https://doi.org/10.31891/2307-5732-2025-353-21
УДК 004.8:303.732.4

ПАСІЧНИК РОМАН
Західноукраїнський національний університет
https://orcid.org/0000-0003-3820-8854
e-mail: r.pasichnyk@wunu.edu.ua
РИБАЧОК РОМАН
Західноукраїнський національний університет
https://orcid.org/0009-0001-4947-0105
e-mail: roman.rybachok@gmail.com

АВТОМАТИЗОВАНА ПОБУДОВА ОНТОЛОГІЧНОЇ МОДЕЛІ СТРАТЕГІЇ ВРЕГУЛЮВАННЯ ЗБРОЙНИХ КОНФЛІКТІВ З ВИКОРИСТАННЯМ ГЕНЕРАТИВНОГО ШТУЧНОГО ІНТЕЛЕКТУ

У статті представлено розробку та концептуальний проєкт метаонтології збройних конфліктів - високорівневої формалізованої моделі, що покликана відобразити складний і багатовимірний характер сучасних і історичних конфліктів. На відміну від традиційних онтологій, які здебільшого зосереджені лише на військових або політичних аспектах, запропонована метаонтологія інтегрує військовий, політичний, економічний, соціальний та інформаційний виміри в єдину модель. У дослідженні запропоновано методологію, яка поєднує експертні знання з методами штучного інтелекту, зокрема із використанням великих мовних моделей (LLM), для напівавтоматизованого створення та уточнення онтологічних структур. Такий гібридний підхід не лише прискорює процес побудови онтологій, але й відкриває нові можливості для виявлення причинно-наслідкових механізмів і стратегічних закономірностей, що містяться в текстових джерелах - історичних описах, політичних документах, академічних публікаціях. Особлива увага приділяється можливостям практичного застосування запропонованої онтологічної моделі у системах підтримки прийняття рішень, діагностиці конфліктів та стратегічному прогнозуванні. Історичний кейс Франко-прусської війни використано як приклад демонстрації можливостей моделі щодо ідентифікації ключових акторів, цілей, переломних моментів та результатів конфлікту, що можуть мати значення для аналізу сучасних ситуацій. Запропонована метаонтологія слугує основою для подальшої формалізації та створення програмних засобів, корисних для дослідників, аналітиків і представників органів влади.

Ключові слова: онтологія, збройні конфлікти, підтримка прийняття рішень, подання знань, аналіз конфліктів, штучний інтелект.

PASICHNYK ROMAN
RYBACHOK ROMAN
West Ukrainian National University

AUTOMATED CONSTRUCTION OF AN ONTOLOGICAL MODEL FOR ARMED CONFLICT RESOLUTION STRATEGY USING GENERATIVE ARTIFICIAL INTELLIGENCE

This paper introduces the development and conceptual design of a meta-ontology for armed conflicts - a high-level, formalized framework aimed at capturing the complex and multidimensional nature of modern and historical conflicts. Unlike traditional ontologies that focus narrowly on military or political aspects, the proposed meta-ontology integrates military, political, economic, social, and informational dimensions into a unified model. The research proposes a methodology that combines expert knowledge and artificial intelligence techniques, particularly large language models (LLMs), to assist in the semi-automated generation and refinement of ontological structures. This hybrid approach not only accelerates the ontology construction process but also opens new opportunities for extracting causal mechanisms and strategic patterns embedded in textual sources, including historical analyses, policy documents, and academic discourse. The paper pays particular attention to the applicability of the ontological framework in decision support systems, conflict diagnostics, and strategic foresight. A historical case study - the Franco-Prussian War - is used to demonstrate how the meta-ontology can help to identify key actors, objectives, turning points, and outcomes, offering insights that may be transferable to present-day conflict scenarios. The proposed model lays the foundation for further formalization and implementation of software systems that could aid researchers, analysts, and policymakers. The work is positioned as an initial step toward a broader research agenda, with future papers expected to present more technical details, formal ontological schemas, and empirical validation.

Keywords: ontology, armed conflicts, decision support, knowledge representation, conflict analysis, artificial intelligence.

Стаття надійшла до редакції / Received 11.04.2025
Прийнята до друку / Accepted 26.04.2025

Problem statement

Modern armed conflicts are characterized by extreme complexity and multidimensionality, resulting from the intertwining of military, political, economic, social, and informational aspects of confrontation. Traditional methods of analysis, which typically focus on one of these dimensions, do not provide a holistic understanding of conflicts and their dynamics [1].

The ontological approach opens new perspectives for a comprehensive analysis of armed conflicts. Unlike relational databases or taxonomies, ontologies provide not only data structuring but also modeling of complex semantic relationships between concepts, their attributes, and interconnections [2].

This paper presents a developed meta-ontology of armed conflicts – a high-level ontology that provides a general framework for creating specific ontologies of individual conflicts. Unlike existing

approaches that apply ontologies to model certain security aspects [3], the proposed meta-ontology comprehensively covers key dimensions of conflicts and provides mechanisms for their integration, analysis, and use in decision support systems.

Theoretical foundations for building a meta-ontology of armed conflicts

Critical analysis of existing approaches to conflict knowledge modeling

Research on armed conflicts traditionally relies on various methodological approaches – from historical narrative to statistical analysis, geopolitical modeling to network analysis of actors. Each of these approaches has its limitations: historical narrative complicates formalization and comparative analysis; statistical methods often do not account for qualitative aspects and causal relationships; network analysis does not always consider contextual factors and conflict dynamics [4].

Analysis of existing ontologies in the field of security and conflicts shows that most of them focus on individual aspects – cybersecurity [5], terrorism [6], or peacekeeping operations. The absence of a comprehensive meta-ontology that would encompass all key aspects of armed conflicts complicates knowledge integration and comparative analysis of different conflicts.

The concept of meta-ontology as an integration framework

In our research, we view the meta-ontology of armed conflicts as a dynamic conceptual model that allows:

1. Integration of data of different natures into a unified knowledge system;
2. Identification of hidden patterns and relationships between different aspects of conflicts;
3. Provision of an interdisciplinary understanding of conflicts;
4. Support for comparative analysis of different conflicts;
5. Facilitation of logical inference of new knowledge.

A key feature of the proposed meta-ontology is its adaptability to different types of conflicts through mechanisms of specialization and extension of basic concepts.

Structure and components of the armed conflicts meta-ontology

Basic ontological components

The developed meta-ontology includes six basic components:

1. **Conflict Entity** – the central component with attributes: identifier, name, temporal and geographical boundaries, type, intensity, status. Supports modeling of multi-level conflicts through hierarchical relationships.

2. **Conflict Phase** reflects the dynamic aspect of the conflict, its development over time with a typical sequence: latent tension, escalation, open confrontation, de-escalation, post-conflict period.

3. **Actor** – conflict subjects, classified by type, role, level of organization, and resource base. Relationships between actors and their evolution are modeled.

4. **Action** – various types of actor activities, classified by type, scale, nature of impact, and temporal parameters. Special attention is paid to causal relationships between actions.

5. **Resource** – tangible and intangible assets, classified by type, availability, strategic value, and vulnerability. Resource relationships help analyze power asymmetry.

6. **Environment** – conflict context: geographical, demographic, political, economic, and international aspects.

Semantic relationship model

The meta-ontology defines five groups of relationships:

1. Causal relationships describe how some elements influence others: "generates," "enables," "constrains," "escalates," and "de-escalates."

2. Compositional relationships reflect structural connections: "whole-part," "inclusion," "belonging." Temporal relationships characterize the sequence and duration of events, including complex temporal patterns.

3. Strategic relationships describe interaction between actors: "support," "confrontation," "cooperation," "competition," and "control."

4. Transformational relationships reflect processes of change: "transformation," "adaptation," "escalation," "de-escalation."

Conflict resolution patterns

Based on the analysis of historical precedents and theoretical models of conflictology [7], five groups of conflict resolution patterns have been defined:

1. Military resolution – patterns related to military victory or forceful intervention;
2. Political resolution – patterns related to political processes and institutional changes;
3. Economic resolution – patterns related to economic mechanisms of settlement;
4. Social resolution – patterns related to social processes and transformations;
5. External resolution – patterns related to the role of the international community.

Process of forming and updating the meta-ontology

Integration of expert knowledge and artificial intelligence methods

The development of the meta-ontology is based on combining expert knowledge with AI methods. This hybrid approach includes:

1. Automated knowledge extraction – using NLP models to analyze large arrays of unstructured data. Customized BERT and GPT models were applied to identify concepts and relationships in texts about conflicts [8].

2. Hypothesis generation – using generative models to formulate potential causal relationships that may not be obvious to human experts.

3. Adaptation to new phenomena – identification of new phenomena in the nature of conflicts (cyberattacks, information operations) and their integration into the ontological structure.

4. Validation of logical consistency – simulation of different scenarios to verify the logical integrity of the ontology.

Meta-ontology update mechanisms

To ensure the relevance and actuality of the ontological model, update mechanisms have been developed:

1. Information environment monitoring – automated tracking of new factors in conflicts;

2. Assessment of the significance of new factors – analysis of their systemic nature, transformational potential, and scale;

3. Integration of new components – development of mechanisms for extending the ontology without violating its logical integrity;

4. Testing of the updated version – verification on current conflicts.

Application of meta-ontology in decision support systems

Knowledge transfer mechanisms between conflicts

The meta-ontology provides mechanisms for knowledge transfer between different conflicts:

1. Identification of structural analogies – identifying similar patterns in different conflicts using ontological matching methods;

2. Identification of causal patterns – identifying common mechanisms of conflict development for predicting new situations;

3. Transfer of contextually adapted knowledge – transferring knowledge considering contextual differences;

4. Analysis of counterfactual scenarios – modeling alternative scenarios of historical conflict development;

5. Meta-analysis of conflict patterns – identifying generalized patterns that manifest in different contexts.

Decision support tools

Based on the meta-ontology, a set of decision support tools has been created:

1. Escalation risk assessment system – analyzes the current situation and assesses the probability of escalation based on identified patterns;

2. Scenario analysis tool – models alternative scenarios of conflict development;

3. Hidden connection detection system – identifies non-obvious relationships between actors, events, and factors;

4. Comparative analysis tool for settlement strategies – evaluates the effectiveness of different strategies based on historical precedents;

5. Monitoring and early warning system – identifies early signs of escalation and generates recommendations for preventive actions.

6. Practical application of meta-ontology using a historical conflict example

Franco-Prussian War in the ontological structure

To demonstrate the practical application of the meta-ontology, let's consider its use for analyzing the Franco-Prussian War (1870-1871). The conflict is represented in the ontological structure with key components:

Conflict Entity:

- Identifier: FrancoPrussianWar.
- Timeframe: 19.07.1870 - 10.05.1871.
- Type: Interstate, classical.
- Status: Completed with Prussia's victory.

Key Actors:

- French Empire (Initiator).
- Prussian State (Defender → Winner).

Key Phases:

- Emergence phase (July 1870, trigger events: Ems Dispatch).
- Escalation phase (August 1870).
- Culmination phase (September 1870, Battle of Sedan).
- Resolution phase (January-May 1871, Treaty of Frankfurt).

Key Resources:

- Prussian railway system (Efficiency: High).
- Prussian mobilization system (Efficiency: High).

Validation of scientific statements and pattern identification

The ontological representation allows validation of scientific statements about the conflict. For example, Howard's (2001) statement about the role of railway logistics is confirmed by the causal chain:

Actor(PrussianState) → has_resource(MilitaryInfrastructure) → has_attribute(RailwayNetwork, Efficiency=High) → influences(MobilizationSpeed) → creates(StrategicAdvantage) → enables(BattleOfSedan) → leads_to(FrenchCapitulation)

Wettig's (2002) statement about the role of the Ems Dispatch as an information catalyst is reflected through the chain:

Action(EditingEmsDispatch) → initiated_by(Bismarck) → has_goal(ProvokingFrance) → influences(ThreatPerception) → leads_to(DeclarationOfWar)

Application of historical lessons to modern conflicts

Analysis of the Franco-Prussian War reveals patterns relevant to modern conflicts:

1. Information operations as conflict catalysts – analysis of the Ems Dispatch's role reveals a pattern where information manipulation provokes escalation;
2. Asymmetry in mobilization capabilities, in the modern context manifests as asymmetry in technological and organizational capabilities;
3. Transformative consequences of military victories – using successes to legitimize political changes;
4. Role of international recognition – critical importance for legitimizing territorial and political transformations.

Conclusions and prospects for further research

The developed meta-ontology of armed conflicts provides a structural basis for integrating heterogeneous data about conflicts, their analysis, and use in decision support systems. Key innovations include:

1. Comprehensive coverage of military, political, economic, social, and informational aspects of conflicts;
2. Integration of artificial intelligence methods in the processes of ontology formation and updating;
3. Development of knowledge transfer mechanisms between conflicts;
4. Creation of decision support tools based on the ontological model.

Promising directions for further research include:

1. Integration with big data analysis methods to scale analytical capabilities;
2. Development of specialized extensions for new types of conflicts (cyber, hybrid);
3. Development of multilingual support for international use;
4. Integration with negotiation and mediation support systems.

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