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D3.2 – Standardised data exchange ecosystem and smart services marketplace architecture

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This document is issued within the frame and for the purpose of the UNCHAIN project. This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101103812. The UK participant in Horizon Europe Project UNCHAIN, is supported by UKRI grant number 10078841 Lancaster University.

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Deliverable details

Deliverable No.	D3.2
Deliverable Type	DEM – Demostrator, pilot, prototype
Dissemination Level	PU – Public
Work Package No.	3
Work Package Title	Data-driven urban logistics cooperation framework
Task No.	T3.2 and T3.3
Task Title	Secure, standardised and interoperable urban logistics data. Smart logistics services marketplace architecture
Author(s)	Daniel Villalobos
Status (F:final; D:draft; RD:revised draft)	F
File name	D3.2 - Standardise data exchange ecosystem and smart services marketplace architecture
Version	0.3
Task start date and duration	M6-M15
Due Date	M15 (July 2024)
Delivery Date	30/07/2024

Review History of Deliverable

Version No.	Date	Revision Details
0.1	09/07/2024	Draft version
0.2	25/07/2024	Reviewed version
0.3	30/07/2024	Final version

Reviewers of Deliverable

Reviewers' name	Company	Date
Konstantinos Zografos	ULANC	15/07/2024 (v0.1)
		26/07/2024 (v0.2)
Vincenzo Savarino	MUNI	12/07/2024 (v0.1)
Lena Korostylova / Ishak Gougam	VMZ	17/07/2024 (v0.1)
Elena García	ETRA	29/07/2024 (v0.2)

Table of Contents

List of Figures

Acronyms

Acronym	Meaning
API	Application Programming Interface
CA	Certificate Authority
DAPS	Dynamic Attribute Provisioning Service
DSC	DataSpace connector
EGI	European Grid Infrastructure
GUI	Graphical User Interface
IDS	Internacional Data Space
IDSA	Internacional Data Space Association
MDB	Metadata Broker
MoU	Memorandum of Understanding
REST	Representational State Transfer
UI	User Interface
WP	Work Package

Executive Summary

The UNCHAIN project focuses on digitally transforming urban logistics to support sustainable and efficient urban mobility. It addresses the challenges of increased urban logistics demand and digitalization by promoting collaboration among local authorities, logistics stakeholders, and technology providers.

One of the key objectives of this collaboration is to establish a robust infrastructure for data sharing and service integration, contributing to a European urban freight data space.

The collaborative framework is based on the International Data Spaces Association (IDSA) reference architecture, ensuring secure, standardized, and efficient data transfers. A user-friendly graphical user interface (GUI) modelled after the IDSA interface, along with APIs documented on Swagger, enhances the usability and effectiveness of the data exchange ecosystem.

The standardised data exchange ecosystem and smart services marketplace architecture developed in the UNCHAIN project represent significant progress towards improving urban logistics and promoting sustainable urban mobility. The project's focus on standardization, interoperability, and user-friendly interfaces aims to break down data silos, facilitate better coordination, and improve logistics operations across urban environments.

1. Introduction

The UNCHAIN project is an Innovation Action targeting the digital transformation of urban logistics to support sustainable and efficient urban mobility. The project focuses on overcoming the challenges associated with the increasing demand for urban logistics and the digitalization of freight operations. By promoting a collaborative framework that involves local authorities, logistics stakeholders, and technology providers, UNCHAIN aims to establish a robust infrastructure for data sharing and service integration, ultimately contributing to the creation of a Pan-European urban freight data space.

Currently, urban logistics faces significant challenges, including traffic congestion, environmental impact, and the inefficiency of freight operations. The increasing urbanization and demand for quick deliveries have exacerbated these issues. Digital transformation in logistics is essential to address these challenges by optimizing routes, reducing emissions, and improving the overall efficiency of freight operations.

1.1. Purpose of this document

D3.2 aims to achieve several key objectives within Work Package 3 (WP3) of the UNCHAIN project. These objectives include:

- **Development of Data Exchange Connectors:** The creation of standardized connectors is crucial for facilitating seamless data exchange between various stakeholders in the urban

logistics ecosystem. These connectors will ensure interoperability and compliance with International Data Spaces (IDS) standards. Standardization is essential to enable different systems and stakeholders to communicate effectively, thus breaking down silos and fostering collaboration.

- **Implementation of the Smart Services Marketplace Architecture:** Establishing the architecture for a marketplace where smart logistics services can be integrated is another key objective. This marketplace will serve as a central hub for the deployment and management of services developed within UNCHAIN, enhancing urban planning, policymaking, and operational efficiency. The marketplace will provide a platform for innovative logistics solutions, enabling cities to manage their logistics networks more effectively.
- **User Interface Design:** Developing user-friendly interfaces for stakeholders to interact with the data exchange ecosystem and the smart services marketplace is vital. Ensuring accessibility and usability for diverse user groups, including logistics operators, local authorities, and technology providers, will facilitate broader adoption and efficient use of the platform.

This deliverable is instrumental in laying the foundation for data-driven urban logistics solutions. By standardizing data exchange and creating a marketplace for smart services, D3.2 aims to:

- **Enhance Data Interoperability:** Facilitate the seamless sharing and utilization of logistics data across different platforms and stakeholders, breaking down existing data silos. Enhanced interoperability will lead to better coordination and integration of logistics activities, reducing redundancies and inefficiencies.
- **Promote Smart City Integration:** Integrate the new logistics services with existing smart city platforms, supporting holistic urban management. By leveraging smart city infrastructure, UNCHAIN will help cities optimize the use of their resources, improve traffic management, and reduce the environmental impact of urban logistics.
- **Improve Decision-Making:** Provide urban planners and policymakers with advanced tools and data insights to make informed decisions that enhance urban mobility and sustainability. Access to data (including real-time data)and analytics will empower authorities to implement effective policies, optimize infrastructure usage, and respond proactively to emerging challenges in urban logistics.

Additionally, the UNCHAIN project emphasizes the importance of collaboration among stakeholders. By fostering a cooperative environment, the project aims to build trust and facilitate data sharing agreements that are essential for the successful implementation of digital solutions in urban logistics.

This collaborative framework will not only benefit individual stakeholders but also contribute to the broader goal of creating more sustainable and liveable urban environments across Europe.

1.2. Relation with other project activities

Deliverable D3.2 comes as a result of the following tasks:

- **T3.2 - Secure, Standardised and Interoperable Urban Logistics Data:** This task focuses on defining and implementing the data exchange modules and connectors required for secure, standardized, and interoperable data sharing. The primary goal is to ensure that data from various sources can be shared and used efficiently across different platforms and stakeholders within the urban logistics ecosystem. This involves the development of software add-ons compatible with existing systems used by urban logistics operators and public administration smart platforms. The modules are designed to comply with IDS principles and reference architecture proposed by the International Data Spaces Association (IDSA). The outcome of this task is a set of data exchange solutions that provide a secure and standardized way of sharing urban logistics data, thereby enabling better coordination and optimization of logistics operations across cities.
- **T3.3 - Smart Logistics Services Marketplace Architecture:** The objective of this task is to design and implement the architecture of a smart logistics services marketplace in a user friendly way to create the collaboration framework. This marketplace will integrate various smart logistics services developed within the UNCHAIN project and serve as a central hub for these services. The architecture is designed to be included as a new module within existing local administration platforms, such as multimodal mobility or smart city platforms. This integration will facilitate the management and visualization of logistics metrics and KPIs, thus enhancing the decision-making capabilities of urban planners and policymakers. The marketplace will support services developed in subsequent work packages (WP4 and WP5), providing a comprehensive platform for urban logistics management

This document comprises the IDSA architecture and its implementation in a front-end solution, but it will be further extended in M18 with a more practical implementation and lab testing of the data space withing D3.3.

The developed software platform will be used by the WP4 and WP5 services for the data acquisition and to allow cooperation between the different partners of the project, as this framework will be transversal to every other service.

The framework platform will be fully deployed and published once the tests outlined in T3.4 are completed, and any necessary corrections were made. This ensures that the platform is robust, reliable, and ready for wide-scale adoption across various urban logistics environments. The testing phase will address any technical issues, optimize performance, and ensure compliance with security and interoperability standards.

1.3. Structure of the document

This document is structured as follows:

- Section 2 includes de common section to all the UNCHAIN deliverables by giving an overview of the gender, ethics and data related issues.
- Section 3 provides the core contribution of this document explaining the collaborative framework and giving insights about the IDSA Reference, its components and the connectors. Within this section it is also analysed the alternatives solutions that were considered, and the selected approach finally followed in UNCHAIN with its Graphical User Interface (GUI). In addition, the Application Programming Interface (API) and documentation using Swagger is described.
- Section 4 concludes the deliverable.

2. Gender, ethics and data related issues

2.1. Gender related issues

Not applicable.

2.2. Ethics related issues

Not applicable.

2.3. Data related issues

As described in the document, the architecture selected for the data space in the UNCHAIN project is based on the Fraunhofer solution. This architecture provides a standardized way to share data among all partners within the consortium. However, it does not automatically make all data available to every partner. By adopting this approach, UNCHAIN ensures that data sharing is facilitated transparently, adhering to the EU's key principle of transparency. In addition, as referenced in the D1.2 Data Management Plan (M6), unless it is stated differently for any specific case, all the data will be anonymised before publication and will comply with the General Data Protection Regulation (GDPR) and the specific national and European laws for the protection of personal data. Additionally, during the lifetime of the project, GDPR will be in force. Furthermore, ethical standards and guidelines will be rigorously applied, regardless of the country in which the research is carried. Partners must provide all necessary associated agreements, such as Memorandums of Understanding (MoUs) and Confidentiality Agreements, during the data provision process.

3. Collaborative framework

3.1. IDSA reference

IDSA offers a reference architecture of how a Data Space should looks and which components will be part of it (Steinbuss, 2022).

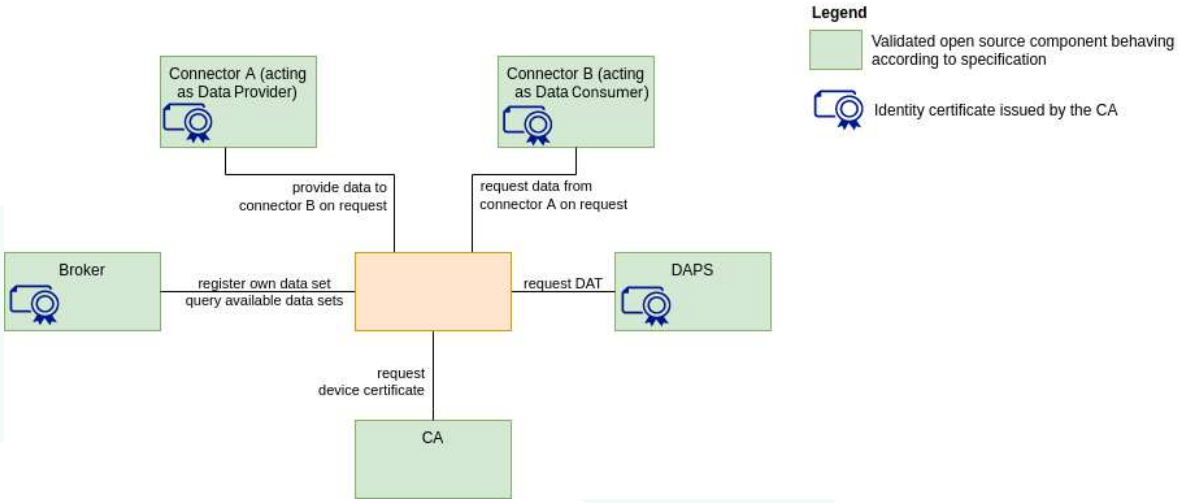

Figure 1 - IDS minimal setup. (Source: https://github.com/International-Data-Spaces-Association/IDS-testbed)

As is described in Figure 1, the following are the minimum necessary components:

- **Certificate Authority (CA)** is responsible for issuing and managing digital certificates, ensuring that entities within the data space can be authenticated securely. This authentication is crucial for establishing trust among participants and facilitating secure communications.
- **Dynamic Attribute Provisioning Service (DAPS)** provides dynamic attributes and supports attribute-based access control within the data space. DAPS helps manage and verify the attributes of entities, ensuring that access to data is granted based on up-to-date and verified information.
- **DataSpace connector (DSC)** acts as the interface for data exchange between entities, ensuring secure, standardized, and efficient data transfers. This component will be discussed in detail in the following chapter.
- **Metadata Broker (MDB)** serves as a registry and repository for metadata within the data space. It allows entities to publish, discover, and access metadata, facilitating the identification and utilization of available data resources.

For the scope of the project, the created framework was completely based on the IDS testbed implementation offered by the IDSA using for that the Fraunhofer components. For the selection of this approach, the key principle of transparency is considered since the data shared within the dataspace should accomplish it.

3.2. What is a Dataspace Connector?

A crucial component within the International Data Spaces Association (IDSA) framework is the connector (Giussani & Steinbuss, 2023). The connector serves as a vital element designed to facilitate secure and standardized data exchange between diverse entities within a data space. It acts as an interface that enables data providers and data consumers to interact seamlessly, ensuring that data can be shared and utilized while maintaining stringent security and compliance standards.

In the context of IDSA, connectors are essential for several reasons. Firstly, they provide the technical infrastructure necessary for establishing secure communication channels. This involves encryption mechanisms and protocols that protect the data from unauthorized access and ensure its integrity during transmission. By leveraging these security features, connectors help mitigate risks associated with data breaches and cyber-attacks, which are critical concerns in data-driven environments.

Moreover, connectors are responsible for enforcing data usage policies and access controls. They enable data providers to define and enforce rules regarding who can access their data, under what conditions, and for what purposes. This policy enforcement is crucial for maintaining trust among participants in the data space, as it ensures that data is used in accordance with the provider's terms and conditions.

In compliance with International Data Spaces (IDS) standards, TLS-encrypted communication is supported for interactions with other IDS connectors and for communication with an IDS broker within an IDS data ecosystem.

The IDS connector is also implicated in the usage control policies for the data. This control policies system will be explained and detailed as part of the D3.3 Integration, open interfaces development and lab-testing.

Another significant aspect of connectors within the IDSA framework is their role in ensuring interoperability. Given the heterogeneous nature of data sources and systems across different organizations, connectors are designed to support various data formats, communication protocols, and standards. This interoperability is fundamental for enabling seamless data integration and exchange, allowing organizations to leverage data from multiple sources without facing compatibility issues.

The IDS connector encompasses several key features that are crucial for its operation within the IDSA framework:

- Security and Trust: The IDS connector ensures secure data transmission through robust encryption protocols and secure communication channels. It adheres to the highest standards of data protection, safeguarding against unauthorized access and ensuring data integrity.
- Policy Enforcement: The connector enforces data usage policies defined by data providers. This includes access control mechanisms that specify who can access the data,

under what conditions, and for what purposes. These policies are crucial for maintaining trust and compliance within the data space.

- Interoperability: Designed to handle a variety of data formats and communication protocols, the IDS connector supports interoperability across different systems and organizations. This flexibility is essential for seamless data exchange and integration.
- Compliance: The connector complies with international data standards and regulations, ensuring that data exchange processes meet legal and regulatory requirements. This compliance is vital for organizations operating in regulated industries.
- Scalability: The IDS connector is built to handle large volumes of data and complex data exchange scenarios. It supports scalable operations, making it suitable for both small-scale and large-scale data sharing environments.
- Modularity: The connector architecture is modular, allowing for customization and extension based on specific organizational needs. This modularity enables organizations to adapt the connector to their unique technical and regulatory requirements.

Choosing the correct connector for specific tasks within a data space is of paramount importance. The right connector ensures that data exchange processes are not only secure and compliant but also efficient and scalable. It should be capable of handling the volume and complexity of the data being exchanged while maintaining performance standards. Additionally, the selected connector should align with the organization's specific technical and regulatory requirements, ensuring that it supports the necessary data governance and compliance measures.

According to the IDSA, the following

Figure 2 shows the overview of the existing connectors.

Section	Name of connector	Maintainer	Open source
2.2.1	AI.SOV connector	Cefriel	
2.2.2	Dataspace Connector (DSC)	SOVITY	✓
2.2.3	ECI IDS Connector powered by TNO	eci Gatewise	
2.2.4	Eclipse Dataspace Connector (EDC)		✓
2.2.5	EGI Datahub connector	egi	✓
2.2.6	IDS Integration Toolbox	open logistics foundation	✓
2.2.7	GAIAboX®.IDS. BasicConnector	nicos	
2.2.8	IIOC (Intel IONOS Orbiter Connector)	truzzt	Planned
2.2.9	Kharon IDS Connector	HOLONIX	
2.2.10	MPAD-C	MONDRAGON UNIBERTSITATEA	✓
2.2.11	OneNet Connector	ONENET	Planned
2.2.12	Silicon Economy EDC	open logistics foundation	✓
2.2.13	sovity Connector-as-a-service	SOVITY	
2.2.14	Tech2B SCSN Connector	TECH2B	
2.2.15	Telekom DIH connector	T Systems	
2.2.16	TeraLab Connector	TERALAB	✓
2.2.17	TNO Security Gateway (TSG)	TNO	✓
2.2.18	Tritom Connector		
2.2.19	TRUE connector	ENGINEERING	✓
2.2.20	Trusted Connector	Fraunhofer AISEC	✓
2.2.21	Trusted Supplier Connector (TSC)		
2.2.22	VTT DSIL Connector	VTT	
2.2.23	WeTech Smart Data Connector		

Figure 2 – Overview of connectors in May 2023. (Source:(Giussani & Steinbuss, 2023))

D3.3 report, with submission date M18, will delve deeper into the connector architecture exploring its various components, functionalities, and deployment methodologies. This comprehensive analysis will provide detailed insights into how connectors can be effectively implemented and utilized within the IDSA framework developed in the UNCHAIN project. By offering a thorough examination of deployment strategies, best practices, and potential challenges, the D3.3 report will aim to equip stakeholders with the knowledge and tools necessary to optimize their data exchange processes, ensuring that their data spaces are secure, compliant, and highly efficient.

3.3. Alternatives chosen as the base study in the UNCHAIN project

During the initial stages of the project, a thorough review of existing alternatives was conducted to identify the most appropriate foundation for the project solution. This decision-making process was informed by the IDSA data connector report (Giussani & Steinbuss, 2023), published by the International Data Spaces Association in May 2023. As this was the latest available report at the onset of the project, it provided the most up-to-date and comprehensive documentation of existing data connector implementations.

The report is an authoritative resource, detailing the state of development and deployment of various data connectors. It includes a meticulous evaluation of each implementation, offering valuable insights into their capabilities, performance metrics, and potential applications. By leveraging this report, we ensured that our project solution was built upon a well-vetted and reliable base, aligning with the current standards and practices within the industry.

In the search for the ideal data connector, several key factors were considered, including interoperability, security, ease of integration, and support for our specific use cases. Among the various options presented in the report, connectors such as the Dataspace Connector by sovity, the Eclipse Dataspace Components, or the EGI DataHub connector were evaluated. Each of these connectors offered distinct advantages and features, such as modularity, support for various protocols, and robust security mechanisms.

After a comprehensive analysis, the Dataspace Connector, originally created by Fraunhofer and maintained by sovity, was selected as the one to be used for the project. This decision was based on several compelling reasons such as:

- The Dataspace Connector supports the IDS Information Model and IDS Messaging Services, ensuring seamless integration with other IDS-compliant components.
- Its open-source nature and modular architecture allowed us to customize and extend its functionalities to meet our specific project requirements.
- Being part of the IDSA Reference Testbed and maintained by an organization like sovity, the connector benefits from a strong community and continuous updates.

By selecting the Dataspace Connector, the project would be aligned with industry standards, ensuring the solution is both future-proof and compatible with a wide range of data ecosystems. This choice has enabled to build a robust and scalable data infrastructure, facilitating secure and efficient data exchange across various platforms and stakeholders.

Future developments of the selected connector could be focused to increase the interoperability of it to allow other solutions to work on it. This is not a minor change as every solution could handle the different tasks in different ways and is presented as a challenge to be checked.

3.4. Graphical User Interface (GUI)

To facilitate access to the infrastructure and streamline data sharing among all stakeholders, a graphical user interface (GUI) was deployed. The interface developed to this project was modelled after the one provided by the International Data Spaces Association (IDSA), originally developed by Fraunhofer and currently maintained by Sovity which allow to create a more user-friendly dashboard to facilitate the use to the different stakeholders (see Figure 3).

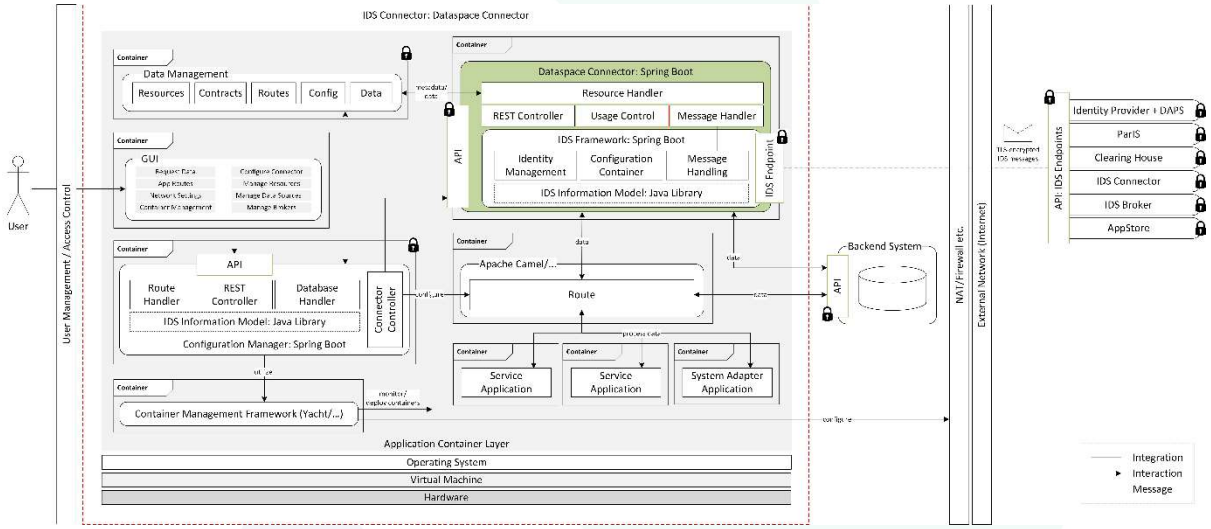

Figure 3 - DSC architecture used in UNCHAIN

Figure 3 provides a view of how the architecture is defined.

The following descriptions describe the different parts that define the DataSpace Connector

- **Data Management**: This container includes modules for managing resources, contracts, routes, configuration, and data. It ensures that data is properly handled and complies with predefined policies.

- **User Interface (GUI)**: The GUI provides a user-friendly interface for managing the various components of the IDS Connector. It includes features for configuration, monitoring, and interaction with other IDS components.
- **API Layer**: The API layer comprises the Route Handler, REST Controller, and Database Handler. These components handle incoming requests, manage routes, and interact with the database to ensure efficient data processing and retrieval.
- **Configuration Manager**: Implemented using Spring Boot, this component manages the configuration of the IDS Connector. It ensures that all components are correctly configured and operate harmoniously.

In the case of the selected implementation, there's some other parts external to the DataSpace Connector that also provide functionality and interactivity to it.

- **Identity Provider / DAPS (Dynamic Attribute Provisioning Service)**: Manages the identities of the participants and ensures secure authentication and authorization.
- **IDS Broker**: Acts as a directory service, enabling the discovery of data sources and services within the IDS.

The GUI is designed to integrate seamlessly with the IDS Information Model and employs the IDS Messaging Services to ensure robust IDS functionalities and efficient message handling. This integration enables users to manage all data space-related information with ease, regardless of their technical expertise, thereby promoting broader participation and collaboration within the data ecosystem.

Incorporating the IDS Information Model ensures that the GUI adheres to standardized data descriptions and structures, facilitating interoperability between different systems and stakeholders. The use of IDS Messaging Services allows for secure and reliable communication within the data space, ensuring that messages are correctly formatted, transmitted, and received in accordance with IDS standards.

The interface provides a user-friendly experience, allowing participants to easily navigate through various functionalities such as data space management, access control, and data sharing policies. Its intuitive design reduces the complexity typically associated with data space interactions, thus lowering the barrier to entry for new users.

By offering a comprehensive and accessible interface, the deployment of this GUI significantly enhances the usability and effectiveness of the data space infrastructure. It ensures that all stakeholders, from data providers to consumers, can engage with the data space seamlessly, thereby fostering a more collaborative and efficient data ecosystem.

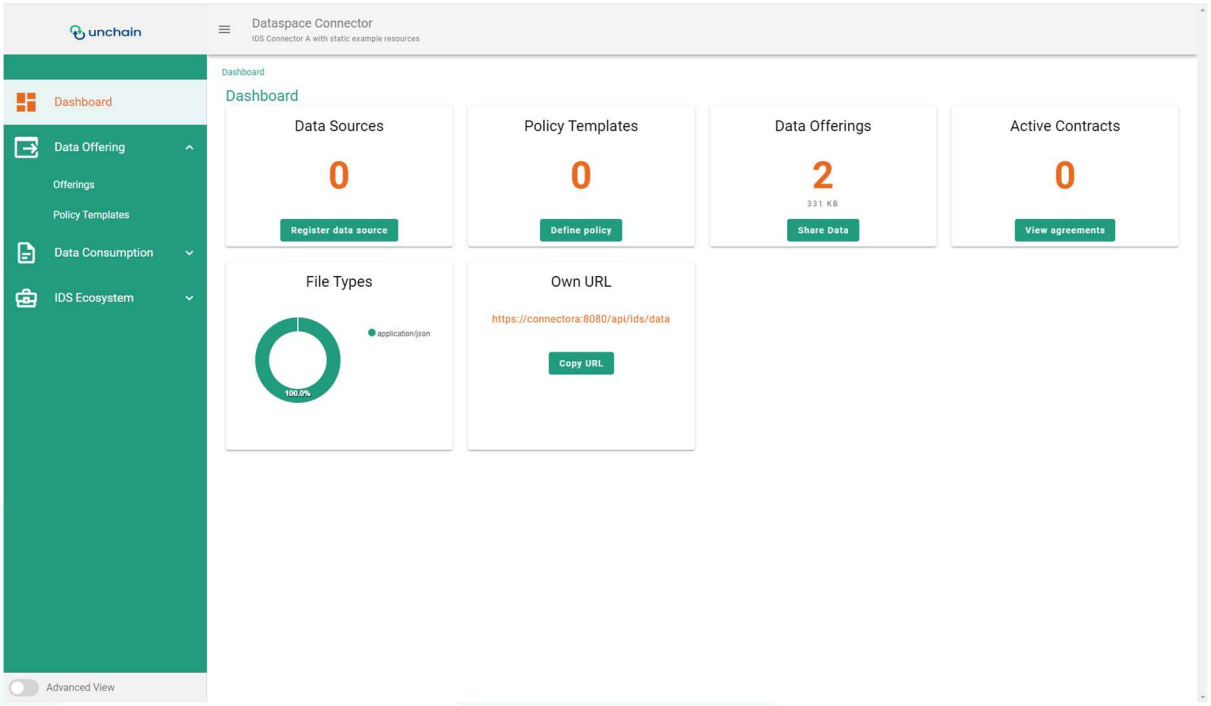

Figure 4 - Main dashboard

The user interface is meticulously structured into several sections to enhance user interaction and data management. The primary section, which serves as the initial landing page, is the main dashboard. This dashboard offers a comprehensive overview of crucial information such as active contracts, the number of data offerings, policy templates, and data sources managed by the Connector.

The main dashboard, see Figure 4, displays the following elements:

- Data Sources: Indicates the total number of registered data sources available for sharing within the data space.
- Policy Templates: Shows the number of defined policy templates that govern data sharing and access.
- Data Offerings: Lists the current data offerings available through the Connector, including details such as the quantity and size of the data shared.
- Active Contracts: Displays the number of active data sharing agreements and contracts.
- File Types: Provides a graphical representation of the types of files being managed and shared.
- Own URL: Displays the URL of the Connector's API, facilitating easy access and integration.

This dynamic dashboard leverages data provided by the Connector API, ensuring that all displayed information is current and accurately reflects the state of the data space.

The detailed API functionalities and integration aspects will be thoroughly discussed in the Section 3.5 of this document.

By offering a visually intuitive and informative dashboard, the user interface significantly enhances the user experience, enabling efficient management and oversight of data space

activities. This facilitates better decision-making and streamlined operations for all participants within the ecosystem.

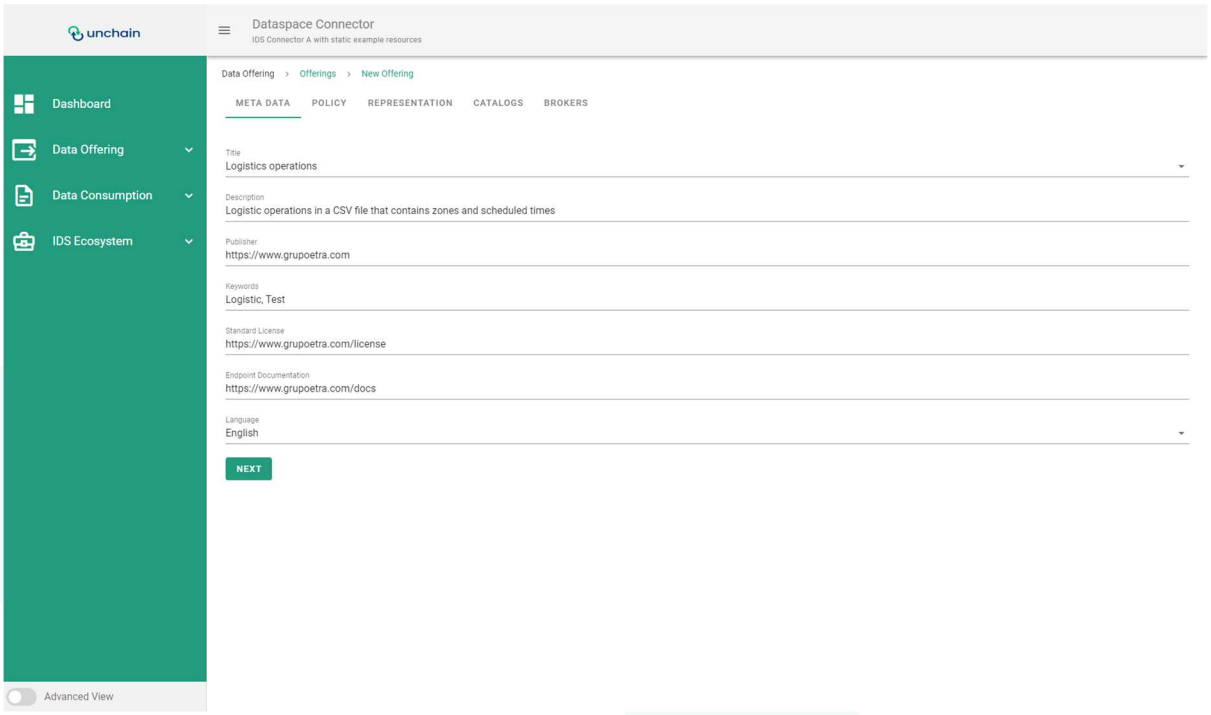

Figure 5 - Add data offering form

One crucial component of the user interface is the form that allows users to add data offerings, making them available for request by any other member within the Data Space. This form simplifies the process of submitting new data offerings, ensuring that even users with limited technical expertise can contribute effectively.

The form is designed to align with the requirements of the Unchain project, incorporating specific adaptations to streamline the data submission process. For instance, the data title field is restricted to options identified during the T3.1 and D3.1 development phases, ensuring consistency and adherence to predefined data categorization.

As shown in Figure 5, the primary elements of the data offering form include:

- Title: Users select a predefined title from a dropdown menu, ensuring that all data offerings are categorized correctly.
- Description: A detailed description field allows users to provide comprehensive information about the data offering, including its scope and relevance.
- Publisher: This field captures the URL of the entity providing the data, ensuring proper attribution and traceability.
- Keywords: Users can add relevant keywords to facilitate easy searching and indexing of data offerings.

- Standard License: The form includes a field for specifying the standard license URL, ensuring that data usage rights are clearly defined and accessible.
- Endpoint Documentation: This field captures the URL to the endpoint documentation, providing essential details for data consumers on how to access and utilize the data.
- Language: Users can specify the language of the data offering, enhancing accessibility for a diverse user base.

By using these fields, the form ensures that all necessary metadata is captured, promoting interoperability and ease of use within the Data Space. The intuitive layout and user-friendly design of the form reduce the complexity typically associated with data submission, thereby encouraging broader participation from various stakeholders.

The policy configuration form (Figure 6) allows users to define and manage data usage policies for their data offerings. This feature is essential for maintaining control over how data is accessed and used within the Data Space, ensuring compliance with organizational and regulatory requirements.

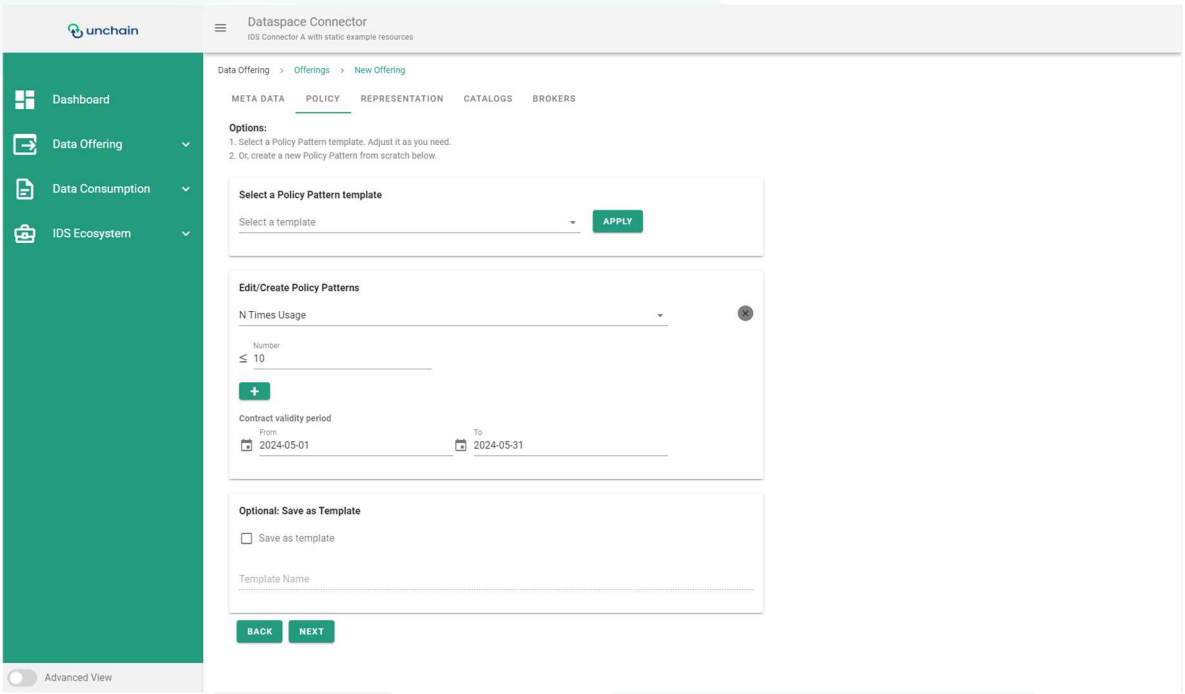

Figure 6 - Data policy form

The form is designed to enable users to either select an existing policy pattern template or create a new one from a list of different restrictions. These restrictions can include the number of times the data can be used or connector-based restrictions, which allow only specified connectors to access the data.

By providing a clear and structured approach to policy management, the form reduces the complexity typically associated with data governance, making it accessible to users with varying levels of expertise.

Another crucial component of the user interface is the "Add Data Source" form (Figure 7), which allows users to integrate external data sources into the data space. This form ensures that data from various origins can be seamlessly added and managed within the platform.

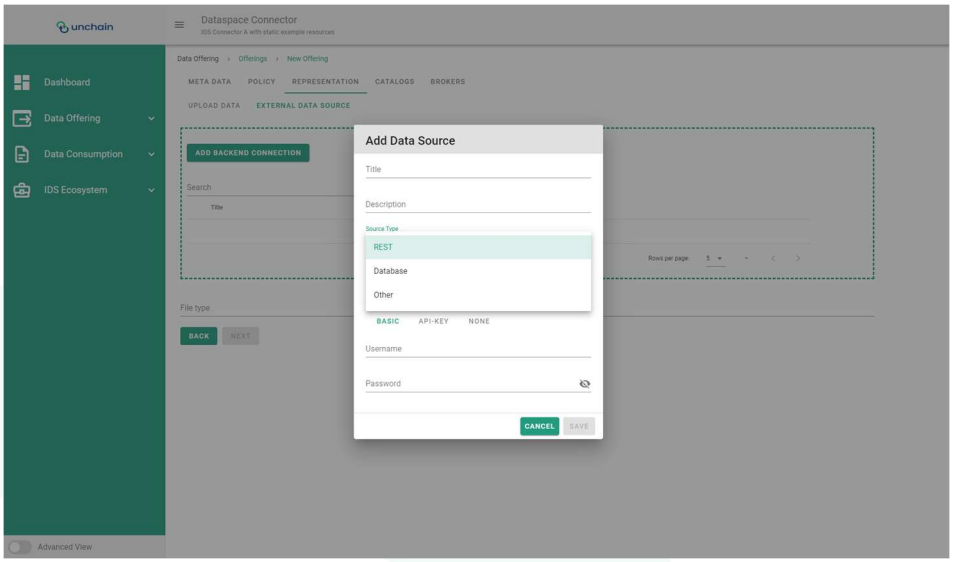

Figure 7 - Add a data source

The form includes the following primary elements:

- Title: Users provide a title for the data source to identify it within the data space.
- Description: A detailed description field allows users to specify the nature and scope of the data source.
- Source Type: Users can select the type of data source from options such as REST, Database, or Other, ensuring flexibility in data integration.
- Authentication: The form provides fields for entering authentication details, including Username and Password, to securely connect to the data source.

By incorporating these elements, the form facilitates the addition of diverse data sources, ensuring comprehensive data availability within the Data Space. The user-friendly design and clear instructions enable users of all technical levels to effectively contribute to the data ecosystem.

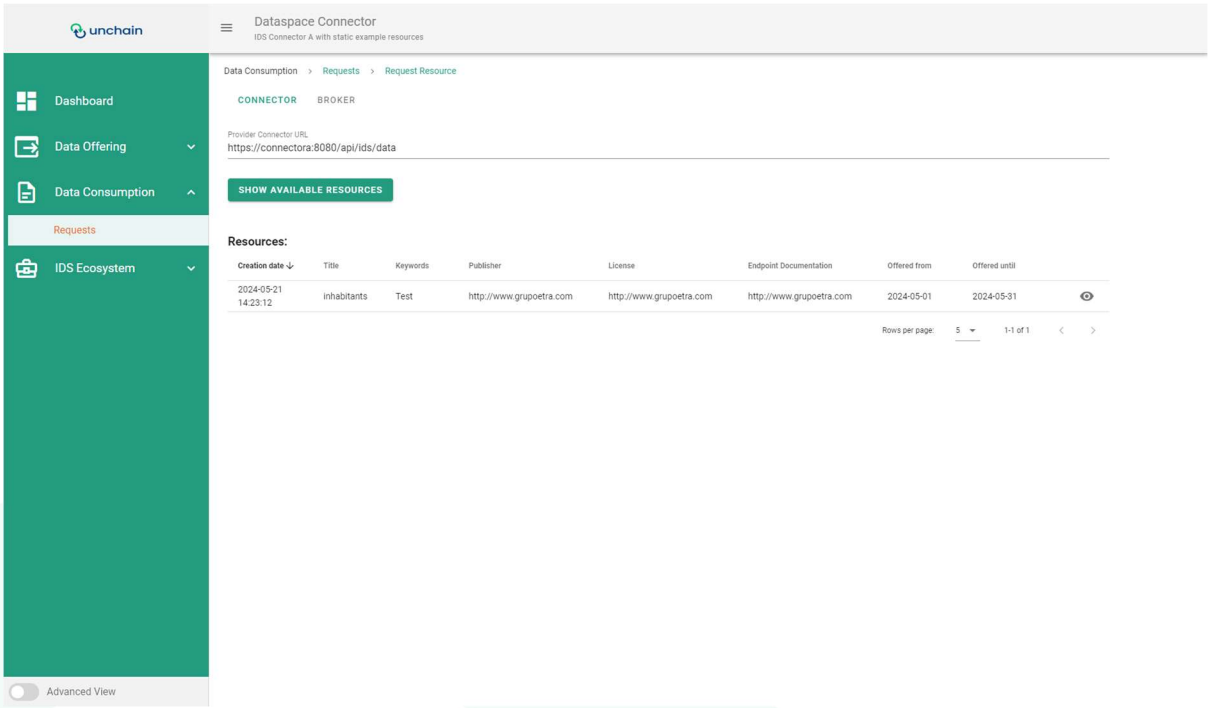

Figure 8 - Data request view

By providing a user-friendly and efficient data request process (Figure 8), the interface significantly enhances the usability and effectiveness of the data space infrastructure. This functionality ensures that all stakeholders, from data providers to consumers, can engage with the data space seamlessly, fostering a more collaborative and efficient data ecosystem.

As part of the Task T6.4 of the Unchain project, a user satisfaction survey will be created and share within the consortium partners, to evaluate the impact of the KER1- Data standardisation connectors for ICT city & transportation platforms, based on the usability and friendliness DataSpace Graphical User Interface.

Deliverable D3.3 will provide a more detailed overview of the data request process and its integration within the Data Space, in there, all aspects of the process will be thoroughly discussed.

3.5. Application Programming Interface (API)

In addition to the components and functionalities discussed so far, the project also explores the possibility of integrating APIs that have their documentation available on Swagger (see Figure 9).

Swagger is a widely-adopted toolset for documenting APIs, providing a comprehensive and user-friendly interface that enhances the understanding and utilization of API endpoints.

Integrating an API documented on Swagger offers several advantages.

Firstly, it ensures that the API's capabilities and usage instructions are clearly defined, enabling developers to quickly grasp the necessary information for implementation. Swagger's interactive interface allows users to test API endpoints directly within the documentation, facilitating seamless integration and debugging processes.

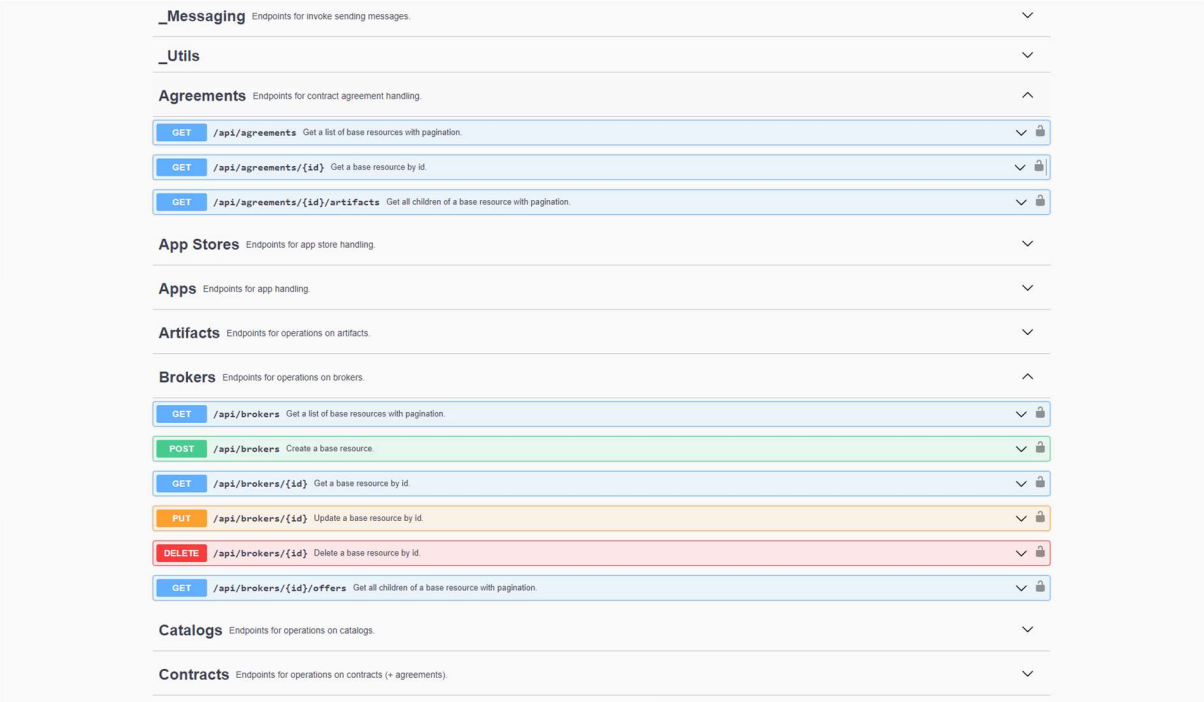

Figure 9 - Swagger UI

By incorporating Swagger-documented APIs into our data space framework, we can achieve several key benefits:

- **Enhanced Clarity and Usability:** Swagger's intuitive layout and interactive elements make it easier for developers to understand the API structure, parameters, and expected responses. This clarity reduces the learning curve and accelerates the integration process.
- **Efficient Testing and Debugging:** The ability to test API endpoints directly within the Swagger documentation allows developers to verify functionality and troubleshoot issues in real-time, ensuring a smoother development experience.
- **Comprehensive Documentation:** Swagger provides detailed information about each API endpoint, including descriptions, request/response formats, and available operations. This comprehensive documentation supports effective and efficient API utilization.

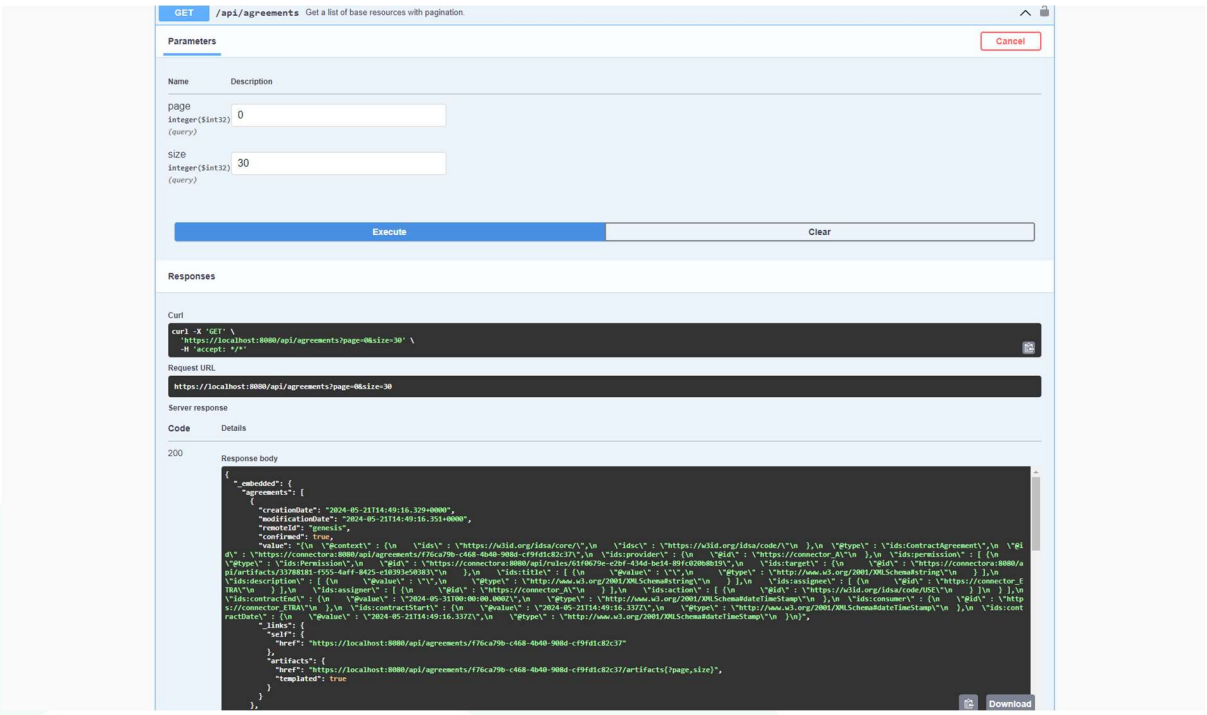

Figure 10 - Request sample in Swagger

The swagger interface allows to make request to test the API and check the result the

services will respond (see an example in Figure 10). This information is crucial for the technological partners in charge of developing the tools that will be tested during the lab testing in Task 3.4.

4. Conclusions

The development and implementation of the standardised data exchange ecosystem and the smart services marketplace architecture within the UNCHAIN project represent significant strides towards enhancing urban logistics and fostering sustainable urban mobility. The user interface and API integrations ensure broad accessibility and usability, promoting wider adoption among diverse stakeholders.

The IDSA architecture and the connectors used in this project are based on the Fraunhofer approach in which the data shared by the partners are publicly shared into the data space with all the consortium partners.

By standardising data exchange protocols and connectors, the project has laid a strong foundation for breaking down data silos, facilitating better coordination, and optimizing logistics operations across various urban environments. The interoperability achieved ensures that different systems and stakeholders can communicate effectively, leading to more efficient and coordinated urban logistics activities.

The user interface developed for UNCHAIN, is meticulously structured into several sections to enhance user interaction and data management and shows a simple interface to facilitate the use by all the partners to contribute setting the collaborative framework.

A crucial aspect of ensuring the system's operational success is the commitment and fulfillment of conditions by data owners. It is essential that all stakeholders adhere to agreed-upon data sharing protocols and maintain the quality and integrity of their contributions. Ensuring data owners are committed to these conditions not only enhances the reliability of the shared data but also builds trust within the ecosystem. Mechanisms for monitoring and verifying compliance, as well as clear guidelines and incentives for participation, are vital for maintaining an efficient and collaborative data exchange environment.

Continued collaboration and standardisation efforts are crucial to maintaining and expanding the data exchange ecosystem and smart services marketplace. Future work should focus on refining the developed solutions based on real-world testing and feedback, ensuring robustness and reliability for wide-scale adoption. Stakeholders should be encouraged to actively participate in the ecosystem, contributing data and utilizing the available services to maximize the benefits of digital transformation in urban logistics.

5. References

Giussani, G., & Steinbuss, S. (2023). *Data conector report.* Internation Data Spaces Association. doi:https://zenodo.org/records/7825732

Steinbuss, S. (2022). *The IDS reference testbed. Key in development and certification.* International Data Spaces Association. doi:https://doi.org/10.5281/zenodo.7376315

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