

Research Article

Software Measurement by Using Artificial Intelligence

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Artificial intelligence (AI) is a subfield of computer science concerned with developing intelligent machines capable of performing tasks similar to those performed by humans. This human-created intelligence began more than 60 years ago. The goal of previous generations of applications was to demonstrate generic human-like behaviour. The goal has expanded with the advancement and increased compliance of this technology. It includes areas such as healthcare, gaming, and smart devices. The COVID-19 epidemic has posed a significant barrier to maintaining a sustainable strategy for mental health support clients with major mental illnesses and clinicians who have had to shift delivery modes quickly. In this study, we have conducted a systematic literature review (SLR) to provide an overview of the current state of the literature related to software measurement of healthcare using artificial intelligence. The study followed a secondary research strategy. The systematic literature review aim was to analyze software measurement of mental health illness in terms of previous literature. This study screened out of 28 research papers out of 1076 initial searches. We used Science Direct, IEEE Xplore, Springer Link, ACM, and Hindawi as database search engines. The research objective was to explore the needs of software applications and automation in the healthcare sector to bring efficiency to the systems. The research concluded that the healthcare setting crucially requires the implementation of software automation.

1. Introduction

In the past years, mental illness among university students increased [1]. Many students and other people during the COVID-19 pandemic is necessitated a significant shift in the way outpatient mental healthcare for people with major mental illnesses is delivered [2]. Mental illness is becoming a very common issue in our society day by day [3]. Many psychological therapies have been developed [4]. Moreover, the pharmaceutical and healthcare industry has experienced massive penetration of software-based technology in the health sector during the past few decades [5]. The IoT-based healthcare infrastructure helps gather and analyze data refined [6]. The E-health architecture has enabled the integration of software-based infrastructure into the health sector [7]. Health professionals utilize the information systems created from this integration to maintain swift medical

operations. The engineers are bound to consider the design requirements, implementation, and timely maintenance of the installed infrastructure [8]. This is because healthcare software provides decision support and knowledge-based IT programs, which deliver guidance, assistance, and feedback in the environment of healthcare [9].

Moreover, hospitals are switching to electronic health record (EHR) software as their main repository of patient files [10] [11]. Due to that, EHR and other healthcare-based software allowed to evaluate and assess the quality of healthcare delivery and provision conditions. However, what remains underexamined is the different dimensions of software engineering in the context of E-health and healthcare resources in connection to software management and automation [11]. There is always a risk to medical and healthcare practices falling behind the competition if attention to innovation in technological developments and medical software is

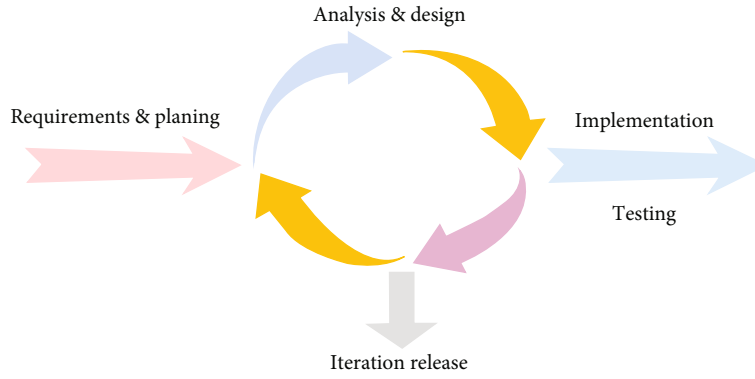


FIGURE 1: Iteration model.

TABLE 1: Review method of implementation.

Stage1: preparation of the review	Stage2: implementation of the actions	Stage 3: report documentation
Identify the objectives	Setting the study methods	Formatting the outline
Identify research questions	Setting study structure	Setting the word count
Setting searching strategy	Selection of related researches	Report writing
Setting keywords	Analysis scope and quality assessment	Documenting the analysis and results
Identifying gaps		Documenting discussion and conclusion

TABLE 2: Questions and motivation of research.

Questions	Motivations
What are the present needs of software automation in the healthcare industry?	Motivation is to identify the needs of software engineering services in the healthcare system
How software engineering helps in the context of E-health, and how can software engineering improve healthcare services?	Motivation is to search out the relationship between E-health and software engineering. Find out the ways of improving the accuracy of healthcare systems
What are the healthcare resources associated with software automation and management systems?	The primary motivation is to recognize the present automation and software engineering contribution to the healthcare industry

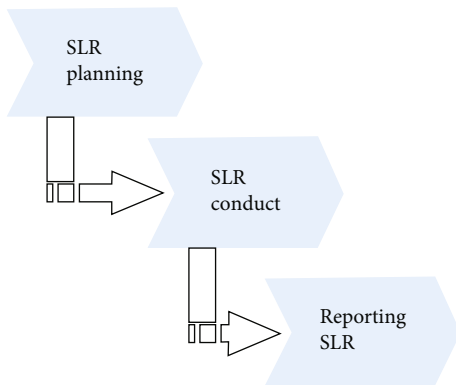


FIGURE 2: Plan of research.

not paid [12]. Recently, a lot of research is related to diagnosing the various diseases through machine and deep learning approaches deployed in E-healthcare sector [13–18].

The existing body of research offers a significant and timely contribution to implementing software in healthcare. However, the underlying dynamics have not been elaborated, calling for further examination into the area to iden-

tify prospects and determine the issues. Figure 1 elaborates the iteration model.

These software requirements for the healthcare industry do pose some significant challenges, which has been a concerning aspect within existing research [19]. The system’s performance from a healthcare software perspective holds key importance in this regard. The primary concern is the performance issues related to data. Data accuracy and availability at critical times are critical to the patients involved. Moreover, the performance of healthcare practitioners and staff is another key aspect evaluated in COVID-19 [20–22].

Solutions for the healthcare sector are gradually being addressed. Many organizations have successfully collected, stored, transmitted, and visualized data. They use segments of accessible patient health data sources across various value framework segments, applications, and standards. This includes information sources such as information shops and distribution centers, parts of the framework such as health data transactions, applications such as data frameworks for emergency clinics and EMRs, and standards such as HL7 [23]. Currently, integrating different parts of a patient record for clinical or business purposes requires staff to search through many papers and electronic information

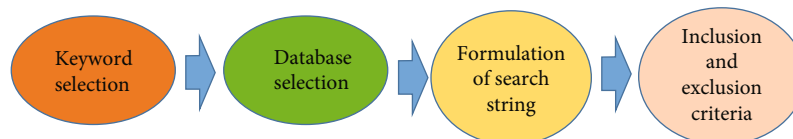


FIGURE 3: Process of research.

databases, using other interfaces, unique loops, and different search strategies.

Future attempts at ensuring transparency will be made to improve this problem. They were linking the needs of patients and providers when patients have a range of experiences with health problems that depend on dealing with different providers and substances. They and their providers should obtain important data quickly and organize. Retrieving and using data in this sequence of experiences allows potential virtual collaboration and care coordination. The need for providers other than clinicians should also have been accounted for in the health software solution. According to the World Health Organization statistics, the global COVID-19 epidemic has made a huge impact worldwide. Today, it has infected over eight million people all across the world. The software measurement can help you learn more about how the software works and how to manage and improve them. A lot of research has been done on software measurement. The contribution of this research is as follows:

- (i) We have applied a secondary research strategy and screened out of 28 research papers out of 1076 initial searches. We used Science Direct, IEEE Xplore, Springer Link, ACM, and Hindawi as database search engines
- (ii) We have created three research questions, and through our screened papers, we try to analyze different aspects and software requirements in the healthcare industry
- (iii) In the last, we answered the prepared question using the finalized papers

The remaining article has been structured in the following manner: Section 2 presents a systematic literature review approach, and Section 3 demonstrates quality evaluation while Section 4 presents results and discussion, and lastly, results from section has been presented in Section 5.

2. Systematic Literature Review Approach

The experimental review method elaborates on how information is collected and subsequently reviewed. Therefore, this paper's chosen review method is based on three stages that Kitchenham and Charters proposed [24]. The illustration shows that reviewing the literature is done in three stages (formation) from left to right. It also shows that each stage has a grouping of exercises. The first stage involves preparing the review, the second stage implements the actions, and the third stage is the report documentation

TABLE 3: Mental healthcare and keywords and category.

Keywords	Category
Healthcare, healthcare resources, software measurements	Healthcare, artificial intelligence
Software engineering, E-health software management, software measurement in healthcare	Software engineering

TABLE 4: digital research libraries and Resources.

Sr.	Search resources	Sr.	Search resources
1	ACM	4	IEEE XPLORE
2	Science Direct	5	Hindawi
3	Springer		

[25]. The comprehensive research standard applies fully to ensure the quality of the research, both internally and externally. The review method of this study is illustrated in Table 1.

2.1. Research Questions. The research questions are based on our objectives shown in Table 2.

2.2. Review of Literature Systematically. This SLR is done through the guidelines [26], and the preliminary study is selected and performed according to [10]. The key objective of this research was to explore the needs of software applications and automation in the healthcare sector to bring efficiency to the systems. The SLR process helps us determine the different studies available in software requirements in healthcare. Different steps that appear in systematic literature are shown in Figure 2.

2.3. Search Scheme. The cycle is based on selecting the keyword, followed by determining the details of the search string. In the end, the decision of the literary values is made. Moreover, the inclusion and exclusion criteria are also set with the help of keywords and search strings. Figure 3 is related to the process of research.

The keywords are an essential part of the research as for the following research, and the keywords are extracted from the research objectives and research questions. Various important keywords are used in the following research, such as software engineering, healthcare, E-health, healthcare solution, modernize healthcare resources, software management, IoT in healthcare, and healthcare automation in Table 3.

2.4. Search String. The search string for the keywords is integrated with the Boolean operators such as (OR and AND).

TABLE 5: Software measurements and search string instances.

Sr. no	Data source	Search string
1	Springer Link	[Mental Healthcare OR software measurements], [healthcare automation OR IoT] AND [mental illness in healthcare requirements OR software management].
2	ACM Digital Library	[All: Metal illness in healthcare] OR [All: software engineering] OR [All: Healthcare automation] OR [All: IoT] OR [All: Healthcare requirements] OR [All: software management].
3	Hindawi	allintitle: ((Mental illness in healthcare OR software engineering), (Healthcare automation OR IoT) AND (Healthcare requirements OR software management))
4	IEEE XPLORE	(“All Metadata”: Healthcare), (“All Metadata”: software engineering), (“All Metadata”: Healthcare Automation), (“All Metadata”: IoT)
5	Science Direct	(“All Metadata”: Mental illness Healthcare requirements), (“All Metadata”: software measurements).



FIGURE 4: Digital libraries for search.

Considering the above keywords, these operators develop search strings through which the most relevant and useful searches are obtained. Some of the essential search strings are “healthcare AND software engineering”, “healthcare automation OR IoT”, “healthcare requirements AND software management”, “E-health solution and software engineering”, etc.

2.5. Search Resources. Our search space comprises four well-reputed research databases to ensure the maximum number of existing studies reclamation. The research databases used in our search effort are listed below in Table 4.

2.6. Search Execution. The search strategy was finalized, we developed the search string instances listed in Tables 3 and 5 from the comprehensive search string illustrated in Figure 4. The standard filter was applied across all digital research libraries, where the initial publication date was from 2005 to 2021.

There is minor literature related to this topic as very few studies have been conducted significantly less since the beginning.

Later on, based on these secondary data sources, we conducted a primary search to carry out smooth and effective results for the study. The results of the search are shown as follows in Table 6.

The search results ratio is also illustrated through the pie chart. The results that are demonstrated in Figure 5.

2.7. Study Selection. According to the results obtained from the primary search, a list of relevant studies has been listed. It demonstrates that 3192 studies are found in the development of the topic. Numerous studies in Figure 6 were obtained, but they were not directly linked to our research.

Therefore, to filter those studies, extensive study selection activity was conducted.

Moreover, there was a lot of research paper for healthcare software requirements. Therefore to make the research reliable and focused, we have defined inclusion and exclusion criteria to select the research papers shown in Figure 7 proposed by the Prisma group [27].

3. Quality Evaluation

The quality of the studies was identified through the screening of searched studies that we emphasize on determining the eligibility and reliability of the studies for extracting effective results from the studies. The analysis of the scope of each study was assessed to meet the study’s goals.

3.1. Data Extraction. Data extraction is the process that helps attain data through a database or SaaS platform so that it is neither replicated nor duplicated for reaching a destination. Data extraction is considered the initial stage of the data ingestion process known as ETL and was extracted and transformed, and load is determined. The data was extracted through various websites for the existing research, including Springer Link, Google Scholar, IEEE XPLORE Science Direct, and Springer Link. The immediate extracting of data is followed by data transformation, which possibly includes metadata before the studies extracting to another stage in the data workflow.

3.1.1. Inclusion Criteria. The researches published during the years of 2016 to 2021 which are related to domain or sub-domain of healthcare requirements. If that research is published in different journals and conferences, we choose that research paper.

3.1.2. Exclusion Criteria. The other researches that are not published or published in some unknown journals and conferences, which are irrelevant from our research questions, exclude those research papers.

3.1.3. Assessment of Extracted Data. The data retrieved from various studies determine the importance of software requirements in healthcare. However, the extracted information is usually poorly organized or entirely unstructured, as obtained through multiple studies. Therefore, after gathering the data, it is essential to initially organize the entire data to

TABLE 6: Extract at initial and primary search result.

Sr.	Search resources	Search date	Initial search results	Extract at initial
1	Springer Link	7-August-2021 (2:53 PM)	410	27
2	ACM Digital Library	7-August-2021 (3:03 PM)	1973	124
3	Hindawi	7-August-2021 [(3:15 PM)	525	25
4	IEEE XPLORE	7-August-2021 (2:30 PM)	150	13
5	Science Direct	7-August-2021 (4:30 PM)	134	11
Total			3192	200

develop a structure for the study. Besides, the studies extracted determine the importance of healthcare software and the software types required in maintaining the patient details. Other than that, the studies highlight the requirements of the hospital management system along with their unique features and advancements that could help the healthcare companies to adopt effectively and lead towards gaining a competitive advantage. The extracted data further illustrates the functional and nonfunctional requirements for establishing nursing homes, hospitals, and rehabilitation centres. Besides, the technical specifications were also highlighted, along with various frameworks. Likewise, the data points out the difference based on the studies conducted through the interview, survey, focus group, case study, experiment, and action research.

3.2. Quality Assessment. Quality assurance is essential for the survey type of paper, but this is rare in systematic mapping research. While going through our research, we focused on our findings by accessing the research relevance. To address our research query, we determined the breadth of every inquiry to examine if it fit with our objective of the research, which was very useful for our research. Going through each item helped us determine that we used the right information for our article. Table 7 illustrates the criteria we used for quality assessment for articles we selected for our research, and these criteria are based on eight research question.

The quality assurance searches must assess the nature of every assertion's findings and correlate each proportion.

According to the given indicator, the relevant measurement is performed for the evaluation connected with the impact factor of articles Table 7. Each paper is rated according to poor exceptional for their major contribution to our research. Based on the criteria, Table 8 depicts the ranking and impact factors. Table 8 shows an overall score that ranges from 0 to 16, consisting of ranging from (0-2) insufficient to (3-5) sufficient, (6-10) for good, (11-13) very good, and for outstanding (14-16).

4. Result and Discussion

4.1. (RQ1) What Are the Present Needs of Software Automation in the Mental Healthcare Industry? The present needs of software automation in the healthcare industry are the first research question of this study. It has been found in [28] that automation in healthcare sectors plays an essential role in the quality care outcome. The authors further stated some positive and negative impacts of automation on

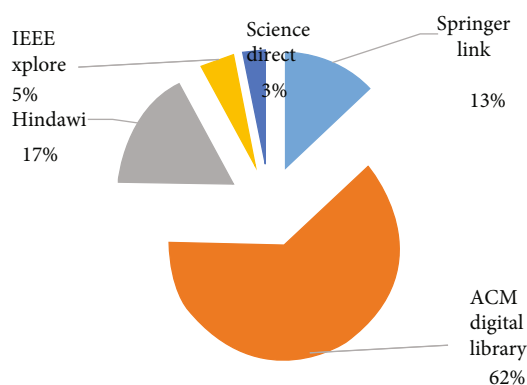


FIGURE 5: Primary search result.

healthcare sectors. Similarly, Sudeep Prakash et al. also discussed in their study that the need for software automation in the healthcare industry is increasing the pharmaceutical and healthcare type of products daily worldwide. They stated that the healthcare sector is very dynamic. Innovative and advanced technologies in the process are required to be included to enhance the quality of life of patients and care delivery. For this reason, at times, the system is compelled to follow regulatory policies and other health compliance standards and requirements for operating successfully. The author further asserted that the advanced technology healthcare system could transform the current healthcare delivery process and remove complexities and hindrances in the path of efficient healthcare delivery and provision. The application of automation systems for monitoring physical fitness, chronic patients, and taking care of elderly patients can significantly reduce the challenges experienced in these aspects. To support the prior argument, [29] further asserted that software automation and engineering, especially for the healthcare sector, assist in developing medical systems that deliver quality healthcare applications, medical middleware devices, and patient management applications. These healthcare applications contribute to high-quality practices with unique expertise tailored from the best software models based on user-centered design. This can reduce the lack of focus on systematic healthcare procedures and flaws in the application, introducing improvement regarding trust, cost, and quality.

4.2. (RQ2) How Does Software Engineering Help in the Context of E-Health, and How Could Software Engineering Improve Mental Illness Healthcare Services? This is the

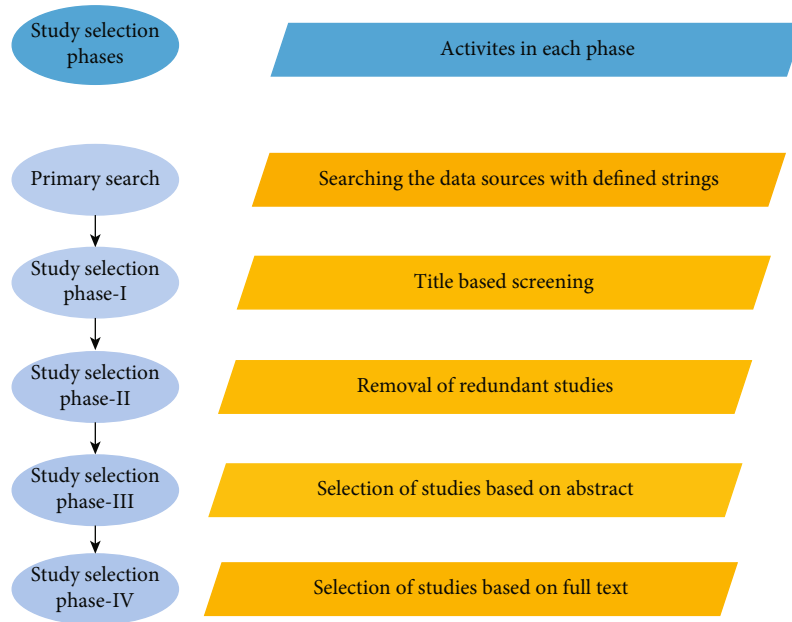


FIGURE 6: Study selection criteria.

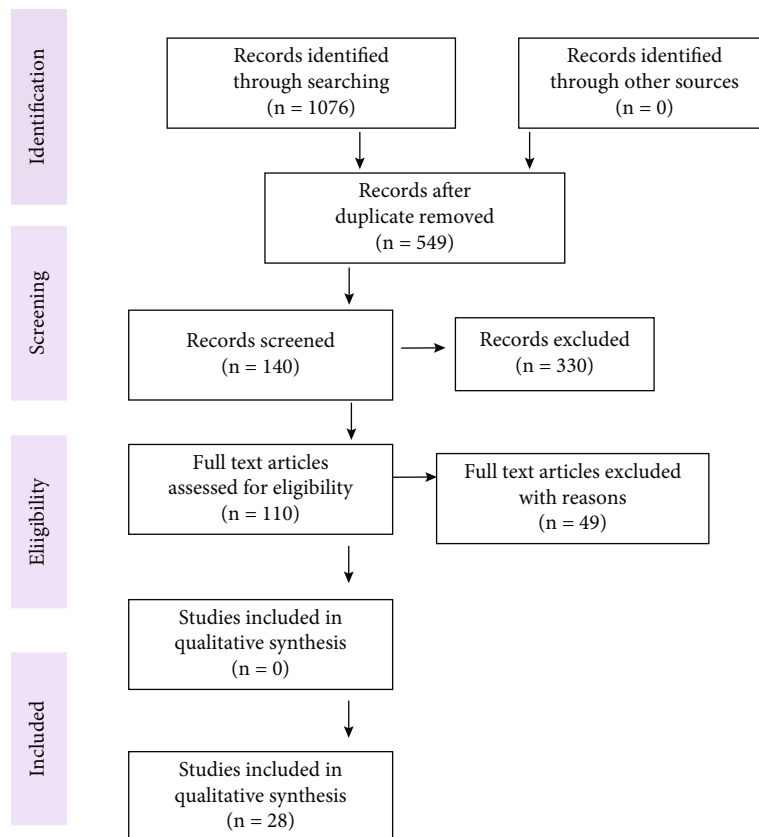


FIGURE 7: PRISMA flowchart adopted modified from Prisma 2009.

second research question of this study; from the systematic literature review, it has been found that software engineering plays an important role in E-health and overall improves healthcare services. Software engineering is a dynamic disci-

pline that delivers high-quality software applications, projects, and systems via adopting a systematic project methodology tailored to user-centred design principles [30]. It includes an SDLC (software development life cycle)

TABLE 7: Relevant measurement of quality metrics.

Matrices	Value	Weight
M1: abstract having the fair assessment as well facts what was done.	0/1	1
M2: provide the criteria for qualify, sources as well as procedures for the selection of participants	0/1	1
M3:gives the system details like architectures and components	0/1	1
M4: validation details of the system are provided.	0/1	1
M5: based on the analysis such as objectives and limitations, the results are provided	0/1	1
M6: examination are done thoroughly and fairly	0/1	1
M7: references of the paper	0/1	1.5
M8: publication types	0/1	1

TABLE 8: Quality assessment of selected papers.

Ref#	M1	M2	M3	M4	M5	M6	M7	M8	TOTAL
(Ansari, M.T.J et al.,2020)	0	0	1	0	0	0	1	1	3
(Cajander, Å. et al., 2018)	1	1	2	0	0	2	0	2	8
(Carroll, N. et al. 2016)	0	0	1	2	0	0	0	0	3.2
(Dodds, S et al. 2018)	1	0	0	1	1	0	0	0	3.2
(Fatehah, M., et al. 2021)	0	0	0	1	0	0	0	0	2.7
(Han, C et al. 2020)	2	1	0	0	1	0	1	0	3
(Cham.Offner, K.L et al. 2020)	1	1	2	1	2	2	1	1	11
(Hemmati, A et al. 2017)	0	1	0	0	0	0	0	0	1
(Ilin, I.V et al. 2020)	0	0	0	2	1	1	2	2	8
(Ross, P.T. et al. 2019)	1	2	2	1	1	1	2	1	11
(S. Keele, et al. 2012)	0	0	1	0	1	0	0	0	3.0
(Sapci, A.H. et al. 2020)	0	0	0	0	0	1	1	1	2.9
(Seric, A. et al. 2010)	2	1	0	1	0	0	0	0	4.2
(Vargiu, E. et al. 2017)	0	2	1	0	2	0	0	0	5
(Yang, H. et al. 2010)	1	0	1	0	0	0	0	0	2.1
(Nagi, A.T., et al. 2021)	1	2	0	1	0	2	1	1	8
(Javed, R., et al. 2021)	0	0	0	1	2	0	1	0	4.1
(Anam, M., et al. 2017)	2	1	0	1	1	0	0	0	5.1
(Aftab, M.O., et al. 2022)	1	0	0	0	1	1	0	0	3
(Awan, M.J., et al. 2020)	1	1	2	0	1	0	1	2	8.2
(Knaak, S., Mantler 2019)	0	2	0	0	1	0	0	1	4.1
(Ajmera, M. et al. 2017)	1	0	0	2	1	1	0	0	5.2
(Seric, A. et al. 2020)	0	2	0	1	0	0	1	2	6
(Vargiu, E. et al. 2017)	2	1	1	0	0	1	0	0	5
(Ross, P.T. et al. 2012)	1	0	0	1	0	0	1	1	4.1
(Yang, H., K. et al. 2010)	0	1	1	0	0	2	0	1	5.3
(Sapci, A.H. et al. 2020)	1	0	1	0	1	0	1	2	6.1
(Awan, M.J. et al. 2021)	1	2	0	0	1	0	1	2	7

that provides a set or framework of fundamental processes utilized to develop, design, and test software applications. These SDLC models involve spiral, waterfall, agile, and rapid application development that boosts the development of millions of software systems, including mobile devices, smart devices, and desktop applications for the healthcare sector. As [31] [32] stated, most consultants and vendors have used different software for the quality of healthcare ser-

vices and applications. These healthcare organizations use electronic medical systems and devices to manage patient record management applications to medical middleware devices.

Similarly, [28] highlighted that software engineering effectively considers applications in the context of E-health during the development process. Even though the E-health system is simple in principles, it is mandatory to ensure that

it systematically informs needs such as privacy and confidentiality while balancing usability requirements. The probability of E-health implementation is increased, which improves healthcare services regarding patient safety and decreases medical errors. On the contrary, [30] [33] informed that E-health has become a significant challenge in the healthcare sector as healthcare information systems and engineered systems are not efficiently comprehended and understood by everyone among staff or patients. This puts hindrances in achieving enhanced quality of care and decreasing practice errors. The author further addressed that the application of E-health is taken as a difficult task despite being an emerging field due to challenges and issues related to acceptance and adaptability in the healthcare area.

Nonetheless, the software engineering applications, including E-health in healthcare, allow developing a secure and reliable healthcare system with efficient performance. To aid the previously developed notion, [32] [34] stated that software engineering in E-health considers new prospects of maintenance and management that enable technological development in the healthcare industry, making the sector more maintainable and invasive. This is because the E-health system is designed to consider several aspects that are not realized by healthcare providers or people at authoritative positions and institutions, which enables the need to implement advanced technological methods. However, healthcare professionals and providers have limited understanding and knowledge of software, due to which they are not motivated to adopt or adapt to it. To further shed light on the prior argument, [29] implied that healthcare systems are not normal or just like other IT systems as they deal with confidential data and patient's data, for which security requirements is one of the most important aspects that is considered when developing new healthcare systems [35]. This adds to the complexity of the applications attributing to which it becomes hard for healthcare providers to comprehend and operate E-health systems, sometimes. Thus, it can be deduced that software engineering significantly assists in developing and deploying E-health systems that improve healthcare services in terms of improving patient care and experience. However, healthcare professionals and staff resist using, understanding, and adapting it completely.

5. Conclusions

The present study is aimed at exploring the software applications' needs concerning the healthcare sector. Due to the revolution in the market, competition has increased, and new advancements have taken place. Because of this, every industry sector is required to align its business operations with the effective implementation of automated software and applications. Similarly, the healthcare sector also needs to work on and implement appropriate software that can fasten the health service systems and improve the patients' quality of life. The first objective of the research was to explore the needs of software applications and automation in the healthcare sector to bring efficiency to the systems. The second objective of the research was to study different aspects of software engineering regarding E-health. In software engineering, the study con-

cluded that software engineering has a strong relationship in developing different systems. Due to these engineers, other new processes, tools, and applications have been designed and implemented, effectively satisfying patient needs and operating healthcare successfully.

Furthermore, one of the study's objectives was to evaluate resources aligned with management and software automation. Because of this, the researcher was able to evaluate current software, tools and management practices being carried out in the healthcare system. The current study also comprised of certain limitations that have been identified.

The limitation of this research is that the researcher had less time to carry out in-depth analysis. This impacted the study's findings in a way that data have been examined more effectively if the researcher had more time. Moreover, the researcher adopted the exploratory review model to review the literature concerned with research objectives. Hence, the present study was only restricted to the exploratory model. Furthermore, to analyze the research data, the researcher acquired a systematic review by which findings of the study were obtained. As a result, the analysis technique was limited to the systematic review only; however, data can be analyzed by using other analysis tools. Moreover, the researcher also had less budget, which impacted the selection of the research design. Thus, these limitations have been observed in the present study.

Every study carries some future practical implications or future agendas by which the research adds value in a certain field. Given the present study, the healthcare sector will be able to explore the prevailing situation in the market in the context of what software applications are commonly adopted. As a result, the health sector can bring enhancement to maintain and upgrade the quality of applications and patient's health.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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