Ontological Modeling of Drug Trafficking in the Global South Using Newspaper Data

Sanju Tiwari[1][0000−0001−7197−0766], Mayank Kejriwal[2,3][0000−0001−5988−8305], and Nandana Mihindukulasooriya[3][0000−0003−1707−4842]

[1] ShodhGuru Innovation and Research Labs, India
[2] University of Southern California, USA kejriwal@isi.edu
[3] IBM Research, USA nandana@ibm.com

Abstract. Ontological modeling of drug trafficking involves constructing a structured representation of the entities, relationships, and processes within the domain of illicit drug trade. Limited ontologies are found in this space to represent entities and relations in publicly available corpora like unstructured newspaper data and online public reports. In this paper, we describe a process and modeling framework that can be used to construct an ontology for drug trafficking in the Global South. Our process aims to capture the complex interplay between various factors such as drug types, routes of transportation, distribution networks, and actors involved, including traffickers, dealers, and consumers. We rely on data collected from multiple independent sources, including newspapers and official reports e.g., The Hindu, Times of India, and dataUNODC, among others.

Keywords: Unstructured Data · Ontology · Drug Trafficking · Global South · Newspapers · Knowledge Graph

1 Introduction

Illicit drug trade and trafficking pose significant challenges to societies worldwide, fueling crime, violence, public health crises, and undermining socioeconomic development [12]. Understanding the complex networks, behaviors, and dynamics involved in drug trafficking is crucial for developing effective interventions. Traditional approaches often lack a systematic framework for organizing and analyzing the vast amount of data and knowledge associated with this domain [6].

Ontologies offer a promising solution by providing a structured representation of concepts and relationships, enabling clearer insights into the nature of drug trafficking. By employing ontological principles, researchers can elucidate the underlying semantics and dynamics of drug trafficking systems, facilitating a deeper understanding of its intricacies and enabling more effective strategies for prevention, intervention, and law enforcement. Such models not only provide a comprehensive view of the phenomena but also serve as valuable tools for decision-makers to devise targeted policies and interventions to mitigate the adverse effects of drug trafficking and crimes on societies worldwide [8, 11].

According to the literature, there is a lack of good ontologies in drug trafficking space although a lot of information available to model a base ontology from Global South countries that can help to reduce drug trafficking cases, and its impact in society. The main objective of developing a drug trafficking ontology is to examine the locations and times of incidents, identify the individuals involved (such as perpetrators, victims, and other relevant parties), determine the motives behind these occurrences, and provide specifics regarding the information source (such as news articles and official reports).

2 Background

Drug trafficking involves the production, distribution, and consumption of illicit substances, spanning across various geographical regions and involving diverse actors and processes. Traffickers employ sophisticated strategies to smuggle drugs across borders, establish distribution networks, and evade law enforcement efforts. The global nature of drug trafficking complicates intervention efforts, requiring comprehensive understanding and collaboration among stakeholders. To our knowledge, there is no drug trafficking ontology that allows us to model this information, especially in the context of publicly available natural-language reports from countries in the Global South. A related ontology is DAO (Ontology for Substance Use) [5, 9] that was designed to examine substance abuse data from social media, the Dark Web and Web forums. It is not meant for modeling information related to trafficking. The CEM (Crime Events in Newspaper Articles) [8] is a newly introduced lightweight ontology for representing crime events and may be better suited to modeling trafficking crimes. Other ontologies relevant to either drugs or to crime (but typically not both) include PDRO (Prescription of Drugs Ontology) [1], DRON (Drug Ontology) [2], OGMS (Ontology for General Medical Science) [10], OMRSE (Ontology for Medically Related Social Entities) [3], DIG (Domain-Specific Insight Graphs) [11], and ODKG (Knowledge graph to capture opioid-related drugs) [4]. In contrast with these ontologies, we propose the Drug Trafficking Ontology (DTO) in this paper to model drug trafficking data from several Global South countries using newspapers and public reports.

3 Ontology Development

The ontology modeling of drug trafficking is based on ontological principles and methodologies, including defining entities, attributes, relationships, actions, and events within the domain. We have followed LOT [7], Linked Open Term Methodology, a lightweight methodology for developing ontologies and vocabularies. Entities encompass drugs of various types, traffickers, distribution networks, law enforcement agencies, and geographical locations. Attributes include quantity, value, geography, and time, providing additional context for understanding drug trafficking activities. Relationships capture the connections between entities, such as transportation routes, supplier-consumer relationships,

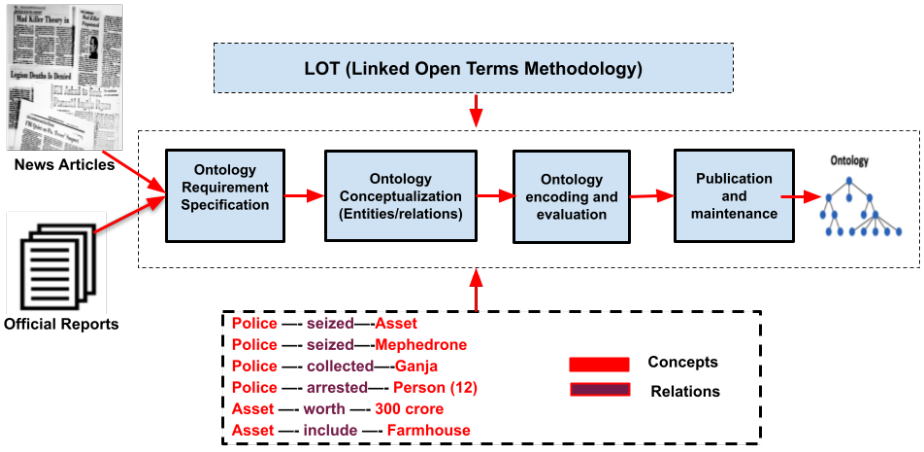

Fig. 1. The ontology development framework used for constructing the Drug Trafficking Ontology (DTO) proposed in this paper.

and interdiction efforts. Actions represent the activities involved in drug trafficking, including smuggling, distribution, and money laundering. Events capture significant occurrences, such as drug seizures, arrests, and trafficking patterns.

Table 1. Examples of extracted entities from three newspaper articles (all from *The Hindu*, a major nationally circulated newspaper in India.

News Headline	Extracted Entities	Date
Drugs worth 300 crore seized; 12 held	Drug, Transport, Trafficking, Person, Case, Seizure, Raid, Arrest, Operation	Oct, 7, 2023
Odisha police arrest Karnataka constable for smuggling ganja	Drug, Transport, Trafficking, Person, Arrest, Smuggling, Legal Action, Investigation	Nov, 4, 2023
Police seize 3-cr. assets of four arrested in drugs case	Police, Trafficking, Asset, Case, Drug, Purchase, Seizure	Dec, 1, 2023

We have collected news from news articles, official reports about drug trafficking related information. We manually ananlyzed collected articles and some examples are presented in table 1. A framework has been proposed to design the ontology by following LOT [7] methodology in Figure 1.

4 Applications of Drug Trafficking Ontology

The ontology of drug trafficking has several potential applications in informing policy-making, law enforcement strategies, and research endeavors. Policymakers

can utilize the ontology to identify key areas for intervention, allocate resources effectively, and assess the impact of policies on drug trafficking dynamics. Law enforcement agencies can leverage the ontology to enhance intelligence gathering, prioritize targets, and coordinate efforts across jurisdictions. Researchers can use the ontology to analyze trends, conduct scenario modeling, and develop predictive analytics to anticipate future developments in drug trafficking networks. In current and future research, we will continue to develop the concepts, properties and ontological constraints in DTO and formally publish it using formal standards like the Web Ontology Language. We also continue to populate a knowledge graph modeled according to the DTO by automatically processing news articles from at least ten countries in the Global South.

References

1. Ethier, J.F., Barton, A., Taseen, R.: An ontological analysis of drug prescriptions. Applied Ontology **13**(4), 273–294 (2018)
2. Hanna, J., Joseph, E., Brochhausen, M., Hogan, W.R.: Building a drug ontology based on rxnorm and other sources. Journal of biomedical semantics **4**, 1–9 (2013)
3. Hicks, A., Hanna, J., Welch, D., Brochhausen, M., Hogan, W.R.: The ontology of medically related social entities: recent developments. Journal of Biomedical Semantics **7**(1), 1–4 (2016)
4. Kamdar, M.R., Hamamsy, T., Shelton, S., Vala, A., Eftimov, T., Zou, J., Tamang, S.: A knowledge graph-based approach for exploring the us opioid epidemic. arXiv preprint arXiv:1905.11513 (2019)
5. Lokala, U., Lamy, F., Daniulaityte, R., Gaur, M., Gyrard, A., Thirunarayan, K., Kursuncu, U., Sheth, A.: Drug abuse ontology to harness web-based data for substance use epidemiology research: ontology development study. JMIR public health and surveillance **8**(12), e24938 (2022)
6. Moncada, E.: The politics of urban violence: Challenges for development in the global south. Studies in Comparative International Development **48**, 217–239 (2013)
7. Poveda-Villalón, M., Fernández-Izquierdo, A., Fernández-López, M., García-Castro, R.: Lot: An industrial oriented ontology engineering framework. Engineering Applications of Artificial Intelligence **111**, 104755 (2022)
8. Rollo, F., Po, L., Castellucci, A.: Cem: an ontology for crime events in newspaper articles. In: Proceedings of the 38th ACM/SIGAPP Symposium on Applied Computing. pp. 1762–1765 (2023)
9. Roy, K., Lokala, U., Khandelwal, V., Sheth, A.: " is depression related to cannabis?": A knowledge-infused model for entity and relation extraction with limited supervision. arXiv preprint arXiv:2102.01222 (2021)
10. Scheuermann, R.H., Ceusters, W., Smith, B.: Toward an ontological treatment of disease and diagnosis. Summit on translational bioinformatics **2009**, 116 (2009)
11. Szekely, P., Kejriwal, M.: Domain-specific insight graphs (dig). In: Companion Proceedings of the The Web Conference 2018. pp. 433–434 (2018)
12. Yakovlev, P.: Global south: Conceptual approaches and socioeconomic processes (2021)