown in Figure 1.

B. Study characteristics

In all 8 studies, 4 were considered from the triage domain and 4 from face-to-face consultation replacement. Of all the associated countries, 4 belonged to America, 2 to Asia, 2 to Europe, and 1 to Oceania. Regarding the intervention area, 5 studies were conducted in healthcare facilities (Hospital, Polyclinic, Clinic), and the remaining outside this context (Community room, Rest Homes, Private Apartments, University, Villages). The study period varied between 8 weeks and 12 months. The total number of participants was 2298, with a mean age ranging from 12 to 94 years. Most kiosks provided usage assistance. The main objective of the system in the various studies was to measure vital signs and extract health information from patients according to the applied domain. The system's type of architecture varied between Web App and Software. Most of the studies addressed the presence of biosensors (height, weight, blood pressure, pulse oximeter, pulse rate, glucometer, and heart rate) and their type of connectivity at kiosks. The use of touchscreen was predominant in most studies. The characteristics of the studies based on the above variables are summarized in tables 1 and 2.
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The authors of the studies were contacted to obtain missing information or confirmation of data extracted for the systematic review. In [15], the age range was clarified by contacting the author since it was not mentioned in the article.

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**Figure 1-Flow of studies in systematic review**

**Table 1 - Studies Extracted Characteristics**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Domain</th>
<th>Area</th>
<th>Country</th>
<th>Study Duration</th>
<th>System Objective</th>
<th>Architecture Type</th>
<th>Type</th>
<th>Purpose</th>
<th>Area</th>
<th>Study Parameter</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coyle, T., et al (2019)[22]</td>
<td>Triage</td>
<td>Hospital</td>
<td>Canada</td>
<td>10 weeks</td>
<td>Self-identify and capture the initial time of patient arrival; admission, and primary complaint at triage</td>
<td>Web App, BP, height, age, NA</td>
<td>89.5, 55 (2018)</td>
<td>Age</td>
<td>Assistance Presence</td>
<td>Prove that ED patients can use a kiosk. BP produces a result that the patient can review their vital signs. BP also monitors BP. BP produces a result that the patient can review their vital signs. BP also monitors BP. BP monitors the heart rate and the heart rate monitor generates difficulties and is the device that takes longer to collect.</td>
<td>136, 27, 79y, Yes</td>
</tr>
<tr>
<td>Ng, G., et al (2018)[14]</td>
<td>FCR</td>
<td>Polyclinic</td>
<td>Malaysia</td>
<td>12 months</td>
<td>Measure patient physiological parameters and confirm that and that comorbid lab results classify patients. Furthermore, also produce a readout on request for the patient</td>
<td>Web App, BP, PO, Bluetooth</td>
<td>842, 12, 8ry, No</td>
<td>Age, PO</td>
<td>Assistance Presence</td>
<td>Evaluate distance, patient satisfaction with the management process, health-related quality of life, and the occurrence of any adverse effect.</td>
<td>--, --, --</td>
</tr>
<tr>
<td>Silva, J., et al (2017)[11]</td>
<td>FCR</td>
<td>University</td>
<td>Portugal</td>
<td>21 days</td>
<td>Measure vital data prior to a consultation, in the scope of a population screening, or for routine monitoring</td>
<td>Web App, Scale, BP, PC, Bluetooth</td>
<td>74, --, Yes</td>
<td>Age</td>
<td>Assistance Presence</td>
<td>Determine the potential of a kiosk to facilitate the management of patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>27, 78, 79y, Yes</td>
</tr>
<tr>
<td>Soares, E., et al (2016)[23]</td>
<td>FCR</td>
<td>University</td>
<td>Portugal</td>
<td>2 weeks</td>
<td>Automate the management of older patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>--, BP, --, --</td>
<td>99, 61, 4 (6.7)</td>
<td>Age, PO</td>
<td>Assistance Presence</td>
<td>Determine the potential of a kiosk to facilitate the management of patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>--, --, --</td>
</tr>
<tr>
<td>Bahadin, E., et al (2017)[11]</td>
<td>FCR</td>
<td>University</td>
<td>Portugal</td>
<td>2 months</td>
<td>Automate the management of older patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>--, BP, --, --</td>
<td>99, 61, 4 (6.7)</td>
<td>Age, PO</td>
<td>Assistance Presence</td>
<td>Determine the potential of a kiosk to facilitate the management of patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>--, --, --</td>
</tr>
<tr>
<td>Chung, C. F., et al (2016)[22]</td>
<td>FCR</td>
<td>Clinic</td>
<td>USA</td>
<td>9 months</td>
<td>Used to measure BP</td>
<td>Web App, BP, --</td>
<td>--, --, --</td>
<td>BP</td>
<td>Assistance Presence</td>
<td>Determine the potential of a kiosk to facilitate the management of patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>152, --, Yes</td>
</tr>
<tr>
<td>Aso, H. S., et al (2014)[24]</td>
<td>FCR</td>
<td>Hospital</td>
<td>New Zealand</td>
<td>12 weeks</td>
<td>Gives helpful information to older people. Store medical history of older people for managing their health conditions</td>
<td>Software, BP, Cables, Yes</td>
<td>99, --, Yes</td>
<td>Age</td>
<td>Assistance Presence</td>
<td>Determine the potential of a kiosk to facilitate the management of patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>27, 78, 79y, Yes</td>
</tr>
<tr>
<td>Demiris, G., et al (2013)[25]</td>
<td>FCR</td>
<td>Community room</td>
<td>USA</td>
<td>8 weeks</td>
<td>Provides users secure access to their patient profile with the ability to capture relevant vital sign data into their personal health-record, and to view pertinent health-related content</td>
<td>Software, BP, HR, Glucometer, PO, scale, Bluetooth</td>
<td>27, 78, 79y, Yes</td>
<td>Age, PO</td>
<td>Assistance Presence</td>
<td>Determine the potential of a kiosk to facilitate the management of patients with chronic conditions to complement face-to-face FCP visits.</td>
<td>27, 78, 79y, Yes</td>
</tr>
</tbody>
</table>

**Information not provided by the study is represented by a dash; FCR = Face-to-face consultation replacement; PCP = Primary Care Physician; BP = Blood Pressure; PO = Pulse Oximeter; HR = Heart Rate; MA = Medical Assistant; USA= United States of America**

D. Risk of bias within studies

The limitations of each study were analyzed to assess the risk of bias. The use of assistance was a limitation in most studies, except for studies [5, 18]. The help provided on-site by assistants when a patient encountered a question or problem using the kiosk significantly influenced usability results.
streamlining procedures in healthcare facilities, expanding healthcare access to populations that otherwise would not have it, and performing large scale population screenings at low marginal costs. This shows that kiosks could help more isolated people lacking some essential health services. Almost all studies use biosensors, but only some transmitted the data via Bluetooth [5, 15, 17]. This communication brings benefits in terms of interoperability and accessibility. However, most studies reported problems with Bluetooth that could not be solved in a reasonable time and prevented kiosk usage, as mentioned in [15]. Studies [5, 15, 16] present biosensors that use batteries as an energy source, and [5,15] reported that the use of batteries could create the need for their replacement, which may indirectly interfere with the usability of the system. Biosensors with Bluetooth Low Energy (LE) technology are a possible alternative for battery replacement since it is intended to provide considerably reduced power consumption. The quality of the measurements performed by the sensors compared to those performed by health professionals was another evaluation performed in [7, 18, 19]. Most patient respondents in [19] thought kiosk blood pressure (BP) were accurate, even though some reported higher values of BP. The physicians explained that this happened because patients did not have the chance to sit and wait in the reception area before measuring their BP. These instructions regarding the BP sensor should be considered at any kiosk or may be provided by clinical staff in an initial process to reduce unrealistic measurements. A discrepancy described in [18] between the values of measurements taken by the kiosk and those taken by clinical professionals affected confidence in the system. This difference in BP readings may be caused by BP measurements changing from minute to minute and can be affected by various factors. A possible factor is that the kiosk’s BP takes single measurements rather than repeated measurements that result takes longer to collect due to the cuff not being rigid. In the choice of this device, one must take into account the type of cuff to avoid the need for manual adjustment to the user’s arm [5]. The incorrect or difficult placement of the cuff hints that a cuff-less blood pressure device would be preferable [15]. The users with several layers of clothing have difficulty performing the blood pressure procedure since it involves clearing the left arm of anything that might block the circulation. The choice of a BP wrist monitor is a solution to this problem since the measurement will be taken at the wrist, and there is no need to collect clothing. Blood pressure measurement is a procedure that requires a set of several instructions, making it difficult for the user. Instructions with more compact information to be presented simultaneously with the measurement will make the procedure more supportive and avoid forgetting instructions [5]. The concern of the providers, patients, and clinic staff and the need to obtain accurate measurements require that accuracy must be taken into account in the choice of BP or another type of sensor. Good accuracy or certification of the sensors provides confidence to the healthcare professionals and patients in the results obtained from the measurements [19].

In [19], hygiene concerns prevented patients from using the kiosk. Hospital institutions must provide solutions to ensure the kiosk’s hygiene and transmit a secure kiosk usage environment to the patients. The kiosk used by different
patients requires constant hygienic cleaning of the sensors, which is not always possible. Thus, sensors that are easy to clean or without body contact should be considered. The oximeter is a small and extremely portable device, but at the same time, some restrictions have to be made to make it theft-proof in public locations [5]. The need for the calibration step reported in [5] led to users spending an excessive amount of time performing this procedure. Therefore, the choice of sensors that require calibration should be avoided. Some patients were confused and concerned by the prehypertension notations on the kiosk paper printout in [19]. Results classification can make patients more anxious and worried, affecting their state of health, and should be avoided after each measurement. Some patients had concerns about measuring their BP in public because of having to sleeve up an arm or others seeing their BP readings [19]. The location of the kiosks in a private area, outside the field of view of other patients, makes the user more comfortable interacting with the system. The kiosks should also be placed in places that do not affect the workflow of hospital institutions. The use of touchscreen was mentioned in [7, 5, 15, 16] to offer direct and easy-to-use interfaces. This interaction modality has reached ubiquitous levels. The replacement of standard procedures with the use of kiosks, showing that independent use of kiosks is beneficial considering the possible use cases [5]. The kiosk's implementation resulted in a saving of $5335 concerning face-to-face consultations, offering a better cost-benefit option to patients [18]. Modularity allows for the health kiosk to be easily adapted for different use cases [5]. The automation of hospital procedures [15] and the application of kiosks in community environments (eliminating the need for monitoring equipment to be installed in every residence) [17] have advantages of being cost-effective. The cost-effectiveness of a healthcare kiosk in clinical care is a parameter to evaluate in a kiosk's development since this analysis can also bring cost benefits to patients derived from reduced physician visits and the flexibility of alternative health service options [7, 16]. The kiosk may be a feasible care option; however, studies [7, 18] present a low sample size, which contributes to limit the generalization of the results. In the kiosk's test phase, one should have a heterogeneous and high sample size to obtain a study that provides well-founded evidence. In [15], the Brazilian patients do not need assistance makes the results of the usability of the kiosk more reliable. The identification time at the self-service kiosk was 13.6 minutes faster, half the time of the standard procedure performed by health professionals. Nurses can prioritize triage by collecting the main complaint during the identification process, allowing them to select patients for triage quicker and more accurately [20]. The use of kiosks allowed more time for physicians to be allocated to the treatment of other patients since the system allowed performing the procedures, which would typically be performed by health professionals [7, 19]. The kiosk's usage for taking blood pressure and performing other activities allows the physician to spend more time talking with the patient [22]. In the same study, nurses gained about 1.5 minutes per patient, which was used to perform other tasks, such as preparing documents, educational materials, and handling telephone encounters and voicemails [19]. Participants who used a citizen card took 5.2 seconds less to complete the identification process than participants who manually entered the data, saving them minutes of form filling [5]. Kiosk usage time was not highly time-consuming, which is beneficial considering the possible use cases [5]. The time of use in [5] was slightly shorter than study [15] since users had a technological background. In relation to study [17], the time of use was the longest due to the cognitive evaluation data's collection performed at the kiosk. In addition, the study required patients to be enrolled for two months, which made it more conducive to withdrawals.

V. LIMITATIONS

Our study has several limitations. The number of final studies for review was reduced because we established specific inclusion and exclusion criteria. Another possible limitation of the study is the use of keywords that may not be sufficient to retrieve all articles related to self-service kiosks in the health area. The quality of the studies varied, and only half of them were randomized and controlled with usual care.

VI. CONCLUSIONS

Self-service kiosks are a promising technology in the healthcare sector in various environments. The kiosks' acceptability was positive for both healthcare professionals and patients. Elderly or less educated patients were able to complete the kiosk's session even without assistance, considering them easy to use. User interface elements were the most relevant efficacy feature, allowing the kiosks to be adapted to patients of different age groups and educational levels. The replacement of standard procedures with the use
of the kiosks relieved health professionals from some simple routine tasks. Biosensor technology has reached a sufficient level of maturity in terms of accuracy and usage simplicity, making it a very important component of health kiosks. More studies are needed to investigate the long-term impact of health kiosks, particularly in emergency settings where waiting times are increased by crowding and in populations with limited access to primary care.

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