

SURVEY

A Comprehensive Analysis of Healthcare Websites Usability Features, Testing Techniques and Issues

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ABSTRACT Healthcare has evolved significantly over time, from traditional healthcare systems to cutting-edge medical technologies. As these technologies advance, researchers have become interested in their usability. The usefulness of healthcare websites helps to provide more precise medical information. A comprehensive review of the literature is required to identify usability features, techniques, and issues in healthcare websites over a specified time period. In this study, articles from the years 2017-2021 are reviewed from well-known digital libraries i.e, IEEE, ACM, and ScienceDirect that include papers from various conferences, magazines, books, and journals. Initially, the study found **10,512** titles based on the search string developed from the proposed research questions which were then further filtered down to a total of **55** papers. This systematic literature review (SLR) summarises and collects relevant data in response to pre-defined research questions. This analysis of existing research will help website designers and developers, in developing more user-friendly healthcare websites for the users. In the future, this SLR will help in determining the optimal solutions and developing a framework for the identified usability challenges and limitations. It also includes employing the usability evaluation tools discovered by researchers to identify and fix usability issues on websites.

INDEX TERMS Healthcare websites, usability, usability testing, usability features, usability problems, human-computer interaction.

I. INTRODUCTION

With the progress of technology, it is vital to employ new and cutting-edge methodological tools and methods. It may be necessary to design or apply new usability testing techniques in the future, or to examine other methods of assessing usability that are more relevant and valuable to researchers or developers [1]. To make effective tools, more research needs to be done on making interfaces that are easy for users. Usability issues have a greater impact on users [2]. As the Internet evolves, new online services in a variety of

forms may become available. As a result of this evolution, its information must be accessible to a diverse group of people. Due to the aging problem, elderly persons (those aged 60 and above) have limited abilities and have had difficulty in connecting with healthcare websites. In addition to regulations and guidelines that aid in the promotion of accessible and relevant web content, different accessibility and usability problems arise, because the majority of websites are not developed with these users in mind, the problems that impact older persons have received little attention [3]. To ensure compliance with the accessibility and usability requirements, all important stakeholders must be included in the websites design phase. The goal is to minimise their

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TABLE 1. List of abbreviations.

HCI	Human Computer Interaction
SLR	Systematic Literature Review
RQ	Research Question

age-related usability issues. If there are digital and social differences then improvements are necessary, especially if the target user groups have impairments or limited abilities, or when the websites are health-related. Websites should be effective, efficient, and gratifying in their delivery of accurate and timely information [4]. However, when new or unskilled users deal with complicated interfaces, they frequently struggle more [5]. The usefulness of a Graphical User Interface (GUI), especially for persons with poor vision, requires special consideration. As a result, before releasing software for potential uses, it is vital to conduct a usability test that considers these individuals into account [6].

A. ABBREVIATIONS

The list of abbreviations are given in Table 1.

B. PROBLEM DEFINITION

According to this SLR, a lot of work has been done to improve the usability of healthcare websites, either by testing or by presenting potential solutions to usability issues that have been identified. Specifically, this SLR examines the following three areas of the usability of healthcare websites:

- Identifying the primary usability elements in current healthcare websites.
- Identifying the approaches used to find usability issues in healthcare websites.
- Addressing usability problems in healthcare websites

The proposed research gives a brief description of the usability features, methods, and issues in Tables 7, 8, and 9. All work is predicated on predefined research questions and keywords developed during the research process. The findings of this research will be beneficial to HCI researchers, website developers, and designers because they can use the results as evidence to aid the investigators in their work. Researchers may assess usability using existing methodology and tools, while website designers and developers can use the features, methods, and problems discovered to help them create the most usable web interfaces.

C. RESEARCH OBJECTIVES & CONTRIBUTIONS

The current study aims to address the complex phenomenon of the healthcare websites usability for patients and physicians. The objective of the current paper is to identify and analyze usability issues that have a high impact on healthcare websites. To achieve the research objectives, a systematic literature review is performed. The findings of the study are analyzed based on decades and study strategy. Moreover, usability features, techniques, and issues are identified from the literature through the defined criteria.

The following defined questions are addressed to achieve the aforementioned objectives.

- *What are the most significant usability features for healthcare websites?*
- *For usability testing in healthcare websites; the researchers proposed how many optimum methods/solutions during the census 2017-2021?*
- *What are the usability problems in healthcare websites?*

D. PAPER OUTLINE

The paper is organized as follows: Methodology for the SLR is explained in Section II. The results are presented in Section III. The discussion is presented in Section IV. Limitations of the work are discussed in Section V. Conclusion and future directions are given in Section VI.

II. RESEARCH METHODOLOGY

The amount of information available in healthcare websites is rapidly increasing. Healthcare websites create a vast amount of data on a daily basis, which limits their use. It is possible to make a substantial contribution to the effective development of healthcare websites by examining their usability. Researchers play an important role in improving the usability of these websites in this regard. From website visitors to website developers, usability influence a multitude of areas. The primary goal of research should be; to improve usefulness by identifying methods for improving usability features, and challenges. Usability issues in healthcare websites have been identified on a broad scale. Numerous approaches are being employed to accomplish this task. critical features and usability concerns are being identified. This SLR has a purpose to gather and analyze data systematically. Papers from the year 2017-2021 are selected for this SLR because the chosen timeframe is the most recent one, the timeframe from 2017 to 2021 was chosen to review the most updated papers published during this period.

A. ROLE OF USABILITY IN HEALTHCARE WEBSITES

According to the study, the usability attribute should be taken under consideration during the development of healthcare websites. All key stakeholders must be involved in the development of websites to ensure that they are as accessible and usable as possible. To address usability challenges of healthcare websites, particularly for persons with impairments or limited abilities [4], the following goals must be met:

- Following the regulations and guidelines that have been developed to ensure the delivery of accessible and usable web content, there are still certain accessibility and usability issues that need to be addressed.
- As most websites are not designed for users with mental health problems, less attention has been given to the difficulties faced by these users, in particular to people with health-related problems at older ages [3].
- User-friendliness and accessibility are important attributes of web interfaces and they should be accessible from a wide range of devices.

- The user interface should be accessible, allowing patients to use it in different situations. This trait will assist them to obtain the necessary information quickly and more easily [7].

Medical websites contain all of the necessary data for information and diagnosis. Usability refers to the ease of use that should be seen on every healthcare website. The usability features are utilized in conjunction with one another to accomplish a task. The data analytics assist in identifying problems, features, and testing methodologies for such websites. The results of this paper eventually will aid website designers and developers, as well as academic researchers who provide recommendations on how to create a useful design for healthcare websites.

B. RESEARCH PROCESS

Numerous studies have been conducted with the use of SLR, most notably in the area of properly identifying complexities [8]. Several methods exist for locating certain types of problems in very challenging situations. The systematic analysis comprises identifying, presenting, and assessing all accessible material that is relevant to the research questions and also publishing them, which gives the research community a better knowledge of a certain subject [8]. The strategy for completing the SLR is determined by following the protocol described in [9]. Three types of actions are included: protocol creation, SLR implementation, and evidence reporting.

C. RESEARCH DEFINITION

The primary objective of this SLR is to undertake a comprehensive assessment of the present state of knowledge in the field of healthcare. A thorough investigation was conducted, which included a review of healthcare website features, issues, and testing methods. These data analysis features assist website designers and researchers in identifying specific usability issues and their solutions. This also informs designers about which usability attributes should be taken into account to increase usability. The purpose of this study’s systematic literature review is to undertake a systematic examination of medical and healthcare websites to provide simple and descriptive metrics for the usability features found on these sites. It also proposes a series of guidelines to follow to complete a successful SLR with particular objectives. Figure 1 depicts the processes required to conduct a thorough systematic literature review [10].

D. RESEARCH PLAN AND METHOD

In order to conduct the planned research study, an SLR methodology based on the recommendations offered by kitchenham is followed [10]. Figure 2 provides various steps to complete the proposed SLR, with each step being represented by a number. The first step is about framing research questions, and the study comes up with three questions to start with. Afterward, a search string is created

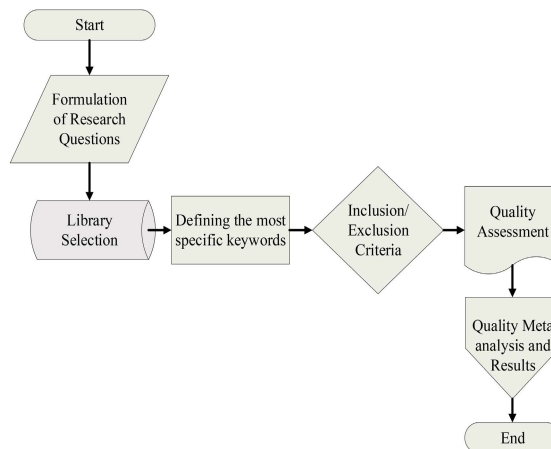


FIGURE 1. Steps for systematic literature review.

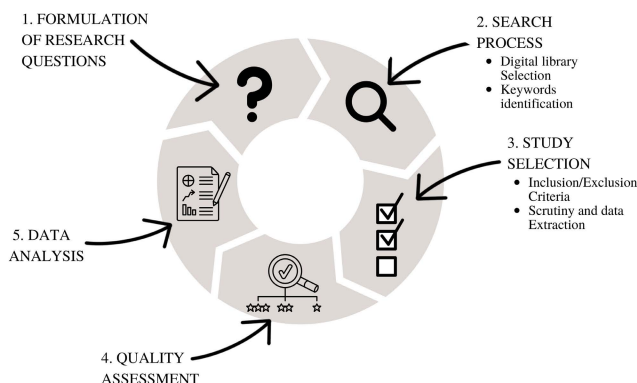


FIGURE 2. Research protocol followed by the proposed SLR.

to locate relevant articles that may be downloaded from the various digital libraries that are identified. Based on the information included in the articles, the inclusion and exclusion criteria is established. The next step is to rank articles based on numerical values given to the papers based on their relevancy to the research questions as they analyze how it is to add those articles to this SLR and also it impacts on the overall quality of this research, the relevance rate of papers to each question is shown in Table 6. All of these phases are explained in greater detail in the later sections.

E. RESEARCH QUESTIONS

This SLR circulates around the research questions throughout the research process and are answered in Section III. Following are the research questions (RQ’s) formulated in this article:

- **RQ1:** What are the most significant usability features for healthcare websites? Healthcare websites provide several usability aspects that should be evaluated and utilized in the future.
- **RQ2:** For usability testing in healthcare websites; the researchers proposed how many optimum methods/solutions during the census 2017-2021? To assess

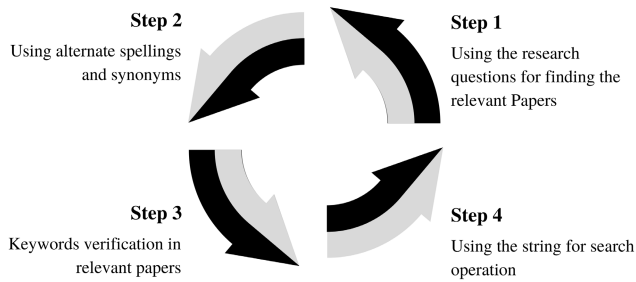


FIGURE 3. Steps involved in the search process.

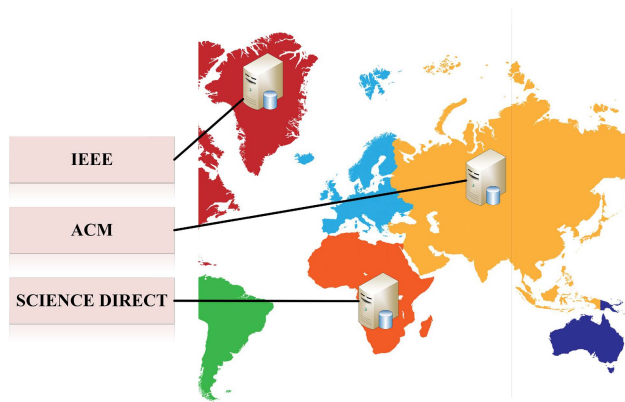


FIGURE 4. Libraries for the proposed research.

the usability of healthcare websites various methods and techniques are examined. These methods must be identified to assist researchers in identifying methodologies concerning usability.

- **RQ3:** What are usability issues exist in healthcare websites? Identifying usability problems with existing healthcare websites will benefit both developers and researchers. In the future, designers will avoid these issues, and researchers will address them.

F. SEARCH PROCESS

When conducting an SLR procedure, it is critical to follow a sound approach to ensure that pertinent studies are gathered from the designated digital libraries. After generating a collection of the most specified keywords, a systematic technique for obtaining the most relevant articles for the research is used. These keywords are used to conduct searches in some peer-reviewed digital libraries for research publications i.e. conference papers, journal articles, book chapters, and surveys etc. Numerous keywords associated with usability characteristics, testing procedures, and identifying usability problems on healthcare websites are searched in the libraries specified in figure 4 following the research questions (provided in Section II-E). The Steps involved in the search process are shown in figure 3. The digital libraries used to obtain relevant primary publications based on the keywords selected are shown in figure 4. These libraries are chosen because they are the most extensively used and

TABLE 2. List of keywords selected for searching.

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('healthcare websites' OR 'medical websites') AND ('usability' OR
'usefulness') AND ('usability evaluation' OR 'usability testing')
AND ('features' OR 'usability features')
  
```

publish high-quality articles. A list of keywords is compiled while searching for relevant articles in these libraries. These keywords have been kept as precise as possible, and concise terminology have been chosen for the task at hand.

Rather than employing shorter keywords, a combination of words is applied, resulting in a large number of articles, such as (usability of healthcare websites). To overcome this issue, the paper used inclusion and exclusion criteria to ensure that only relevant studies are included. Appropriate keywords are selected to locate relevant articles. These keywords have been chosen in combination with the research topic and the intended suggested study. The search is filtered by a date ranging from the year 2017 to 2021. As a result, articles are found in the form of conference proceedings, workshop papers, journal articles, books, and a variety of other accessible resources. To find a collection of relevant articles with the help of predefined keywords for searching, all the digital resources are accessed and searched through a manual process.

The Mendeley [11] research management application for citation is used to keep track of all of the bibliographic information. The complete search mechanism is shown in figure 5. Using the root directory as a starting point, a second folder is created to collect relevant articles from the specified libraries. Relevant titles of **10,512** are found. To begin, each folder is manually categorized, and all of the articles that are downloaded are renamed with their titles. As a result, duplicate articles are removed from the database, which allows for saving time while evaluating the quality of articles. While filtering the papers manually, **239** papers based on their titles are selected. Furthermore, the publications are thoroughly evaluated following the abstracts supplied, resulting in a total of **84** relevant papers. Moreover, for the quality assessment, these articles are selected in accordance with the information provided in these research articles. After applying all the filters, for data extraction **55** papers are finalized. Due to the fact that all of these steps are performed manually, including/excluding articles is a time-consuming process. The complete details of the papers are shown in figure 6. The Mendeley [11] software-based tool for the bibliographic information is used to keep track of the final 55 papers.

G. STUDY SELECTION

The selection process uses well-known digital libraries to search for and retrieve papers that are most pertinent to addressing the research objectives and questions. The

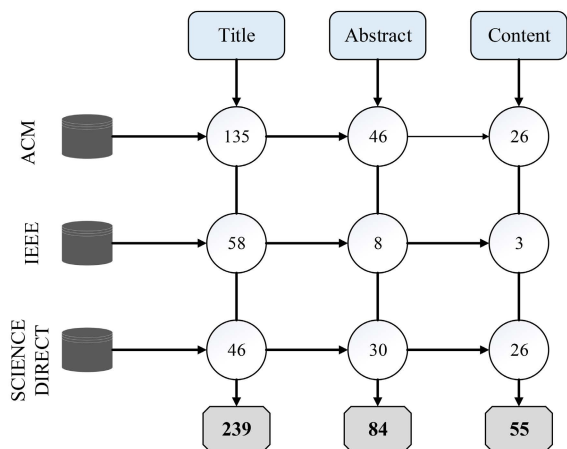


FIGURE 5. Filtering of papers by title, abstract, and contents.

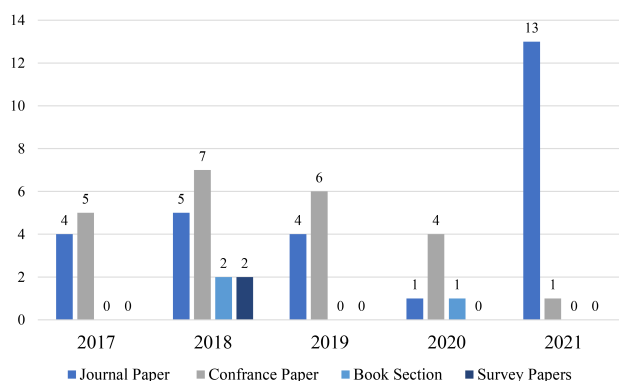


FIGURE 6. Types of selected papers.

various papers (10,512 articles) acquired from libraries will need to be filtered further before assembling a selection of the most pertinent papers for the evaluation. The accumulating papers undergo an inclusion and exclusion process. To determine which papers should be included in the final pool, the authors considered the following criteria:

- Only those papers were evaluated that exhibit a comprehensive grasp of the usability of healthcare websites.
- Those papers that provide the facts and background information necessary to adequately discuss and reply to the research questions posed in this work are included.

H. STUDY SELECTION PROCESS

When it comes to SLR, selecting articles is a difficult task. Confusion arises at every level, especially when authors select papers while considering whether to include them in the final pool or not. As a result, the most important step is to conduct a thorough study of the journal publications. Correct selection of the paper consists of three phases: the first step involves selecting relevant papers based on their titles by reading out the titles of the papers. A total of

TABLE 3. Selection of primary studies.

Library	Keywords based Search results	Filtration by Title	Filtration by Abstract	Filtration by Contents
ACM	1,071	135	46	26
IEEE	58	58	8	3
Science Direct	9,383	46	30	26
Total	10,512	239	84	55

TABLE 4. Inclusion/Exclusion criteria of the relevant articles.

Inclusion Criteria
<ul style="list-style-type: none"> • Only those papers ranging from the year 2017 to 2021 are included • The paper written in English language • The paper that is most relevant to the topic • The papers are first checked whether the paper has sufficient information about the research questions • The content of each article is checked whether it is according to the topic selected or not
Exclusion Criteria
<ul style="list-style-type: none"> • Those papers that are out of the range of the year 2017-2019 • Gray papers • Paper that is written other than the English language • Paper that does not answer the research questions

239 papers are included in this evaluation, all of which were chosen solely on their titles. In the second phase, the papers that are selected based on their titles are filtered using the abstract of each paper, which is accomplished by reading out the abstracts of relevant articles. A total of 84 papers are chosen based on the abstract in the second stage of the process.

While at the third and final stage, papers are chosen based on the content presented in the paper, which is determined after the information has been thoroughly examined. To extract the relevant information, a total of 55 papers are selected for the final study for data extraction. All of this process is carried out manually. Table 4 shows the inclusion and exclusion criteria.

In Table 3, the procedure for selecting of key studies for the proposed systematic literature review is shown. Figure 5 represents the selection of papers through title, abstract, and content. Figure 6 shows the year and type of the final number of papers. Table 5 presents details of years for the total number of papers for the study. Table 6 depicts the ranking of articles based on filtering for quality assessment. Figure 8 shows the total percentage of papers selected from respective libraries.

I. QUALITY ASSESSMENT

A ranking criteria is applied for the quality assessment after the inclusion/exclusion step on the final papers. These papers are explained in detail below. This process shows how much a paper is similar to the research question.

TABLE 5. Year-wise representations of selected papers.

2017	2018	2019	2020	2021
[6]	[12]	[13]	[7]	[14]
[15]	[16]	[17]	[18]	[19]
[5]	[20]	[1]	[21]	[22]
[23]	[24]	[25]	[26]	[27]
[28]	[29]	[30]	[31]	[32]
[33]	[2]	[34]	[35]	[36]
[37]	[4]	[38]		[39]
[40]	[41]	[42]		[43]
[44]	[45]	[46]		[47]
	[3]	[48]		[49]
	[50]			[51]
	[52]			[53]
	[54]			[55]
	[56]			[57]
	[58]			
	[59]			

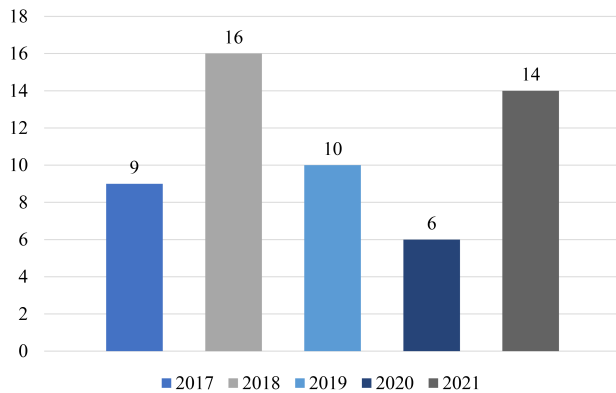


FIGURE 7. Year-wise distribution of selected studies from year 2017-2021.

RQ1. What are the most significant usability features for healthcare websites?

RQ2. For usability testing in healthcare websites; the researchers proposed how many optimum solutions during the census 2017-2021?

RQ3. What are the usability problems in healthcare websites? The authors analyzed every paper manually, and after the analysis of each paper their relevancy is shown based on below scoring:

- **0** - In case of paper that do not show any relevancy to the respective question.
- **0.5** - In case of paper show some relevancy to the respective question.
- **1** - In case of paper shows full relevancy to the respective question.

Based on the quality assessment the papers are evaluated according to the predefined research questions. Table 6 shows the assessment results for each article. After completing the assessment procedure and assigning weighted values to each article is based on the research questions, the paper is arranged in descending order with the most relevant paper at the top and the less relevant at the bottom. After executing this procedure, it is discovered that an article

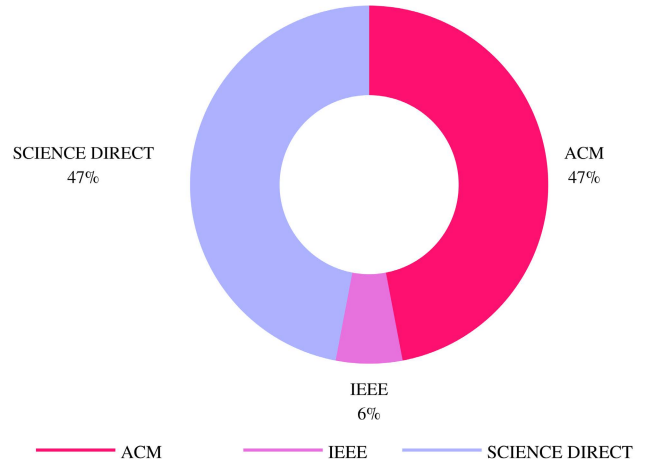


FIGURE 8. Percentage contribution of articles/papers.

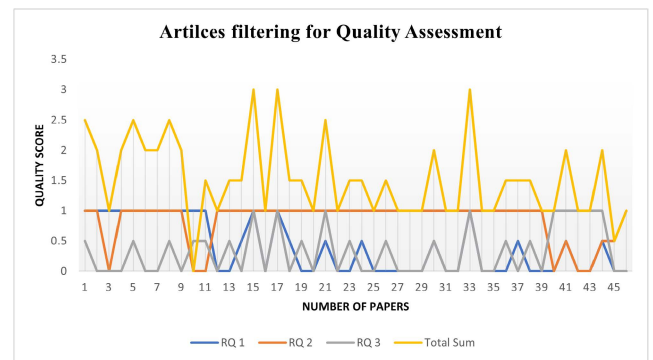


FIGURE 9. Quality assessment of articles.

summed value is more than or equal to 2, indicating that the paper is most relevant to the selection criteria. Figure 9 shows the quality assessment of articles after filtering diagrammatically.

J. DATA EXTRACTION

All of the analysis is stored and evaluated after the search process, the quality assessment phase, and the aggregation of the most relevant papers. Important information gathered during the evaluation and inclusion/exclusion phases is presented in the form of a table.

- Figure 6, shows the total number of papers and their information.
- Table 5, shows the yearly distribution of the papers ranging from the year 2017 to 2021.
- Figure 7, shows the yearly based distribution of papers.
- Table 7, provides the most significant usability features for healthcare websites.
- Table 8, shows usability testing techniques used for testing healthcare websites during the census 2017-2021.
- Table 9, presents usability issues identified in healthcare websites.

TABLE 6. Articles filtering for quality assessment.

S. No	Ref	Scoring									Total Sum
		RQ.1			RQ.2			RQ.3			
		Irrelevant 0	Partially Relevant 0.5	Relevant 1	Irrelevant 0	Partially Relevant 0.5	Relevant 1	Irrelevant 0	Partially Relevant 0.5	Relevant 1	
1	[3]			•			•			•	3
2	[12]			•			•			•	3
3	[34]			•			•			•	3
4	[4]			•			•		•		2.5
5	[50]			•			•		•		2.5
6	[46]			•			•		•		2.5
7	[23]		•		•				•		2.5
8	[15]			•			•		•		2
9	[7]			•			•		•		2
10	[52]			•			•		•		2
11	[35]			•			•		•		2
12	[33]			•			•		•		2
13	[29]		•				•		•		2
14	[13]		•			•				•	2
15	[48]		•			•				•	2
16	[44]			•	•				•		1.5
17	[28]	•					•		•		1.5
18	[41]		•				•		•		1.5
19	[6]		•				•		•		1.5
20	[17]	•					•		•		1.5
21	[25]	•			•				•		1.5
22	[54]		•				•		•		1.5
23	[20]	•					•		•		1.5
24	[22]	•					•		•		1.5
25	[49]		•				•		•		1.5
26	[55]	•					•		•		1.5
27	[27]	•					•		•		1
28	[2]	•					•		•		1
29	[5]	•					•		•		1
30	[43]	•					•		•		1
31	[45]	•					•		•		1
32	[59]	•					•		•		1
33	[24]	•					•		•		1
34	[26]	•					•		•		1
35	[14]	•					•		•		1
36	[56]	•					•		•		1
37	[58]	•					•		•		1
38	[31]	•					•		•		1
39	[42]	•					•		•		1
40	[53]	•					•		•		1
41	[47]	•			•					•	1

TABLE 6. (Continued.) Articles filtering for quality assessment.

42	[18]	•				•	1
43	[21]	•		•			1
44	[36]	•			•	•	1
45	[39]	•			•	•	1
46	[40]	•			•	•	1
47	[57]	•		•			1
48	[38]	•		•			1
49	[51]	•			•	•	0.5
50	[19]		•	•		•	0.5
51	[16]		•	•		•	0.5
52	[1]		•	•		•	0.5
53	[32]		•	•		•	0.5
54	[30]		•	•		•	0.5
55	[37]	•		•		•	0.5

III. RESULTS

A. RQ1. WHAT ARE THE MOST SIGNIFICANT USABILITY FEATURES FOR HEALTHCARE WEBSITES?

Numerous researchers have identified and presented usability features for healthcare websites. The usability of healthcare websites will improve if the features listed below are included. According to researchers, accessibility, efficiency, efficacy, and satisfaction are all desirable characteristics. Utilization of interface elements such as physical buttons and iconic representations, as well as estimation of amplexness, proficiency, and satisfaction are also necessary. Menus, colors, navigation, feedback, video representation, web-based media, content organization, design, and usability all play a vital role in the presentation of the webpages. Healthcare websites must have a variety of elements including images, videos, and have properties of readability, interaction, and reliability.

Accuracy, completeness, technical elements, aesthetics and design, readability, usability, and accessibility are only a few of the basic features of healthcare websites. Table 7 contains the traits, a full description of these attributes, and responses to RQ1. The selected papers cover the years 2017–2021.

B. RQ2. FOR USABILITY TESTING IN HEALTHCARE WEBSITES; THE RESEARCHERS PROPOSED HOW MANY OPTIMUM SOLUTIONS DURING THE CENSUS 2017-2021?

This research question focuses on determining the methodologies utilized in prior studies for usability testing. This SLR proposes several ways for usability testing that are discovered through a systematic process. Several usability testing techniques are identified, including task-based evaluation, qualitative (e.g., interviews), quantitative (e.g., questionnaires), Accessibility Guidelines 2.0 (WCAG 2.0), task-based checklists, semi-structured interviews, software-based testing, Nielsen usability heuristics, generation of a

virtual amblyopia screen, observation, systematic literature review, content analysis, remote usability testing, think-aloud usability testing, guideliner, controlled experiments, remote access method, modified think-aloud, collaborative user experience, System Usability Scale, Qualitative Research via focus group, interview, survey, sampling procedure using codebook, scoping review methodology, omnibus test, tool based evaluation, telephone-based. Table 8 has a full summary of the usability testing approaches. The articles are chosen from the year 2017–2021.

C. RQ3. WHAT ARE THE USABILITY PROBLEMS IN HEALTHCARE WEBSITES?

Each website encounters a variety of issues, one of which is usability because usability is the primary characteristic of websites, particularly for healthcare websites, the third research question addresses identifying current healthcare websites with usability issues. Inadequate feedback, navigational difficulty, consistency, coloring, layering, navigational complexity, layout persistence, an inconvenient input method, cross-device interactions, accessibility and navigation, findability, search feature, visual media, written media, anecdotal, factual, and digital message features are just a few of the issues discovered. Table 9 shows a full overview of these points. The articles chosen span the years 2017–2021.

The results of this SLR are provided systematically so that it is easy for everyone to extract their relevant information efficiently.

In the next discussion section IV will discuss previous work done on usability evaluation, usability heuristics provided by Nielsen, usability metrics, 5 basic principles of usability, some equations to calculate usability, and the results of this paper will also be discussed. Limitations of the research are further analysed in section V which will provide a gateway for the researchers to work on.

TABLE 7. Most significant usability features for healthcare websites.

S. No	Reference	Features	Description
1	[4]	Accessibility, Efficiency, effectiveness, and satisfactory	Accessibility should be offered in such a way that physical venues and resources are accessible. Effectiveness refers to a user’s capacity to favorably utilize a website in order to acquire information and execute activities. Once understood, efficiency is a productive method of accomplishing a task. Satisfaction is the sense of accomplishment one receives after doing something.
2	[15]	Use of interface elements with physical buttons	Interface components work well when combined with physical buttons, such as the keyboard’s home button. The user interface of websites should have an alternative physical buttons that perform the same task. This can also improve accessibility.
3	[13]	Iconic representations	The presentation of icons in the website interface has a better effect on its usability. Icons are also good navigators. The author also suggests providing short, descriptive labels at any time for the readability of the interface.
4	[7]	Accessibility	The web interface must instruct the user on how to use it and should be compatible with a variety of devices. The interface should be intuitive, allowing patients to utilize it in any scenario and with ease. This feature will allow them to get the information they need more quickly.
5	[50]	Estimating completeness, proficiency, and satisfaction	The research findings indicate that satisfaction, completeness, and proficiency are the traits that assist the users to accomplish their tasks easily and quickly.
6	[52]	Menus, colors, navigation, and feedback	According to the results of trials done on normal and dyslexic students, some usability features that have been determined to be more successful and should be included are useful menus, feedback capability, good colors, and navigation features that direct users in the appropriate direction.
7	[35]	Video representation	During the testing performed in research [35], a feature that is enjoyed by the participants is videos on the websites. The users, especially, teenagers preferred videos on text especially if they are related to the topic they are searching for in the healthcare sector. Keeping in mind that long videos caused the loss of concentration, therefore, the videos should be short.
8	[46]	Web-based media	The author of this paper suggests that web-based multimedia like (videos, icons, helping images etc) has a good effect on the success of websites. The website should have media embedded in it to enhance its usability.
9	[33]	Accessibility, content organization, useful design, and user-friendliness	Four attributes of usability in healthcare websites will enable the user to access the required information easily. These are the content organization, user-friendliness, design, and accessibility.
10	[60]	Images and videos, readability, interactive, and reliability	The author of this paper researched useful usability elements and discovered that some of them include photos and videos, readability, interactivity, and reliability.
11	[44]	Accuracy, completeness, technical elements, design and aesthetics, readability, and accessibility	The investigators examined the websites and discovered several helpful usability features, including correctness, completeness, technical elements, design and aesthetics, readability, and accessibility. Navigation is also a very essential element of usefulness.

IV. DISCUSSION

Conventional reviews are believed to be less successful than SLR [1], while the outcomes of a well-designed

systematic literature review can be more effective. The researcher’s examined the websites and discovered several helpful usability characteristics, including correctness,

TABLE 8. Usability testing techniques used for testing healthcare websites during census 2017-2021.

S. No	Reference	Testing Techniques	Description
1	[2] [4] [21] [52]	Tasks based evaluation	In task-based assessment, the quality of an interface is determined by how well it assists a user in accomplishing their goals. Two factors are measured: task completion time and task performance.
2	[41]	Qualitative (e.g. interview) and Quantitative (e.g. questionnaire)	The process of determining the target users and their requirements consists of two parts. The first stage is to define who will be using the interface, and the second step is to test a developed prototype on that user. If an evaluator wants to integrate qualitative and quantitative data, an interview is a great approach, while a questionnaire is a suitable tool for quantitative data.
3	[3]	Accessibility Guidelines 2.0 (WCAG 2.0)	Usability testing may be conducted by including a checklist in the task completion process. This will enable usability issues to be identified.
4	[5]	Semi-Structured Interviews	A semi-structured interview is one in which the interviewer asks only a few pre-determined questions and the remainder of the questions are unplanned. Semi-structured interviews combine the best characteristics of organized and unstructured interviews.
5	[12]	Software-based testing and Nielsen usability heuristics	Testing the usefulness through developed software especially for usability testing. WikiBudaya's usability evaluation is based on the Nielsen Model for user testing and descriptive statistical data utilized to determine the usability quality.
6	[6]	Generation of a virtual amblyopia screen	A screen is blurred in this manner, and then the interface is tested by users. The user is assigned seven levels. Amblyopia is a condition that impairs vision in one eye due to problems with vision development during childhood.
7	[15]	Observation	Users are observed during the test. This approach for establishing the requirement may be more advantageous. Numerous types of needs may be analyzed using the criterion of necessary or preferred requirements.
8	[17] [43]	SLR	Webster and Watson define SLR as a method for doing a systematic study of the literature to discover usability issues. Papers are retrieved based on the users' requirements.
9	[7]	Content Analysis, Remote usability testing, and think-aloud Usability Testing	These evaluation approaches significantly increase the degree of dependability, fidelity, and validity and are used extensively by evaluators to assess usability since they are multi-dimensional usability testing frameworks. These principles may be extended to different technology and environments to effect positive change.
10	[23] [45] [25] [54] [59]	Questionnaires and observations	Questionnaires and observations are the most commonly used methods of assessing the usability of the interface.
11	[20]	Software-based testing	In the paper [20] two strategies are used. The first is a smartwatch based, while the second is a tablet. The author created communication software for senior users to verify whether their equipment is operating properly and will continue to operate in the event of an emergency.
12	[24]	Guideliner	A guideliner is a tool that makes use of a certain sort of recommendation throughout the user interface's development stage. It has a predetermined set of usability principles and also enables the creation of new ones by researchers.
13	[26]	Controlled Experiment	A controlled experiment is one in which all variables are maintained constant while holding the independent variable. In a frequent sort of controlled experiment, a control group is compared to an experimental group. Except for the component under examination, all variables in the two groups are comparable.

TABLE 8. (Continued.) Usability testing techniques used for testing healthcare websites during census 2017-2021.

14	[14]	Remote Access method and Modified Think-Aloud	"Thinking aloud" refers to the simultaneous verbalization of thoughts while performing a task. When this approach is used, participants are instructed to record everything that comes to mind while doing a task but are not permitted to assess or analyze their ideas.
15	[29]	Collaborative user experience	Collaborative interfaces, also known as social cognition interfaces bring people together by allowing them to share information, actions, and experiences. This joint user experience report provides new insight into what has to be changed to accommodate usefulness.
16	[50]	SUS	The System Usability Scale (SUS) is a proven "quick and dirty" usability assessment instrument. The poll has 10 items and provides respondents with five response options ranging from "strongly agree" to "strongly disagree." John Brooke founded this company in 1986. It enables individuals to experiment with a broad variety of products and services, including hardware and software, mobile devices and apps, websites, and mobile applications.
17	[35]	Qualitative Research via focus group	In this paper, a qualitative study was performed in which users are exposed to a variety of sexual health websites and apps before participating in a follow-up focus group to discuss their experiences with these interfaces.
18	[56]	Approach inductive, thematic analysis, and deductive interpretative analysis	Inductive thematic analysis and deductive interpretative analysis are both used in this study.
19	[46]	Interview	By interviewing forty people, each of whom visited and compared six volunteer websites, the researchers can put an initial model developed from the literature for the test. Ten website features (interaction, factual, anecdotal, external recognition, organizational expression, value suggestion, explanatory content, visual media, written media, and website design), seven perceptions (ease of use, aesthetics, information quality, trust, negative affect, positive affect, and argument strength), and one motivation are included in this refined design model.
20	[58] [33]	Survey	A survey is performed in both papers, in one paper [58] users are questioned about the features of child and adolescent-friendly websites. The author then utilized a 12-point website assessment tool to evaluate 131 children and adolescent-targeted websites. Additionally, program directors were tasked with establishing best practices for websites.
21	[60]	Sampling procedure using codebook	The codebook is used to store the contents, structure, and layout of a data collection. A well-documented codebook includes data for each usability attribute in a data file designed to be exhaustive during testing. The codebook's six sections were: the usage of pictures and videos; readability; appropriateness assessment of materials (SAM); advertising; interaction; and reliability cues.
22	[42]	Scoping Review Methodology	A scoping review methodology is adopted based on the Arksey and O'Malley framework stages. The framework is divided into six phases. 1) defining the research issue, 2) locating related/relevant papers, 3) selecting studies, 4) locating relevant data, 5) summarising, synthesizing, and reporting the results, and 6) consulting with experts.
23	[22]	Omnibus test	The author uses F statistic for omnibus tests and the test statistics for planned comparisons based on constrained maximum likelihood estimation are supplied for models that did not fulfill the assumption.
24	[49] [55]	Tool Based Evaluation	The DISCERN tool was used to assess the quality of health information websites about a treatment option following Google.ca searches. The DISCERN tool consists of sixteen questions, each of which is answered on a five-point Likert scale in order to assess the quality of health information regarding a treatment option.
25	[53]	Telephonic-based semi-structured interviews	To assess website usability, telephone-based semi-structured interviews were done to test users' behaviors and preferences when using websites.

TABLE 9. Usability problems identified in healthcare websites.

S. No	Reference	Problems Identified	Description
1	[2]	Inadequate feedback	The author suggests that the websites do not provide valid feedback on the forms, controls, and functionalities.
2	[3]	Difficulty in navigating	Websites designed for elderly people must provide a navigation menu.
3	[12]	Consistency	According to a survey on emergency management websites, there is a lack of uniformity in the parent/child site architecture, which might cause user confusion.
4	[13]	Coloring and layering	Coloring and layering are the limitations found in the study.
5	[18]	Navigational complexity, the persistence of layout, an inconvenient input method, cross-device interactions, and accessibility	Today's interfaces provide usability challenges in the form of navigation complexity, layout persistence, an inconvenient input method, cross-device interactions, and accessibility.
6	[23]	Accessibility and Navigation	According to the article's preliminary statistics, 55% of students with sensory disabilities believe that the accessibility of their existing website material has a detrimental impact on their studies, and 70% believe that the web pages are not adequately structured for learners with sensory disabilities to navigate.
7	[21]	Findability, search feature, navigation	If the information is easily accessible, it is simple to find and recognize data. The challenges that must be overcome are data retrieval, searching ability and navigation etc.
8	[46]	Visual media, Written media, Anecdotal, and Factual data	Three website components (visual media, textual media, and factual data) were perceived negatively. All of these qualities are absent from websites, eliciting negative emotional reactions such as guilt, wrath, and despair. Anecdotal (information that is based on personal experience without being proven from systematic research) is also the main issue.
9	[37]	Digital Message Features	Communication professionals should make greater use of digital message features. Videos, narration, and interactive elements are infrequently used, despite their potential benefit for individuals with low health literacy.

completeness, technological aspects, design, aesthetics, readability, usability, and accessibility. Navigation is also critical to a website's usability [44]. The next sub-section will examine the topics in more detail, taking into account the previously mentioned research questions. Each question is addressed individually. The paper is discussed sequentially in accordance with the research questions. Table 5 shows a total of **55** relevant primary studies that are chosen based on the inclusion/exclusion criteria.

A. WEBSITE USABILITY

Usability is a term that refers to both characteristics of a website and a design strategy that prioritizes the user's needs. It takes a user-centric approach to design in order to guarantee that websites are efficient and simple to use for everyone, not just the designers. Making a website useful

(by making it simple) is one of the most challenging aspects of web design. The usability of a website is driven by two objectives: clarity and utility, and designers must prioritize both. In other words, web designers are tasked with the responsibility of building websites that not only appear nice but also perform as expected by users, which is not an easy task even for the most experienced designer. Table 10 summarises many of the usability aspects reported by several evaluators.

B. NIELSEN'S USABILITY HEURISTICS

These are 10 fundamental principles of user interface design. They are referred to as "heuristics" since they are more similar to general guidelines and specific usability recommendations proposed by Nielsen [68], as seen in Figure 11.

TABLE 10. Usability attributes of various standards or models.

S. No	Reference	Usability Attributes				
1	[62]	Efficiency in use	Learnability	Rememberability	Reliability in use	User satisfaction
2	[63]	Efficiency	Satisfaction (Comfort and acceptability of use)			
3	[64]	Speed of performance	Time to learn	Retention over time	Rate of errors by users	Subjective satisfaction
4	[65]	Efficiency of use	Learnability (Ease of learning)	Memorability	Errors/safety	Satisfaction
5	[66]	Throughput	Learnability (Ease of learning)	Throughput	Attitude	
6	[67]	Effectiveness (Speed)	Learnability (Time to learn)	Learnability (Retention)	Effectiveness (Errors)	Attitude

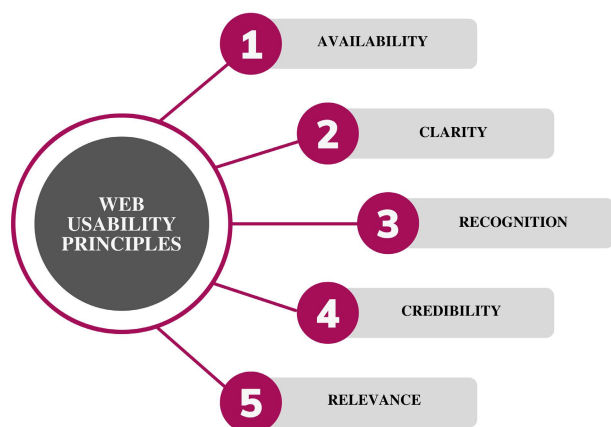


FIGURE 10. Basic five website usability principles [61].

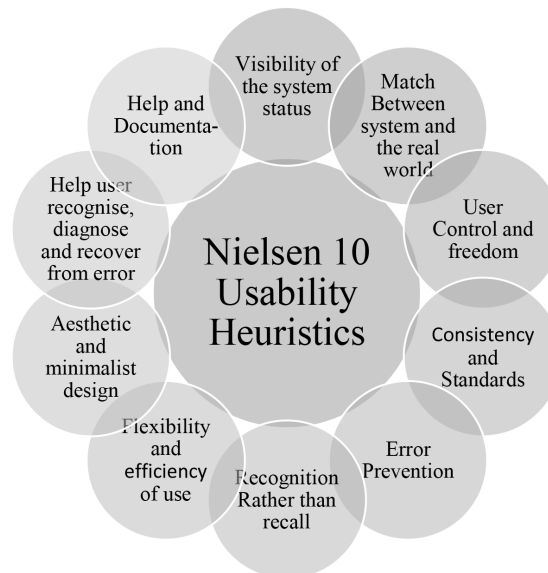


FIGURE 11. Nielsen’s ten usability heuristics [68].

C. USABILITY METRICS: A MEASUREMENT APPROACH

The question is, how can a design be evaluated? It should be examined by the designers themselves in the first step. Decision-makers should express their ideas in light of this assessment. Then, test it with the intended audience to get feedback. The same procedure should be used to evaluate usability. It is beneficial if the design is accepted by users or testers. They should be subjective since these data-driven methodologies are employed for the majority of designs, but usability metrics are critical for determining how users feel [69].

1) USABILITY METRICS: WHAT IS IT?

While assessing the effectiveness, satisfaction, and efficiency of users while interacting with products, these metrics are utilized to determine the ease with which the user

interacts with the interface. When it comes to determining the usability of a website, it is often calculated during user testing. The researcher is critical in documenting and monitoring the activities completed by users during usability assessments. Several of the duties include “finding a doctor’s contact information” and “locating a therapy for an illness”, particularly when browsing healthcare websites. While Jacob Nielsen, inventor of “NN Groups” recommends a minimum of five people for the usability test, the findings are more acceptable with twenty users.

During usability testing, researchers record the behaviors of users and calculate these measures. Let’s take a closer

look at how these metrics are measured and how a successful measurement may be accomplished.

2) SUCCESS SCORE

Regardless of how long it takes, usability measurements will nearly always be at the top of the list, as the success rate is a critical component of usability assessment. Success may be defined as if users successfully complete a task assigned to them. The formula for determining the success score is shown below:

$$\text{Success Score} = \frac{\text{No of completed tasks}}{\text{Total No of attempts}} \quad (1)$$

When calculating the success rate, the range of possible scores is 0 to 1, or 0 to 100%. While measuring using the 0 and 1 system, this showed whether the task was successfully completed or not. Whereas intermediate instances are disregarded. A small amount of success in an endeavour typically equates to failure or zero. If the task is done with some inaccuracy, it should be assigned to a different group for more exact measurement. Consider the task of scheduling an appointment with a physician. In this case, a partial error might be as simple as inputting the incorrect payment card information, being unable to pay with a credit card, or choosing the inaccurate doctor. The difficulties may be precisely traced using the score of the “partially successful” group. Finding the source of the problem is simple with this group. As a result, qualitative UX research yields more extensive and in-depth results than quantitative research, which produces a precise but narrowly focused collection of data. It is not necessary to have a 100% success rate when considering the success rate; a score of 78% is sufficient.

3) NUMBER OF ERRORS

There are two types of errors in general. An error is any incorrect action that a user does while completing a task. If the objectives are met but errors occur, they are referred to as “slips.” For instance, if typos are made during the date of birth registration or if the goals are incorrect, they are referred to as “mistakes”, for example instead of inserting the birth date, entering today’s date. The error may be measured in two ways: first, by calculating the percentage of errors that occur, and second, by focusing on a single error, especially if it occurs frequently (error occurrence rate). To get the error occurrence rate, divide the total number of errors by the total number of attempts. Why should mistakes be recorded if they occur regularly? If a user is repeatedly pressing the disabled button then, each click should be counted as one attempt.

$$\text{Error Rate} = \frac{\text{No of errors}}{\text{Total No of attempts}} \quad (2)$$

To calculate the error rate, all potential mistakes must be counted. To do this, the number of error possibilities must be specified, taking into account all conceivable slips and

errors. Complex task will result in more mistakes than the simple one. The following equations may be used in this manner:

$$\text{Error Occurrence Rate} = \frac{\text{Total No of errors}}{\text{Total No of possible errors}} \quad (3)$$

Because of the fact that human is not a machine, it will make errors during the interaction. The total number of errors cannot be zero. Due to the inherent human tendency to make errors, users must commit errors during usability testing. According to Jeff Sauro in his book, “just 10% of tasks are completed without error.” The success rate and error rate of a product can be used to determine its effectiveness. Additionally, these indicators are used to assess efficiency.

4) TASK TIME

Usability is frequently used to refer to a user’s ability to effectively perform a task on time. Nonetheless, the task time metric is simple, and it may be completed with maximum efficiency.

$$\text{Task Time} = \frac{\text{time}_{1st\ user} + \text{time}_2 + \dots + \text{time}_n}{\text{Total No of users}} \quad (4)$$

How can a tester assess if a result is acceptable or unacceptable if the average time is recorded? While there are some standards for other metrics, none exist for task time. Experienced users can recommend an optimal task time. To do this, an average of each small task, such as “pointing with the mouse” or “clicking,” is added. The time may be computed relatively precisely by utilizing a specialized model such as KLM (Keystroke Level Modeling). It is common practise to utilize task time metrics to compare the performance of a product to prior versions or to compete with other products. While the time difference is frequently minimal, keep in mind that a short task time does not always imply a flawless design.

5) EFFICIENCY

One of the most fundamental methods of evaluating efficiency is time-based efficiency, which considers how long an activity takes and how effectively it is completed.

$$\text{Time – Based Efficiency} = \frac{\sum_{j=1}^R \sum_{i=1}^N \frac{n_{ij}}{t_{ij}}}{NR} \quad (5)$$

There are several satisfaction indicators accessible. Users are prompted to complete a questionnaire during usability testing to collect data for these metrics.

6) SINGLE EASE QUESTION (SEQ)

UX researchers should utilize this statistic since it’s simple but effective. When a task is completed, a single question is asked, as shown in figure 12. This is much simpler than all those intricate computations.

The core of user experience is captured by SEQ. The job may take a user longer to complete, but the other metrics did

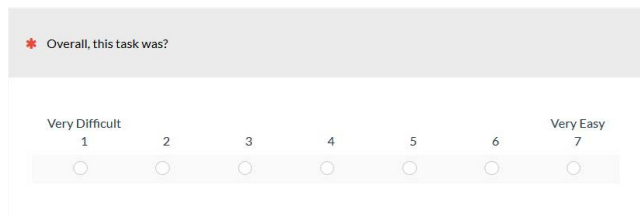


FIGURE 12. Single Ease Question (SEQ) [69].

System Usability Scale Questionnaire	Strongly Disagree	Strongly Agree
1. I think that I would like to use this product frequently.	1	5
2. I found the product unnecessarily complex.	1	5
3. I thought the product was easy to use.	1	5
4. I think that I would need the support of a technical person to be able to use this product.	1	5
5. I found the various functions in the product were well integrated.	1	5
6. I thought there was too much inconsistency in this product.	1	5
7. I imagine that most people would learn to use this product very quickly.	1	5
8. I found the product very awkward to use.	1	5
9. I felt very confident using the product.	1	5
10. I needed to learn a lot of things before I could get going with this product.	1	5

FIGURE 13. System Usability Scale (SUS) [69].

not give them the same sense like What if the user just takes longer to react? Users’ subjective assessments of difficulty are just as important as the number of errors they make. On a scale of 1 to 7, users assess task difficulty to 4.8 but it should not be less than that, as this indicates that it is difficult.

7) SYSTEM USABILITY SCALE (SUS)

For those who don’t believe in the single-question approach, the System Usability Scale is a set of 10 questions. The product is given a score on a scale of 0 to 100 depending on the responses, as illustrated in figure 13, (each question is worth 10 points). This approach is quite successful when comparing a self-made design to others: the average SUS is 68 points. A score of 80 or above is deemed exceptional.

D. USABILITY AND ITS ROLE IN HEALTHCARE WEBSITES

The term “usability” is coined around ten years ago to replace the term “user friendly”, which had gained a slew of very imprecise and subjective meanings by the early 1980s. There is no exact definition of the term usability. Many views are regarding the word usability in which three are as under:

- User-oriented view: presents usability of the product that can be judged in terms of the user’s mental effort and attitude.

- Product-oriented view: shows that usability can be judged in terms of the product’s ergonomic features.
- User performance view: determines usability by looking at how a user interacts with a product, with a focus on either;

Acceptability: determines whether or not the product will be used in the actual world.

Ease-of-Use: simplicity of using the product.

Usability refers to the ease with which an interface may be used. The study revealed that usability is crucial when it comes to designing healthcare websites. The web user interface should be simple to navigate. Patients should always be able to use the user interface in a simple and easy way [7].

V. LIMITATIONS OF THE RESEARCH

The current study used a sample size of 55 publications to extract usability features, techniques, and issues. However, these articles were chosen in accordance with pre-defined inclusion/exclusion criteria. The majority of the researchers of the chosen publications are academics. They may lack knowledge in the field of web development. To validate the current study’s conclusions, we will perform an empirical investigation in the healthcare web development industry. Following are some of the limitations of this work:

- 1) Articles only from high peer-reviewed libraries are selected.
- 2) Only the papers ranging from the year 2017-2021 are selected for review.
- 3) This research used a search string instead of manual keywords resulting in a huge amount of data.
- 4) Google scholar is not utilized for article searches due to the possibility of receiving results from different journals.
- 5) Only those papers which are in the English language are considered.

VI. CONCLUSION

Usability of healthcare websites is a problem that must be resolved. Since doctors and patients are the primary users of these websites, their usability must be the main focus during the design process. The proposed research found usability features, methodologies, and issues for the websites presented in Tables 7, 8, and 9 respectively. The current research is an endeavour toward a comprehensive report on healthcare websites usability. The proposed study uses systematic literature protocol and guidelines as presented by Kitchenham *et al.* [8]. Data was collected from the work published from the year 2017-2021 in the form of conferences, magazines, books, journals, and other online resources. Initially, the study found **10,512** titles based on the search string developed from the proposed research questions which were then filtered down to a total of **55** papers. This research work provides the year-wise distribution of the included relevant articles ranging from 2017 to 2021. Results present questionnaires, observations, task-based evaluations, tool-based evaluations, and surveys are frequently

utilised techniques to evaluate the usefulness of healthcare websites. Providing appropriate feedback, efficiency, iconic representation, video representation, and accuracy are some of the basic usability features of healthcare websites while inadequate feedback, difficulty in navigating, consistency, search features, cross-device interactions, and lack of digital messaging features are some of the problems identified in healthcare websites. Furthermore, to guarantee optimal usability, designers typically test a design at various levels of production, from wireframes to the final deliverable. With the development of technology, user-centered design should be developed to make tasks simple for users to accomplish their goals. User preferences are mostly ignored. This SLR is conducted in light of these concerns to investigate new approaches for researchers and designers, so a useful design can be developed.

IMPLICATIONS AND FUTURE DIRECTIONS

This study will assist designers and researchers for evaluating healthcare websites and improving their quality using the outlined techniques identified in the work. With the help of this SLR, the identified usability problems will serve as a basis for further investigation and possible solutions.

Additionally, the study will direct doctors and other healthcare professionals to helpful websites. The article also highlights key usability elements that should be taken into account while designing healthcare websites.

CONFLICT OF INTEREST

The authors declared that there are no potential conflicts of interest regarding the article.

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