

Towards a Sustainable and Resilient Future: The Transformative Role of Data in Crisis Management

University of Technology Sydney (UTS)

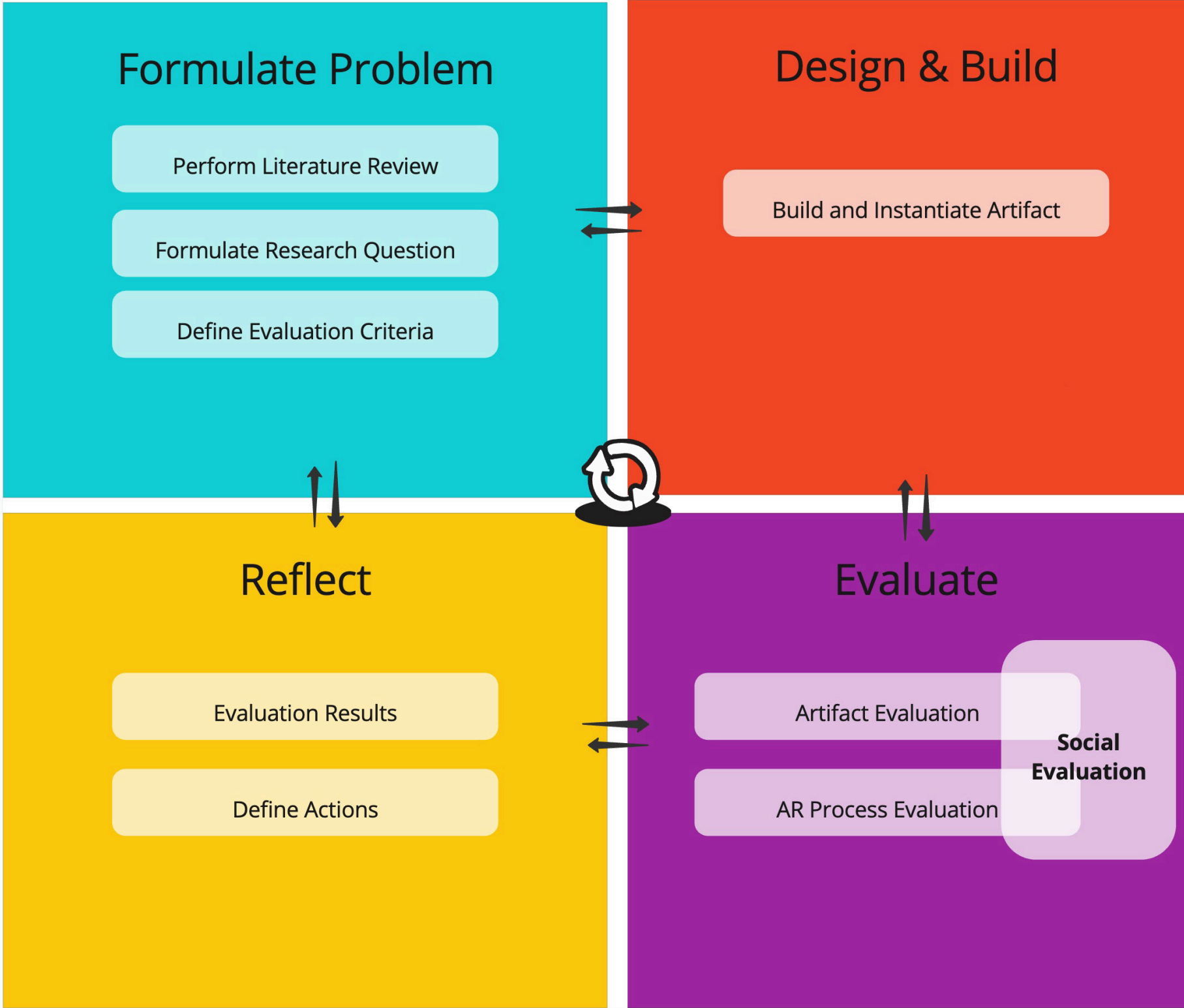
Shreya Srinivas - Gnana Bharathy - Salvatore Flavio Pileggi - Ghassan Beydoun

INTRODUCTION

Crisis management and disaster response generates large volumes of heterogeneous data spanning structured databases, unstructured government reports, real-time news updates, and informal channels like social media. However, this information is siloed, inconsistently classified, and inaccessible across systems, resulting in delays and inefficiencies in decision-making. This poster introduces the Ontology Alignment, Structure, Integration, and Synthesis (OASIS) framework: an AI-driven approach designed to create, align and harmonize crisis-related information through the integration of ontologies, knowledge graphs, and large language models (LLMs) to achieve semantic interoperability.

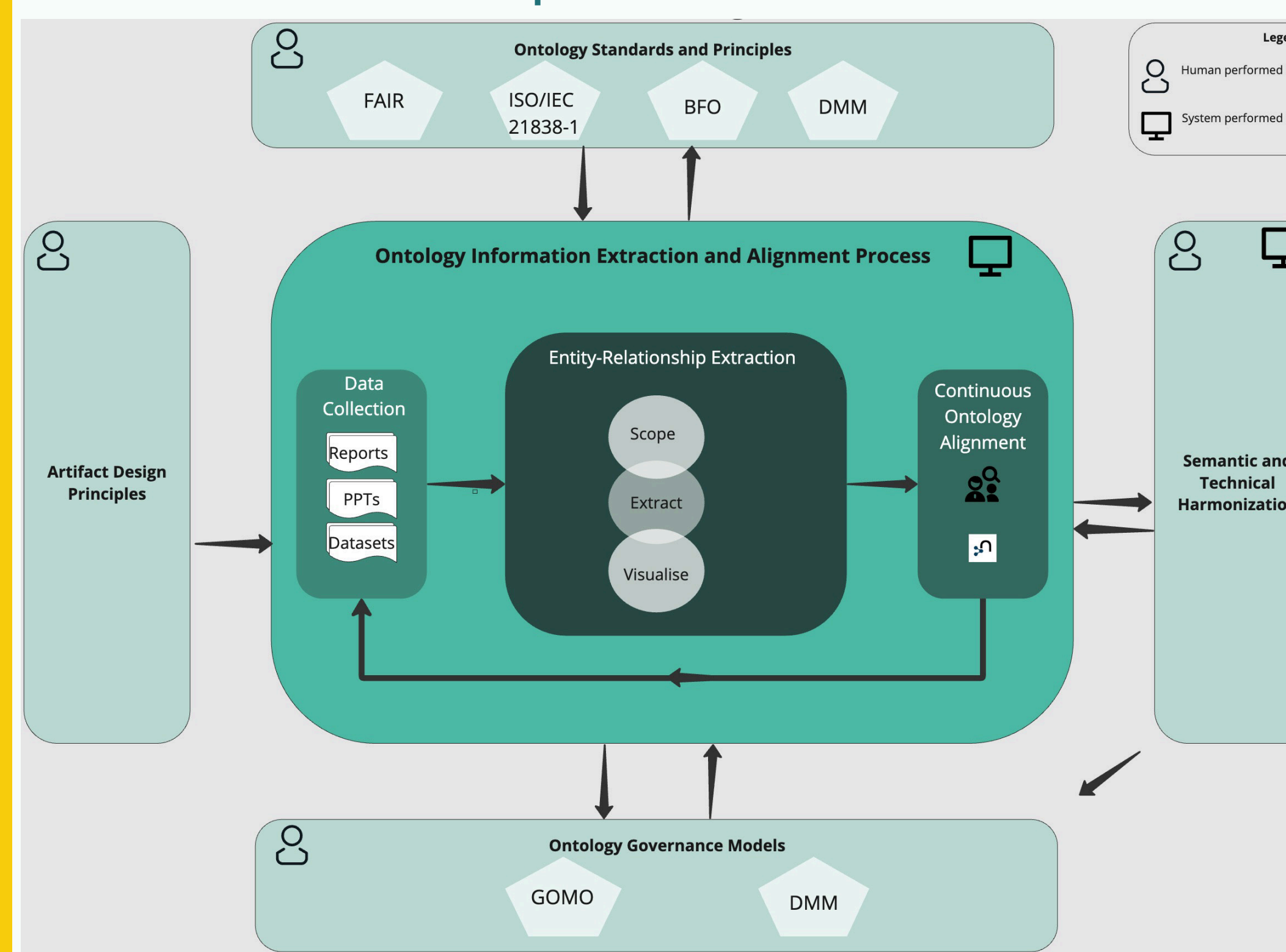
METHODS

This research employs an Action Research methodology that includes an iterative way of working with industry practitioners to develop the research artifacts. The outputs of this research include the proposed OASIS framework and a prototype implementation model trained on the EM-DAT[1] database, consisting of over 27,000 disasters. Two case studies were performed on actual crises data. The results were evaluated using both a quantitative evaluation (through measures like f-score, precision, recall) and a qualitative evaluation through practitioner interviews.



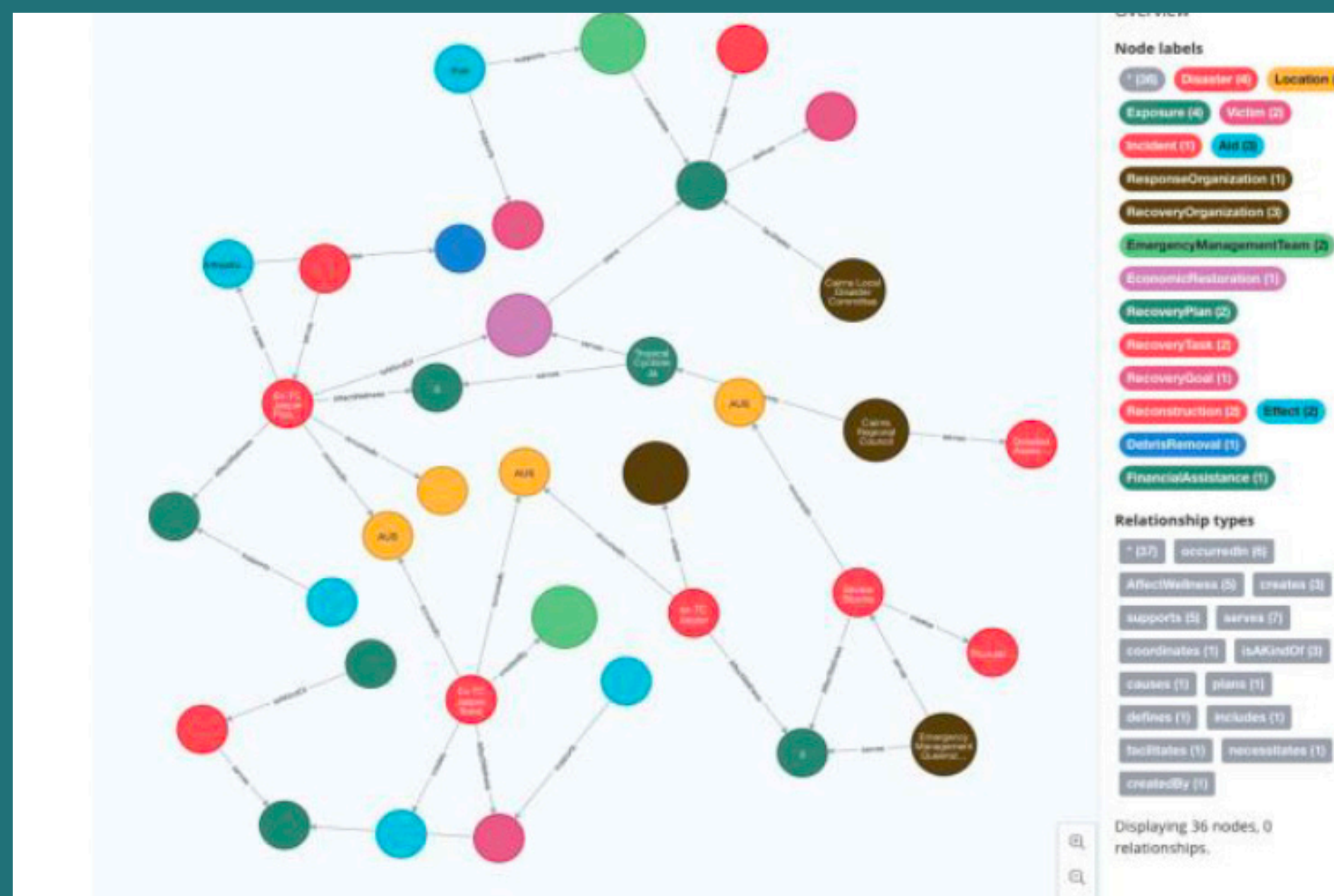
OASIS FRAMEWORK: Ontology Alignment, Structure, Integration, and Synthesis

An ontology is defined as an abstraction of semantic knowledge to model domain knowledge[2]. The OASIS framework is a contribution of this research. The framework automates the tasks of ontology extraction, alignment, harmonization and knowledge representation and employs a human in the loop evaluation.



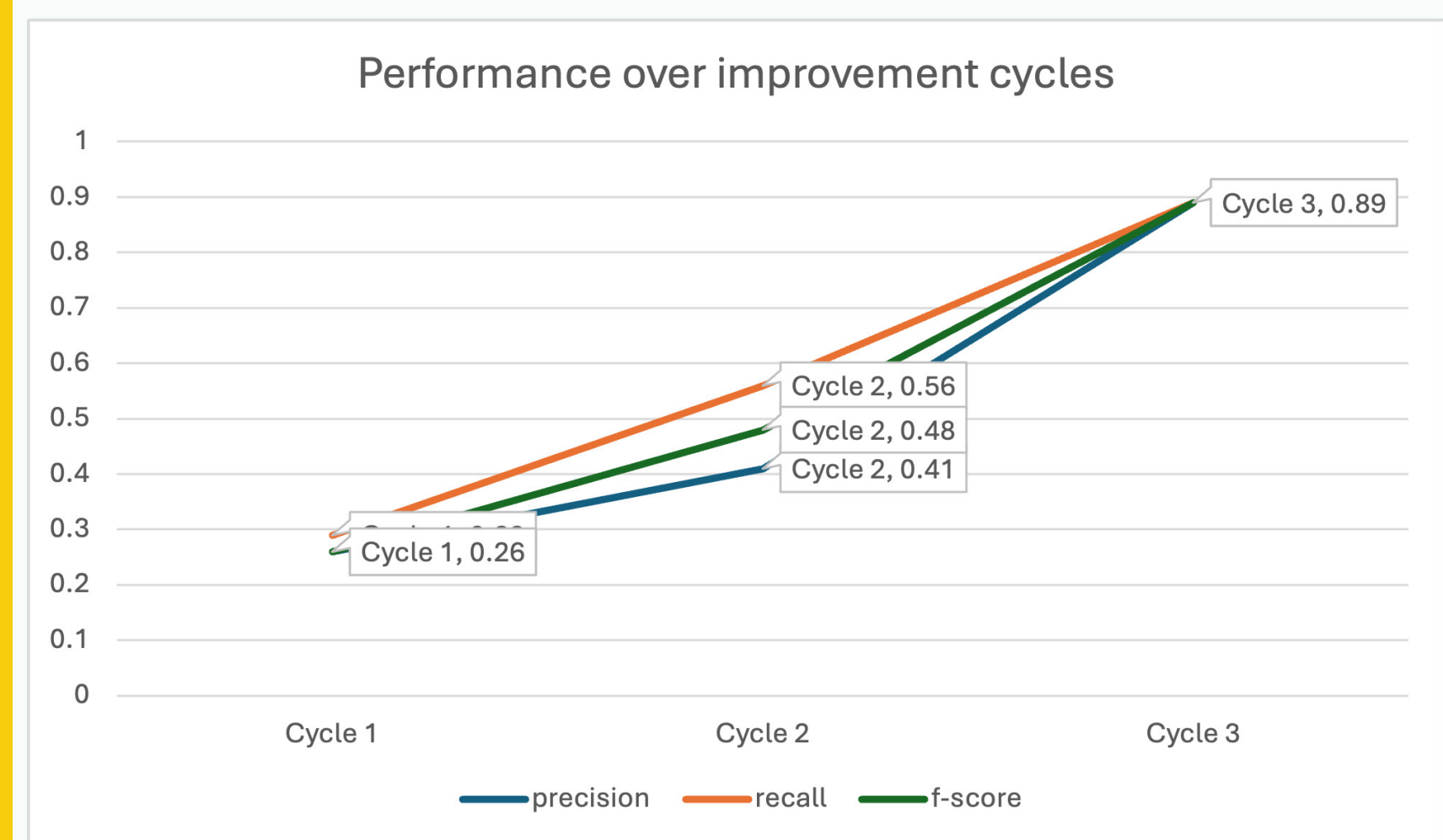
RESULTS

Data sources include unstructured data, including post-disaster reports, emergency declarations, and news articles. These were processed using GPT-4.o and Gemini to extract entities, relationships and attributes. Extracted entities and relationships were aligned to the Disaster Management Metamodel and visualised as a knowledge graph.



The two case study implementations for Cyclones Jasper and Alfred achieved a F1-score of 0.89 for structured data extraction after iterative prompt refinement and ontology alignment. The resulting knowledge graph showcased the extracted entities and data gaps.

A two shot training approach, with a narrow extraction and metamodel scope demonstrate an improvement in results. These demonstrate that LLMs can reliably accelerate information modeling when guided by structured schema such as the Disaster Management Metamodel.



DISCUSSION

Beyond a technical implementation, the OASIS framework contributes a reusable, domain-agnostic model that can be adapted to other sectors. Future research should prioritise the improvement of ontology discoverability, reusability, and accessibility across domains. This presents a compelling opportunity to innovate ontology management practices and to streamline data sourcing processes. Further investigation is also required into advanced data integration techniques, as well as the refinement of AI models to address increasingly sophisticated architectural challenges.

CONCLUSION

The proposed OASIS framework and prototype contributes to a reusable model that provides a repeatable methodology for rapid, AI-assisted ontology extraction, alignment and harmonization in crisis management. The research contributes to achieving data interoperability as detailed in FAIR data principles and disaster resilience targets outlined in the Sendai Framework.

[1] <https://www.emdat.be/>
[2] CAHYANI, D. E. & WASITO, I. 2017. Automatic Ontology Construction Using Text Corpora and Ontology Design Patterns (ODPs) in Alzheimer's Disease. Journal of computer sciences and information