



Article

The Success of Introducing Electronic Medical Records Using the Delone and Mclean Method: A Study in Nine Primary Healthcare Facilities in Surabaya

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Abstract: Since 2022, primary healthcare facilities in Surabaya have adopted electronic medical records for patient admission services. However, an evaluation of the implementation of the program has never been conducted. Therefore, the objective of this study is to evaluate the efficacy of integrating electronic medical records in the admission department of basic healthcare institutions in Surabaya. The evaluation is performed utilizing the DeLone and McLean methodologies. The characteristics assessed in this study are system quality, information quality, service quality, usage, user happiness, and perceived net benefit. The research was carried out using a descriptive approach and incidental sampling. The respondents of this study are nine admission officers from nine primary healthcare facilities in the city of Surabaya. The result of this study indicates that all variables are in good to excellent condition. The system quality is in excellent condition, with a rating of 55.56%. The information quality, use, and perceived net benefit are also excellent, with a rating of 66.67%. Meanwhile, service quality is at a satisfactory level of 66.67%, and user satisfaction is at a satisfactory level of 89%. The conclusion is that the implementation of electronic medical records has been highly successful, at 78%. It requires a step to implement to enhance the functionality of electronic medical records, including the incorporation of universal consent and the inclusion of patients' electronic signatures.

Keywords: *electronic medical records, primary healthcare facilities, admission, DeLone and McLean, Successful*

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1. Introduction

Electronic medical records, as defined by [1] on medical records, refer to medical records that are created and maintained utilizing electronic systems. Article 3 elaborates that every healthcare establishment is required to uphold electronic medical records. The health facilities mentioned include locations where doctors and other healthcare professionals practice independently, as well as Primary Healthcare facilities, clinics, hospitals, pharmacies, health laboratories, walk-in clinics, and other healthcare facilities. Furthermore, The World Health Organization (WHO) defined electronic medical records in 2006 as automated systems that employ document imaging or are generated by healthcare facilities. Moreover, the WHO clarified that the shift from manual medical records to electronic systems does not just involve converting paper records into digital formats. To establish the electronic medical record, it is necessary to first identify and resolve the problem with the paper-based medical record. Under those circumstances, the outcome will solely involve the automation of the content and procedures without effectively addressing the shortcomings in medical record management. Consequently, the intended objective of implementing medical records will not be accomplished.

Health facilities that rely on paper medical records instead of electronic medical records may need help accessing patient data promptly, as real-time access may be hindered. In addition, the retrieval of medical records may be time-consuming, leading to probable instances of missing files. Furthermore, discrepancies in the filling of medical abbreviations by healthcare professionals and concerns with the availability of medical records can also arise. These issues can result in disruptions to the provision of services

[2]. Electronic medical records have the advantage of eliminating issues related to clear handwriting, as they are not reliant on doctors, dentists, or nurses manually creating documents [3]. Nevertheless, electronic medical records have weaknesses, including the incapacity to retrieve data during internet network failures, which obstruct access to information stored in the electronic medical record for medical purposes.

Primary healthcare facilities of Surabaya City mandate the use of electronic medical records and have been utilizing electronic medical record services in daily work since 2022. Electronic health records in all primary healthcare facilities in Surabaya City have fully integrated services such as patient admission and general health services. This study aims to investigate the efficacy of deploying electronic medical records, specifically in the context of patient admissions.

In general, the assessment of the implementation of electronic medical records within primary healthcare settings in Indonesia has been understudied, particularly in comparison to analogous studies conducted in hospitals. In addition, the majority of research concerning electronic medical records in Indonesia remains predominantly concentrated on the examination of technical data system components, such as data security and interoperability, alongside general user satisfaction. Meanwhile, comprehensive evaluations of the implementation of electronic medical records continue to be markedly limited. Moreover, in Indonesia, there has yet to be a scholarly publication that delves into the assessment of electronic medical record implementation within Primary healthcares utilizing the DeLone and McLean model. Prevailing studies disseminated in Indonesia have predominantly concentrated on the readiness measures of Primary healthcares for the paper-based medical records to electronic medical records [4], [5], [6], as well as the appraisal of electronic medical record maturity employing the PIECES framework [7].

2. Materials and Methods

This study is descriptive, employing a cross-sectional methodology for data collection. The study's population comprises admission officers at Primary Healthcare institutions in Surabaya City, where a single admission officer represents each primary healthcare facility. The sampling technique is performed using the method of accidental sampling. In this study, there were nine admission officers from nine primary healthcare facilities who were willing to participate as respondents in this research. In addition, all respondents in this study are medical recorders. Moreover, data collection was conducted by having respondents fill out questionnaires distributed through Microsoft Forms, and interviews were also conducted to supplement the information obtained from this research. The questionnaire used in this study is an adapted version of the instrument developed by [8]. The variables, definitions, and the measurement results used in this study are presented in Table 1.

Table 1. Variables, Definitions, and Result of data measurement and collections

No	Variables	Definitions	Results of data measurement and collections
1	System quality	Measurement of the ease of use, functionality, and flexibility of the electronic medical record system.	Score per question: Excellent = 4 Good = 3 Poor = 2 Very poor = 1

No	Variables	Definitions	Results of data measurement and collections
			Overall Category per respondent: Poor = score 4-8 Good = score 9-13 Excellent = score 14-16
2	Information quality	Measurements related to the content and output of the electronic medical record system.	Score per question: Excellent = 4 Good = 3 Poor = 2 Very poor = 1
			Overall Category per respondent: Poor = score 4-8 Good = score 9-13 Excellent = score 14-16
3	Service quality	Measurements regarding the technical support provided in the implementation of the electronic medical record system.	Score per question: Excellent = 4 Good = 3 Poor = 2 Very poor = 1
			Overall Category per respondent: Poor = score 6-12 Good = score 13-19 Excellent = score 20-24
4	Use	Measurements concerning the perceived usefulness of the electronic medical record system by users and its actual usage.	Score per question: Excellent = 4 Good = 3 Poor = 2 Very poor = 1
			Overall Category per respondent: Poor = score 4-8 Good = score 9-13 Excellent = score 14-16
5	User satisfaction	Measurements assessing overall satisfaction with the implementation of the electronic medical record system.	Score per question: Excellent = 4 Good = 3 Poor = 2 Very poor = 1
			Overall Category per respondent: Poor = score 2-4 Good = score 5-7 Excellent = score 8
6	Net benefit	Measurements aimed at evaluating the perceived	Score per question: Excellent = 4 Good = 3

No	Variables	Definitions	Results of data measurement and collections
		impact of the EMR system since its adoption by users.	Poor = 2 Very poor = 1 Overall Category per respondent: Poor = score 4-8 Good = score 9-13 Excellent = score 14-16

3. Results and Discussion

3.1. Result

The interview results indicate that the service flow at patient admission in primary healthcare facilities in the City of Surabaya starts with patients autonomously registering through the e-health application. Then, patients will receive notification of their appointment scheduling through the application. The application is seamlessly connected to the patient's electronic medical records in the patient admission. It allows the patient to promptly wait in the registration waiting room upon visiting the chosen primary healthcare facilities. They will then be contacted by the primary healthcare facility admission officer for service. Afterward, the admission officer will identify and conduct an initial assessment of the patient's treatment requirements and the specific primary service that the patient requires. For non-citizens of Surabaya City or participants of the National Health Assurance (JKN) who have selected specific primary healthcare facilities will be instructed to submit payment. Lastly, patient data will be transmitted to the intended service either electronically or in physical form to the specified primary service.

In general, show in figure 1, the electronic medical record system provides positive performance results, especially in the speed of data access, accuracy of patient information, and efficiency in supporting the work performance of registration staff. However, there are several aspects that need attention from the Surabaya City Health Office as the manager of the electronic medical record system in all primary healthcare facilities operating in Surabaya. One of the problems that need attention is connectivity issues during service hours, which are an element with a majority of low ratings, indicating that this problem needs serious attention to the technical infrastructure. In addition, communication between healthcare professionals in the system is rated lower compared to other elements, indicating potential collaboration constraints.

In contrast, a particularly noteworthy discovery is that some respondents expressed that the outputs of the electronic medical records system did not entirely meet their expectations. This emphasizes the necessity for a more thorough alignment between the system's capabilities and the operational requirements, alongside the expectations of its users.

The results concerning six variables analyzed to assess the successful implementation of electronic health records are presented below.

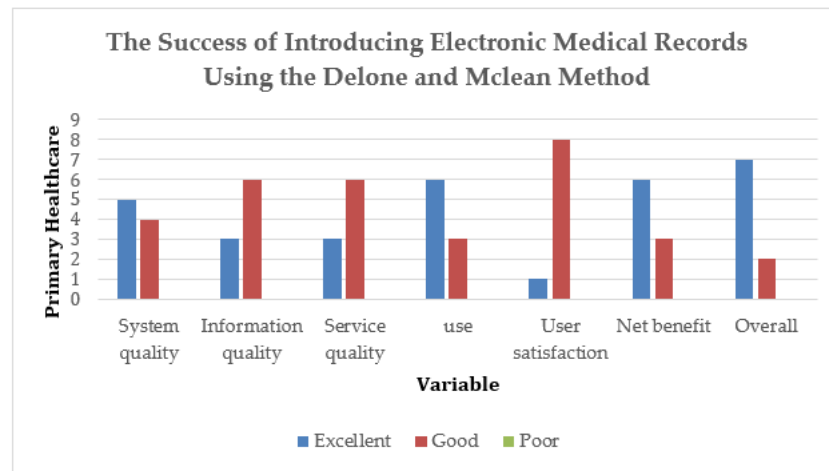


Figure 1. Results of Successful Electronic Medical Record Adoption Utilizing the DeLone and McLean Methods in Six Variables

3.1.1 System Quality and Information quality

The accessibility of historical patient data has achieved seven remarkable ratings, underscoring the widespread appreciation for this feature. This implies that the system adeptly facilitates users in extracting vital information. Additionally, the ease of use concerning the entry of new patient information has garnered six excellent ratings; however, the existence of a singular very poor rating may indicate specific challenges, potentially associated with onboarding or training nuances. In contrast, a significant area of concern pertains to communication with other healthcare professionals, which has attained only two excellent ratings, revealing a likely shortcoming in interprofessional communication processes.

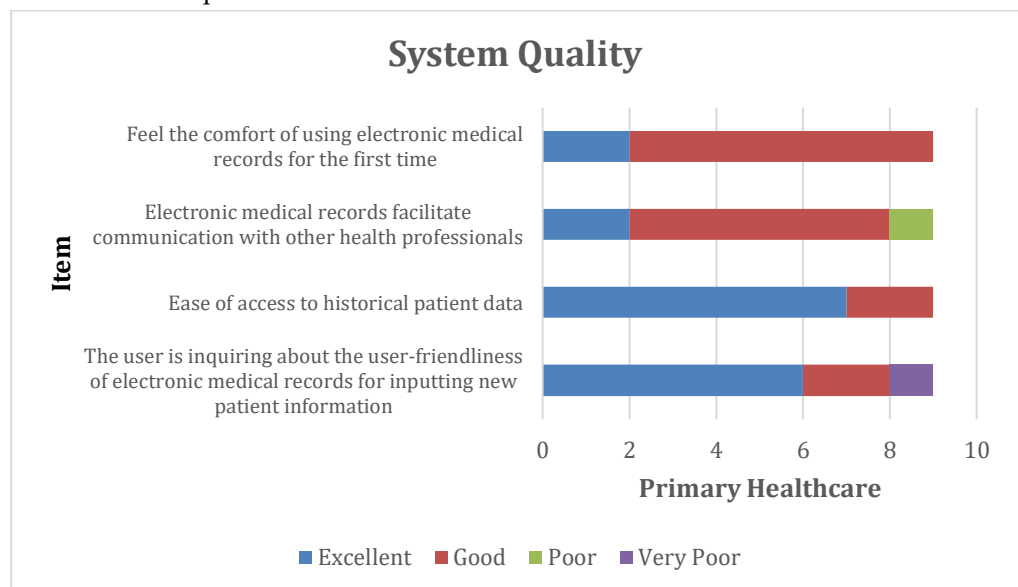


Figure 2. Indicator for system quality

3.1.2 Information Quality

The accuracy of patient information and instantaneous accessibility are notable strengths; for instance, instantaneous access exemplifies trustworthiness in promoting collaboration and has achieved eight outstanding ratings. Conversely, the synchronization of outputs with the requirements of admission officers has received two inadequate ratings, which may suggest areas where the output format or the information supplied needs enhancement.

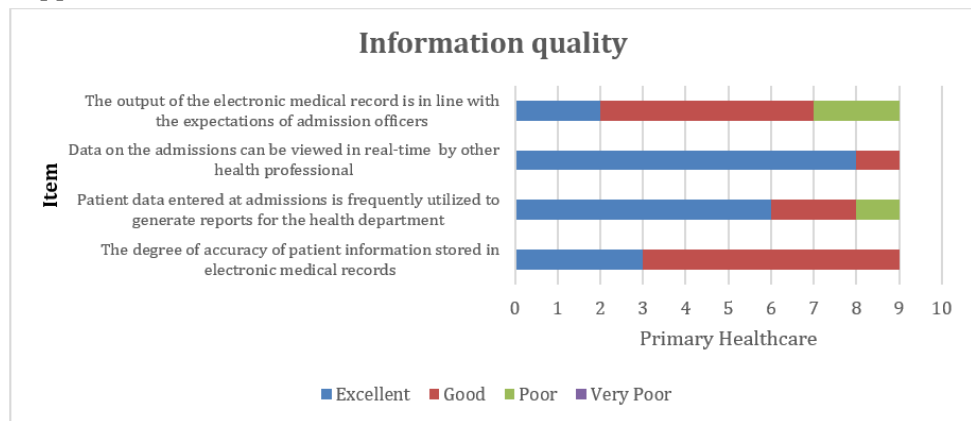


Figure 3. Indicator for information quality

3.1.3 Service Quality

Connectivity difficulties are distinctly evident, as underscored by six ratings classified as inadequate and one as profoundly deficient. This situation presents a considerable obstacle to effective operations and considerably undermines user satisfaction. In contrast, other facets, such as the expertise of IT personnel and the alignment of reports with established procedural workflows, predominantly receive commendable evaluations, reflecting a degree of proficiency while simultaneously leaving ample opportunities for refinement and enhancement.

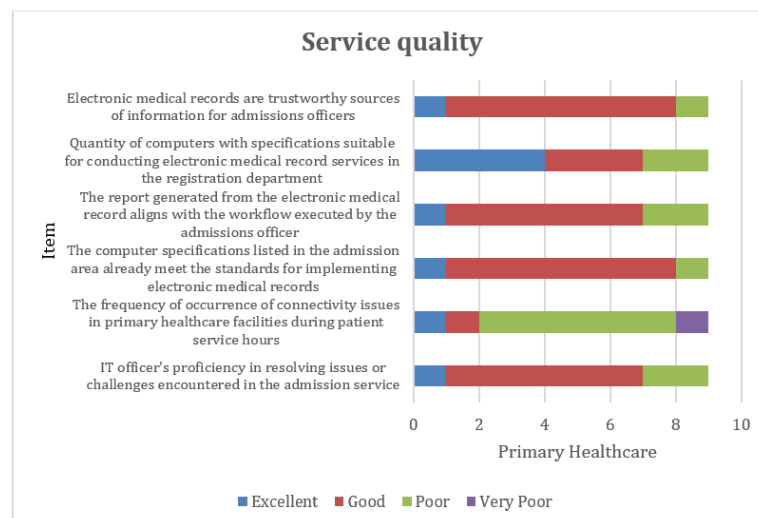


Figure 4. Indicator for service quality

3.1.4 Use

Support in performance has achieved seven remarkable ratings, indicating that users regard electronic medical records as pivotal in enhancing their productivity. The frequency of utilization (Monday through Saturday) and the hours dedicated to usage primarily receive excellent and good ratings, reflecting strong adoption and effective integration into customary workflows.

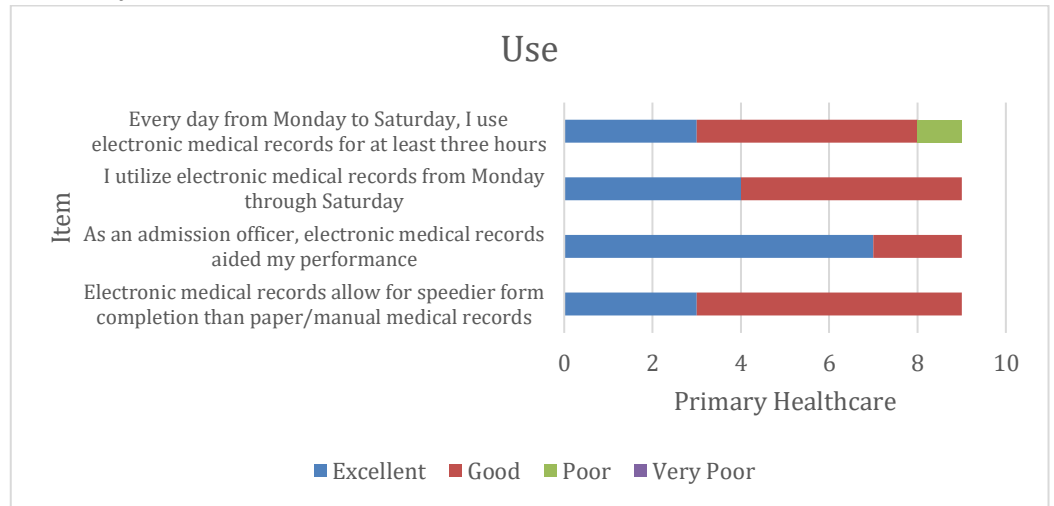


Figure 5. Indicator for use

3.1.5 User Satisfaction

Both aspects concerning user satisfaction are rated somewhat lower in comparison to other variables. While they typically garner positive ratings, the absence of outstanding commendations indicates that this category could substantially improve through enhancements to features or usability.

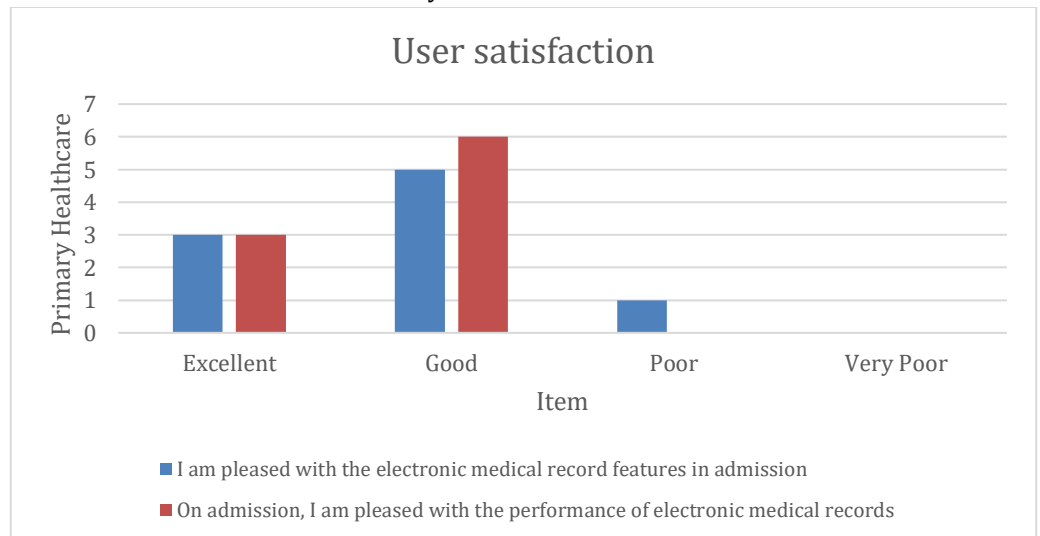


Figure 6. Indicator for user satisfaction

3.1.6 Perceived Net benefit

Reduced storage needs and faster response times perform excellently, showing clear value-added benefits to healthcare operations. Moreover, the overall perception of

improvement in patient care is strong, with 5 excellent ratings. This indicates that users recognize the broader impact of the system.

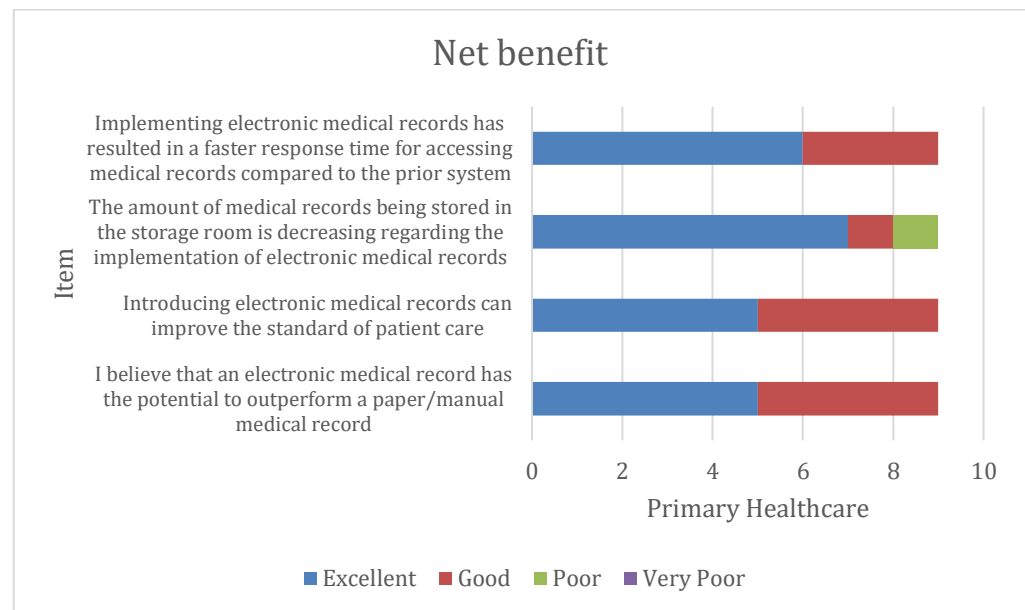


Figure 7. Indicator for net benefit

3.1.7 Overall Assessment of The Implementation of The Electronic Medical Record at Patient Admission

The overall analysis of the success achieved through the implementation of electronic medical records in the patient registration domain at primary healthcare, shown in Figure 1, resulted in 7 excellent ratings and 2 good ratings, reflecting a substantial overall perception of accomplishment. However, challenges remain in advancing the efficacy of electronic medical records, specifically in relation to the dimensions of service quality and user satisfaction, which still reflect inadequate ratings.

3.3 Discussions

Based on the findings on six variables, we underline several conditions that require immediate attention to be immediately improved, namely: communication among health professionals (system quality), output alignment with expectations (information quality), frequent connectivity issues and computer specifications (service quality), daily usage duration (use).

3.3.1 Communication Among Health Professionals

The findings highlight a significant deficiency in the quality of communication among healthcare practitioners. This notable shortcoming is considerably less favorable in relation to other elements of the quality system, underscoring the urgent need for focused advancements in this area.

Fostering improved communication is essential, as effective collaboration among healthcare professionals directly impacts the overarching efficiency and quality of patient care. The introducing of electronic medical records has the potential to

alter the communication practices among healthcare professionals, as demonstrated by [9] who employed the DeLone and McLean model to show that the implementation of electronic health records resulted in a transformation in hospital communication.

To effectively tackle these challenges, it is suggested to incorporate integrated communication tools within the electronic medical record (EMR) platform. Features such as messaging systems or collaborative modules specifically designed for healthcare professionals can significantly enhance interaction and coordination. Additionally, investing in structured and recurring training sessions aimed at strengthening communication practices and optimizing workflow dynamics would foster enhanced teamwork and efficiency among healthcare practitioners [10].

3.3.2 Output alignment with expectations

According to research data on the quality of information regarding the implementation of electronic medical records in primary healthcare facilities in Surabaya City, officials have the highest level of access to up-to-date registration data, which is used for reporting purposes in primary healthcare facilities. It signifies the admission section of the electronic medical records system can perform the interoperability function. Nevertheless, two participants in this study expressed dissatisfaction with the electronic medical records output, as it failed to fulfill the expectations of the registration department staff. It is likely due to the presence of some elements that cannot be included in the electronic medical record, including the overall consent and the patient's digital signature that is linked to the registration in electronic medical records. These findings align with the research conducted by [14], where 75% of the respondents indicated that not all material on electronic medical records met the requirements of the officers. Moreover, [15], [16] study highlight the need to address the quality of information.

3.3.3 Frequent connectivity issues and computer specifications

The use of electronic medical records and user satisfaction are both influenced by the quality of service. In fact, the quality of service is considered the most crucial aspect in assessing the effectiveness of hospital information systems [17]. The study conducted by [18] establishes a robust correlation between the quality of services and the satisfaction of respondents regarding the adoption of electronic health records. In addition, the quality of the service is closely correlated with the use and contentment of users [19]. However, this study found that the most excellent rating for service quality was attributed to the competency level of the computers used for electronic medical record services in the admission part.

Additionally, the reliability of the electronic medical record data also received a high rating. The lowest score pertains to the occurrence of network issues throughout the operational hours of the primary healthcare facilities. The nine primary healthcare facilities in the city of Surabaya utilize a shared electronic medical record system that is connected to the Health Department of Surabaya's

server. Consequently, it is common for issues to arise during peak service hours. The most prevalent network issues, according to the findings of the interviews, are sluggish networking during service hours and downtime. If these issues arise, the officers ensure that service is not disrupted by transferring the data from the paper medical record to the electronic medical record after service hours conclude or the connection stabilizes once more. This can be an enabling factor for the occurrence of burnout due to the increased workload after the service is completed [20], [21].

3.3.4 Daily usage duration

Despite some lingering connectivity issues, the use of electronic medical records is mandatory for daily operations in the Health Department of Surabaya City. As a result, the bulk of medical data is in great shape. However, the study results indicated that respondents rated the usefulness of electronic medical records as the highest in terms of assisting with their daily work. On the other hand, the lowest score was given to the use of electronic health records for a minimum of three hours per day, followed by the statement regarding the faster completion of electronic medical files compared to paper records.

Additional research indicates that the utilization of medical records does not inherently impact the contentment of those utilizing electronic medical records. [19] conducted a study that revealed a significant correlation between the usage of electronic medical records and the discontentment of participants. According to [17], the utilization of electronic medical records has no substantial impact on satisfaction, but it does influence the perceived net benefit. In addition to that, the use variable is the most important in assessing the effectiveness of the implementation hospital information systems.

Based on [15], [22], [23], it is essential to take into account user satisfaction in order to enhance the effectiveness of implementing electronic medical records. On the other hand, user satisfaction is influenced by the system's quality and the quality of service provided [24]. Additional research also asserts that user satisfaction is influenced by both the system's quality and the quality of service provided [24], [25], [26]. This study found that the system quality score exceeded the average level of user satisfaction. However, the service quality fell below the average level of user satisfaction. Therefore, the system's quality will significantly impact the user's satisfaction more than the system's inherent quality. Hence, the system's quality is more likely to significantly influence user satisfaction rather than the quality of the system itself.

This study highlights several limitations that should be addressed in future research endeavors. Firstly, the scope of the study was restricted to nine primary healthcare facilities within Surabaya, a city characterized by relatively uniform geographical and infrastructural conditions. Consequently, the findings may not be fully generalizable to healthcare settings in other regions, particularly rural or resource-constrained areas that may present distinct challenges in the implementation of electronic medical record systems.

Secondly, the study primarily captures the perspectives of healthcare professionals, excluding other significant stakeholders such as patients, administrative staff, and policymakers. Future research could benefit from incorporating the viewpoints of these groups to provide a more comprehensive and holistic understanding of the system's effectiveness and areas for improvement. This broader perspective would facilitate the development of tailored strategies to optimize electronic medical record adoption across diverse healthcare contexts.

Thirdly, factors such as digital literacy levels, users' technological experience, and technical infrastructure support may not have been fully examined in this study, despite their significant potential to influence implementation outcomes. Digital literacy may prove particularly advantageous in elucidating evaluative outcomes pertinent to system output alignment and interprofessional communication among healthcare providers, thereby presenting a more nuanced understanding of the challenges and opportunities inherent in the adoption of electronic medical records.

Lastly, the study's focus on short-term evaluations limits insights into the long-term impacts of electronic medical record systems. Future research could adopt a longitudinal approach to assess sustained outcomes, including improvements in patient care quality and operational efficiency over time. Addressing these limitations will enhance the depth and reliability of subsequent studies and contribute to the advancement of electronic medical record implementation strategies.

This research presents critical implications for public policy, particularly in shaping the development of digital health infrastructure in Indonesia. The findings offer a solid empirical foundation for crafting more effective policies related to electronic medical records in primary healthcare settings. By analyzing the factors contributing to the success and limitations of electronic medical record implementation, the study enables policymakers to better allocate resources, such as improving internet connectivity and fostering the development of digital health technologies that are both inclusive and responsive to the diverse needs of healthcare facilities across the country.

This study also provides meaningful insights for enhancing electronic medical record system design, with a focus on improving communication interfaces and the quality of report outputs. Policy initiatives that support the development of more intuitive, user-centered electronic medical record systems can facilitate broader adoption and increase operational efficiency within clinical environments. Aligning electronic medical record functionalities with the practical workflows and expectations of health professionals is essential to ensure their sustained use and integration into everyday healthcare delivery.

4. Conclusions

In general, the evaluation of the six factors that contribute to the effective adoption of electronic medical records, as assessed using the DeLone and McLean methods, is highly favorable. The majority of respondents rated the electronic medical record system positively, particularly for its accessibility and speed, demonstrating its effectiveness in addressing operational needs.

Internet connectivity challenges have emerged as a major obstacle, significantly affecting user satisfaction, with a majority of respondents providing "Poor" or "Very Poor" ratings. This underscores the urgent need for improving technical infrastructure to enhance system reliability and minimize disruptions in healthcare services.

While the electronic medical record system has successfully improved service standards and time efficiency, certain elements still need attention. Specifically, improving communication among healthcare professionals and aligning system outputs with user requirements will be essential to fully maximize the system's benefits for all stakeholders.

Considering the limitations of this study, which focuses on nine primary healthcare facilities in Surabaya, several potential recommendations for future research can be proposed. Expanding the geographical scope to include healthcare facilities in rural areas or other provinces could provide valuable comparative insights into electronic medical record adoption across diverse settings. Additionally, conducting a comparative analysis involving different types of healthcare facilities, such as secondary and tertiary hospitals, could help identify variations in the factors contributing to successful electronic medical record implementation. Another significant avenue for research lies in examining the influence of digital literacy, including other stakeholders in primary healthcare, and evaluating long-term outcomes.

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