An Efficient Delivery Mechanism of Goods using Continental Groupage Enabled by Smart Data Sharing

Charumathi Palanikumar
s2545160
University of Twente
c.palanikumar@student.utwente.nl

Marzieh Adineh
s2548690
University of Twente
m.adineh@student.utwente.nl

Sneha Ramesh
s2471469
University of Twente
s.ramesh-1@student.utwente.nl

Vibha Ravindra
s2585847
University of Twente
v.ravindra@student.utwente.nl

Zahra van Egdom
s1185578
University of Twente
z.vanegdom@student.utwente.nl

***Abstract*— The logistics and transport industry is a highly complex and diverse network, owing to the fact there are multiple stakeholders involved, many geographical locations and unfathomable amounts of data exchange taking place. The third feature, data exchange, is crucial to ensure timely and efficient deliveries. This raises the question of data interoperability among the stakeholders. This is especially true when each one of them maintains their data in different storage facilities (such as CRMs), thereby leading to different data formats. If data has to be exchanged between the participating stakeholders, a data transformation process is necessary for every exchange activity between each stakeholder, resulting in a messy network. Given the number of participants in the logistics industry, this complex network leads to process-heavy and time-consuming data processing activities. The process of data sharing can be eased by a centralised and standard data repository. This would also address the issues of semantic interoperability and seamless data sharing. These desired features can be realised by the International Data Space (IDS), which is an open-source and centralised data-hub that can be accessed by all the stakeholders using IDS components such as connectors, data apps and clearing house. This paper proposes a target architecture, which showcases the advantages of using an architecture with the IDS components over using a traditional multi-system, decentralised data architecture.**

KEYWORDS- : *Transport and Logistics, Data Sharing, Semantic Interoperability, International Data Space*

1. Introduction

The transport and logistics industry connects multiple end-points throughout the globe. This is a multidimensional network involving a multitude of stakeholders such as transport mechanisms (waterways, airways, roadways), logistic providers (such as trucks), distribution centers (hubs), collection centers (spokes), suppliers/ senders/ shippers (individuals, organisations), end users/ buyers (individuals, organisations), governments etc.

All the stakeholders have started using the data generated during the various transport activities to stay informed about the consignment and to ensure efficient delivery and transport services. A term that requires introduction here is ”Continental Groupage”. It improves transport efficiency by the aggregation of smaller shipments for the same region or corridor. This is referred to as Less-than-Truckload (LTL) shipments. For combining cargo from more than one shipper and/or to more than one consignee for shipment together, usually in a single truck, LTL carriers use “hub and spoke” operations: small local terminals are the spokes (‘end of line’), and larger more central terminals are the hubs (also called Distribution Centers or DC’s). Spoke terminals collect local freight from various shippers and consolidate that freight onto enclosed trailers for transporting to the delivering hub terminal, where the freight will be further sorted and consolidated for additional transport (also known as linehauling). Combinations of LTL-shipments are being made to optimize linehaul transport.

It is therefore safe to say that data is one of the most important assets of every participating organisation. To achieve a system that functions holistically, the companies involved seek to exchange the data that they have among the different parties of the supply chain to improve the efficiency of the process. The many benefits of data are accompanied by a set of issues that have to be circumvented in order to capitalise on the benefits of data. Some of the complexities that come along with the idea of data sharing are described as followed. Data transfers are governed by multiple factors such as national laws, cross-border data transfer policies, regulations, contracts etc. Additionally, there is the added complexity of data transformation processes for data exchange between each stakeholder. Having a transformation process for data exchange between each stakeholder is going to be very time-consuming and process-heavy. Lack of data standards can also cause problems with semantic interoperability [38] and data security. Without a proper strategy for optimised data transfer, data becomes more of a liability than a utility. This conundrum demands a novel way to simplify the messy and intertwined networks.

Logically speaking, what we need is a simple and standard way of sharing data. If all the stakeholders followed a standard and were able to access data from one single place, that would answer the aforementioned problems. Here is where we need to revamp in the current system. For an efficient system to be designed, we need the following:

- Data from multiple users/owners is shared with an entity that allows the easy access of data, while providing the necessary security standards.
- Data from the different sources is semantically verified with the help of data dictionaries or vocabularies.
- Confidentiality of the shared data has to be maintained.

From the above points, we can say that the main problem we aim to address in this paper is: **How do we enable the efficient sharing of data between stakeholders in the logistics industry to facilitate Continental Groupage?**

As per our research, goods are currently not being transported in the most optimal way possible. We wish to propose an optimisation solution, using a centralised data service such as IDS. Such a service will ensure that the data is FAIR (Findable, Accessible, Interoperable and Reusable) [50] [47] [21]. By using centralised data smartly, we will be able to save many important resources such as fuel, inventory space, transport time, personnel etc.

To ensure the possibility of FAIR data concepts implemented in the stakeholders' systems, the use of common ontologies or data dictionaries are required. This would ultimately resolve the issue of semantic interoperability between the different shippers, central hubs and spokes and transport logistics systems. With this high-quality data, analysis can be performed to forecast the resources that will be required in specific geographical region and personnel or assets can be managed efficiently.

With the use of the right data resources, improvement can be seen in terms of service quality, reliability, sustainability and flexibility of non-road transport solutions. This would also lead to the flexible allocation of multi-modal capacities and resources. All of this can be achieved by the use of a centralised data service, such as International Data Space (IDS), which helps in combining data sources from various stakeholders.

In summary, data can be made FAIR using a centralised data space. This is provided to us by IDS. We envision using the IDS components to propose a model for seamless and standardised data sharing, thereby benefiting all stakeholders in the transport and logistics domain. The following sections describe in detail our proposed model for the usecase and its different. The main goal and contribution of this paper is to produce a target architecture (with a business model and multiple viewpoints) for ensuring efficient continental groupage with the help of a centralised data space.

The remainder of this paper is organized as follows. Section 2 presents the research methodology used for this project. We then move on to explain the theoretical background in Section 3. Section 4 describes the present scenario of data exchange among stakeholders in the logistics industry. Section 5 explains the motivation behind the need for a new architecture. The proposed architecture is described in 7. Finally, we proceed to perform a gap analysis in Section 8 , followed by a discussion and conclusion in Section 9 and Section 10, respectively.

2. Research Methodology

In this section, we discuss the research methodology that was used during the development of this project. In order to guide our project on efficient data transfer to improve transport efficiency for continental groupage logistics operations, we used the Design Science Research Methodology (DSRM). The DSRM aims to provide a sequential process for the accomplishment of a high-quality research and design project. Peffers et al. [37] lists the steps for the DSRM as follows:

1) Problem identification and motivation
2) Define objectives and solutions
3) Design and development
4) Demonstration
5) Evaluation
6) Communication

As per [37], the entry point of the researchers (us) can be in any one of these six steps. As part of this research project, we were provided with the task of developing a model for efficient Continental Groupage. We then proceeded to identify and analyse the problem by using a set of tried-and-tested methods such as SWOT Analysis, Business Model Canvas (BMC) and Gap Analysis. Based on our research and review of existing literature of IDS and transport logistics, we propose a solution with the aid of ArchiMate 3.1 [23], which is based on the TOGAF Architecture Development Methodology. The scope of our project is limited within the three steps of the DSRM proposed by effers et al. [37].

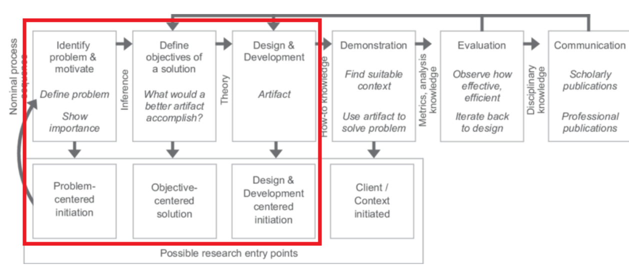

Figure 1. DSRM for our Case

3. Literature Review

With the boom of Industry 4.0, data exchange between different organisations is a prerequisite [19] for most modern business models. Smart devices are increasingly used to capture data by the second. This can be seen as having immense value in terms of information and data assets. However, several challenges have to be addressed while facilitating the transfer of such data. Some of them are discussed below.

One of the major issues of such data transfers from sensors in IoT devices is the lack of data security [13] and the lack of data FAIRness. This is highly prevalent in the logistics industry as smart devices are being used extensively to track shipments.

Secondly, the logistics domain comprises multiple stakeholders, where each of the stakeholder, in the multi-actor network from diverse domains, selects a technology or platform that satisfies both their business requirements and budget constraints [52]. These companies could have a data facility that is different from their respective counterpart's data facility, and the storage spaces could consist of data of varying importance and worth. These diverse resources need to be prioritised and used optimally, in order to derive the maximum benefit out of them.

Thirdly, high costs in the supply chain operations occur due to the lack of availability of timely information associated with the shipments. Improvements in digital solutions serve as a basis for data flow optimization in the supply chain process. A research study by Shamsuzzoha et al. [43] shows that a centralized data pipeline system has improved vehicle utilization from 60% to 92%. It also supported the overall improvement of performance. Environmental sustainability was accelerated by the reduction in travel distance with the help centralized hubs, thereby contributing towards lower CO_2 emission. This shows that it is pivotal to provide digital services with a transparent flow of data across the supply chain and create business models to reduce the process costs for the effective functioning of the logistics elements.

Inter-organisational data exchange scenarios are constantly evolving with the technological landscape. The solution to such data-related challenges is provided by centralised data spaces, where every participant has sovereignty over the use of the data. IDS is an excellent example of such a data space. It is a functional framework allowing the participation of organisations to tailor their data-sharing mechanisms conforming to company-specific needs. There are technical standards, governance models and specifications provided by IDS for enabling seamless and interoperable data exchange between trusted inter-domain and cross-domain ecosystems [5]. Not only does IDS promote interoperability among participants in the technical layer but also does so in the business, legal and ethical aspects [30]. By this, every participant benefits from the use of shared data [1]. IDS [29] [27] [45] provides solutions to realise secure and trustworthy data exchanges, while ensuring data sovereignty.

Lastly, data sovereignty is a key success factor for data-driven business models [2]. It encompasses an idea that data is subject to multiple laws and governance structures within the nation it is collected from and at the nation it is received in. The concept of data sovereignty is closely linked with cloud computing, data security and data privacy, which are all key concepts in Industry 4.0.

In order to address these challenges and address our research question, we follow an enterprise architecture approach in order to translate these high-level concepts to formal constraints. This enables the connection of the proposed strategy with the actual business operations. Enterprise architecture helps us understand the business processes associated with data sharing mechanisms. For this paper, we make use of the enterprise modelling language *ArchiMate 3.1* for the development of a digitised data flow disruption handling ecosystem enabled by IDS [23].

4. Current Scenario

As mentioned in Section 1, the logistics industry is a huge network and therefore there has been a large amounts of data being generated and shared every split second. An efficient delivery mechanism calls for data sharing between the stakeholders. This raises the next cascade of questions - What data? Who sends this data? How will this be exchanged? What if the formats do not match? Is the shared data secure? Does it comply to legal regulations? The list definitely does not end here.

In reality data *is* being exchanged, but not entirely in the most efficient way possible. Most of the stakeholders maintain their own CRM system and data is stored in one specific format in each of these systems. If these stakeholders had to exchange the information with each other, a data processing activity would be necessary between each of the stakeholders to ensure interoperability.

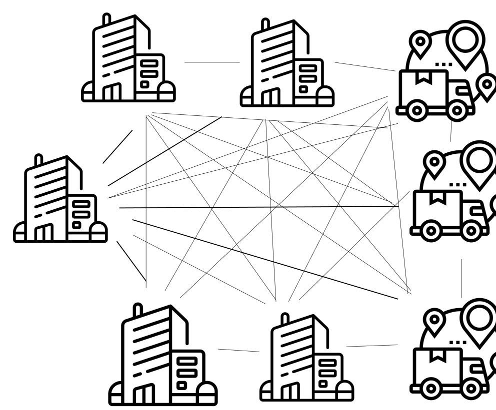

Figure 2. A Complex Data Exchange Scenario

To exemplify this simplistically, consider three stakeholders A, B and C (where we assume A to be a distribution center, B to be a land-based freight shipper and C to be a container ship). If data is to be exchanged between any two of the stakeholders with different data formats, we need a data processing service between A to B (and vice versa), B to C (and vice versa) and C to A (and vice versa). Extrapolating this further, if we had n different stakeholders, the number of processing activities would be $n * (n - 1)$, which is of the order n^2 as shown in 2. This number would be unimaginably complex when there are multiple stakeholders involved. This has been depicted in figure 3.

An additional complexity arises when the data stored in the different systems have different meanings in the two different

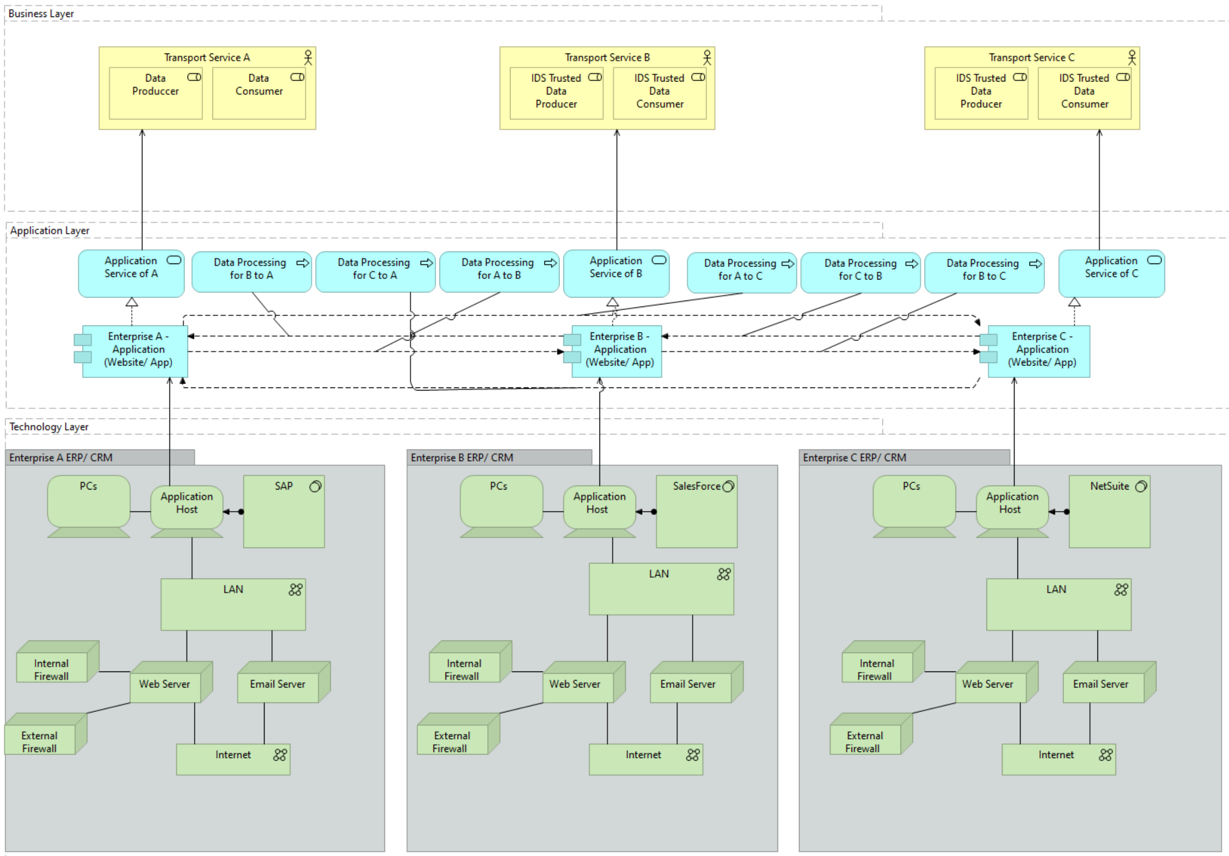

Figure 3. Current Scenario (Baseline Architecture) for Data Exchange among the Stakeholders of Transport Logistics

cases. For instance, in stakeholder A's system *Order Date* may mean the date that the customer orders from the retailer, whereas in stakeholder B's system *Order Date* may mean the day the retailer orders it from the wholesaler. Similarly, the ID fields may have different terminology in the different systems. The problem would blow up even more if even one of the participating companies decided to migrate to another CRM platform or data management system. This would mean that the all the data processing activities tied back to the specified company would have to undergo a revamp in order for data transfers to happen. Naturally, this can be extrapolated to all the participating stakeholders and the problem would cascade with many repercussions.

Such semantic disparities can also greatly affect the data sharing and thereby hinder the efficiency of continental groupage and delivery [36]. To sum up, what is observed of the current scenario is that there is a definite lack of semantic interoperability and standardised data exchange procedures between stakeholders in the transport and logistics domain, leading to the shortcomings in data transfer efficiency for continental groupage. The differences in technology or architecture between the participating companies add to the data processing complexity, for which we would like to propose a solution. The following section describes the motivation for our target architecture, a SWOT Analysis, a business model and the overall architecture for the system that we envision.

4.1. Evaluation of the Current Scenario

As described in Section 4, the current scenario certainly has scope for improvement. If a successful improvement has to be carried out, we need a solid strategy in place [6]. And a solid base for the strategy formulation is obtained by using techniques that allow a systematic analysis of the current scenario. There are many tools that facilitate this process. Among them, we have chosen the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis method to analyse the current situation.

4.2. SWOT Analysis of the Current Scenario

Performing a SWOT Analysis on our project helped us identify four very crucial areas for our strategy (target architecture) formulation. This is a popular analysis method used to evaluate the 'strengths', 'weaknesses', 'opportunities' and 'threats' of the desired state an organisation, a plan, a project, a person or a business activity [25].

- Strengths and Weaknesses are a result of the internal characteristics of the current process.
- Opportunities and Threats denote the external characteristics that influence the process.

After careful consideration, we have listed the following points under each of the four categories.

4.2.1. Strengths.

The main strength of the current system is that it opens avenues for the collaboration between different stakeholders by means of data exchange and communication. It has certainly improved the efficiency of package transport and tracking. Additionally, it helps connect the different locations and smart devices present in these different locations.

4.2.2. Weaknesses.

Although the idea of sharing data for improving delivery accuracy and efficiency is novel, the fact that are multiple stakeholders is not particularly considered. Hence, one of our primary weaknesses is inefficient data sharing. Data preprocessing and standardisation is a long-drawn and complex process. This is majorly aggravated by the fact that data standards and vocabularies are not being used effectively used, while sharing data among the participating stakeholders.

4.2.3. Opportunities.

The availability of open source data through IDS provides a massive opportunity for all stakeholders to centrally dump and access the desired data. IDS components such as connectors facilitate this process. This is discussed in detail in Section 6. Also, [44] standards such as OTM5 [38], provided by the Open Trip Model serve as a uniform language for the electronic exchange of logistical data. By using such standards, logistical IT systems can communicate with each other since they can accurately interpret messages from variety of systems having different formats. These opportunities address the weaknesses that we have identified.

4.2.4. Threats.

The main threats that we have identified are related to data security and legal issues. As the transport and logistics industry provides global channels for data exchange, we must be mindful of the national and cross-border data transfer regulations for each country (such as GDPR). Non-compliance to these regulations can lead to hefty fines on the participating organisations [15]. Another concern that stems from the sharing of data is the security and privacy aspect, that could lead to data breaches, having repercussions that could linger on for years. However, IDS components do have an inbuilt security module that addresses this threat.

Now that we have identified our strengths, weaknesses, opportunities and threats, we proceed to create a business model canvas for our target architecture to clarify the customer segments, value proposition, relationships etc.

4.3. Goals

Along with the SWOT analysis, we need to define a list of goals that will help us steer our project to reality. The main goals that we have identified for achieving a state of seamless data transfer for transport logistics has been listed below:

- Make data from different sources comply to FAIR principles.

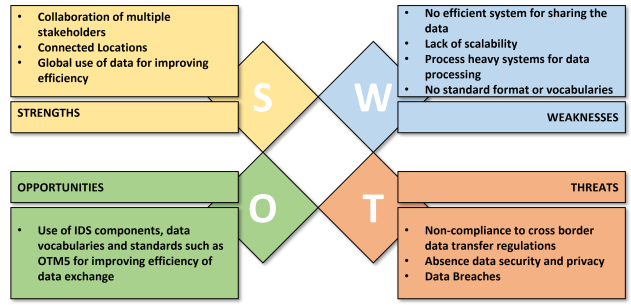

Figure 4. SWOT Analysis for the Current Scenario

- Improve the information accuracy by understanding current position and future trends.
- Optimization of resources (fuel, inventory, personnel, time etc.) by managing the shipments geographically.
- Compliance to global data transfer regulations
- Improve logistics and transport efficiency.

4.4. Requirements for Achieving the Envisioned Goals

A set of requirements have been identified in order to achieve the goals listed above.

- Develop a sound digitisation of logistics data services.
- Utilise the IDS components in order to access shared open data in a secured manner.
- Use data vocabularies and dictionaries of global standard to ensure semantic interoperability of (meta)data.
- Provide data analytics tools to provide insights
- Facilitate the effective data management of the various stakeholders and third-parties involved in the process.

5. Motivation

From our SWOT analysis in Section 4.2, the main thing that stands out is that the current system lacks an efficient data sharing mechanism. Based on the requirements for the improved model obtained by the gap analysis, we created an Motivation using Archimate 3.1.

The motivation model, shown in Figure 5, identifies and describes the requirements, and provides metrics for analysis and validation at a business level. It also gives us an idea of how the requirements are realized in subsequent enterprise architecture models. Coming up with a motivation model influenced the design phase of our target architecture, by serving as a guide and providing constraints to focus on the goals.

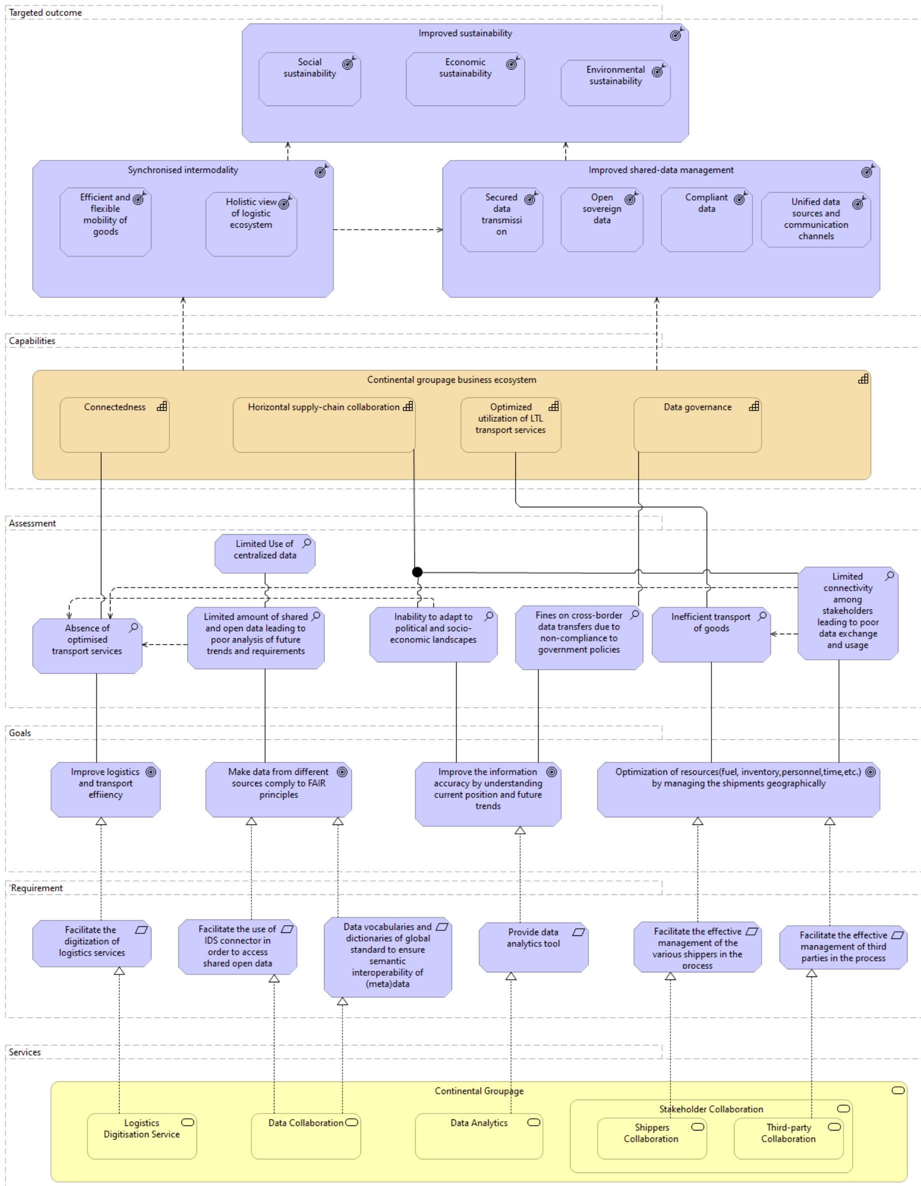

Figure 5. Motivation to Transition to an IDS Based Architecture for Data Sharing in Transport and Logistics - Motivation Viewpoint

5.1. The Osterwalder Business Model Canvas for our Target Architecture

One of the most popular tools for visualising a strategy or a business proposition is the Business Model Canvas (BMC). It helps in understanding the high-level structure of our proposal and aids in ensuring that we are progressing in the direction of our mission [6]. The BMC provides the base for identifying the motivation elements such as goals and drivers.

As shown in Figure 6, the following segments are identified and considered while modelling the target architecture.

- Key Partnerships
- Key Activities
- Key Resources
- Value Proposition
- Customer Relationships
- Customer Segments
- Cost Structure
- Revenue Structure

6. IDS as the Primary Support Component for the Proposed Solution

This section speaks in detail about IDS and its components, the very basis of our target architecture.

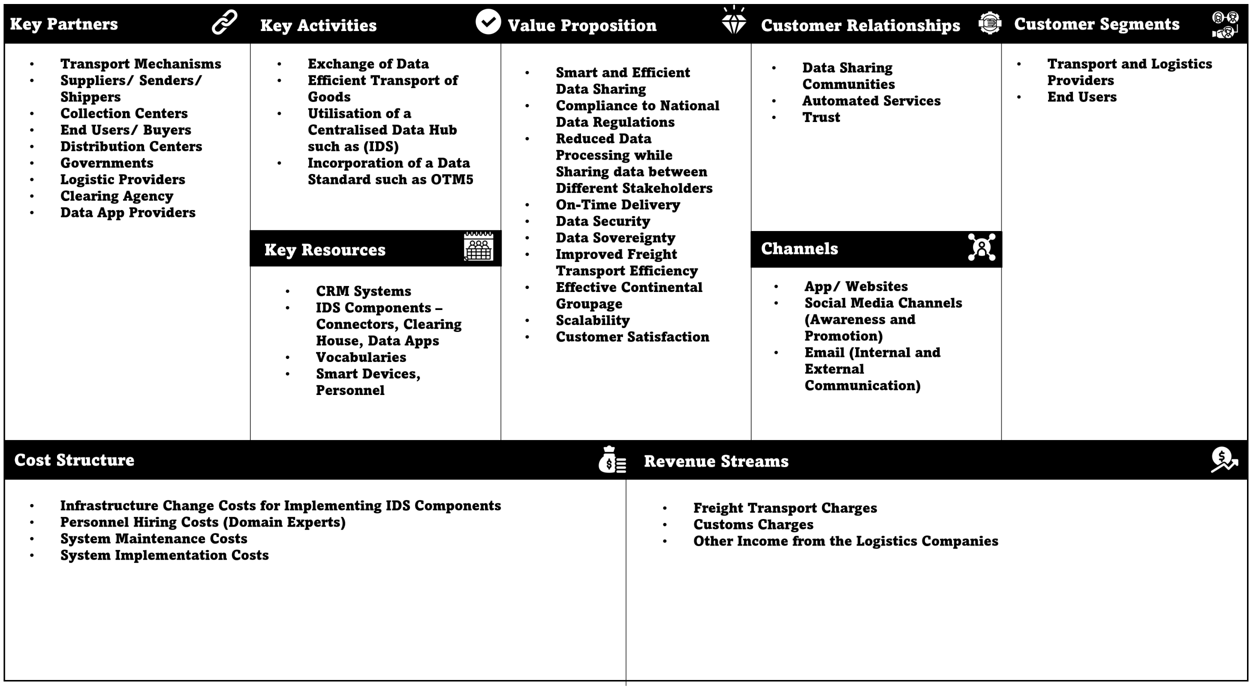

Figure 6. The Business Model Canvas for the Efficient Data Transfer for Continental Groupage

6.1. Improving the Efficiency of Data Exchange Using International Data Space (IDS)

The problem of complex processes for data exchange, explained in Section 4, motivates the need for a centralised data access point for stakeholders wanting to store and retrieve data. One solution for this is by using the components of the IDS.

IDS is a certified standard and it is used internationally for data exchange. IDS aims to create a secure data exchange platform for businesses to get the most out of their data and exchanges with partners, as well as creating a space to foster innovative businesses solutions.

Data exchanges take place in this centralised data space, while ensuring data security and sovereignty. To facilitate these environments, IDS provides the following components to facilitate the secure and seamless sharing of data.

Some of the main benefits from using a centralised and unified data source such as IDS are:

- Use of open data from associated organizations and levelled playing field for all enterprises involved (Open, sovereign data).
- Synchronized Intermodality - guaranteeing efficiency and flexibility in the mobility of goods. The mobility of goods needs digitization, information exchange and communication as enablers as well as a holistic view of logistics structures and processes.
- Horizontal supply chain collaboration solution contributes to ensure the transparent, reliable and secure transfer of data in collaboration between supply chain participants by means of the IDS trusted connector.
- Optimized Utilization of Less-Than-Truckload (LTL) Transport services using an effective application(Sound digitized transaction system of transport booking data and efficient optimization).

The use of IDS also provides some economic benefits, making it a very lucrative option for most companies to resort to. Major economic benefits can be realised with the efficient management of resources using data. Some of them are listed below:

- Reduced warehousing costs.
- Reduced fuel and transportation costs.
- Reduced server and hardware costs (investment and maintenance) due to centralized data servers maintained by IDS.
- Higher customer satisfaction (and lower attrition rates), thereby leading to higher income/ profits.
- Improved utilization of data assets.
- Horizontal supply chain collaboration.

In Section 6.2, we discuss some of the main components used in the target architecture. This is supported by an application viewpoint of the target architecture, comprising the enlisted target components.

6.2. IDS Components

The main facilitator of our target architecture is the IDS. IDS enables secure data exchange between companies where data

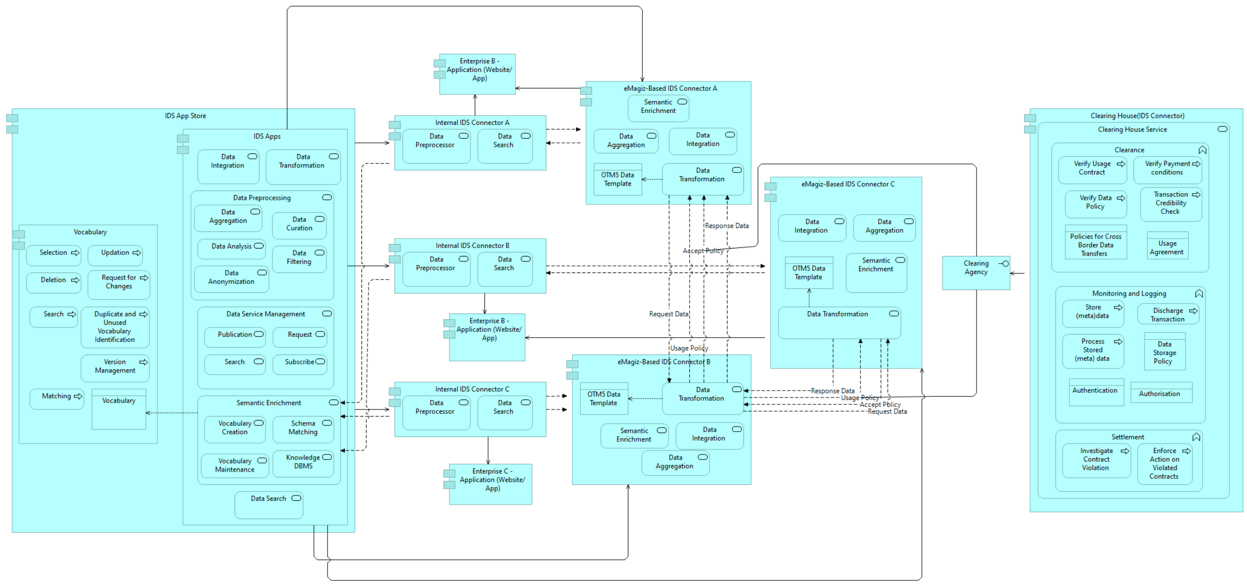

Figure 7. Application Viewpoint - IDS Components

sovereignty and FAIRness is maintained [42]. The core of IDS lies on the principle that digital transformation in industry is based on the methodical exchange of data and services between companies.

The main benefit that can be realised by enabling the networking between the companies is the value generation in the form of new products or services and cost savings. We use this value proposition of IDS to propose a solution to tighten the existing data exchange mechanism in the transport and logistics industry to facilitate continental groupage. An added benefit of using IDS is that it provides data security and trust, which were some of our main threats discussed in the SWOT analysis.

The main IDS components that manifest in our target architecture are discussed in brief in below and are represented as an application viewpoint using Archimate 3.1, as shown in Figure 7.

6.2.1. IDS Connector. IDS connectors are used, as the word implies, for creating connections. This is used to send the businesses data to where it needs to go. A company hosts the connector in its own data space and sets the conditions data sharing and access. The connector makes sure the data is used by the requirements that are set by the data owner. They essentially use a technlogy that puts the organisation's data in a virtual "container", which ensures that it is used only as per the regulations set by the parties involved.

Additionally, they allow flexibility and extendibility of the data space's functionality. Individual organizations can 'personalise' it to their specific needs. Hence, it can be thought of as a managed and secure 'data sharing operating system' [3]. The connector has two parts - the internal connector and the external connector. The stakeholder using the connector can decide what portion of data to make visible to the remaining stakeholders by publishing the data on the external connector. The portion of data that is present in the internal connector is only visible to the data producer (data owner) and this data can be used for organisational perspectives such as data analytics.

6.2.2. IDS Clearing House. The IDS clearing house, which is also a specific type of IDS connector, can be thought of as the validator in the IDS ecosystem. The functions (prior to data sharing) performed by the clearing house are listed below [27]:

- **Legal:** Verifying the usage contract and data usage policy between the stakeholders.
- **Financial**: Verifying payment conditions between the interacting parties.
- **Technical**: Enabling execution of transaction and binding transaction to an instance of a data-sharing agreement and usage contract.

The connector also facilitates monitoring and logging functions during the data-sharing process. These processes include:

- Discharging of data-sharing transaction.
- Logging of transaction's metadata.
- Tracing data provenance.
- Monitoring and reporting of data transaction.
- Auditing and tracking of data transactions for determining accountability and resolving possible conflict.
- Billing and invoicing of data transactions.

After the data has been exchanged, the administrative part of the transaction must be addressed, including aspects such as logging, billing, and invoicing. The Clearing House charges a fee for conducting these functions and for absorbing the risk of not fulfilling the contract between both parties.

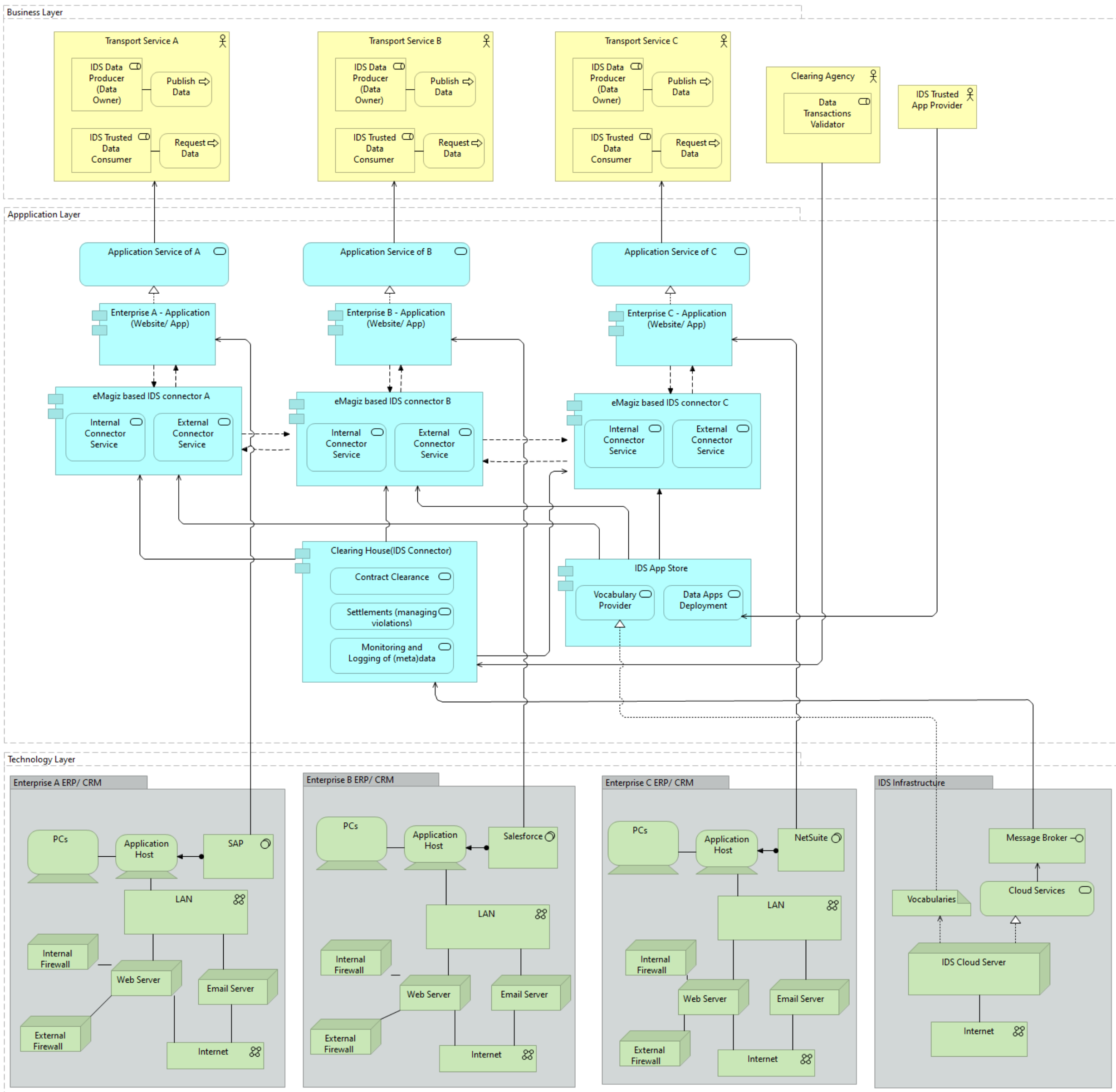

Figure 8. The Proposed Target Architecture

6.2.3. IDS App Store. IDS enables the deployment of apps to connectors which provides services added to the exchange of data. Services can be data processing, data analysis, data format alignment and protocols for exchange of data. Data apps are developed by trusted App providers, who should be compliant with the IDS system architecture so it can be deployed in an IDS environment [29].

7. The Target Architecture

Our target architecture makes use of the IDS components discussed in Section 6. The proposed architecture is represented using three layers: the business layer, the application layer and the technology layer. These layers have been explained in detail in the subsections below.

7.1. Business Layer

The business layer depicted in Figure 8 shows the main stakeholders and the roles associated with our proposed model. The stakeholders are modelled as ”actors” and each actor has an associated role. In this case, we have considered three participating enterprises (transport service companies) A, B and C for the purpose of simplicity. The role associated with the transport service company is that of an IDS certified data producer or consumer. This means that once they have undertaken the necessary certification, these stakeholders can use the connectors to send or receive data to and from other consumers or producers respectively. In this case the data producers are also considered as the data owners.

The next role in the business layer include the Clearing Agency, which provides the clearing House with services (explained in the IDS components) required for the data transactions.

Lastly, the Data Apps required by the connectors are provided by an IDS trusted App provider, which help in the data processing applications within the connectors.

7.2. Application Layer

The application layer lists the application components that are envisioned for our target architecture. This layer consists of most of the IDS components discussed in Section 6.

As mentioned in the business layer, we consider three enterprises A, B and C. All the three enterprises have their own application (which could be in the form of an app or a website) that they use for their business operations. Each of these enterprises exchange data for facilitating the efficient deliver of goods. For this purpose, each enterprise has a dedicated connector. As mentioned in Section 6 , the connector is divided into an internal and external connector, which allows the company to share only the data that they would like to share. We have used an eMagiz based connector [12], which would facilitate the system integration easily.

These connectors are served by an application called the IDS App Store, which provides the connector with the necessary data transformation apps. This is served by the IDS Trusted App provider in the business layer. The last application in this layer of the target architecture shown in Figure 8 is the Clearing House application, which serves as the validator for the data subscription and transactions.

7.3. Technology Layer

The technology layer shown in figure 8 represents the backend systems for all the applications described in the Application Layer. Each of the enterprises A, B and C has a CRM or ERP system in which all the data storage and management takes place. To show that companies with different CRMs or ERPs add to the data transfer complexity, we have assumed that A, B and C are using different CRMs or ERPs (SAP, SalesForce and NetSuite, respectively). These CRMs serve as the data seat (back-end) for the enterprise specific applications.

All these enterprises are assumed to have internal servers such as web and email servers, which are secured by means of internal and external firewalls to ensure system security.

The IDS technology components are also represented in brief. The IDS cloud server is the main data storage hub for all the data that flows through the virtual container space in the connectors. An important artifact of the IDS Cloud server is the Data Vocabulary that is used to provide semantic interoperability during the data transactions.

8. Gap Analysis

Now that we have modelled our target architecture (to-be scenario), we perform a gap analysis on between our as-is (baseline architecture) and to-be (target architecture).

A gap analysis is a process to identify where gaps are and what differences exist between an organisation's current situation and "what ought to be" in place [34].

By performing a strategic gap analysis, we can observe that the main differences from a strategy point of view are the IDS components and the associated roles and technology. The major value proposition of the target architecture model is due to the IDS connector, that enables the sharing of data; the IDS clearing house that acts as a validator for the data transactions; the OTM5 standard that provides a semantic standard for data exchange and the data apps, that facilitate the data processing. These are the main components that are missing from our current (decentralised) architecture.

If the to-be architecture/ model is successfully realised, this would mean that the participants are properly certified by IDS and imbibe the values proposed by IDS. This would result in optimised deliveries and effective continental groupage. Thus it could be a possibility to envision a secured ecosystem, where the enterprises set specific usage policies, yet realise the true value of data as an asset in trusted and levelled play field.

9. Discussion

This paper discussed the possible transition of a decentralised data exchange mechanism to a centralised data exchange system facilitated by IDS. This can be achieved by means of the different IDS components. The transition to such a centralised service will need considerable amount of decisions to be made at an organisational level. The decisions will involve budget estimations and modifications in the organisations existing workflows. Such a transition will require careful planning, transition and change management.

While our proposal might seem like a lucrative option for most the stakeholders of the supply chain, there might be reluctance to shift to an entirely new business model when the age-old organisations have their current fool-proof strategies in place. This might be one of the major road-blocks while trying to achieve our vision of an ecosystem which entirely relies on the centralised data space among equal enterprise partners.

Another potential speed-breaker that we see for this migration strategy is that the stakeholders involved might be of different economic sizes (in terms of revenue, employees, capacity etc.). The requirement for a certification by IDS to become an IDS certified data producer or consumer will require a certain amount of investment that might be out of the expected budget of a smaller logistics company as compared to a bigger one. It is important to note that this is not the only cost involved. Additional costs incurred may include the costs for modifying the existing architecture, hiring domain experts and technical experts. This might prevent smaller companies from deciding to adopt such a strategy.

However, it may be easier for smaller enterprises to transition from their legacy system to the proposed system and comparatively harder for larger enterprises to deploy. Additionally, there could be organisational challenges while trying to implement a solution where every participant is expected to have a levelled playing field.

A good way to ensure that companies get certified and actively take part in this initiative is by generating awareness on the positive impact that a shared space such as IDS can have on the business and supply chain operations in the long run. If this strategy is adopted by an organisation's competitor(s), they might be driven to also take up this initiative in order to stay in the ever-evolving market.

10. Conclusion

This paper presented a target architecture for the efficient transfer of data between different stakeholders in the logistics domain. The purpose of this study was to present an overview of the current scenario of data transfer in the logistics industry. For this, a SWOT analysis was conducted to identify the internally influencing factors (Strengths and Weaknesses) and the externally influencing factors (Opportunities and Threats). The outcome of the analysis served as the building blocks for our motivation model. The BMC was used to clarify the value proposition of the case further.

We followed a focused approach of analysing all the IDS components and then modelled our target architecture with the help of ArchiMate 3.1. The application and application usage view point helped us analyse the architecture in various perspectives.

Following the design of the target architecture, we performed a gap analysis to understand the differences between the baseline architecture and the target architecture. This analysis helped us understand that components that have been added to the target architecture.

Our analysis also helped us understand that while transitioning to the target architecture seems like a lucrative option theoretically, there might be resistance from the various stakeholders to migrate to the new system. This could be due to a variety of factors such as reluctance to shift from legacy systems, budget constraints and organisational concerns. However, with the boom of Industry 4.0 data-needs demand a strong and resilient architecture.

The future scope of this project would involve the demonstration and the implementation of this proposal. Considering the scale at which the project would manifest in real-life, a simulation would also help in the demonstration of our work. The outcome of this work can also spark new research interests. We can explore the possibility of introducing many Privacy Enhancing Technologies such as anonymisation, pseudonymisation, Principles of Least Privilege (PLoP), Data Loss Prevention (DLP) etc [14]. In addition, the proposed target architecture might also be useful in other use cases (apart from logistics) and industries.

11. Acknowledgements

The authors would like to thank Maria Iacob, Sebastian Piest, Danniar Firdausy and Iqbal Mukti for mentoring us and for providing timely and valuable inputs. We would also like to express our sincere gratitude to our peers for providing us with constructive feedback throughout the course of this project.

References

[1] Achatz, Reinhold E. *Success Story: Data Spaces Create a Level Playing Field for Sovereign Data Sharing*. Feb. 18, 2021. URL: https://internationaldataspaces.org/success-story-data-spaces-create-a-level-playing-field-for-sovereign-data-sharing/.

[2] al., Andreas Eitel et. "Usage Control in the International Data Spaces 3.0". In: (Mar. 2021).

[3] al., Bastiaansen et. "The logisticsdata sharing infrastructure". In: (2020).

[4] al., Bernhard Holtkamp et. "A Lightweight Industrial Data Space Sensor Connector. Concept,Implementation and First Experiences". In: *Fraunhofer* (Apr. 2018).

[5] al., Otto et. "Industrial data space: digital sovereignity over data". In: *Fraunhofel* (2016).

[6] Aldea, Adina, Iacob, Maria-Eugenia, and Quartel, Dick. "From Business Strategy to Enterprise Architecture and Back". In: IEEE, Oct. 2018. DOI: 10.1109/edocw.2018.00029.

[7] Aldea, Adina et al. "Strategy on a Page: An ArchiMate-based tool for visualizing and designing strategy". In: 25.2 (Apr. 2018), pp. 86–102. DOI: 10.1002/isaf.1423.

[8] Bemthuis, Rob, Iacob, Maria-Eugenia, and Havinga, Paul. "A Design of the Resilient Enterprise: A Reference Architecture for Emergent Behaviors Control". In: 20.22 (Nov. 2020), p. 6672. DOI: 10.3390/s20226672.

[9] Bergren, Martha Dewey and Johnson, Kathleen. "Data Sharing". In: 34.4 (July 2019), pp. 211–213. DOI: 10.1177/1942602x19852934.

[10] Boucharas, Vasilis et al. *Achievement of Organizational Goals: A Review of the Evidence*. Springer-Verlag GmbH, Nov. 1, 2010. 101 pp. ISBN: 9783642168192. URL: https://www.ebook.de/de/product/25412167/trends_in_enterprise_architecture_research.html.

[11] Boysen, Nils, Fedtke, Stefan, and Weidinger, Felix. "Truck Scheduling in the Postal Service Industry". In: *Transportation Science* 51.2 (May 2017), pp. 723–736. DOI: 10.1287/trsc.2016.0722.

[12] eMagiz. *Hybride Low-Code Enterprise Integration Platform as a Service*. URL: https://www.emagiz.com/enterprise-ipaas-hip-low-code-nl/.

[13] Eustis, Alexander G. *16th International Conference on Information Technology-New Generations (ITNG 2019)*. Springer-Verlag GmbH, May 22, 2019. 652 pp. ISBN: 9783030140700. URL: https://www.ebook.de/de/product/37055039/16th_international_conference_on_information_technology_new_generations_itng_2019.html.

[14] eXate. *Privacy Enhancing Techniques*. 2015. URL: https://www.exate.com/privacy-enhancing-techniques.

[15] eXate. *Global Data Diaries*. Sept. 3, 2021. URL: https://www.exate.com/post/global-data-diaries-september-3-2021.

[16] Fehér, Norbert. "Ipar 4.0 -¿ Logisztika 4.0 Industry 4.0 -¿ Logistics 4.0". In: *Logistics Information Management 2016(1)* (Sept. 2018).

[17] Fritz, Michael. "Industrie 4.0: fraunhofer-research and development in the ict sector and beyond". In: (May 29, 2017).

[18] Giusti, Riccardo et al. "Synchromodal logistics: An overview of critical success factors, enabling technologies, and open research issues". In: 129 (Sept. 2019), pp. 92–110. DOI: 10.1016/j.tre.2019.07.009.

[19] Glistau, Elke and Machado, Norge Isaias Coello. "Industry 4.0, Logistics 4.0 and Materials - Chances and Solutions". In: 919 (Apr. 2018), pp. 307–314. DOI: 10.4028/www.scientific.net/msf.919.307.

[20] Glistau, Elke and Machado, Norge Isaias Coello. "Logistics concepts and logistics 4.0". In: 12.1 (Apr. 2019), pp. 37–46. DOI: 10.32971/als.2019.003.

[21] Groth, Paul et al. "FAIR Data Reuse – the Path through Data Citation". In: 2.1-2 (Jan. 2020), pp. 78–86. DOI: 10.1162/dint_a_00030.

[22] Group, Open. *Gap Analysis*. 2011. URL: https://pubs.opengroup.org/architecture/togaf91-doc/arch/chap27.html.

[23] Group, The Open. *ArchiMate 3.1 Specification*. URL: https://pubs.opengroup.org/architecture/archimate3-doc/.

[24] Gumzej, Roman. "Logistics 4.0". In: Springer International Publishing, 2021, pp. 67–73. DOI: 10.1007/978-3-030-81203-4_8.

[25] GÜREL, Emet. "SWOT analysis: a theoretical review". In: 10.51 (Aug. 2017), pp. 994–1006. DOI: 10.17719/jisr.2017.1832.

[26] Iacob, M. E. et al. "From enterprise architecture to business models and back". In: (Dec. 2012). DOI: 10.1007/s10270-012-0304-6.

[27] IDS. "Specification: IDS Clearing House". In: (Apr. 2020).

[28] IDS. *IDS Officially a Standard*. URL: https://internationaldataspaces.org/ids-officially-a-standard-din-spec-27070-is-published/#:~:text=The%20IDS%20standard%20is%20the,data%20and%20trust%20between%20participants..

[29] IDS. "IDS Reference Architecture Model Version 2.0". In: ().

[30] IDSA. "IDSA Rule Book". In: (Dec. 2020).

[31] Jonkers, H. et al. "ArchiMate(R) for Integrated Modelling Throughout the Architecture Development and Implementation Cycle". In: IEEE, Sept. 2011. DOI: 10.1109/cec.2011.52.

[32] Jurenka, Richard, Cagáňová, Dagmar, and Horňáková, Natália. "The Smart Logistics". In: Springer International Publishing, 2020, pp. 277–292. DOI: 10.1007/978-3-030-30911-4_20.

[33] Jürjens, Jan. "The industrial data space: digital industrial platform across value chains in all sectors of the economy". In: ().

[34] Kim, Sora and Ji, Yingru. *Gap Analysis*. Aug. 2018. DOI: 10.1002/9781119010722.iesc0079.

[35] Otto, Boris et al. "GAIA-X and IDS". In: (Jan. 2021).

[36] Pagano, Pasquale, Candela, Leonardo, and Castelli, Donatella. "Data Interoperability". In: 12.0 (2013), GRDI19–GRDI25. DOI: 10.2481/dsj.grdi-004.

[37] Peffers, Ken et al. "A Design Science Research Methodology for Information Systems Research". In: 24.3 (Dec. 2007), pp. 45–77. DOI: 10.2753/mis0742-1222240302.

[38] Piest, Jean et al. "Evaluating the Use of the Open Trip Model for Process Mining: An Informal Conceptual Mapping Study in Logistics". In: SCITEPRESS - Science and Technology Publications, 2021. DOI: 10.5220/0010477702900296.

[39] RMTap. *Logistical Risks*. URL: http://www.rmtap.com/logistical-risks.htm.

[40] Ronald Wall, Tiffany Tsui. "Logistics Networks". In: (Sept. 2015).

[41] Sahlmann, Kristina et al. "MUP: Simplifying Secure Over-The-Air Update with MQTT for Constrained IoT Devices". In: 21.1 (Dec. 2020), p. 10. DOI: 10.3390/s21010010.

[42] Scerri, Simon. "Industrial data space - digital sovereignty over data". In: (Dec. 8, 2016).

[43] Shamsuzzoha, Ahm, Ndzibah, Emmanuel, and Kettunen, Kasperi. "Data-driven sustainable supply chain through centralized logistics network: Case study in a Finnish pharmaceutical distributor company". In: 2 (Dec. 2020), p. 100013. DOI: 10.1016/j.crsust.2020.100013.

[44] Simacan. *The Open Trip Model: how a visionary idea of Simacan was embraced by the logistics sector*. Mar. 4, 2021. URL: https://www.simacan.com/about-us/enterprise/blog/open-trip-model-simacan-logistics.

[45] Space, International Data. "White paper certification framework for the ids certification scheme, version 2". In: ().

[46] Stall, Shelley et al. "Advancing FAIR Data in Earth, Space, and Environmental Science". In: 99 (Nov. 2018). DOI: 10.1029/2018eo109301.

[47] Thompson, Mark et al. "Making FAIR Easy with FAIR Tools: From Creolization to Convergence". In: 2.1-2 (Jan. 2020), pp. 87–95. DOI: 10.1162/dint_a_00031.

[48] TNO. *International data spaces (ids) makes it safe and easy to exchange data*. URL: https://www.tno.nl/en/focus-areas/information-communication-technology/roadmaps/data-sharing/international-data-spaces-ids/.

[49] Ünver, Hamid Akın and Kim, Grace. "Cross-Border Data Transfers and Data Localization". In: (2016). DOI: 10.13140/RG.2.2.11628.82567.

[50] Wilkinson, Mark D. et al. "The FAIR Guiding Principles for scientific data management and stewardship". In: 3.1 (Mar. 2016). DOI: 10.1038/sdata.2016.18.

[51] YOSHIMOTO, Ryuichi and NEMOTO, Toshinori. "The impact of information and communication technology on road freight transportation". In: 29.1 (2005), pp. 16–21. DOI: 10.1016/s0386-1112(14)60114-x.

[52] Z-BRE4K. "Strategies and Predictive Maintenance models wrapped around physical systems for Zero-unexpected-Breakdowns and increased operating life of Factories". In: (July 3, 2018).