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18. abstract

1. Current State of Science and Technology

Before the start of the project, only isolated approaches existed for the digitalization of transport chains and the use of federated data spaces in logistics. Standardized, interoperable systems for rendezvous-based delivery logics, autonomous transport vehicles, and data-space-enabled applications were scarcely established in either research or practice. Existing solutions were mostly siloed, lacking comprehensive integration into federated data ecosystems.

2. Rationale / Objective of the Study

The objective was to develop a novel concept for a Smart Managed Freight Fleet system based on Gaia-X principles. Autonomous transport solutions (ANPs), multi-agent systems, and digital booking platforms were to be integrated in order to increase efficiency, transparency, and sustainability in freight logistics. Particular emphasis was placed on interoperability, data sovereignty, and realistic demonstration of the developed concepts.

3. Methodology

The project pursued a prototypical and iterative approach. Key technical methods included the development of modular backend systems, the implementation of a rendezvous and booking concept, the integration into federated Gaia-X data spaces, and validation through demonstrators in both laboratory and real-world environments. In addition, mobile web applications for shippers and receivers were developed.

4. Results

A functional demonstrator was developed, covering the essential elements of the use case: booking platform, rendezvous logic, multi-agent systems, ANP integration, data space connectivity, and operator-centered cockpits. The demonstrations—among others at Hannover Messe 2024 and the final public event in Osnabrück—successfully showcased the feasibility and benefits of the developed solutions. Furthermore, business models for data-driven logistics services were identified and evaluated.

5. Conclusion / Application Potential

The results confirm the feasibility of a Gaia-X-compliant smart freight system. Potential applications lie particularly in urban logistics, in the operation of autonomous transport fleets, and in data-driven control of complex supply chains. Through transferability to other industries and integration into federated data spaces, substantial market potential arises. The project thus established the foundation for productization, follow-up projects, and large-scale implementation in real logistics environments.

19. keywords

Gaia-X, Federated Data Spaces, Digital Sovereignty, Smart Logistics, Smart Managed Freight Fleet, Autonomous Transport Vehicles, Rendezvous Logic, Multi-Agent Systems, Booking Platform, Data Integration, Remote Operation, Operator Cockpits, Data-driven Service Business Models, Supply Chain Transparency, Urban Logistics

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