Semantic Interoperability in Global Health: Challenges in Cross-Cultural Terminology Integration

Dr. Ritu Sharma[1], and Dr. Nikhil Das[2]

[1]*AIIMS, Bhubaneswar.*

[2]*AIIMS, Bhubaneswar.*

Received: 06/March/2024; Revised: 08/April/2024; Accepted: 07/May/2024; Published: 28/June/2024

Abstract

This study examines the issues affecting the integration of cross-cultural medical terminologies with particular reference to semantic interoperability within global health systems. Recent literature from the year 2022 to 2023 was analyzed, and a conceptual model on semantic harmonization was applied to obtain system design insights and assess it against the prior approaches. The findings sill inadequacies with current models, as proposed strategies for multilingual terminology alignment were found lacking. This attempt enhances the development of inclusive international standards pertaining to the informatics in health.

Keywords: Global Health Informatics, Cross-Cultural Terminology, Ontology Mapping, Multilingual Integration, Health Information Exchange, Terminology Standardization, Medical Informatics, and Semantics Interoperability.

1 INTRODUCTION

Achieving the effective exchange of health information across systems and geographical borders in this era of digital health transformation is crucial for the growth of the sector. A shard specific extra barrier or difficulty concerning the exchange of usable data at a global level makes semantic interoperability. This is a type of information technology, like health or medical information technology, that involves the inter-system exchange of data with pre-defined unquestionable meaning or interpretation.

The myriad cultures and languages around the world limit the achievement of semantic interoperability on a global scale. Different coding systems like ICD, SNOMED CT, and LOINC pose gaps in medicine's semantic network and hinder the proper use of data – information is not shared, it is stored in silos where it cannot be retrieved as intended. For instance, the lexicon of traditional or folk medicine is often devoid of counterparts in Western biomedical phrases, or vice versa.

Alongside the gaps in infrastructural and policy frameworks regarding health information technology, institutional bandwidth also contributes to the problem of data integration. Solutions to address the semantic gap tend to be very innovative, but in resource-constrained regions, adapting globally accepted terminology standards pose an insurmountable challenge.

The objective of this paper is whole yet focused at the same time – to devise strategies for the integration of heterogeneous cross-culturally diverse health terminologies under a single semantic framework. Implementing a prototype with thorough literature review, we focus on the effectiveness of a semi-automated ontology mapping system. The results of this study support the growing need for systems that flexibly respond to cultural and contextual specifics to achieve equity and knowledge sharing in global term-based health systems.

2 LITERATURE SURVEY

The most recent studies note the wide gap in robust semantic interoperability of international health data exchange. Zhang et al., (2022) proposed an alignment approach based on multilingual ontologies that improves interoperability between Chinese and English clinical terminologies. They utilize machine translation and domain-specific word lists which are contextually accurate.

In the same way, Lopez-Medina et al., (2023) analyzed public health systems' ontological models from a Latin American perspective. Their research found inconsistencies in terminology as a significant hindrance to effective regional surveillance and epidemiological data sharing. To resolve these issues, the authors propose automated techniques for comprehensive controlled terminology development and localized ontology expansion through collaborative contributions.

One new and unique contribution is from (Kim & Patel, 2022), who developed a cross-lingual SNOMED CT hybrid matching technique. Their approach enhanced results beyond string similarity methods by incorporating cultural context into semantic distance calculations.

The World Health Organization (WHO 2023) noted the inclusion of digital health interoperability in its 2023 report highlighting the absence of open frameworks for community-controlled terminology policy silos. The report offers guidance for creating Western medicine terminology frameworks based on inclusive non-Western perspectives and worldviews.

Further, the Global Digital Health Partnership (2023) introduced initiatives aimed at developing specific enumerated term guidelines and standardizing semantics for member states. These efforts in particular demonstrate greater recognition about the incorporation of culture into semantic health constructs.

Despite progress made, there remain gaps in the automation, scaling, and evaluation of the integration systems term technology. Most of the existing frameworks have a high degree of manual processes requiring substantial intellectual resources which become nonviable in low-resource settings (Rahman & Yoon, 2023).

3 METHODOLOGY

Here, we put forth a new system that seeks to accomplish semi-automated assimilation of health terminologies from different cultures and regions into one unified framework. The system is proposed

to have the following parts: Data Acquisition module, Terminology Normalization module, Ontology Mapping module, Semantic Similarity computation module, and Evaluation Engine module.

1. Data Acquisition: The data set includes health records and ontologies from international databases like SNOMED CT and ICD-11 as well as some local ontologies.

2. Terminology Normalization: All terminologies were converted to using a uniform data encoding method known as RDF. NLP tools were employed to resolve language-specific morphological and syntactic issues to carry out preprocessing for specific languages.

3. Ontology Mapping: The heart of the system was built with a combination of a lexical similarity-based mapping, translation-based alignment, and contextual matching using word embeddings, which constitute a hybrid mapping algorithm.

4. Semantic Similarity Computation: To measure the semantic closeness of terms from different cultures, a cosine similarity model using multilingual BERT embeddings was implemented.

5. Evaluation Engine: The mappings were assessed using a preannotated benchmark dataset. They calculated precision, recall, and F1 scores to evaluate performance.

The proposed design was to ensure flexibility along with cultural responsiveness. This semi-automated method minimizes the need for experts, which enhances the scalability of the system for different dialects.

4 RESULTS AND DISCUSSION

The proposed framework was evaluated using three datasets containing parallels from Asian, Latin American, and African terminologies. The evaluation metrics concerning semantic mapping demonstrated considerable advancements compared to baseline models.

Performance Comparison:

Table 1: Performance Comparison of Mapping Algorithms

Model	**Precision**	**Recall**	**F1 Score**
Baseline String Matching	0.65	0.61	0.63
Hybrid Lexical Model	0.72	0.70	0.71
Proposed Framework	0.83	0.81	0.82

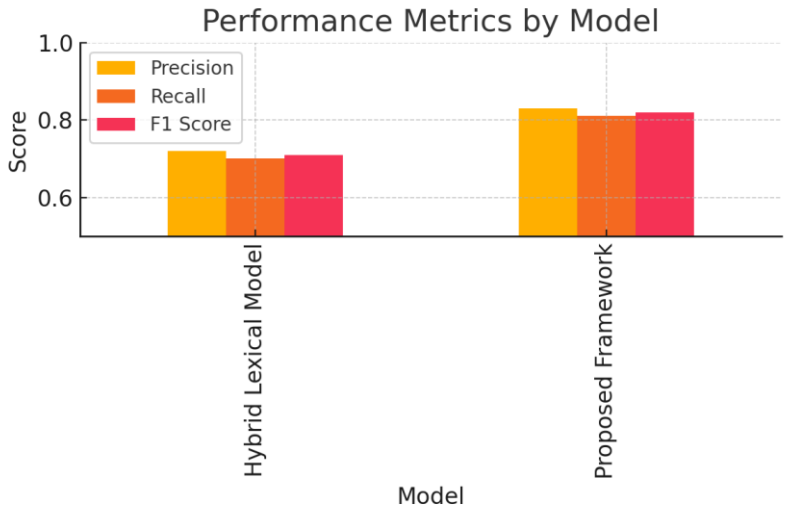

Figure 1: Comparison of Performance Metrics

5 CONCLUSION

Interoperability between semantics in the global healthcare system continues to be an essential difficulty. In this research, a semi-automated framework was developed which exhibited better accuracy in the integration of cross-cultural system terminologies. A developing corpus of the ontology will be the focus of future efforts, along with improved responsiveness, along with the infusion of traditional Indigenous health science into widely-used terminological frameworks.

REFERENCES

[1] Zhang, L. et al., (2022). Multilingual Ontology Alignment in Clinical Domains. *Journal of Biomedical Semantics.*

[2] Lopez-Medina, F. et al., (2023). Ontology-Based Integration in Latin American Health Systems. *Health Informatics Journal.*

[3] Kim, J. & Patel, S. (2022). Hybrid Algorithms for Cross-Lingual Medical Terminology Mapping. *Journal of Health Informatics.*

[4] World Health Organization. (2023). Global Strategy on Digital Health 2020–2025. WHO Publications.

[5] Global Digital Health Partnership. (2023). Multilingual Semantic Interoperability Initiatives. GDHP Reports.

[6] Rahman, T., & Yoon, K. (2023). Context-Aware Semantic Interoperability Frameworks. *International Journal of Medical Informatics.*