Digital Health and Informatics Innovations for Sustainable Health Care Systems
J. Mantas et al. (Eds.)

doi:10.3233/SHTI240361

Factors Influencing the Strategic Governance of EHR Interoperability: A Rapid Literature Review

Fuko CHIBA[a,1], Alessia NOWAK[a], Nicolas FREY[a], Sophie KLOPFENSTEIN[a,b], Falk MEYER-ESCHENBACH[a,b] and Akira-Sebastian PONCETTE[a]
[a] *Institute of Medical Informatics, Charité – Universitätsmedizin Berlin, Germany*
[b] *Berlin Institute of Health at Charité (BIH), Germany*
ORCiD ID: Fuko Chiba https://orcid.org/0009-0006-4503-0272, Alessia Nowak https://orcid.org/0009-0009-5194-5585, Nicolas Frey https://orcid.org/0009-0000-0195-6096, Sophie Klopfenstein https://orcid.org/0000-0002-8470-2258, Falk Meyer-Eschenbach https://orcid.org/0009-0000-9813-0249, Akira-Sebastian Poncette https://orcid.org/0000-0003-4627-7016

Abstract. While the importance of Electronic Health Records (EHR) interoperability is widely recognised in the healthcare digitalisation context, its optimal governance structure remains controversial, requiring further research. Through the rapid literature review of 32 articles retrieved from PubMed and EBSCO, 47 distinct factors under ten categories were established. The three most cited factors in the reviewed 32 articles were "Robust inter-institutional connections, trust, and the technologies to ensure security", "Legal adaptations to the evolving digitalisation needs", and "Standardisation of terminologies and codes, and harmonised data structure". This review contributes preliminary results for the ongoing research to optimise EHR interoperability governance.

Keywords. Electronic Health Records, Interoperability, Governance, Health Information Management

1. Introduction

Interoperability, defined in IEEE 1990 as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged" [1], is widely acknowledged as a pivotal element for maximising the benefits of Electronic Health Records (EHR) [2]. Specifically, semantic interoperability is essential for facilitating the meaningful exchange of data across federated cross-institutional settings [3]. Inadequate interoperability leads to increased clinician workload, higher healthcare costs, and potential risks for patients with chronic conditions, polypharmacy, and multiple comorbidities [4]. Furthermore, despite the expanding adoption of Health Level Seven International's (HL7) Fast Healthcare Interoperability Resources (FHIR) interoperability standard for exchanging healthcare data, along with international terminologies, ontologies, code systems, and agreed-upon value sets of defined concepts,

[1] Corresponding Author: Fuko Chiba, Institute of Medical Informatics, Charité – Universitätsmedizin Berlin; Charitéplatz 1 10117 Berlin, Germany; E-mail: fuko.chiba@hotmail.com.

there remains a lack of systematic and comprehensive evaluation methods [5]. These facts underscore the current urgency in the healthcare industry for the development of structured and strategic governance to enhance EHR interoperability [6-11]. As part of the ongoing research to address this urgency, this rapid literature review identifies the factors influencing the EHR governance in OECD countries to further enhance interoperability.

2. Methods

Studies that met the following criteria were included in the review: (i) original research articles and review articles (ii) written in English (iii) published between 2018 and 2023 with (iv) full text publicly available. Selected research focused on large-scale EHR or Health Information Exchange (HIE), conducted in OECD countries, and explicitly depicted factors contributing to (or hindering) interoperable HIE. The criteria of publication year were established to focus on the latest and most relevant trends of EHR interoperability governance.

Following a rapid literature review methodology described by Smela and colleagues [12], identical search strings were used in two databases, EBSCO and PubMed, and analysed by the first author: (Interoperability OR FHIR OR HL7 OR interface) AND ("Electronic Health Records" OR "Hospital Information Systems" OR "Health Information Exchange") AND (Factor* OR Challenge* OR Hindrance OR Facilitat* OR Benefit*) AND ("Change management" OR governance OR "organisational governance" OR "organisational governance"). The keywords in the search string were selected to identify the articles outlining the factors that facilitate or hinder the effective organisational change management processes and EHR or HIE governance, to enable EHR interoperability. Of the 636 initially identified articles, 46 duplicates were eliminated. Subsequently, 375 were excluded based on title screening, 82 after abstract screening, and 101 after full-text screening based on the selection criteria, finalising the 32 original and review articles for further analysis. The mean impact score of the 32 articles was 16.4. Upon the inductive qualitative content analysis described by Mayring [13], 47 factors impacting the governance to enhance EHR interoperability were identified. These factors were classified into ten categories, also established in the inductive analysis process, for enhanced clarity of the results, adopting the approach of Bogaert and colleagues [14]. The categorization served to further analyse whether certain areas of the factors stand out as the most crucial.

3. Results

Of the total 32 articles reviewed, the average number of citations across the 47 factors was 6.2. The three most cited factors were *Robust inter-institutional connections, trust, and the technologies to ensure security*, cited in 23 articles, *Legal adaptations to the evolving digitalisation needs*, cited in 23 articles, and *Standardisation of terminologies and codes, and harmonised data structure*, cited in 21 articles. The three factors all fell under differing categories: *Data infrastructure of the EHR*, *Data Governance*, and *Legal Framework*. The comprehensive table illustrating the 32 articles, 47 factors, and citations is found at https://doi.org/10.5281/zenodo.11238682.

3.1. Robust Inter-institutional Connections, Trust, and Technologies to Ensure Security

Robust inter-institutional connections, trust, and the technologies to ensure security underscores the importance of secure technological methods for data exchange, coupled with stakeholders' trust in these technologies for facilitating EHR interoperability. For example, blockchain technology has emerged as a robust solution for secure user control over stored records; that said, its potential utilization in EHR frameworks is not yet completely comprehended [15]. In addition, the transparency of the data collection and distribution [14, 16-22] and the acceptance of those methodologies by the stakeholders were deemed crucial [9, 14, 16, 17, 19, 21-25]. Fostering the technological implementation to ensure secure and trustworthy inter-institutional networks, along with the reduction of organisational silos are crucial aspects of EHR governance to enhance interoperability.

3.2. Legal Adaptations to the Evolving Digitalisation Needs

Legal adaptations to the evolving digitalisation needs, signifying the existence of clear regulations governing data usage, efficient implementation of regulations to align with digital transformations, and the absence of outdated laws impeding EHR interoperability were regarded as crucial. Nation-wide programs aimed at enhancing interoperability were noted in nine articles as an effective strategy to promote EHR interoperability. That said, the endeavours to draft federal privacy legislation that facilitates HIE face the challenge of balancing the seamless flow of healthcare and upholding patients' privacy rights [23, 26]. Increasing financial incentives or reducing the cost of HIE may encourage greater participation among providers compared to further reducing legal barriers [26].

3.3. Standardisation of Terminologies and Codes, and Harmonised Data Structure

The *Standardisation of terminologies and codes, and harmonised data structure* highlight that harmonised data structures and standardised coding systems are fundamental for achieving interoperability, particularly at the semantic level [22, 27-29]. Embedding terminologies in EHRs standardizes expressions and fosters semantic context, fostering data linkage. However, the open and unstructured nature of patients' history fields, preferred by healthcare professionals, poses readability challenges for machines [28, 29]. This point further underscores the importance of engaging the end-users and holistic stakeholders in the process of optimising EHR governance.

4. Discussion

A few remarks could be drawn from the three most cited factors. First, all three factors emphasise stakeholder collaborations across institutions and professional roles. Elaborating on this point, organisational silos are a critical obstacle to EHR interoperability, accentuating the governance approach to enhance alliances. Moreover, all three factors concern acclimating or implementing innovative schemes, emphasising strategic governance to foster adaptability. Meanwhile, the heterogeneity within the categories to which the three factors were assigned suggests that none of the ten categories emerges as a specific area deserving recognition or further research focus.

There are two limitations in this study. As a rapid literature review, no conclusive recommendation is provided on the prioritisation among the three factors. Also, as the examined articles were restricted to the context of OECD countries, the broader applicability of the identified 47 factors may be constrained. That said, the extensive acknowledgment in the literature highlights the three most cited factors as the areas essential for further research and development of specific governance strategies, especially regarding reducing organisational silos, fostering rapport and collaborations of multidisciplinary stakeholders, and enhancing organisational adaptability.

5. Conclusions

This rapid literature review identified 47 factors impacting the strategic governance to enhance EHR interoperability. Deriving from the three most cited factors, the overarching remarks on EHR governance are to boost the collaborations of interdisciplinary stakeholders and institutional adaptability while mitigating organisational silos. This research recommends further research and development of practical governance strategies, particularly relating to the three most cited factors to optimise EHR interoperability.

References

[1] "IEEE Standard Glossary of Software Engineering Terminology," in IEEE Std 610.12-1990, vol., no., pp. 1-84, 31 Dec. 1990. DOI: 10.1109/IEEESTD.1990.101064. Keywords: {Terminology; Software engineering; Standards; glossary; terminology; dictionary; Software engineering; Definitions}.

[2] Zhang J, Ashrafian H, Delaney B, Darzi A. Impact of primary to secondary care data sharing on care quality in NHS England Hospitals. npj Digital Medicine. 2023 Aug 14;6(1). doi:10.1038/s41746-023-00891-y

[3] Wulff A, Haarbrandt B, Marschollek M. Clinical Knowledge Governance Framework for Nationwide Data Infrastructure Projects. Stud Health Technol Inform. 2018;248:196-203. PMID: 29726437.

[4] Li E, Clarke J, Neves AL, Ashrafian H, Darzi A. Electronic Health Records, interoperability and patient safety in health systems of high-income countries: A systematic review protocol. BMJ Open. 2021 Jul;11(7). doi:10.1136/bmjopen-2020-044941

[5] Griffin AC, He L, Sunjaya AP, King AJ, Khan Z, Nwadiugwu M, et al. Clinical, technical, and implementation characteristics of real-world health applications using Fhir. JAMIA Open. 2022 Oct 4;5(4). doi:10.1093/jamiaopen/ooac077

[6] Holmgren AJ, Esdar M, Hüsers J, Coutinho-Almeida J. Health Information Exchange: Understanding the policy landscape and future of Data Interoperability. Yearbook of Medical Informatics. 2023 Jul 6;32(01):184–94. doi:10.1055/s-0043-1768719

[7] Holmgren AJ, Everson J, Adler-Milstein J. Association of Hospital interoperable data sharing with alternative payment model participation. JAMA Health Forum. 2022 Feb 18;3(2). doi:10.1001/jamahealthforum.2021.5199

[8] Romme AG, Meijer A. Applying design science in public policy and administration research. Policy & Politics. 2020 Jan;48(1):149–65. doi:10.1332/030557319x15613699981234

[9] Severinsen G-H, Silsand L, Malm-Nicolaisen K, Pedersen R. Interoperability and governance; important preconditions for establishing large-scale healthcare infrastructures like the Akson Program in Norway. MEDINFO 2021: One World, One Health – Global Partnership for Digital Innovation. 2022 Jun 6; doi:10.3233/shti220023

[10] Fennelly O, Cunningham C, Grogan L, Cronin H, O'Shea C, Roche M, et al. Successfully implementing a National Electronic Health Record: A Rapid Umbrella Review. International Journal of Medical Informatics. 2020 Dec;144:104281. doi:10.1016/j.ijmedinf.2020.104281

[11] Farringer DR. Maybe if we turn it off and then turn it back on again? exploring health care reform as a means to curb cyber attacks. Journal of Law, Medicine & Ethics. 2019;47(S4):91–102. doi:10.1177/1073110519898046

[12] Smela B, Toumi M, Świerk K, Francois C, Biernikiewicz M, Clay E, et al. Rapid literature review: Definition and methodology. Journal of Market Access & Health Policy. 2023 Jul 28;11(1). doi:10.1080/20016689.2023.2241234
[13] Mayring P. Qualitative content analysis: theoretical foundation, basic procedures and software solution. SSOAR Open Access Repository. GESIS. 2014. Available from: https://www.ssoar.info/ssoar/bitstream/handle/document/39517/ssoar-2014-mayring-Qualitative_content_analysis_theoretical_foundation.pdf
[14] Bogaert P, Verschuuren M, Van Oyen H, van Oers H. Identifying common enablers and barriers in European Health Information Systems. Health Policy. 2021 Dec;125(12):1517–26. doi:10.1016/j.healthpol.2021.09.006
[15] Reegu FA, Abas H, Gulzar Y, Xin Q, Alwan AA, Jabbari A, et al. Blockchain-based framework for interoperable electronic health records for an improved healthcare system. Sustainability. 2023 Apr 7;15(8):6337. doi:10.3390/su15086337
[16] Symons JD, Ashrafian H, Dunscombe R, Darzi A. From EHR to PHR: Let's get the record straight. BMJ Open. 2019 Sept;9(9). doi:10.1136/bmjopen-2019-029582
[17] D'Amore J, Bouhaddou O, Mitchell S, Li C, Leftwich R, Turner T, Rahn M, Donahue M, Nebeker J. Interoperability Progress and Remaining Data Quality Barriers of Certified Health Information Technologies. AMIA Annu Symp Proc. 2018 Dec 5;2018:358-367.
[18] Persons KR, Nagels J, Carr C, Mendelson DS, Primo H "Rik," Fischer B, et al. Interoperability and considerations for standards-based exchange of medical images: HIMSS-Siim Collaborative White Paper. Journal of Digital Imaging. 2019 Nov 25;33(1):6–16. doi:10.1007/s10278-019-00294-0
[19] Hawley S, Yu J, Bogetic N, Potapova N, Wakefield C, Thompson M, et al. Digitization of measurement-based care pathways in mental health through redcap and Electronic Health Record Integration: Development and Usability Study. Journal of Medical Internet Research. 2021 May 20;23(5). doi:10.2196/25656
[20] Vest JR, Simon K. Hospitals' adoption of intra-system information exchange is negatively associated with inter-system information exchange. Journal of the American Medical Informatics Association. 2018 May 30;25(9):1189–96. doi:10.1093/jamia/ocy058
[21] Tutty MA, Carlasare LE, Lloyd S, Sinsky CA. The complex case of ehrs: Examining the factors impacting the EHR user experience. Journal of the American Medical Informatics Association. 2019 Apr 2;26(7):673–7. doi:10.1093/jamia/ocz021
[22] Bestek M, Grönvall E, Saad-Sulonen J. Commoning semantic interoperability in Healthcare. International Journal of the Commons. 2022;16(1):225–42. doi:10.5334/ijc.1157
[23] Scheibner J, Sleigh J, Ienca M, Vayena E. Benefits, challenges, and contributors to success for National eHealth Systems Implementation: A scoping review. Journal of the American Medical Informatics Association. 2021 Jun 21;28(9):2039–49. doi:10.1093/jamia/ocab096
[24] Rathert C, Porter TH, Mittler JN, Fleig-Palmer M. Seven years after meaningful use: Physicians' and nurses' experiences with electronic health records. Health Care Management Review. 2019 Jan;44(1):30–40. doi:10.1097/hmr.0000000000000168
[25] Yang L, Huang X, Li J. Discovering clinical information models online to promote interoperability of electronic health records: A feasibility study of openehr. Journal of Medical Internet Research. 2019 May 28;21(5). doi:10.2196/13504
[26] Mello MM, Adler-Milstein J, Ding KL, Savage L. Legal barriers to the growth of health information exchange—boulders or pebbles? The Milbank Quarterly. 2018 Mar;96(1):110–43. doi:10.1111/1468-0009.12313
[27] Freij M, Dullabh P, Lewis S, Smith SR, Hovey L, Dhopeshwarkar R. Incorporating social determinants of Health in Electronic Health Records: Qualitative study of current practices among top vendors. JMIR Medical Informatics. 2019 Jun 7;7(2). doi:10.2196/13849
[28] de Mello BH, Rigo SJ, da Costa CA, da Rosa Righi R, Donida B, Bez MR, et al. Semantic interoperability in health records standards: A systematic literature review. Health and Technology. 2022 Jan 26;12(2):255–72. doi:10.1007/s12553-022-00639-w
[29] Gamal A, Barakat S, Rezk A. Standardized Electronic Health Record Data Modeling and Persistence: A Comparative Review. Journal of Biomedical Informatics. 2021 Feb;114:103670. doi:10.1016/j.jbi.2020.103670