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# Optimizing Information Flow in Renovation Projects: A Linked Data Approach

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## Résumé

Optimizing Information Flow in Renovation

Projects: A Linked Data Approach

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Abstract:

The Architecture, Engineering, and Construction (AEC) industry is marked by multifaceted processes, diverse stakeholders, and extensive data sources. This paper delves into the pivotal role of efficient information exchange in AEC projects and the challenges imposed by data heterogeneity, poor communication, and coordination. Through an exploration of various approaches to facilitate information exchange and mitigate data silos, including Master-Slave systems, Data lakes/Data warehouses, PLM solutions, and Linked Data, it becomes evident that Linked Data holds significant promise for addressing these challenges. By adopting Linked Data principles and technologies, AEC projects can achieve improved interoperability, streamlined collaboration, and enhanced efficiency. This aim of this work is to ensure the correct information is delivered to correct actor at the correct time. To achieve this a comprehensive Linked Data approach focusing on ontology development and implementation is developed, and showcases its applicability through a detailed proof of concept in the renovation of the Jarville building in Nancy, France.

Keywords: AEC industry, Interoperability, Information flow, Linked Data, Ontology, Information delivery.

### 1. Introduction:

The AEC industry faces multiple complex challenges, including fragmented project data, lack of standardization, and poor project management and communication, leading to inefficiencies and stagnant productivity (Lynch, 2022). Despite extensive research efforts, these

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challenges persist, necessitating innovative solutions. Linked Data emerges as a promising approach to address these challenges, offering a standardized framework for data integration and interoperability.

## 2. State of the Art on the Current Approaches to Facilitate Information Exchange and Mitigate Issues Related to Data Silos:

During this work, an exploration of current approaches employed in the AEC industry to facilitate information exchange and mitigate data silos was conducted. It includes an analysis of Master-Slave systems, Data lakes/Data warehouses, PLM solutions, and Linked Data, highlighting their strengths and limitations. Despite their utility in specific contexts, some of these approaches often fall short in addressing the complex information needs of AEC projects.

Linked Data, with its emphasis on standardization, interoperability, and semantic enrichment, emerges as a promising solution to bridge data silos and streamline communication across diverse stakeholders.

## 3. Approach Presentation:

The developed approach consist of the development of a comprehensive Linked Data framework tailored to address the unique challenges of AEC projects. This approach utilizes an ontology at its core for formalizing, organizing and integrating project data. Through the adoption of Linked Data principles, such as RDF graphs and SPARQL endpoints, AEC projects can achieve enhanced interoperability and information exchange (Wood, 2014). The NeOn methodology was used for the ontology development since it provides a robust approach for ontology development, leveraging existing resources and standards to expedite the process (Fernandez-Lopez, 2015).

### 3.1. Ontology Development:

The NeOn methodology was chosen for ontology development, given its relevance in the context of AEC projects due to the resources reuse protocols. Resources from similar European projects were reused, which was a strategic approach to expedite ontology development while ensuring alignment with established standards. The developed ontology is validated through structured interviews with domain experts, confirming its applicability and relevance within the renovation domain. Key concepts within the renovation process, such as activities and actors, are systematically organized within the ontology, providing a comprehensive framework for information representation.

### 3.2. Linked Data Approach:

Linked Data principles were explored in depth, focusing on their application in addressing interoperability challenges and data heterogeneity in AEC projects. The interconnected nature of Linked Data enables seamless collaboration and information exchange across diverse stakeholders. By leveraging RDF graphs and SPARQL endpoints, AEC projects can create a unified platform for accessing and querying project data. The ontology serves as a cornerstone of the Linked Data approach, providing a structured framework for representing knowledge and relationships within the AEC domain.

## 4. Proof of Concept:

The Proof of Concept demonstrates the practical application of the Linked Data approach through a detailed case study of the renovation of the Jarville building in Nancy, France. This real-world example illustrates how Linked Data principles can be implemented to enhance efficiency and transparency in AEC projects. The proof of concept begins with the collection of site data, including a 3D scan of the building and historical energy performance records. These data are integrated into a Building Information Modeling (BIM) model, which serves as a central repository for project information.

The BIM model is enriched with metadata and linked to the ontology developed earlier, creating a structured framework for organizing and accessing project data. Through SPARQL queries, users can extract relevant information and perform analysis, facilitating decision-making and project management. The RDF graph of the entire data repository illustrates the interconnected nature of project information, highlighting the seamless collaboration enabled by Linked Data principles.

Furthermore, the proof of concept examines the RDF graph of the activity "panel installation" in detail, showcasing the breakdown of tasks, actors involved, and associated documentation. Each element in the RDF graph is assigned a unique URI, facilitating easy access and retrieval of information. Through linked data, various file formats, such as CSV, IFC, and JSON, are interconnected, providing a comprehensive view of the renovation project.

## 5. Conclusion and Future Works:

A new linked data framework, featuring a centralized ontology, emerges as a solution to tackle the intricate interoperability hurdles and data heterogeneity pervasive in renovation projects. This innovative ontology serves as a nexus, seamlessly interlinking crucial concepts and properties, thereby fostering interoperability among diverse data repositories and dismantling the barriers of data silos.

Looking ahead, the imperative lies in establishing exhaustive testing and implementation frameworks to ascertain the reliability and efficacy of this solution. Streamlining the ontology population process and automating its deployment emerge as paramount objectives for future endeavors. Furthermore, facilitating Linked Data querying necessitates the development of a sophisticated search engine tool capable of translating user inquiries seamlessly into SPARQL queries, thus enabling efficient exploration and utilization of the linked data ecosystem.

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