October 1st, 2024, Budapest
Workshop on Semantic Interoperability in Data Spaces

Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI

Lightning Talk

Cascading effects analysis enabled by semantic interoperability in the Resilience Data Space

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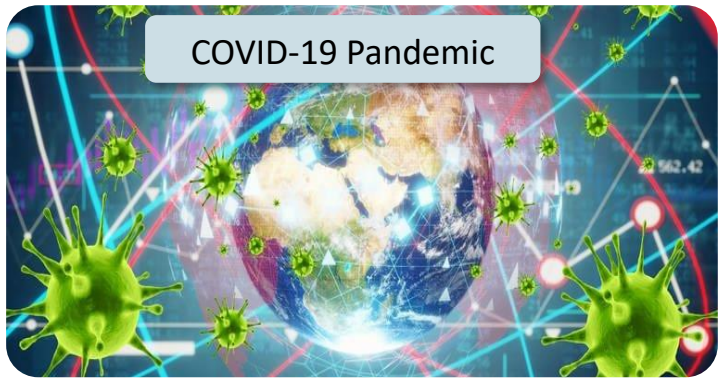
1. Crises and their cascading effects

stress the need for resilient critical infrastructure (CI) via data-driven crisis management



Challenges for Municipal Crisis Managers

- Resilient CI is vital for a well-functioning society
- CI systems are highly interdependent
- Crisis management of CI demands diverse, high-quality, trustworthy data

- How to identify cascading effects in CI systems?
- How to make CI more resilient?
- How to handle heterogeneous & decentralized relevant data?

Analysis of cascading effects

- Increase CI systems' resilience
- Enable data-driven crisis management of CI systems

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2. Resilience Data Space

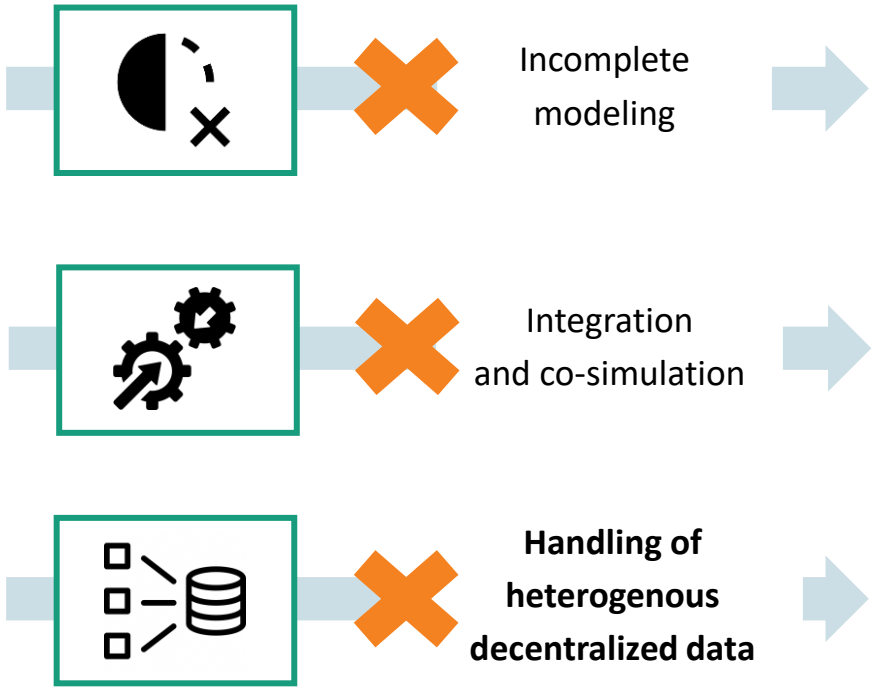
resolves challenges faced in existing methods for cascading effect analysis of CI systems

Existing methods for modeling interdependent critical infrastructure

1. Agent-based
2. System dynamic-based
3. Economic theory-based
4. Network-based
5. Empirical approaches
6. Causality analysis approaches

[1]

face challenges due to



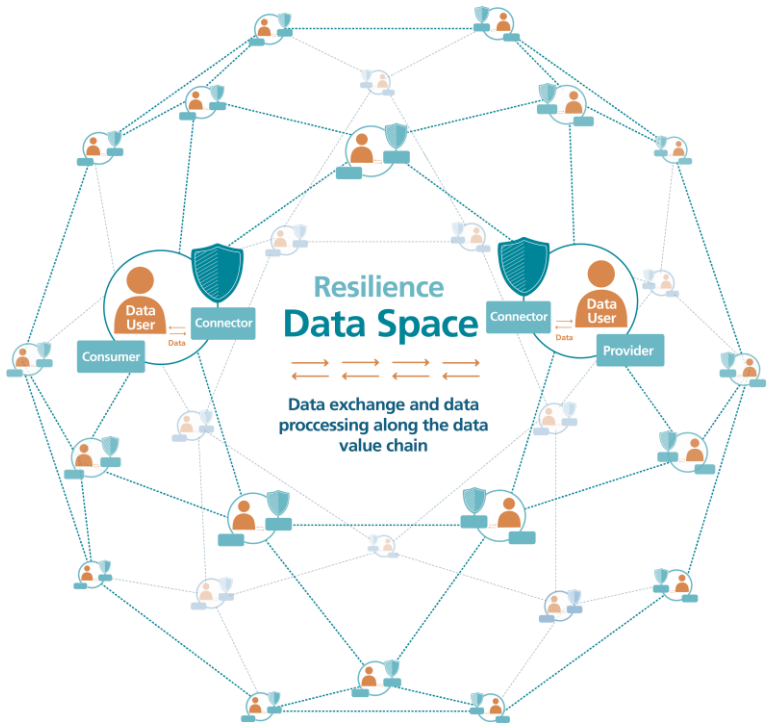
Incomplete modeling

Integration and co-simulation

Handling of heterogenous decentralized data

SOLUTION

Resilience Data Space



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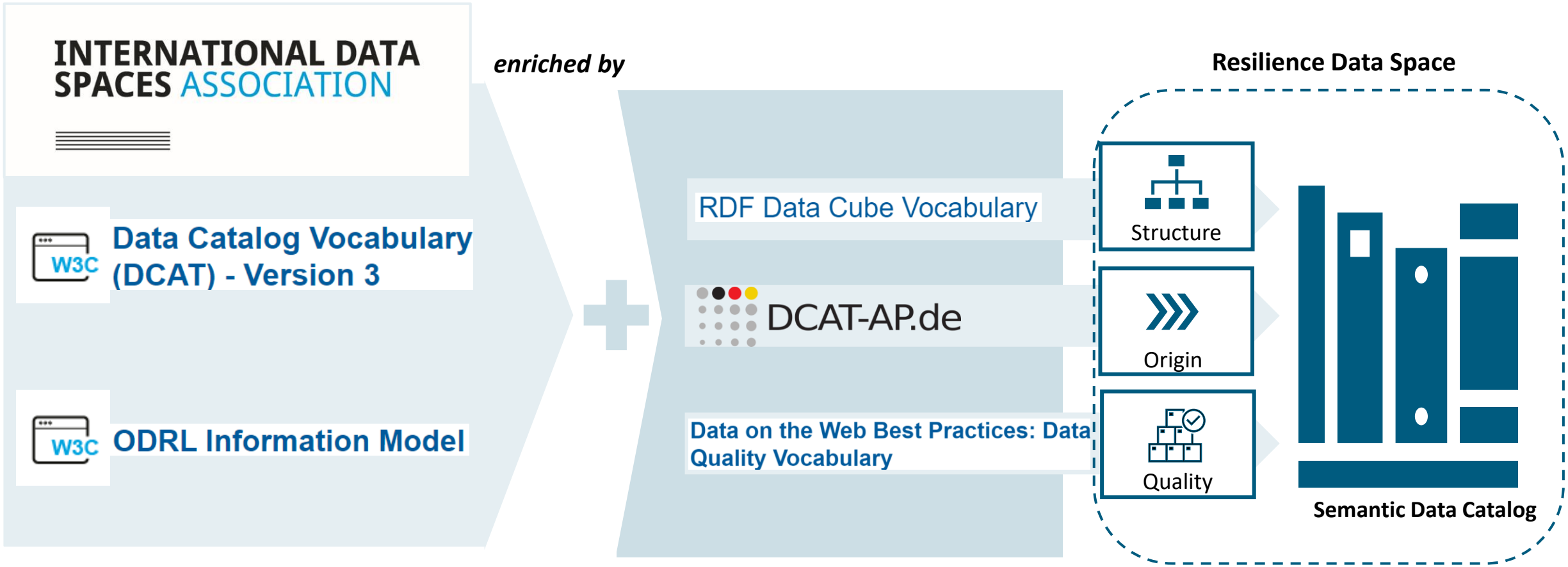
3. International Data Space Modeling Vocabularies are enriched

with data origin, structure & quality aspects for interoperability & trust in data-driven crisis management



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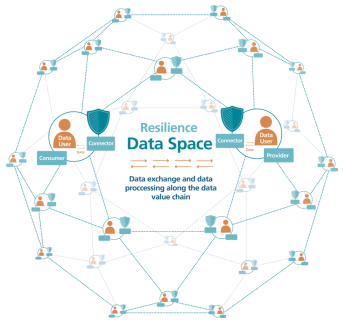
4. Knowledge graph-based approach can enable cascading effect analysis

via semantic modeling of the statistically quantified interdependencies from selected (meta) data

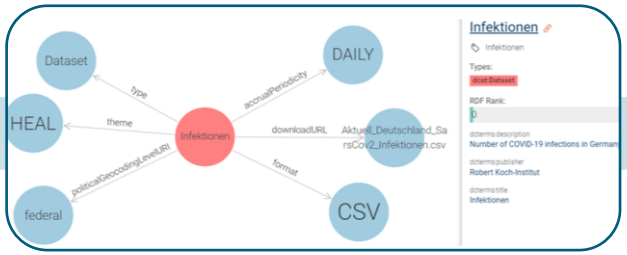
Data selection

- Origin
- Structure
- Data Quality

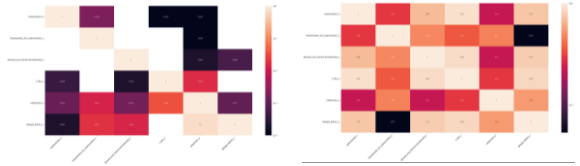
Semantic Data Catalog



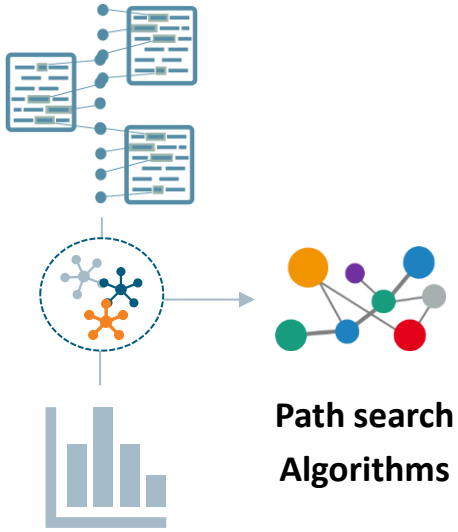
Metadata retrieval



Statistical Analysis

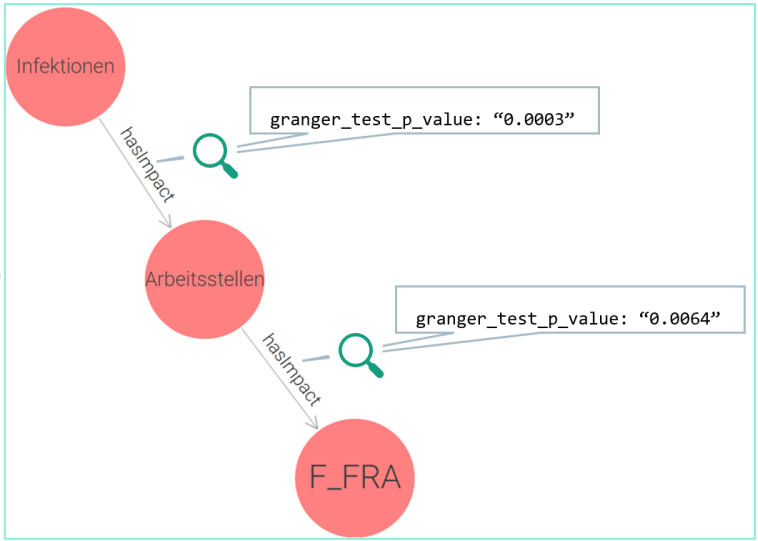


Semantic modeling of interdependencies



Path search Algorithms

Cascading Effect Analysis displayed on a Knowledge Graph



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Summary

Cascading effect analysis enabled by semantic interoperability in the Resilience Data Space

Motivation	■ Crises and their cascading effects stress the need for resilient CI systems via data-driven crisis management
Resilience Data Space	■ Resilience Data Space resolves challenges faced in existing methods for cascading effect analysis of CI systems.
Semantic Interoperability	■ IDS Modeling Vocabularies are enriched with data origin, structure, and quality aspects for interoperability & trust in data-driven crisis management.
Knowledge Graph-based Approach	■ Knowledge graph-based approach can enable cascading effect analysis via semantic modelling of the statistically quantified interdependencies from selected (meta) data.
Added Value	Cascading effect analysis enabled by semantic interoperability in the Resilience Data Space.

References

[1] M. Ouyang, “Review on modeling and simulation of interdependent critical infrastructure systems,” Reliability Engineering & System Safety, vol. 121, pp. 43–60, Jan. 2014, doi: 10.1016/j.ress.2013.06.040.

[2] P. Trucco, B. Petrenj, S. Bouchon, and C. D. Mauro, “Ontology-based approach to disruption scenario generation for critical infrastructure systems,” IJCIS, vol. 12, no. 3, Art. no. 3, 2016, doi: 10.1504/IJCIS.2016.079022.

[3] J. Dao, S. T. Ng, Y. Yang, S. Zhou, F. J. Xu, and M. Skitmore, “Semantic framework for interdependent infrastructure resilience decision support,” Automation in Construction, vol. 130, p. 103852, Oct. 2021, doi: 10.1016/j.autcon.2021.103852.

Thank you!

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