REVIEW ARTICLE

Failure Modes of Electronic Medical Record Implementation: A Bibliometric Study

Ellya Yudianti[1], Merita Arini[1,2,3]

[1] Master of Hospital Administration, Postgraduate Program, Universitas Muhammadiyah Yogyakarta, Daerah Istimewa Yogyakarta 55183, Indonesia
[2] Family Medicine and Public Health Department, School of Medicine, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Daerah Istimewa Yogyakarta 55183, Indonesia
[3] Sustainable Development Goals (SDGs) Center, Universitas Muhammadiyah Yogyakarta, Daerah Istimewa Yogyakarta 55183, Indonesia

ABSTRACT

Electronic Medical Records (EMRs) still have implementation failure risks, impacting service quality and safety. More research is needed to improve it. Hence, this study aims to explore publication patterns and research developments on the failure modes of EMR implementation to obtain novel future research topics. This research used descriptive quantitative with bibliometric analysis using VOSviewer, collected the data using specific keywords, and set no limitations to get the comprehensive data. The majority of EMR research and researcher affiliations come from developed countries. There were multiple frequently appearing keywords from each cluster, grouped into three themes, including the quality of the EMR system, the subject of EMRs, and the use of EMRs. There is still potential to study EMR failure modes in developing countries, especially about the scarce topics to ensure the implementation of this technology is safe, effective, and runs as intended.
Malaysian Journal of Medicine and Health Sciences (2025) 21(SUPP3): 228-235. doi:10.47836/mjmhs.21.s3.34

Keywords: Bibliometric, VOSviewer, Failure mode, Electronic medical record, Electronic health record

Corresponding Author:
Ellya Yudianti, MARS
Email: ellya.yudianti@gmail.com
Tel :+62 816-5411-504

INTRODUCTION

Implementing technology in the health sector has brought changes to the administration of medical records, from paper-based to electronic ones. The crucial advantages of electronic medical records (EMRs) and electronic health records (EHRs) have been the subject of numerous studies, enhancing the standard of healthcare through the reduction of errors in medication, mitigation of duplicate errors, elimination of unneeded procedure variants, and simplification of gathering data and access. Consequently, these measures contribute to an overall upsurge in satisfaction and facilitate the sharing of information among healthcare providers (1–3).

In developing countries, however, there remains a need for further enhancements in EMR implementation and consumption despite their substantial impact on the healthcare industry (4). It is essential that in addition to benefits, there are repercussions of using EMR that risk patient safety. Such impacts include users copying and pasting EMR data that contributed to diagnostic and treatment errors due to copying and pasting previous visit history (5), also wrong administration of medications, scheduling, patient-provider communications, referrals, laboratory and diagnostic procedures (6). In studies on the health technology acceptance, over fifty percent of EMR initiatives fail before achieving their objectives (7), and the implementation of EMRs has yet to reach the expected target (8). Recent studies on implementing EMRs have explored the influencing factors (9–11). Further studies are needed regarding the failure mode of implementing EMRs to improve its objectives (12). Before exploring this failure mode, it is essential to know how previous studies describe it to obtain information about trends, updates, and research opportunities.

Research on EMRs that is now available focuses mostly on the advantages and difficulties associated with their deployment (9–11), ignoring the methodical identification and examination of failure modes (12). This research gap calls for a bibliometric study to map out the landscape of failure modes in EMRs implementation, providing important insights into locations that call for targeted risk management and mitigation techniques. This might lead to enhancements in EMR system robustness, user satisfaction, and patient safety (12–14).

On the basis of this context, this study aims to investigate the publication pattern and research

development concerning the failure modes of EMRs or EHR implementation through bibliometric analysis. The findings of this study will offer significant insights to direct future research topics and and the rising themes within this critical area, ultimately enhancing the EMR implementation that prioritize EMR system robustness, user satisfaction, and patient safety, which has yet to reach its implementation target.

MATERIALS AND METHODS

The research design is descriptive quantitative with bibliometric analysis of various failure mode studies in applying EMRs or EHRs from the Scopus Database using VOSviewer. Bibliometric analysis frequently examines the evolution of research fields, their growth, and their prominence in academia (15). Bibliometrics is a Greek word that consists of biblion, meaning 'book', and metron, meaning 'measurement'. The term was first introduced by Alan Pritchard in 1969 in his article 'Statistical Bibliography or Bibliometrics?'. Bibliometrics is referred to as the application of mathematical and statistical methods in books or other scientific communication media (16). Bibliometrics is a quantitative method used to measure, track, and analyze print-based scientific literature (17). This method carries out quantitative scientific assessments of literature to examine the development of the field under study, the growth of publications, and salient aspects of the scientific field (15). Bibliometric studies are often used to uncover essential elements in the field of research (authors, institutions, countries, and journals), uncover networks between important elements of research that contribute to intellectual structures based on groups of related themes within the research field, and identify most of the historical roots (18,19).

VOSviewer is a free bibliometric analysis software that focuses on the graphical representation of bibliometric maps, which is notably effective for displaying big bibliometric maps in an easy-to-understand format (20). The Scopus Database includes the entire Medline and is bigger than the Web of Science (21,22). Scopus comprises over 23,000 indexed journals spanning diverse domains and studies. Moreover, Scopus offers a variety of user-friendly functions that facilitate bibliometric analysis. Scopus' trustworthiness has led to its adoption as a bibliometric data source for large-scale analysis in research reviews, research surroundings studies, scientific policy examinations, and institution rankings (23).

There are four research stages. Stage one begins with a search in the Scopus Database with keywords (Electronic Medical Record) OR (Electronic Health Record) AND (Failure Mode), conducted on June 18, 2024 (Table I). Specific cases or topics that are still rarely researched could be a bit of a reference per se, nevertheless bibliometrics are still crucial for gaining thorough yet brief insights into pressing issues (24,25). Regarding data mining, bibliometrics law like Bradford's Law can be aplied to delineates the exponential relationship and the zone distribution of research journals (26). Hence, this study focuses more on describing publication patterns and novel topics for further researchs on EMRs or EHRs. Furthermore, this search uses no limitations to get the comprehensive data and gathered 160 documents, which analyzed in stages two, three, and four.

Table I: Data Search Keywords

(TITLE-ABS-KEY ((electronic AND medical AND record)) OR TITLE-ABS-KEY ((electronic AND health AND record)) AND TITLE-ABS-KEY ((failure AND mode)))

Stage two downloads all 160 documents collected into "CSV" and "RIS" formats. In stage three, data in "CSV" format works into graphs and maps to make visualization easier. This data analyzes publication trends based on year of publication, country of research, the field of study, ten most affiliations, ten most publication sources, ten most funding sponsor, citation overview, and the most cited article. Meanwhile, data in "RIS" format works with VOSviewer for overlay, network, and density visualization. Lastly, in stage four, visualization analysis of graphs, maps, and tables was carried out with discussion so that they could answer the research objectives.

RESULTS AND DISCUSSION

The search collected 160 documents from the Scopus Database from 2002 to 2024. Based on the graphs in Fig. 1 (a) and Fig. 2 (a), publications regarding failure modes in the application of EMRs have fluctuated over two decades. The most research publications were in 2021. The use of EMRs started to increase in 2013, thus encouraging much research to examine its application (27). Publication trends show that the number of studies is growing in line with the use of EMRs (27). The leverage in 2019-2021 is likely due to the conditions of the COVID-19 pandemic. EHR emerged as a pivotal data source amidst the COVID-19 pandemic, supplying medical professionals and scientists with crucial data about illness movement, treatment efficacy, investigations, and novel approaches. However, the data's validity and the limitations of EMRs received little attention (28). The failure mode research also decreased in that year. It takes an opportunity for further studies.

Fig. 1 (b) reveals that the United States dominates research publications' contribution on this topic with 82 studies. The United States dominates the number of studies because it was in this country that EHRs were first implemented in 1967 at Latter Day Saints Hospital through the Health Evaluation Through Logical Programming (HELP) platform after several studies concluded that manual records were inefficient and required high paper costs (27). The United States developed EMRs in 1972 at The Regenstreif Institute (29). This study shows that

the majority of publications regarding EMR/EHR failure modes are studied in developed countries, including the United States (30,31), the United Kingdom (32), and Canada (33,34). It is not surprising, considering that developed countries first implemented the use of EMRs along with the development of information technology (27). Thus, EMRs still present an opportunity for new research and publications regarding failure modes in developing countries.

Fig. 1 (c) describes the trend of publications from research fields or subjects. The field of medicine accounted to be the most significant proportion (56.5%) publication, followed by health professions and nursing with 8.4% each. EMRs and EHRs are used in healthcare facilities, so medicine is the most researched subject. Meanwhile, the primary EHR users are the nursing profession, who have direct contact in filling out EHRs related to the nature of the work of the nursing profession, namely providing nursing care and transferring the data to the patient's medical record (35).

Fig. 1 (d) shows that most research publications on the failure mode of implementing EMRs or EHRs were leaded by Harvard Medical School, with six research publications. Harvard University is a private college belonging to the Ivy League association in Cambridge, Massachusetts, United States. It was founded in 1636, becoming the oldest higher education institution in the United States and one of the best universities in the United States. Harvard University is known for academic excellence and has many leading social sciences, humanities, science, engineering, law, business, medicine, and education programs (36). These advantages align with the amount of research conducted for academic interests and the advancement of science in various fields.

Fig. 1 (e) presents the documents per year published by source. Top 10 publications based on the source of the published journal, which is leaded by the Journal of The American Medical Informatics Association (JAMIA) with 6 documents along 22 years. This journal was published in the United States, where many articles about this subject are released. The journal disseminates articles about the most recent advancements in medical information technology (IT) management, research, education, and information technology for healthworkers.

This study revealed a significant link between subject areas and funding sources Fig. 1 (f). A substantial proportion of the obtained papers disclosed that they had received financial support from Agency for Healthcare Research and Quality followed by the National Institutes of Health (NIH) with six publications. This result indicates that funding sources with a significant interest in improving the healthcare system are likely to have an impact on the research topics that gather the most attention in the field. Fig. 1 (g) shows that the trend of citations is increasing in line with the increasing number of documents published. The peak of publications on this topic occurred in 2021, as many as 24 documents with 495 citations. This is also related to the COVID-19 pandemic, where the use of digital technology has increased significantly (28).

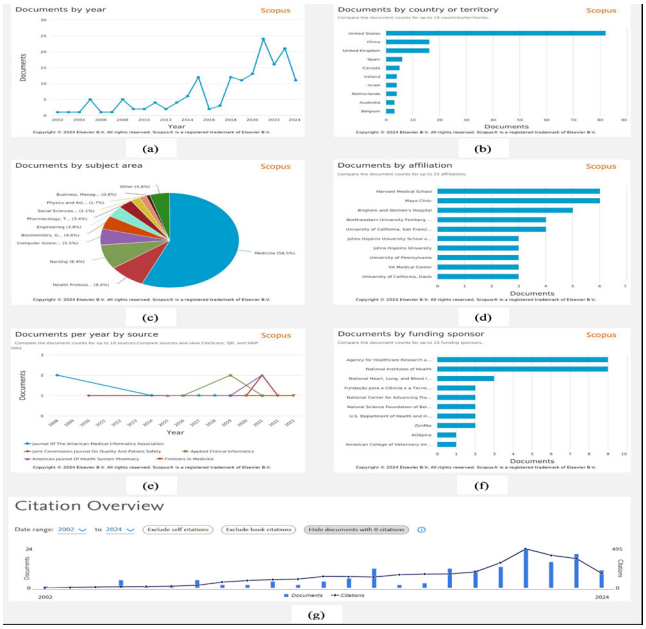

Fig. 1: Publication pattern. (a). Publication trends by year, (b). Publication trends by countries, (c). Publication trends by subject area, (d). Publication trends by affiliation, (e). Publication trends by the journal source, (f) Publication trends by funding sponsor, (g) Citation overview. Data in "CSV" format works into graphs and maps to make visualization easier. This data analyzes publication trends based on year of publication, country of research, the field of study, ten most affiliations, ten most publication sources, ten most funding sponsor, and citation overview. (Adapted from Scopus Database).

One of the 160 publications analyzed has the most citations. The study entitled "Workarounds to Barcode Medication Administration Systems: Their Occurrences, Causes, and Threats to Patient Safety" was conducted by Koppel et al in 2008 and published in the Journal of American Medical Informatics Association (index Q1) has been cited the most with 558 times (37). The open-source access to this article makes it easier for other researchers to carry out citations. Affiliated with Center for Clinical Epidemiology and Bio-statistics, School of Medicine, Sociology Department, University of Pennsylvania, Koppel has established a commendable research portfolio, having authored 87 scholarly articles published in Scopus in 1982-2023 and achieved an h-index of 29. With an h-index of 29, his work is not only prolific but also influential, indicating that at least 29 of his papers have been cited 29 times or more by other researchers.

The different point of view of the most cited article, unique but meaningful, becomes the novelty of this research. This study identified 15 types of workarounds and 31 types of cause of workarounds on using barcoded medication administration (BCMA) systems,

which integrated to interface with electronic medication administration records. Design, implementation, and workflow integration flaws in BCMAs lead to workarounds that guarantee proper usage of safety features. This Koppel et al. study, aligned with the Cheng et al. study 2022, found that copying and pasting can cause diagnostic writing errors, leading to patient injury and medication errors included in patient safety violations (5).

Besides publication patterns, this study also describes the development of research on failure modes in applying EMRs in over two decades. The Network visualization in Fig. 2 (b) reveals three clusters marked with three colors: red, green, and blue. This study organized keywords that often appear in each cluster into three thematic clusters that characterize the entire set (Table II), based on bibliometric analysis enhancement techniques as network metric, clustering, and visualization (19,38). Theme grouping helps focus on failure mode's key elements, allowing for a more detailed examination.

Table II: Most frequently appearing keywords

No	Keywords	Cluster	Themes
1	Electronic Medical Record, Medical Record System, Patient Safety, Quality, Medical Error	Red	The quality of the EMR system
2	Human, Adult, Female, Middle Aged, follow up,	Green	The subject of EMRs
3	Electronic Health Records, Total Quality management, Clinical Decision Making, Hospital, Hospitalization	Blue	The use of EMRs

EMRs = Electronic Medical Records
(Adapted from Scopus Database and reworked with VOSviewer)

The Quality of The EMR System

The EMR systems that have not been updated, systems that are not yet interconnected with other systems, and missynchronized system codes are potential failure modes of EMR implementation. The outcomes of the implementation are also impacted by the EMR system's installation. The advantage of the incremental method, which implements the system gradually, is that staff may gradually become proficient with the system's capabilities and that each problem will be easier to fix because it is isolated from other EMR modules or operations. Although staff members not understanding the regulations may be a barrier, regular processes can be followed in a different way (12). Another study in Ethiopia concludes that hospital readiness is determined by choosing a standardized and certified EMR system in addition to adequate equipment, improving infrastructure, and information technology team components in hospitals (39).

Three challenges must be addressed in order to overcome this obstacle: first, the work plan must be strictly followed in order to keep the implementation stage on schedule; second, the manual and electronic hybrid processes must be carefully observed because not all tasks can be completed electronically; and third, knowledge of the various functions that are implemented at different times must be gained (12). Inconsistencies between the EMR system's characteristics and the requirements of healthcare facilities represent another possible source of system quality failure. Potential remedies to improve the usability of electronic health records include redesigning them and streamlining the implementation process (13). Furthermore, interoperability is a crucial component of a high-quality EMR system. This is in line with studies that state that the interoperability of the Health Information System (HIS) to other databases can reduce information transmission errors (40).

In order to raise customer "lock-in" and transition expenses to other providers, EMR companies may sometimes intentionally design incompatible systems (41). It's crucial that users of EMR systems take note of this locking point of view, wherein customers ultimately have to choose between maintaining the chosen EMR system with a patch that's been applied after the fact or moving to a better product. All ideas pertaining to the issue of EMR system quality are intended to increase the deployed EMR system's robustness and user satisfaction to the goals of EMR implementation. This is a consideration that should be taken into account before selecting an EMR system.

The Subject of EMRs

Physicians, nurses, midwives, medical recorders, analysts, administrators, and financial professionals—men and women of all ages—who work in healthcare facilities that employ electronic medical records (EMR) are the EMR subjects. This group was potentially in the failure mode of EMR implementation because some participants believed they couldn't operationalize EMR, while others were unaware of their duty to use it. The admissions department uses EMRs the most, while doctors utilize them the least (42–44). Building an overall knowledge capacity to increase officers' computer abilities, attitudes, and knowledge is vital because health personnel need to be better prepared as subjects in the EMR implementation (4).

This theme suggests that strengthening the subject's capacity to operationalize the EMR is crucial. Socialization and education alone are undoubtedly insufficient. One of the keys to successful implementation is the requirement for both direct practice and training. Furthermore, the training requires reassessment to determine whether ability has improved, and retraining may be required if non-significant changes are found in the evaluation results. This theme is consistent with research showing that nurses can perform better through a variety of actions taken to acquire, share, document, and use information as needed (45).

The Use of EMRs

The use of EMR is considered in line with how users

perceive its usefulness. This theme is consistent with research from Nevada and California that shows the majority of nurses believe that implementing EMR increases productivity. Others believe that EMR is time-consuming and affects how much a subject uses it; for this reason, hospitals and providers need to offer sufficient training to lessen the load on the subject (13,46). Research has indicated that a robust association exists between the behavioral interest in utilizing EMR and the impression of its effectiveness (42–44). In other words, all EMR subjects should have a better perception of the benefits and interest in using them.

The theme of the use of EMRs also aligns with the study in 2021, which concluded that knowledge quality and effective utilization should be considered when assessing the efficacy of EHR systems in healthcare facilities (47), where the nurse's duties included establishing care for the EHRs (35). A digital training method adapted to the nurses' learning requirements and styles, the on-the-job training structure, and enough peer support are required for effective health information technology adoption to improve the utilization of EMR (48). The use of EMR with optimal subject ability enhancing user satisfaction. In addition, user accuracy will also increase, thereby reducing the occurrence of copy-pasting errors that threaten patient safety.

This theme suggests that the adoption of EMR in healthcare must include a policy component. All employees will be obligated by the organization's leadership policies to fulfill its objectives, particularly physicians and nurses, who are the primary providers of healthcare services. EMR guidelines that are comprehensive, understandable, and workable for EMR subjects must be prepared. The aforementioned principles and guidelines are consistent with study findings that indicate the need for manual guidance during all phases of HIS implementation, ranging from design and planning to evaluation, due to the inevitable evolution of numerous concerns and challenges (11). The EMR usage policy, along with its comprehensive guidelines and periodic evaluations, can improve the strength of the EMR system, user satisfaction, and patient safety.

Density visualization (Fig. 2 (c)) shows that keywords often mentioned in the research are indicated by yellow areas that are denser the more often they are cited. This result is in sync with the network visualization in Fig. 2 (b). From the keywords mentioned least, this can be important information for further writers to develop research and achieve novelty. These keywords include patient safety to the quality of EMRs' system in the red cluster. From the green cluster, the keyword medical record's review is the least used, associated with the subject of the EMR system. The blue cluster has the keyword multidisciplinary team related to the theme of EMR utilization. These topics need to be developed further with holistic assessment. Aguirre RR et al. study in 2019 stated that only a few publications covered all the aspects required, from selection and regulation to the process for carrying out and afterward of the EHR system within a single origin (12). Another study in Iran stated that although EHR users have resolved information communication barriers in developed countries, many developing countries that have recently implemented EHRs face similar problems (40).

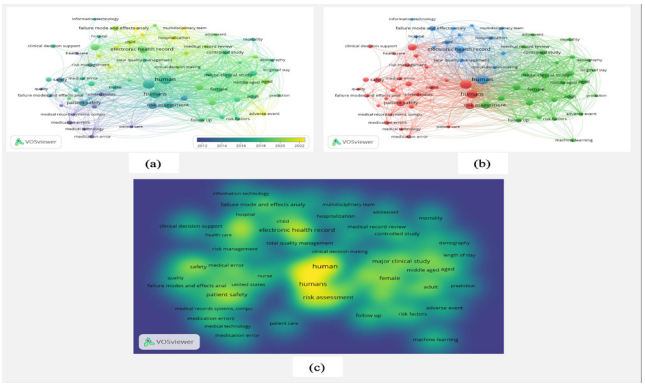

Fig. 2: Research development. (a). Overlay visualization, (b). Network visualization, (c). Density visualization. Data in "RIS" format works with VOSviewer in order to easily visualization. This data analyzes research development according to overlay, network, and density visualization. (Adapted from Scopus Database and reworked with VOSviewer).

This research can explain information on publication patterns and research developments on the failure mode of implementing EMRs or EHRs and construct three themes enhancing EMR implementation with Bibliometric analysis, but has considered its limitations. Regarding data sources, this research only uses studies in the Scopus database. Therefore, suggestions for further research using a global database as another data source. This study only obtained and analyzed 160 publications. Specific cases that are still infrequently investigated may serve to be a bit of reference, but bibliometrics are still critical for acquiring comprehensive yet concise insights into important issues. Qualitative design can also be added to strengthen the synthesis. In addition, identifying the correct search terms restricts the scope of the examined journals and may omit significant journals that should been part of the analysis.

CONCLUSION

The failure mode of EMRs or EHRs implementation studies have continued over two decades despite fluctuating. Developed countries still contribute the most to research on this topic from the publishing pattern and topic in research development. There are three themes according to frequently appearing keywords of clusters: the quality of the EMR system, the subject of EMRs, and the use of EMRs that prioritize EMR system robustness, user satisfaction, and patient safety. The application of EMR remains an interesting topic to study in line with the development of technology that influences its evolution. On the other hand, research on the application of EMR through a risk management

approach needs to be improved. Further investigation as a risk mitigation strategy against potential failure in EMR implementation is essential to ensure the implementation of this technology is safe, effective, and runs as intended. There is still potential to study the failure mode of implementing EMRs in developing countries, especially about the scarce topics.

REFERENCES

1. Ibrahim AA, Ahmad Zamzuri MAI, Ismail R, Ariffin AH, Ismail A, Muhamad Hasani MH, et al. The role of electronic medical records in improving health care quality: A quasi-experimental study. Med (United States). 2022;101(30):E29627. https://doi.org/10.1097/MD.0000000000029627.
2. Chen RF, Hsiao JL. Health professionals' perspectives on electronic medical record infusion and individual performance: Model development and questionnaire survey study. JMIR Med Informatics. 2021;9(11). https://doi.org/10.2196/32180.
3. Hodgson T, Burton-Jones A, Donovan R, Sullivan C. The role of electronic medical records in reducing unwarranted clinical variation in acute health care: Systematic review. JMIR Med Informatics. 2021;9(11):1–15. https://doi.org/10.2196/30432.
4. Awol SM, Birhanu AY, Mekonnen ZA, Gashu KD, Shiferaw AM, Endehabtu BF, et al. Health professionals' readiness and its associated factors to implement electronic medical record system in four selected primary hospitals in Ethiopia. Adv Med Educ Pract. 2020;11:147–54. https://doi.org/10.2147/AMEP.S233368. https://doi.org/10.2147/AMEP.S233368.
5. Cheng CG, Wu DC, Lu JC, Yu CP, Lin HL, Wang MC, et al. Restricted use of copy and paste in electronic health records potentially improves healthcare quality. Med (United States). 2022;101(4):E28644. https://doi.org/10.1097/MD.0000000000028644.
6. Khatami A, Marcus J, Arslan F, Guergachi A, Keshavjee K. Towards a Regulatory Framework for Electronic Medical Record Interoperability in Canada. In: K. K, A. K, editors. Studies in Health Technology and Informatics. Institute of Health Policy and Management, Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada: IOS Press BV; 2024. p. 59–63. https://doi.org/10.3233/SHTI231312.
7. Ketikidis P, Dimitrovski T, Lazuras L, Bath PA. Acceptance of health information technology in health professionals: An application of the revised technology acceptance model. Health Informatics J. 2012;18(2):124–34. https://doi.org/10.1177/1460458211435425.
8. Janett RS, Yeracaris PP. Electronic medical records in the american health system: Challenges and lessons learned. Cienc e Saude Coletiva. 2020;25(4):1293–304. https://doi.org/10.1590/1413-81232020254.28922019.
9. Tubaishat A. Evaluation of electronic health record implementation in hospitals. CIN - Comput Informatics Nurs. 2017;35(7):364–72. https://doi.org/10.1097/CIN.0000000000000328.
10. Ramar P, Ahmed AT, Wang Z, Chawla SS, Suarez MLG, Hickson LTJ, et al. Effects of Different Models of Dialysis Care on Patient-Important Outcomes: A Systematic Review and Meta-Analysis. Popul Health Manag. 2017;20(6):495–505. https://doi.org/10.1089/pop.2016.0157.
11. Setyonugroho W, Puspitarini AD, Kirana YC, Ardiansyah M. The complexity of the hospital information system (HIS) and obstacles in implementation: A mini-review. Enferm Clin. 2020;30:233–5. https://doi.org/10.1016/j.enfcli.2020.06.053.
12. Aguirre RR, Suarez O, Fuentes M, Sanchez-Gonzalez MA. Electronic Health Record Implementation: A Review of Resources and Tools. Cureus. 2019;11(9). https://doi.org/10.7759/cureus.5649.
13. Upadhyay S, Hu HF. A Qualitative Analysis of the Impact of Electronic Health Records (EHR) on Healthcare Quality and Safety: Clinicians' Lived Experiences. Heal Serv Insights. 2022;15. https://doi.org/10.1177/11786329211070722.
14. Kartika Y, Rusetiyanti N, Pertiwi AAP. Nurses and physicians' perceptions on the Electronic Health Record implementation. Enferm Clin. 2021;31:521–5. https://doi.org/10.1016/j.enfcli.2020.10.039.
15. Apriliyanti ID, Alon I. Bibliometric analysis of absorptive capacity. Int Bus Rev. 2017;26(5):896–907. https://doi.org/10.1016/j.ibusrev.2017.02.007.
16. Ellegaard O, Wallin JA. The bibliometric analysis of scholarly production: How great is the impact? Scientometrics. 2015;105(3):1809–31. https://doi.org/10.1007/s11192-015-1645-z.
17. Chin Roemer R, Borchardt R. A 21st-Century Librarian's Guide to Bibliometrics, Altmetrics, and Research Impact. 1976.
18. Kokol P, Blažun Vošner H, Zavr nik J. Application of bibliometrics in medicine: a historical bibliometrics analysis. Health Info Libr J. 2021;38(2):125–38. https://doi.org/10.1111/hir.12295.
19. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. J Bus Res. 2021;133(April):285–96. https://doi.org/10.1016/j.jbusres.2021.04.070.
20. Van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 2010;84(2):523–38. https://doi.org/10.1007/s11192-009-0146-3.
21. Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, Scopus, Web of

Science, and Google Scholar: strengths and weaknesses. FASEB J. 2008;22(2):338–42. https://doi.org/10.1096/fj.07-9492LSF.
22. Aghaei Chadegani A, Salehi H, Md Yunus MM, Farhadi H, Fooladi M, Farhadi M, et al. A comparison between two main academic literature collections: Web of science and scopus databases. Asian Soc Sci. 2013;9(5):18–26. https://doi.org/10.5539/ass.v9n5p18.
23. Baas J, Schotten M, Plume A, Côté G, Karimi R. Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. Quant Sci Stud. 2020;1(1):377–86. https://doi.org/10.1162/qss_a_00019.
24. Fox S, Lynch J, D'alton P, Carr A. Psycho-oncology: A bibliometric review of the 100 most-cited articles. Healthc. 2021;9(8):1–24. https://doi.org/10.3390/healthcare9081008.
25. Shah SAA, Sukmana R, Fianto BA. Macaulay's theory of duration: 80-year thematic bibliometric review of the literature. J Econ Stud. 2020 Dec 23;48(1):103–32. https://doi.org/10.1108/JES-11-2019-0540.
26. Yang JM, Tseng SF, Won YL. A bibliometric analysis on data mining using Bradford's law. Lect Notes Electr Eng. 2016;345:613–20. https://doi.org/10.1007/978-3-319-17314-6_78.
27. Aviat. Fakta Perkembangan Teknologi Rekam Medis di Berbagai Negara [Internet]. Aviat. 2022 [cited 2023 Mar 21]. Available from: https://aviat.id/fakta-perkembangan-teknologi-rekam-medis-berbagai-negara/
28. Binkheder S, Asiri MA, Altowayan KW, Alshehri TM, Alzarie MF, Aldekhyyel RN, et al. Real-world evidence of covid-19 patients' data quality in the electronic health records. Healthc. 2021;9(12):1648. https://doi.org/10.3390/healthcare9121648.
29. Honavar S. Electronic medical records - The good, the bad and the ugly. Indian J Ophthalmol. 2020;68(3):417–8. https://doi.org/10.4103/ijo.IJO_278_20.
30. Parker M, Partridge B. Management and Leadership Distinctions Required at Stages of Maturity in an EHR/EMR Adoption Model Context. In: Mobile Medicine: Overcoming People, Culture, and Governance. CISSP, The CISO, IU Health, United States: Taylor and Francis; 2021. p. 79–102. https://doi.org/10.4324/9781003220473-7.
31. Ndabu T, Mulgund P, Sharman R, Singh R. Perceptual gaps between clinicians and technologists on health information technology-related errors in hospitals: Observational study. JMIR Hum Factors. 2021;8(1). https://doi.org/10.2196/21884.
32. McDowall RD. Effective and practical risk management options for computerised system validation. Qual Assur J. 2005;9(3):196–227. https://doi.org/10.1002/qaj.339.
33. Rodriguez-Gonzalez CG, Martin-Barbero ML, Herranz-Alonso A, Durango-Limarquez MI, Hernandez-Sampelayo P, Sanjurjo-Saez M. Use of failure mode, effect and criticality analysis to improve safety in the medication administration process. J Eval Clin Pract. 2015;21(4):549–59. https://doi.org/10.1111/jep.12314.
34. Paredes-Atenciano JA, Roldán-Aviña JP, González-García M, Blanco-Sánchez MC, Pinto-Melero MA, Pérez-Ramírez C, et al. Failure mode and effects analysis on computerized drug prescriptions. Rev Calid Asist. 2015;30(4):182–94. https://doi.org/10.1016/j.cali.2014.12.011.
35. Top M, Gider Ö. Nurses' views on electronic medical records (EMR) in turkey: An analysis according to use, quality and user satisfaction. J Med Syst. 2012;36(3):1979–88. https://doi.org/10.1007/s10916-011-9657-6.
36. SUN Education Group. Apa Itu Harvard University? [Internet]. SUN Education Goup. 2023 [cited 2023 Mar 21]. Available from: https://suneducationgroup.com/app/sun-media-app/news-app/universitas-harvard/#:~:text=Harvard University adalah sebuah perguruan,tinggi tertua di Amerika Serikat
37. Koppel R, Wetterneck T, Telles JL, Karsh BT. Workarounds to Barcode Medication Administration Systems: Their Occurrences, Causes, and Threats to Patient Safety. J Am Med Informatics Assoc. 2008;15(4):408–23. https://doi.org/10.1197/jamia.M2616.
38. Carvalho ARB de, Neto AR de S, Silva MDF da, Freitas DRJ de, Moura MEB. Global research trends related to coronavirus disease 2019 and the aged: a bibliometric analysis. Sao Paulo Med J. 2024;142(2):1–9. https://doi.org/10.1590/1516-3180.2022.0662.r1.190523.
39. Bisrat A, Minda D, Assamnew B, Abebe B, Abegaz T. Implementation challenges and perception of care providers on Electronic Medical Records at St. Paul's and Ayder Hospitals, Ethiopia. BMC Med Inform Decis Mak. 2021;21(1):1–12. https://doi.org/10.1186/s12911-021-01670-z.
40. Khajouei R, Abbasi R, Mirzaee M. Errors and causes of communication failures from hospital information systems to electronic health record: A record-review study. Int J Med Inform. 2018;119:47–53. https://doi.org/10.1016/j.ijmedinf.2018.09.004.
41. Atasoy H, Greenwood BN, McCullough JS. The Digitization of Patient Care: A Review of the Effects of Electronic Health Records on Health Care Quality and Utilization. Annu Rev Public Health. 2019;40:487–500. https://doi.org/10.1146/annurev-publhealth-040218-044206.
42. Maryati Y, Nurwahyuni A. Evaluasi Penggunaan Electronic Medical Record Rawat Jalan Di Rumah Sakit Husada Dengan Technology Acceptance Model. J Manaj Inf Kesehat Indones. 2021;9(2):190. https://doi.org/10.33560/jmiki.v9i2.374.

43. Ahmed MH, Bogale AD, Tilahun B, Kalayou MH, Klein J, Mengiste SA, et al. Intention to use electronic medical record and its predictors among health care providers at referral hospitals, north-West Ethiopia, 2019: Using unified theory of acceptance and use technology 2(UTAUT2) model. BMC Med Inform Decis Mak. 2020;20(1):1–11. https://doi.org/10.1186/s12911-020-01222-x.
44. Mohammed A, Mehrez A, Aladel L. Investigating the impact of electronic health record on healthcare professionals. Int J Data Netw Sci. 2021;5(1):63–74. https://doi.org/10.5267/j.ijdns.2020.11.001.
45. Nurhidayah. Hubungan Knowledge Management dengan Kinerja Perawat di Ruang Rawat Inap Rumah Sakit Unhas Makassar. Wind Heal J Kesehat. 2018;1(2):125–32. https://doi.org/10.33096/woh.v1i2.660.
46. Oumer A, Muhye A, Dagne I, Ishak N, Ale A, Bekele A. Utilization, Determinants, and Prospects of Electronic Medical Records in Ethiopia. Biomed Res Int. 2021;2021. https://doi.org/10.1155/2021/2230618.
47. Salleh MIM, Abdullah R, Zakaria N. Evaluating the effects of electronic health records system adoption on the performance of Malaysian health care providers. BMC Med Inform Decis Mak. 2021;21(1):1–13. https://doi.org/10.1186/s12911-021-01447-4.
48. De Leeuw JA, Woltjer H, Kool RB. Identification of factors influencing the adoption of health information technology by nurses who are digitally lagging: In-depth interview study. J Med Internet Res. 2020;22(8). https://doi.org/10.2196/15630.