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Opportunities and Challenges of Implementing SNOMED CT to Support Data Quality in Health Information Systems: A Systematic Literature Review

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ABSTRACT

Objective: *This review aims to examine the implementation of SNOMED CT in different countries and the opportunities and challenges of its implementation in Indonesia.* ***Method:*** *Articles were identified through PubMed, Scopus, ScienceDirect, and hand searching. Article selection followed the PRISMA flow, with inclusion criteria covering primary research, implementation studies, mapping studies, system evaluations, and methodological studies on SNOMED CT implementation. After identification, deduplication, title and abstract screening, and full-text review, 22 articles met the inclusion criteria. Data were extracted by country, objective, design, implementation context, main findings, benefits, and challenges, then synthesized thematically in narrative form.* ***Results:*** *The results show that SNOMED CT has been used in different countries to support electronic health records, local terminology integration, mapping with ICD and LOINC, natural language processing-based coding, clinical data exchange, and secondary data use. Implementation in developed countries is generally supported by national policies, digital infrastructure readiness, clinician involvement, and ongoing terminology governance.* ***Novelty:*** *In Indonesia, SNOMED CT implementation is emerging through the SATUSEHAT ecosystem and a study at Prof. Dr. Margono Soekarjo Regional Public Hospital in Purwokerto, but still faces challenges including variation in electronic health record systems, limited staff understanding, training needs, vendor standardization, local term mapping, licensing, and integration with other standards.*

INTRODUCTION

Electronic health records (EHRs) have changed how health information is recorded, stored, exchanged, and used. Healthcare facilities can now produce structured clinical data for care, reporting, research, and decision-making. Facilities, systems, and clinicians may use different terms or codes to express the same clinical information. These differences can impede exchange and change the meaning of data as they move between systems. Clinical terminology standardization is therefore important to interoperable health information systems. SNOMED CT represents clinical information through concepts, terms, synonyms, and relationships so that systems and users can interpret it more consistently [1].

EHR interoperability depends on preserving meaning when systems exchange data. SNOMED CT covers clinical findings, diagnoses, anatomical structures, procedures, specimens, organisms, and substances [1]. Mapping to other terminologies and classifications can also support reporting and analysis [2]. Published examples include mapping to ICD-10 for computer-assisted coding [3] and using SNOMED CT alongside LOINC to standardize terminology in primary care asthma records [4].

International implementations have used SNOMED CT to support clinical documentation, information exchange, retrieval, analysis, and decision support [5]. The

approach varies with national policy, system architecture, organizational resources, and clinical needs. Some organizations use SNOMED CT directly for clinical documentation, while others use it as a reference terminology for mapping existing local codes. These choices affect workflows, training and maintenance requirements [6].

Mapping becomes more complex when organizations already use multiple local vocabularies or classifications. Mapping teams need to understand the meaning of local entries, the SNOMED CT hierarchy, synonyms, and relationships between concepts. An inaccurate mapping can change or obscure the original meaning. Published guidance addresses mapping decisions, validation, and maintenance [2]. A methodological study from South Korea illustrates the need for explicit mapping rules when working with local terms for clinical findings and procedures [7]. Implementation also requires trained staff, vendor readiness, content updates, and governance across facilities [8].

In Indonesia, the SATUSEHAT platform promotes the use of standard clinical terminology in national health information exchange. Its documentation specifies SNOMED CT for clinical terms and describes links with standards such as ICD and LOINC [9]. This creates opportunities to reduce variation in clinical terminology and improve consistency when facilities exchange and reuse data. A study at Prof. Dr. Margono Soekarjo Regional Public Hospital in Purwokerto describes the use of SNOMED CT and LOINC in EHRs [10].

Implementation can be affected by differences in EHR readiness, limited staff expertise, training needs, vendor capabilities, and the complexity of mapping local terms. Planning also includes licensing, content management, release updates, and map maintenance [8]. A separate evaluation in Purwokerto identified gaps in system content, operating procedures, and staff training [11]. National interoperability also depends on the exchange architecture. HL7 FHIR provides a framework for structuring and exchanging health information [12].

This review analyzes evidence on SNOMED CT implementation across countries, identifies opportunities and barriers, and considers their implications for Indonesia. International experience can inform terminology governance, mapping, workforce preparation, and system integration. In Indonesia, implementation strategies must account for differences in infrastructure and staff capacity across facilities. Continued investment in training, standardized mapping, vendor support, terminology maintenance, and evaluation can help sustain consistent use.

RESEARCH METHOD

This systematic literature review used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance to identify and synthesize evidence on SNOMED CT implementation in health information systems and to examine opportunities and challenges in Indonesia [13]. PubMed, Scopus, ScienceDirect, Google Scholar, and Garuda were searched using combinations of SNOMED CT, SNOMED Clinical Terms, clinical terminology, health information system, electronic health record,

electronic medical record, interoperability, implementation, adoption, challenges, and Indonesia, with the Boolean operators AND and OR. Hand searching supplemented the database searches.

Studies were eligible if they examined SNOMED CT implementation, use, adoption, mapping, interoperability, benefits, or challenges in a healthcare context, were available in full text in English or Indonesian, and were published from 2015 to 2025. Exclusions comprised duplicates, papers outside the health information systems context, technical studies with no implementation relevance, editorials, letters, opinion pieces, conference papers with insufficient research information, and records without full text.

The search identified 486 records. Removing 104 duplicates left 382 records for title and abstract screening, after which 87 records remained. Full-text availability and the inclusion and exclusion criteria were used to select 48 articles for eligibility assessment. Assessment of substantive fit, methodological quality, and relevance to the research objectives yielded 22 articles for data extraction, analysis, and narrative synthesis.

RESULTS AND DISCUSSION

Results

The review included 22 articles on implementation of SNOMED CT in health information systems. The evidence addressed EHR implementation, interoperability, terminology mapping and integration, reuse of clinical data, decision support, and workforce and organizational challenges. Twenty-one articles described implementation across international settings. Article (22) provided Indonesian context through a study of SNOMED CT and LOINC in EHRs at Prof. Dr. Margono Soekarjo Regional Public Hospital in Purwokerto [10].

Table 1. Characteristics of the included articles

Characteristic	Category	n	Article codes
Geographical context	North America	4	(1), (7), (12), (17)
Geographical context	Europe	6	(2), (3), (5), (8), (10), (15)
Geographical context	Asia	5	(4), (6), (9), (13), (18)
Geographical context	Oceania	2	(11), (16)
Geographical context	Multicountry/global	4	(14), (19), (20), (21)
Geographical context	Indonesia	1	(22)

Characteristic	Category	n	Article codes
Research focus	SNOMED CT implementation in health information systems	5	(1), (4), (7), (15), (22)
Research focus	Interoperability and data exchange	4	(2), (5), (10), (14)
Research focus	Terminology mapping and standards integration	4	(3), (6), (13), (19)
Research focus	Clinical data use and analytics	3	(8), (12), (17)
Research focus	Clinical decision support	2	(9), (16)
Research focus	Adoption, governance, and implementation challenges	4	(11), (18), (20), (21)
Implementation setting	Hospitals and EHRs	7	(1), (4), (7), (10), (15), (17), (22)
Implementation setting	National or regional health information systems	5	(2), (5), (11), (14), (20)
Implementation setting	Primary and community care	3	(6), (9), (13)
Implementation setting	Decision support and research systems	4	(8), (12), (16), (19)
Implementation setting	Multisector or multisystem settings	3	(3), (18), (21)
Benefit	Terminology standardization	6	(1), (3), (4), (6), (13), (22)
Benefit	Data interoperability	6	(2), (5), (7), (10), (14), (15)
Benefit	Improved use of clinical data	4	(8), (12), (17), (19)
Benefit	Clinical decision support	3	(9), (16), (20)
Benefit	Health system integration	3	(11), (18), (21)
Main challenge	Terminology and mapping complexity	5	(3), (6), (10), (13), (19)
Main challenge	Staff and organizational readiness	5	(4), (11), (15), (18), (21)
Main challenge	Integration and interoperability	5	(1), (2), (5), (7), (14)
Main challenge	Governance and policy	4	(8), (12), (20), (22)
Main challenge	Infrastructure and technology readiness	3	(9), (16), (17)

Table 2. Implementation contexts, research focus, and main findings by article

Article	Topic	Setting	Focus	Main finding
(1)	SNOMED CT implementation in health information systems	North America	Implementation and standardization	SNOMED CT supports consistent representation of clinical concepts and improves data consistency.
(2)	SNOMED CT and interoperability	Europe	Clinical data exchange	SNOMED CT supports information exchange by representing clinical concepts consistently across systems.
(3)	Clinical terminology mapping	Europe	Mapping and terminology services	Mapping local terminology to SNOMED CT can improve interoperability and requires ongoing validation and maintenance.
(4)	SNOMED CT implementation in EHRs	Asia	Electronic health records	SNOMED CT promotes standardized clinical documentation and supports data reuse.
(5)	SNOMED CT in an interoperability ecosystem	Europe	Interoperability	SNOMED CT serves as a reference terminology for integrating clinical data across applications and organizations.
(6)	Clinical terminology integration	Asia	Mapping and integration	Integration with local terminology requires accurate mapping to preserve clinical meaning.
(7)	SNOMED CT in EHR systems	North America	EHR implementation	Standard terminology improves data structure and supports the exchange of clinical information.
(8)	Use of standardized clinical data	Europe	Data analytics	Data coded in SNOMED CT are easier to retrieve, aggregate, and analyze.
(9)	SNOMED CT and clinical decision support	Asia	Clinical decision support	Standard terminology can support decision systems by providing structured and consistent clinical data.

Article	Topic	Setting	Focus	Main finding
(10)	Mapping and interoperability	Europe	Standards integration	Mapping SNOMED CT to other standards can improve data exchange and requires effective terminology management.
(11)	SNOMED CT adoption	Oceania	Organizational adoption	Implementation depends on organizational readiness, staff training, management support, and infrastructure.
(12)	Terminology-based data analysis	North America	Clinical data	Standard terminology helps systems identify and group clinical information.
(13)	Mapping local terms to SNOMED CT	Asia	Mapping	Mapping local terms requires expert involvement to ensure that concept meanings match.
(14)	SNOMED CT and global interoperability	Multicountry	Data exchange	SNOMED CT supports data exchange across organizations and countries when paired with suitable interoperability standards.
(15)	Clinical terminology implementation	Europe	Health systems	SNOMED CT improves data consistency and requires clear governance and an implementation strategy.
(16)	SNOMED CT for clinical decision support	Oceania	Decision support systems	Structured SNOMED CT data can improve the ability of systems to provide clinical decision support.
(17)	SNOMED CT and EHR data use	North America	Analytics and EHRs	Terminology standardization supports the reuse of EHR data for analysis and research.
(18)	SNOMED CT implementation challenges	Asia	Organizations and workforce	Key barriers include limited skills and training, system readiness, and changes in workflows.
(19)	Integration with other terminologies	Multicountry	Terminology mapping	Integration with ICD and LOINC supports data use in care and reporting.

Article	Topic	Setting	Focus	Main finding
(20)	Implementation governance	Multicountry	Governance	Implementation requires policies, content management, terminology updates, and ongoing evaluation.
(21)	Adoption and sustainability	Multicountry	Sustainability	Sustainability depends on organizational support, funding, staff, and integration with existing systems.
(22)	SNOMED CT and LOINC in EHRs	Indonesia	EHR implementation	SNOMED CT and LOINC offer opportunities to improve clinical data consistency and EHR interoperability in Indonesia.

Article codes (1)–(22) follow the study labels in the source extraction table. Article (22) is identifiable from its hospital setting and topic [10].

Discussion

The synthesis identified a common role for SNOMED CT in standardizing the representation of clinical information. Articles (1), (4), (7), (15), and (22) described how it can reduce variation in EHR documentation. Articles (3), (6), and (13) highlighted the difficulty of mapping established local terminologies to SNOMED CT. Earlier mapping research provides supporting context on preserving meaning so that data can be reused [14]. Work on local interface terminologies illustrates how organizations can retain familiar entry terms while linking them to reference concepts [15].

Articles (2), (5), (7), (10), (14), and (15) identified interoperability as a principal benefit. Systems can use different words for the same clinical concept, and SNOMED CT provides a shared framework for representing that concept. Article (14) emphasized the importance of standards usable across organizations and system environments. Articles (5) and (10) highlighted integration with other standards. The design of that integration varies with national standards and existing systems. A report on an online clinical database provides an example of clinical terminology integration in practice [16].

Articles (3), (6), (10), (13), and (19) identified mapping as a major implementation challenge. A local term can have several possible matches or no direct equivalent. Articles (3) and (13) emphasized expert validation to preserve clinical meaning. Article (19) indicated that linking SNOMED CT with ICD and LOINC can support multiple uses. SNOMED CT can represent clinical meaning, ICD can support classification and reporting, and LOINC can identify measurements and observations. The experience of using SNOMED CT and LOINC in asthma records illustrates the complementary roles of those standards [4].

Articles (8), (12), (17), and (19) showed how standardization can improve the usefulness of EHR data after capture. Articles (8) and (12) pointed to clinical analytics,

Article (17) emphasized research, and Article (19) identified opportunities for clinical use and reporting through mapping. Structured terminology makes it easier to retrieve and aggregate data and reduces the need for repeated manual interpretation. The value of reuse still depends on accurate original documentation and mapping [14].

Articles (9) and (16) showed the potential for standard terminology to support clinical decision support systems. Consistent representations allow applications to identify relationships among patient conditions, diagnoses, procedures, and related information. The articles addressed different systems and use settings. Decision support also depends on clinical rules, algorithms, accurate data, and clinical validation.

Articles (4), (11), (15), (18), and (21) identified staff readiness, training, organizational support, workflow changes, financing, and management commitment as recurring implementation factors. Articles (11) and (18) emphasized that staff need to understand how and why standard terms are used. Article (21) highlighted continuing support and integration with existing systems. A mixed qualitative and quantitative evaluation of introducing SNOMED CT coding into an EHR provides an example of examining operational impact [17].

Articles (8), (12), (20), and (22) highlighted terminology governance. Clinical terminology requires updating as clinical knowledge and service needs change. Article (20) emphasized policies for content management, maintenance, and evaluation. Article (22) provided an Indonesian example of implementing SNOMED CT and LOINC together [10]. Consistency across facilities requires defined responsibilities for mapping, validation, maintenance, releases, and evaluation. Relevant participants include government agencies, facilities, clinicians, health information management professionals, informatics specialists, and vendors.

For Indonesia, the review identified opportunities to support the national interoperability ecosystem and align clinical documentation with reporting requirements. Local implementation plans need to address differences in facilities, information systems, vendor support, terminology skills, and local vocabularies. The literature reviewed emphasized technical and conceptual considerations more frequently than longitudinal assessment. Evidence on effects on service quality, patient safety, staff efficiency, and data quality remains limited. Comparative studies across facilities and evaluation models covering technology, people, organizations, governance, and interoperability could address these gaps.

CONCLUSION

Fundamental Finding: The systematic literature review of 22 articles shows that SNOMED CT plays a strategic role in supporting clinical terminology standardization, electronic health record interoperability, health information exchange, clinical data use, analytics, and decision support system development. Implementation of SNOMED CT in different countries shows benefits in improving the consistency of data meaning, although implementation faces challenges related to terminology mapping complexity,

infrastructure readiness, workforce competence, organizational support, governance, and the need for ongoing terminology maintenance. **Implication:** The Indonesian context shows increasing opportunities through the use of SNOMED CT and LOINC in electronic health records and the development of a national health interoperability ecosystem. **Limitation:** Another limitation of the literature reviewed is that some studies address technical and conceptual aspects more often than they evaluate the longitudinal impact of implementation. Empirical evidence on the direct effects of SNOMED CT implementation on service quality, patient safety, staff efficiency, and data quality still needs to be strengthened. **Future Research:** Future research should empirically evaluate SNOMED CT implementation across healthcare facilities in Indonesia using mixed methods and longitudinal designs. Research should also examine the effect of SNOMED CT implementation on data quality, interoperability, service efficiency, healthcare workers' workload, and the use of data for analytics and decision-making. Development of a national terminology governance model, strategies for mapping local terms, improvement of healthcare workers' competence, and assessment of facility and information system vendor readiness should also be priorities for future research so that implementation in Indonesia can be consistent, sustainable, and beneficial to digital health transformation.

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