Investigating Cologistics Hubs: Business Models, Added Values, Flows, Perceptions and Scalability.

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Abstract

Multi-service transport hubs provide a potential opportunity to achieve sustainability and emission goals and have been in contemporary research and policy discussions, however, mostly in the passenger transport sector. In Urban logistics, the delivery vehicles leaving a warehouse or a consolidation centre entering the city to deliver goods are usually filled to a certain capacity during their onward journey and when the goods are delivered, they return mostly empty during their return journey. In Urban waste management, the waste collection vehicles leaving from a waste collection centre into the city are almost empty during the onward journey and are filled to a certain capacity during their return journey, which is the opposite. To address this underutilized capacity issue, in 2017, in the city of Stockholm, a new type of Urban logistics hub was created through the Älskade Stad initiative which combined the urban logistics flows with the urban waste management flows reducing the number of vehicles required and reducing the empty space in the vehicles during both the onward and return journeys. This type of hub consolidates deliveries acting as an urban consolidation centre and also consolidates wastes, acting as a waste management centre. Due to the central nature of the hub, it can also include other services. The study coins a new term called 'Cologistics Hub' for this type of hub and investigates the scenarios in which Cologistics hubs are required and then builds the business models suitable for these scenarios and for maximum scalability. It identifies different types of stakeholders that can be part of the Cologistics hub ecosystem. Along with this, the study analyses different types of flows involved in a Cologistics hub, maps the business ecosystem, and identifies added values for all types of identified stakeholders in the ecosystem. In addition to this, this study analyses the perception of Cologistics hubs among the identified stakeholders and compares how the stakeholders perceive their current business-as-usual solution for urban logistics and waste management versus the Cologistics hub solution. In the end, the study provides a step-by-step strategy to follow using different conceptual frameworks used in this research for implementing a scalable Cologistics hub solution.

Keywords: Urban logistics, Urban Consolidation Centers, Cologistics hubs, Business models.

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Sammanfattning

Transporthubbar med flera tjänster utgör en potentiell möjlighet att uppnå hållbarhets- och utsläppsmål och har varit föremål för aktuell forskning och politiska diskussioner, dock främst inom passagerartransportsektorn. Inom stadslogistik fylls leveransfordonen som lämnar ett lager eller en konsolideringscentral och kör in i staden för att leverera varor vanligtvis till en viss kapacitet under sin vidare resa och när varorna har levererats återvänder de mestadels tomma under sin returresa. Vid hantering av urbant avfall är avfallshanteringsfordonen som lämnar en avfallshanteringscentral i staden nästan tomma under den fortsatta resan och fylls till en viss kapacitet under returresan, vilket är motsatsen. För att lösa problemet med underutnyttjad kapacitet skapades 2017 i Stockholms stad en ny typ av urbana logistikhubbar genom initiativet Älskade Stad som kombinerade de urbana logistikflödena med de urbana avfallshanteringsflödena, vilket minskade antalet fordon som krävs och minskade det tomma utrymmet i fordonen under både fram- och återresorna. Denna typ av hubb konsoliderar leveranser och fungerar som ett urbant konsolideringscenter och konsoliderar även avfall och fungerar som ett avfallshanteringscenter. På grund av hubbens centrala karaktär kan den även omfatta andra tjänster. Studien myntar en ny term som kallas "Cologistics Hub" för denna typ av hubb och undersöker de scenarier där Cologistics-hubbar krävs och bygger sedan affärsmodeller som är lämpliga för dessa scenarier och för maximal skalbarhet. Den identifierar olika typer av intressenter som kan vara en del av ekosystemet för kologistikhubben. Utöver detta analyserar studien olika typer av flöden som är involverade i en Cologistics-hubb, kartlägger affärsekosystemet och identifierar mervärden för alla typer av identifierade intressenter i ekosystemet. Utöver detta analyserar studien uppfattningen om Cologistics hubbar bland de identifierade intressenterna och jämför hur intressenterna uppfattar sin nuvarande business-as-usual-lösning för stadslogistik och avfallshantering med Cologistics hub-lösning. Slutligen ger studien en steg-för-steg-strategi som ska följas med hjälp av olika konceptuella ramverk som används i denna forskning för att implementera en skalbar Cologistics-hublösning.

Nyckelord: Urban logistik, Urban Consolidation Centers, Cologistics hubs, Affärsmodeller.

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Pawan Seshadri Venkatesh,

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1.0 Introduction

Urban Consolidation Centers has been an interesting topic and field of research in the field of urban logistics for a long time. There have been plenty of successful and failed urban consolidation centers due to various reasons however the positive aspects of UCCs are well known due to the collaborative nature of UCCs. This thesis aims to define a Cologistics hub, a new type of urban logistics hub which is different from an Urban Consolidation Centre. This thesis aims to justify how it is different from an Urban Consolidation Centre, identify different scenarios where a Cologistics hub is needed, and understand the potential added values, requirements, business models and essential factors to scale the Cologistics hub solution in urban logistics. This part provides the background information for the topic of study and the stakeholders, along with a summary of existing projects and initiatives fitting the definition of a Cologistics hub. Furthermore, the purpose of the research, research questions and the research delimitations are stated before moving on to the literature review. The justification for proposing the term "Cologistics hub" and its definition is given in the literature review section.

1.1 Background

Urban logistics in cities create a lot of negative social and environmental impacts. With the growing rate of e-commerce and urbanisation, there is a growing requirement for the logistics of goods in a city. Most trucks performing last-mile logistics in cities are not filled to capacity or even near capacity. There is a massive amount of empty space in delivery trucks in a city. Delivery vehicles leaving the transhipment hub or a consolidation centre to deliver goods contain a certain amount during the onward journey. However, they are almost empty during the return journey (Islam et al., 2019).

On the other hand, Waste collection vehicles that collect waste leaving the waste collection station are empty during the onward journey but filled with a certain capacity during their return to the waste collection station. Merging these two flows created the Älskade Stad initiative, operated in Stockholm, with an agreement between Ragn-Sells and Bring (Westerlund & Baban, 2021). As part of this initiative, heavy delivery trucks will only be used to deliver goods to the hubs and travel from the hubs back to the waste management centre with the collected waste. Within the city, for urban logistics, only small electric vehicles will deliver parcels and pick up the waste from the business or residential units. Depending on agreements with the property owners, they will also perform the last-meter delivery within the property, which is part of the regular "city services" service offered by Ragn-Sells. Älskade Stad runs based on the contractual agreement between Bring and Ragn-Sells. Ragn-Sells are responsible for the operations of the last-mile deliveries and perform the last-mile deliveries as a third-party service to Bring. This is the first known implementation of a hub and a logistics service in Europe which is used for delivering parcels and collecting waste in a city using the exact vehicle during the same trip. This has reduced the total number of trips and vehicles on the road, reducing congestion and emissions. However, this solution faces operational challenges, but most importantly, it faces a considerable challenge to scale up despite the positive impacts. For scalability, it is essential to generate multiple sources of logistics flow, and therefore, it is essential to involve more than just one stakeholder. There are more projects at its inception, such as Urban Logistik Barkarby, which plan to involve multiple stakeholders. In such projects, stakeholders such as real estate companies, offices, construction companies, retail, etc. can use the hub solution for their logistics needs, generating more flows and not just limited to delivery companies. However, involving these stakeholders comes with specific barriers which naturally act as barriers to scalability. Therefore, there is a need to analyse the hub projects and the stakeholders' needs to determine the barriers to scale.

1.2 Problematisation

As stated in the previous section, there are many challenges when implementing and making such hubs scalable. There are also no recommendations or a guidebook in the literature which provides knowledge on such multi-stakeholder logistics hubs. These are the general problems this paper is trying to address. There is a lack of knowledge on how the hub solution for logistics and waste management can fit into the core business activities of stakeholders. Currently, the Älskade Stad initiative is driven by two companies. However, when it comes to setting up a hub solution involving more stakeholders, it is necessary to understand the added values provided to them to make a strong case for them to get involved. There is also limited knowledge of the requirements to set up such a multi-stakeholder hub solution. To attract more stakeholders to generate more flows, it is necessary to understand the added values the hub solution provides to each stakeholder. Moreover, to set up a properly functioning hub that should be scalable, it is essential to understand different types of flows, the requirements for the hub solution, and the business models.

1.3 Purpose and Research Questions

This research study aims to define multi-stakeholder logistics hubs, understand the added values for different stakeholders, identify business models, map the flows and requirements for these business models, and provide a guidebook to implementation for scalable hubs. First, it is essential to identify what type of businesses can make use of and be integrated into the hub solution. The 'jobs to be done' for each stakeholder type will be identified and analysed to understand the added values that these stakeholders can get through this solution. It is also essential to understand the types of flows when it comes to operating this hub solution. Then the scenarios are planned based on the needs of the stakeholders. Furthermore, for each scenario, a business model is created and suggested. Then the required flows are mapped along with a discussion of requirements.

For these purposes, these three research questions are presented, along with the sub-research questions.

1. *What additional services/businesses can be integrated into the Cologistics hub in addition to deliveries and waste management?*
    a. *What will be the third-party services which make use of the hub for their operations?*
    b. *How are the stakeholders' current logistics, warehousing, and waste management operations and what are the added values gained by the stakeholders with the Cologistics hub service?*
2. *What do the operational flows look like for the hub solution?*
    a. *What do the system's material flow, information flow and money flow look like and what are the corresponding infrastructural requirements?*
    b. *Which factors are the most important for stakeholders when choosing the hub solution over other alternatives?*
3. *What are the most feasible strategies to operationalise the business models for scalability given the context mentioned in questions 1 and 2?*
    a. *What are the different scenarios based on the needs?*
    b. *For different scenarios, how could the different business models look like for the hub provider?*
    c. *What does the collaboration ecosystem with different stakeholders look like?*

1.4 Delimitations

The scope of this study is limited to the existing logistics hub projects, the projects under creation and the future projects of the waste management company, Ragn-Sells, based in Scandinavia. A selected set of companies, most of them based in Sweden and associated with the project, Urban Logistik Barkarby, are interviewed to understand the stakeholders' jobs to be done and the added value. Some additional stakeholders who are not associated with any such logistics projects are also interviewed. The discussed results are based on the qualitative interviews conducted with these specific companies, which are then generalised for each stakeholder group. The total investigation period is about six months, with interviews lasting between 45 and 60 minutes per interviewee. Interviews are conducted with representatives from key stakeholder businesses who possess valuable insights into the urban logistics challenges their businesses face. Generally, only one individual is interviewed per company, with some exceptions, providing a representative perspective from that organisation.

Additionally, qualitative data is gathered from workshops conducted for the projects Urban Logistik Barkarby and another similar project in Malmö. The Multi-criteria decision analysis conducted to understand which factors are more important than others when it comes to logistics hub solutions over others also incorporates a qualitative way of data collection. The methodology of the entire research is purely qualitative.

1.5 Brief Description of the Study Area

These are some of the relevant projects currently or under the formulation process. This section will provide a brief overview of these projects, mainly focusing on the number and the type of stakeholders involved and the flows.

1.5.1 Älskade Stad and Elskade By

Älskade Stad initiative in Sweden and the Elskade By initiative in Norway are projects with just two stakeholders, a waste management company and a delivery company. Currently, these are being run in four different cities. It consolidates flows of recycling materials with parcel deliveries in a hub in the city centre. The hub handles recycling materials and parcels and transports them using a light slow-driving electric truck. The onward flow from the hub is mostly the parcels from the delivery company.

In contrast, the return flow to the hub is mostly the recycling waste collected by the service offered by the waste management company. This initiative operates based on an agreement between waste management and delivery companies. Älskade Stad is explained in depth in the literature review section.

1.5.2 Urban Logistik Barkarby

Urban Logistik Barkarby (ULB) is a Vinnova project based in Barkarbystaden, Järfälla kommun, Sweden, currently in the preliminary research stage. In ULB, the stakeholders are not limited to waste management and the delivery company. The stakeholders of this project involve the municipality of Järfälla, retail companies, real estate property managers, construction companies, shared economy companies and IT service providers, in addition to a waste management company and a delivery company. This project aims to generate more multi-directional flows by adding more stakeholders to the hub solution.

1.5.3 Jernhusen Project in Malmö

A new property area development is set to happen in Malmö, Sweden, by the state-owned company, Jernhusen, which owns and runs railway stations and other buildings attached to the railway network in

Sweden. This area will have housing, a train depot, warehouses, hotels, schools, sports facilities, etc. The development area will also have city logistics hubs and mobility hubs. This is an example of a logistics hub project driven by a real estate company. It aims to find more uses for the hubs besides just delivery consolidation and waste management. Through these hubs, other services will be provided.

1.6 Outline of the Thesis

The thesis is divided into six sections. A brief overview of each section is given below in Table 1.

Table 1. Thesis Outline.

Section	Description
Introduction	This section provides the background information about the research, the purpose of the research, the problematisation and the formulated research questions, and the delimitations defining the boundaries and limitations of the data collection process and the study. This section also provides a brief overview of existing hub projects relevant to the study's scope.
Literature Review	The literature survey gives an overview of urban logistics. It discusses the problems and challenges, the stakeholders involved, the environmental aspects, fleet electrification and the need for collaboration in urban logistics. Urban consolidation centres are also discussed to give a detailed overview of how they work and to address the need for collaborative logistics. Then the research gaps are addressed, and the term "Cologistics hub" is coined and defined along with the justification for a new term and how it differs from an urban consolidation centre.
Methodology	This section explains the research methodology in-depth, briefly describing the conceptual framework and the tools used to perform the research.
Findings	This section discusses the findings from the data collection process with the help of the conceptual frameworks.
Perception of Cologistics Hub and Implementation Strategy	This section discusses how the Cologistics Hubs are perceived by various stakeholders based on the results of survey and suggests a step-by-step strategy for implementing a Cologistics hub which are based on the various conceptual frameworks used in this research.
Conclusion	This section provides a summary of the research process, the findings, and the discussions to provide an overall conclusion. The section also discusses some key findings. Then, the limitations of this research and the recommendations for further research are also discussed.

2.0 Literature Review

The literature review section is divided into five segments. The initial segment provides a detailed overview of urban logistics, focusing on the challenges faced in urban logistics, the innovations occurring in urban logistics, the stakeholders involved in modern-day urban logistics, the environmental and social aspects of urban logistics, the use of electrified vehicles in Urban Logistics. The second segment provides a definition for the Cologistics hub and presents the challenges faced in implementing Cologistics hubs which are derived from the challenges faced in implementing traditional urban consolidation centers. The third

segment provides an overview of business models and added values. The fourth segment provides a detailed review of the Älskade Stad initiative. And the fifth segment addresses the research gaps in the literature and discusses the need for this research.

2.1 Urban Logistics

Urban logistics refers to the transportation and distribution of goods within urban areas. A lot of research efforts has been put into this field over recent years due to the increase in population and economic growth in urban areas, which has contributed to congestion, pollution, and negative impacts on the environment and the citizens.(Lagorio et al., 2016). Last-mile deliveries are a huge problem in urban logistics as they are complex and the least efficient part of the supply chain (Bosona, 2020). Some of the problems in last-mile logistics include high delivery costs, low efficiency, and poor environmental performance (Miko & Abbas, 2023; Yi, 2023). Energy efficiency is an extremely important factor in first-mile and last-mile delivery logistics, since deliveries are composed of individual orders and each order must be picked up and delivered at many different locations (Bányai, 2018). The increase in e-commerce over recent years has also led to an increase in freight volumes, which has further increased the challenges faced in urban logistics (Schöder et al., 2016a). The optimal location of urban logistics centres is crucial in reducing transport costs, the flow of goods in urban areas, and greenhouse gas emissions (Jiao et al., 2023). Consolidating deliveries outside a city or on the edge of a city with the development of integrated logistics centres is considered one of the potential solutions to tackling the high transportation costs, congestion, and emissions (Wang et al., 2023). In addition to determining the optimal location of logistics centres, effective management of urban transport and logistics systems is also very crucial in addressing the challenges faced in urban logistics (Ilchenko et al., 2022). Urban Consolidation Centers (UCCs) have emerged as a promising solution to the challenges of urban logistics, serving as platforms for managing last-mile deliveries of goods within city centres. They are designed to reduce the number of vehicles entering city centres, thereby reducing congestion and pollution (Deng et al., 2021; Katsela et al., 2022).

2.1.1 Innovations in Urban Logistics

Innovations and collaboration are essential with the increasing trend in urban goods flows. There have been a lot of studies into novel concepts such as the use of Unmanned aerial vehicles and autonomous delivery robots to solve these last-mile challenges in recent years (Boysen et al., 2021). Most of the research articles in urban logistics (as per 2018) focus on issues like commodity flows and economic modelling aspects, but there has been relatively little research reported on issues like collaboration among stakeholders, usage of Intelligent Transportation Systems (ITS) and E-commerce (“Urban Logistics: A Systematic Literature Review,” 2018a). According to Ranieri et al., (2018), the innovations to tackle the last mile challenges are classified into five main categories: innovative vehicles, proximity stations or points, collaborative and cooperative urban logistics, optimisation of transport management and routing, and innovations in public policies and infrastructures. In this research, the primary focus is on identifying research gaps which enable collaborative and cooperative urban logistics.

2.1.2 Stakeholders in Modern-Day Urban Logistics

In Urban logistics, there is a wide range of stakeholders, such as transport companies, retailers, local authorities, and residents. Collaboration and cooperation among the various parties engaged in urban logistics are crucial for fostering sustainable development and addressing the challenges associated with urban logistics however such collaborations have a lot of challenges. Information sharing between the stakeholders is one such challenge. Stakeholder collaboration on projects ultimately yields substantial

outcomes that contribute to the sustainability of cities. (Teixeira et al., 2023). Sustainable development has become a contemporary and significant objective for urban logistics stakeholders since the last decade. (Tadić et al., 2015). Therefore, multi-stakeholder collaboration in urban transport is a crucial research issue that needs to be addressed and can lead to the development of sustainable urban logistics systems that benefit all parties involved. Waste management companies have also been involved in modern-day urban logistics by providing sustainable waste management solutions, such as the urban consolidation centre explored in the case of the Älskade Stad initiative (Westerlund & Baban, 2021) The Älskade Stad initiative will be discussed further later.

The multi-stakeholder nature of urban freight is a recurring theme in urban logistics research. This complexity arises from the diverse range of actors involved in the urban freight ecosystem, including shippers, carriers, receivers, public administrators, and citizens. Each of these stakeholders has distinct interests and perspectives, which can sometimes be at odds with each other. For instance, traditional logistics actors such as shippers, carriers, and receivers are primarily concerned with cost and quality, while public administrators and citizens are more focused on social welfare, including environmental sustainability and traffic congestion. Balancing these diverse interests requires a high degree of cooperation and collaboration among all stakeholders. This need for cooperation encouraged the deployment of Freight Quality Partnerships in several countries, including the UK and Sweden. These partnerships involve all key stakeholders in freight transport in a city or transport corridor meeting collectively to solve problems. Despite the challenges, the multi-stakeholder nature of urban freight also presents opportunities for innovation and the development of more sustainable and efficient urban logistics solutions. However, the literature suggests that city logistics and urban freight are “difficult to organise, difficult to modernise” due to local peculiarities in both place and time and the disruption of efficient supply chains. (Cowie et al., 2023; Kervall & Pålsson, 2022; Nuzzolo et al., 2016)

2.1.3 Environmental and Social Aspects in Urban Logistics

Globally, urban freight represents up to 25% of urban vehicles, takes up to 40% of motorised road space and contributes to up to 40% of urban transport-related CO_2 emissions (*EcoLogistics - ICLEI Sustainable Mobility*, n.d.). Last-mile delivery is inefficient, expensive, and generates a significant amount of harmful greenhouse gases. As a result, it has become an obstacle to the development of a sustainable economy (Jiang et al., 2019). Governments are implementing regulations aimed at lowering the environmental impact of last-mile deliveries to enhance the living standards for their citizens (Bakogianni & Malindretos, 2021). Innovations in urban logistics can change the behaviour of society, lifestyle, preferences in movement, quality of life, and the identification of residents with the city (Stec, 2021). Logistics sprawl, or the relocation of logistics facilities away from the inner urban areas towards the suburban areas, contributes to increases in truck travel distance and thus, emissions (Aljohani & Thompson, 2016). With the rise of e-commerce, there has been increased freight volumes and carbon emissions. The utilisation of new electric power train technologies for e-commerce logistics can offer sustainable solutions for reducing these impacts (Schöder et al., 2016b). Logistics collaboration with electrified vehicles can reduce the number of delivery trucks, shorten delivery times, and travel distances, and mitigate negative environmental impacts resulting from urban logistics (Do et al., 2019).

2.1.4 Electrified Vehicles in Urban Logistics

Electrified vehicles such as e-bikes and electric commercial vehicles play an important role in modern-day urban logistics due to their potential to reduce negative impacts such as carbon emissions and noise

pollution (Ivanisevic et al., 2020). Policy decisions such as purchase subsidies and zone entry fees promote the use of electric vehicles in city logistics (*Urban Logistics: A Systematic Literature Review*, 2018b). Although electrified freight vehicles have good technical performance, the business case for delivery companies to use EVs for urban logistics is still suffering from high vehicle purchase prices and uncertainty about their depreciating value. The current business models are designed for conventional vehicles and should be changed to fit EVs better. Another significant barrier in electrification for delivery companies is due to the substantial long-term investments they have already made in their current fleets. These investments include not only the initial purchase of the vehicles, but also ongoing maintenance, repairs, and fuel costs. Transitioning to an electric fleet would require a significant upfront investment in new vehicles and the infrastructure needed to support them such as charging stations. Additionally, the existing fleet would likely need to be sold or otherwise disposed of, potentially at a loss. This financial burden, coupled with the operational challenges of integrating new technology, makes the shift to electric vehicles a daunting prospect for many delivery companies (Morganti & Browne, 2018). In order to find a positive business case, the support of local authorities' is essential. (Quak et al., 2016; Quak & Nesterova, 2014).

2.1.5 Logistics of Waste Management

Waste collection is essentially a reverse logistics process in the context of urban logistics. There are some papers such as (Budak & Ustundag, 2016; Buhrkal et al., 2012; Gallegos et al., 2012) running optimisation algorithms to make logistics more efficient. However, waste management in the context of urban logistics has very little literature. Martinez et al., 2019 are one of the studies which discuss waste collection as a part of the urban logistics process. Further research into this is required.

2.2 Cologistics Hub

To the best of our knowledge and through the extensive literature survey, we have not seen a hub which is utilized for delivery consolidation, waste collection and other services at the same time.

A typical Urban Consolidation Centre (UCC) is a facility located at the city border where long-distance transports are consolidated, and from which smaller, often environment-friendly vehicles take over the transport of goods for the last mile to the final recipient, requiring collaboration and synchronisation among multiple shippers for efficient operation (Cleophas et al., 2019). An Urban Consolidation Centre according to various instances in the literature, just refers to a delivery consolidation hub from one or more providers and does not include waste collection or other services as part of its operations.

A Cologistics hub cannot be referred to as an Urban Consolidation Centre as consolidation and last-mile delivery of parcels are just one part of a Cologistics hub. In this research, we focus on a hub which includes waste collection as a primary part of the operations with the delivery consolidation and last-mile deliveries alongside other secondary operations in some cases such as repair stations, reuse stations etc. Due to the multi-functional aspect of the hubs, a Cologistics hub cannot be referred to as an Urban Consolidation Centre and a new definition for a Cologistics hub is required. -

2.2.1 Definition of a Cologistics hub

Cologistics hubs are urban logistics hubs located in an urban area which function as an urban consolidation centre for parcel deliveries and a collecting and compacting station for waste management operations. It may or may not have other services integrated into the hub infrastructure. These hubs are characterised by a shared vehicle system, where vehicles are utilised for all hub operations, including deliveries, waste management, and other integrated services.

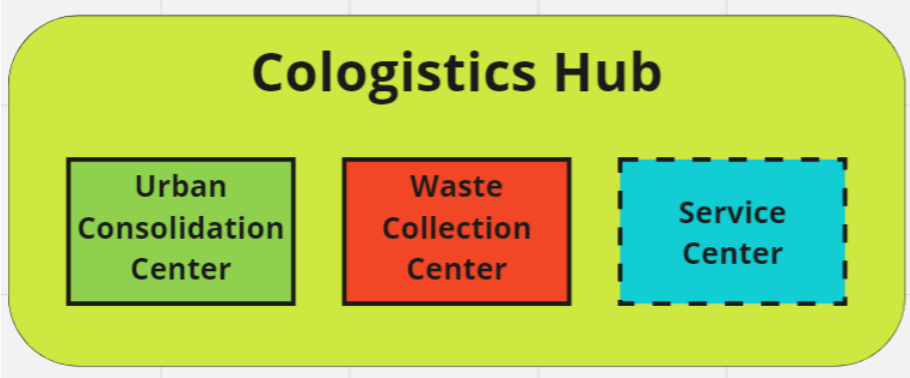

Figure 1. Cologistics Hub

As per the definition, an Urban Consolidation Centre is one component of a Cologistics hub along with waste collection and other services. Waste collection is an essential component of a Cologistics hub while other services may or may not be a component of a Cologistics hub.

2.2.2 Challenges in the Implementation of Cologistics Hubs

Since Cologistics hubs are a new concept, there is no literature on the challenges faced to implement a Cologistics hub however, the challenges faced in implementing a typical Urban Consolidation Center are relevant as UCC is one part of a Cologistics hub.

The number of successful Urban Consolidation Centre projects in Europe is very low and most of them have experienced serious difficulties in going past the experimental phase (Paddeu, 2018). The implementation of UCCs faces several challenges. Achieving financial sustainability for UCCs remains a significant challenge, with many failing to operate autonomously after the initial experimental phase, often heavily supported by public funds. One of the main challenges is the multi-stakeholder nature of urban freight. The interests of various stakeholders, including logistics service providers (LSPs), retailers, and local authorities, need to be considered and balanced. For instance, a study on the UCC in Leiden, Netherlands, found that the project was halted due to a lack of participating LSPs, whose needs were not adequately met. Similarly, the UCC project in Kassel, Germany, suffered from a collapse in revenues due to stopped subsidies and a lack of strategies targeted to receivers. (Ciardiello et al., 2021). (Björklund et al., 2017) highlights the importance of viable business models for UCCs. (van Heeswijk et al., 2019) conveys that a key challenge in implementing UCCs is in identifying financially sustainable schemes. The high costs of running an UCC prevents attracting an adequate name of users. The study shows the importance of committing the delivery service providers to the UCC as soon as possible, as they potentially generate the bulk of the revenue. More revenues may be generated by offering value-adding services to receivers. Therefore, financial sustainability is a significant limitation or challenge in implementing an urban consolidation centre. HITS project, which is a research and innovation project focused on developing new technologies for the automotive industry. The project report references approximately 50 completed or ongoing projects within Europe that have addressed urban logistics challenges and introduced different types of Urban Consolidation Centers (UCC). Even though there are indications of both an economic as well as environmental potential in these systems, very few of these projects have survived after the public

funding has ended (*Författare: Magnus Blinge Datum: 20220531 Projekt Inom Strategisk Satsning HITS Hållbara Och Integrerade Transportsystem Publik Rapport*, n.d.).

Overall, the studies suggest that UCCs can be successful if stakeholders work together to address financial, operational, and regulatory challenges. A lot of papers on UCC discuss the need for a higher reverse flow for more efficiency and cost-effectiveness. Cologistics Hubs can address these challenges with its reverse waste flow along with an improved collaboration among stakeholders.

2.3 Business Models

According to Zott et al., (2011), a business model can be understood as a new unit of analysis that explains how firms "do business". It involves interplay of various activities of the firm and seeks to explain how value is created, not just how it is captured. And it is important to understand the structural elements of an organization's internal and external environment to implement processes or services that create value for all stakeholders effectively.

Another perspective on business models is provided by Xu et al., (2018), who conducted in-depth interviews with experts in the field and defined a business model as the logic of how companies deliver value to consumers in search of income. This definition included concepts such as value proposition, market segmentation, value chain definition, income source, and income capture.

Shetty et al., 2019 describe a business model as an architectural design that strategizes on governance, customer relationships, business marketing, and revenue to enhance the quality of life for citizens. This definition emphasizes the social, economic, and cultural aspects of value creation.

A business model can be understood as a conceptual tool that helps to understand the logic involved in the business operations of a company or a project. There is no single definition that is accepted universally in the literature; however, this summary provides a basic understanding of the concept of a business model which is required in the context of this research.

The Business Model Canvas (BMC) created by Osterwalder & Pigneur, (2020) is a tool which is popular in the startup ecosystem that is simple and plays a significant role in explaining business models. BMC is a comprehensive framework which is helpful in understanding a firm’s business by mapping the individual components such as key activities, channel etc. By using the BMC, organizations can evaluate and change or improve their existing business models or create new ones that are more appropriate and suitable for their operations. It helps with the evaluation and improvement of business models and also supports the development of innovative and sustainable business strategies. (GS & Istanti, 2022).

2.3.1 Added Values

Added values refer to the benefits or advantages that are provided to consumers or stakeholders along with the core product or the service that is offered. These added values can enhance the overall customer experience, differentiate a company from its competitors, and create value for both the firm and the consumer (Prahalad & Ramaswamy, 2004). A value proposition refers to the unique combination of products, services, and benefits that a company offers to its customers to meet their needs and create value (Skålén et al., 2015).

2.4 Älskade Stad Initiative

Älskade Stad is an initiative that was introduced by the City of Stockholm, together with the recycling company Ragn-Sells, the logistics company Bring, and the property owner Vasakronan. Älskade Stad aims to consolidate flows of recycling materials with parcel deliveries in the central hub located in the city centre of Stockholm. It aims to reduce emissions, congestion, and disturbance in the city while improving the use of vehicles and employees and increasing profitability. The hub handles both recycling materials and parcels and transports them using a light slow-driving electric truck. The hubs are functional in a few locations in Stockholm, where the delivery parcels are handled together with recycling materials. The parcels intended for business customers are picked up by Ragn-Sells with their bigger trucks at Bring's Terminal and brought to the hub where they are received and later packed into a small electric truck. These are the same trucks used by Ragn Sells to transport waste from the collection centre to the processing facility outside the city. The parcels do not contain edible products or goods with temperature restrictions. Heavy trucks will be kept out of the city, and they will only travel from the distribution centres to bigger logistics hubs or waste management locations. They will carry parcels to the consolidation centres and pick up the recycling waste from them. Within the city, only small electric vehicles will deliver parcels and pick up the recycling waste from the business or residential units, and depending on agreements with the property owners, they will also perform the last-meter delivery within the property. (About Älskade Stad – Älskade Stad, n.d.; Älskade Stad Goes Live in Norway, n.d.; #BELOVEDCITY-Collaboration for a Better City | News - Smart City Sweden, n.d.; Westerlund & Baban, 2021)

According to Westerlund & Baban, (2021), the Älskade Stad initiative has resulted in reduced CO_2 emissions per kilogram of recycled waste by a factor of 3.7 compared to traditional waste management methods. This reduction has been achieved through several measures such as reducing the number of vehicles on the road, optimising routes, and using electric vehicles for transport. The initiative has also led to other benefits such as reduced traffic congestion, improved air quality, and increased safety on the roads due to fewer heavy vehicles on the road. Overall, Älskade Stad is an innovative solution that addresses multiple challenges related to urban waste management and parcel delivery while also contributing to a cleaner, safer, and more attractive city.

2.5 Research gaps

Existing studies have primarily focused on logistics hubs that function as Urban Consolidation centres, analysing their benefits and added values. The study (Westerlund & Baban, 2021) categorises the hub of Älskade Stad as a case of Urban Consolidation Centre. However, no other study contains waste management flows within their definition of an Urban Consolidation Centre. Therefore, there is a need to establish a new term that encompasses city hubs providing logistics and warehousing services for parcel deliveries, waste management, intra-city logistics, and other services. To address this gap, this thesis has introduced the term "Cologistics hub" and provided a clear definition for such hubs, thereby expanding the understanding and classification of these multifunctional urban hubs in section 2.2.

This research aims to identify and explore other services or businesses that can be integrated into the Cologistics hub beyond deliveries and waste management. By examining the current logistics and warehouse operations of stakeholders, this research aims to understand the existing practices and challenges faced by stakeholders in their operations and evaluates the benefits and added values of the Cologistics hub solution. The research investigates the material flow, information flow, and money flow to provide operational understanding of Cologistics hubs. This addresses operational dynamics and

interactions within the system. By identifying the factors that influence stakeholders' choices between the hub solution and other alternatives, the research aims to fill the research gap in understanding the decision-making process and key considerations for stakeholders when choosing their logistics solution. This knowledge can help design and optimise the Cologistics hub solution to align with stakeholders' needs and preferences. The research seeks to identify and propose strategies for operationalising scalable business models within the Cologistics hub solution. This addresses the research gap in developing effective and scalable business models tailored to the needs of different scenarios and stakeholders. The research aims to investigate the collaboration ecosystem required for the successful implementation and operation of the hub solution involving various stakeholders.

3.0 Methodology

The methodology section outlines the research design and methods utilised in this study to address the primary research question and its sub-questions. Considering the exploratory and investigative nature of the research study, a qualitative research approach has been selected. This approach permits an in-depth comprehension of stakeholders' needs when it comes to logistics and waste management operations, identifying system flows, and prospective business models that can be implemented in the context of the Cologistics hub solution.

Primary data collection methods comprise literature review and conducting interviews with representatives from companies who are part of the identified stakeholder types and/or involved in current Cologistics hub projects. Additional data are obtained through participation in project workshops attended by various stakeholder groups and the administration of a survey to perform multi-criteria decision analysis. To analyse the gathered data and provide a thorough response to the research questions, multiple conceptual frameworks are employed, including Scenario Planning, Business Model Canvas, System Flow Mapping, Ecosystem Mapping, and Multi-Criteria Decision Analysis.

Figure 2 shows the diagrammatic representation of all the data collection channels and the conceptual frameworks used for the data analysis. The set of data collection channels represented within the blue box is used to conduct each of the data analysis methods using the conceptual frameworks which are mentioned in the blue box in the Data analysis section. For each of the conceptual frameworks Scenario Planning, Business Model Canvas, Flow Diagrams and Ecosystem Mapping, all three data collection methods of Literature Survey, Semi-structured interviews and the data collected from participating in project workshops are used. These analyses are then used to discuss the implementation strategy of the Cologistics hub. Similarly, for the Multi-Criteria Decision Analysis shown in the red box, the Multi-Criteria Decision Analysis Survey is the only Data Collection method and then the analysis results are used to discuss the perception of the Cologistics hub solution.

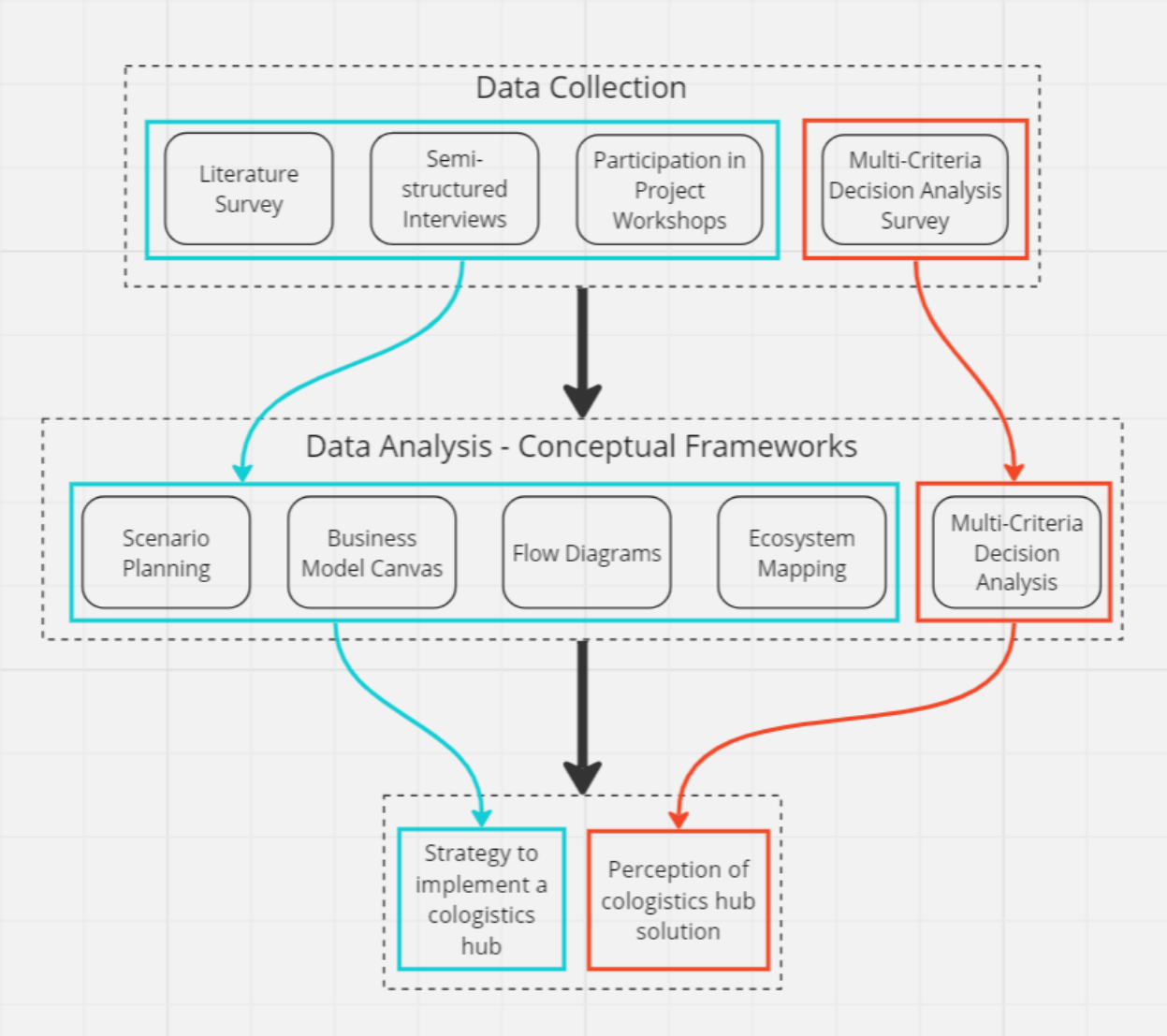

Figure 2. Diagrammatic Representation of Data Collection Channels and Data Analysis Frameworks.

Throughout this section, the chosen research methods are elaborated upon; the reasons for their selection and the data collection processes are explained in detail. Additionally, the conceptual frameworks are described comprehensively, and the ethical considerations underpinning the research are discussed.

3.1 Data Collection

To comprehensively address the research questions and objectives, a multi-faceted data collection approach was employed, combining insights from various sources. An operationalisation framework was developed to guide the data collection process shown in Table 2. This framework began with outlining the research questions and sub-research questions, followed by identifying specific indicators to be investigated for each sub-research question. Next, the data collection and the analysis methods, such as literature review, interviews etc., were determined for each sub-research question. Then the relevant stakeholder types relating to each sub-research question were identified.

Lastly, a list of interview questions was compiled and the questions corresponding to each sub-research question were shown. The interview questions are shown in Appendix 1. Interview Questionnaire. It is important to note that these questions served purely for reference purposes and were not necessarily asked verbatim or in a specific order during the interviews. The Operationalization framework is designed for efficient data collection using different Data collection methods. The data collection process comprised four primary methods: semi-structured interviews with stakeholders, an extensive literature review, active participation in project workshops, and the administration of a Multi-Criteria Decision Analysis (MCDA) survey. This diversified approach ensured the triangulation of the data, enhancing the study's validity and reliability. The following sub-sections will elaborate on each data collection method in detail, explaining their significance and application within the research context.

Table 2. Operationalization Framework

Sub research Question	Indicator	Answered by	Questions asked to (Stakeholder type)	Interview question number*
1. What additional services/businesses can be integrated into the Cologistics hub in addition to deliveries and waste management?				
a. What will be the third-party services which make use of the hub for their operations?	1. Integration - Services that are coherent with the existing platform. 2. Purpose - Value added/Profitable/Scalability.	1. Literature Review 2. Market Research 3. Interviews	Circular Logistics IT Services Waste Management	3
b. How are the stakeholders' current logistics, warehousing, and waste management operations and what are the added values gained by the stakeholders with Cologistics hub service?	1. Logistics operation requirements. 2. Added Values. 3. Decision-making factors while choosing logistics providers.	1. Interviews 2. Literature Review 3. Analysis	All Stakeholders	1, 2, 4, 5, 6, 7, 8, 9
2. What do the operational flows look like for the hub solution?				
a. What do the system's material flow, information flow and money flow look like and what are the corresponding infrastructural requirements?	1. Material flow 2. Information flow 3. Monetary flow	1. Analysis	Waste Management	10
b. Which factors are the most important for stakeholders when it comes to choosing the hub solution over other alternatives?	1. Important factors and infrastructure requirements	1. Analysis 2. MCDA Survey	All Stakeholders	11
3. What are the most feasible strategies to operationalize the business models for maximum scalability given the context mentioned in questions 1 and 2?				

a. What are the different scenarios based on the needs?	1. Scenarios	1. Analysis	Waste Management	
b. For different scenarios, how could the different business models look like for the hub provider?	1. Business model	1. Analysis 2. Literature Review	Waste Management	
c. What does the collaboration ecosystem with different stakeholders look like?	1. Ecosystem map	1. Analysis	All stakeholders	

*** Refer to Appendix 1. Interview Questionnaire**

3.1.1 Semi-structured Interviews

To obtain primary data, semi-structured interviews were conducted with representatives from seven identified stakeholder categories: Circular Logistics companies, Construction companies, Delivery Service providers, Real Estate property managers, Waste Management companies, Retail companies, and Municipalities. These stakeholder categories are identified as stakeholders from these categories who are either already involved in existing Cologistics hub projects/initiatives such as Älskade Stad and/or have shown interest in getting involved in future Cologistics hub projects/initiatives such as Urban Logistik Barkarby. Within each stakeholder group, at least one company was interviewed up to the limit of three. The companies which were interviewed are located primarily in Sweden except for one company, which is based in Norway. In addition to the previously mentioned selection criteria, the companies were chosen based on their location and their alignment with the identified stakeholder groups. The representatives from each company were selected based on their sound knowledge of their company's logistics and waste management operations and their understanding of the challenges faced in these areas. The interviewed individuals and their companies were selected with utmost effort to be representative examples of different identified stakeholder groups. The inputs received from these individuals are generalised to their respective stakeholder group.

The interviews, conducted online, followed a semi-structured format with open-ended questions with the help of the developed operationalisation framework and the questionnaire as a reference, allowing for flexibility and encouraging participants to express their perspectives freely. Usually, with open-ended questions, answers from the interviewees were naturally obtained for multiple questions at the same time without asking for them specifically. These interviews were recorded and then transcribed using automatic transcription software. Initially, the interviewees were not given a detailed description of the Cologistics hub solution. Instead, they were asked about their current 'Jobs to be done,' the needs and pain points in their existing operations, and further inquiries were made. This approach was undertaken to prevent participants from associating their challenges with the Cologistics hub solution and attempting to match their problems to it. Only after discussing their genuine concerns were the respondents introduced to the concept of the Cologistics hub. The data obtained from the interviews were analysed using thematic analysis, identifying commonalities and differences among the stakeholders. This method helped identify the distinct needs of the stakeholders and preferences when it comes to logistics and waste management operations, as well as their perspectives Cologistics hub as a potential solution.

Total number of Interviews conducted: 10.

Interviews of representatives from Delivery companies: 3

Interviews of representatives from Retail companies: 1

Interviews of representatives from Real estate companies: 2

Interviews of representatives from Waste Management Companies: 2 (from the same company)

Interviews of representatives from Circular economy companies: 1

Interviews of representatives from Municipality: 1

In addition to these interviews, the interview transcripts from 4 previously conducted interviews as part of a course assignment associated with the project 'Urban Logistics Barkarby' were also used.

3.1.2. Literature Review

An extensive literature review was conducted to give a theoretical foundation for the study and to identify gaps in the existing knowledge base. Relevant literatures were found using various tools, including web searches, academic databases such as Google Scholar, and AI-powered tools like Elicit were also used. The emphasis was on finding the most recent articles, particularly those published in 2020 and later, to ensure that the latest research developments and findings are surveyed. Elicit, an AI powered tool was used to efficiently identify relevant papers on the topic. To ensure research accuracy, a snowball sampling technique was utilised, examining the references of identified papers to discover more relevant sources. The literature review focused on key topics such as urban logistics, urban consolidation centres, collaborative urban logistics, electrification in urban logistics and business models.

3.1.3. Participation in Project Workshops

As part of the data collection process, the researcher attended workshops held for the Urban Logistic Barkarby project, the Jernhusen Malmö project and a few more internal workshops conducted by Ragn-Sells where the researcher is stationed. These workshops comprised representatives from stakeholder groups involved in Cologistics hub projects, discussing their operational requirements and needs. As an active participant, the researcher gathered valuable insights to supplement the findings from interviews and the literature review. Observations and notes obtained during these workshops provided additional context and practical examples for the study.

3.1.4. Multi-Criteria Decision Analysis Survey

The Multi-Criteria Decision Analysis (MCDA) survey served as another data collection method to better understand stakeholder priorities when deciding on logistics and waste management solutions. The survey content included a brief explanation of the Cologistics hub concept, followed by a series of questions aimed at comparing the participants' perception of the Cologistics hub solution to their business-as-usual practices. The same interview participants, who were representatives from the identified stakeholder groups, willingly responded to the survey.

The selection of factors and the survey structure were explained in detail later in the thesis. Once the data from the MCDA survey was obtained, it was analysed to determine the most critical factors for

stakeholders when evaluating a potential Cologistics hub. Results from the analysis were used to develop a robust understanding of stakeholder preferences and contributed to the formulation of well-informed recommendations for Cologistics hub implementation.

These revisions ensure a deeper understanding of the data collection methods mentioned in the in-depth elaboration of each section, encompassing relevant details, and establishing clear connections between the collected data and the research questions being addressed.

3.2 Conceptual Frameworks

To analyse the data collected through interviews, literature review, workshop participation, and the MCDA survey, various conceptual frameworks were utilised. Using these frameworks ensured that the analysis and examination of information was systematic. The following sub-sections will give an explanation on each conceptual framework used in the study, explaining its purpose, the method of implementation, and relevance to the research objectives.

3.2.1 Scenario Planning

Scenario planning is a strategic foresight tool that helps organisations prepare for and navigate uncertain future situations. It involves developing a set of alternative future scenarios based on certain factors and exploring their implications (Dean, 2019). Scenario Planning is used due to its ability to create structured and coherent future scenarios while considering various factors such as potential stakeholder needs and legislative changes. The primary goal in using this approach was to develop three specific scenarios, representing a spectrum from simpler, existing situations to more complex future possibilities. By identifying these scenarios, it became feasible to understand which stakeholders would be involved in each case and build a tailored business model for each unique scenario.

This framework helped to examine how the Cologistics hub solution might evolve and adapt to emerging challenges, stakeholder requirements, and regulatory alterations. By focusing on three scenarios with clarity and comparability across the scenarios, it enabled an in-depth assessment of the implications and opportunities in each scenario.

From the data collection process, key driving factors influencing the Cologistics hub solution were identified. From these factors, three distinct scenarios were created that differed in complexity: Scenario 1 represented a simpler existing situation, Scenario 2 was slightly more complex, and Scenario 3 reflected the most advanced and complex. Each scenario was created based on the stakeholder needs, emerging flows, and potential legislative changes.

The analysis then involved the construction of business models tailored to each of the three scenarios. By applying Scenario Planning in this simplified manner, the study provided a clearer understanding of future opportunities and risks, resulting in more informed, adaptable, and effective Cologistics hub implementation strategies for each of the three scenarios.

3.2.2 Business Model Canvas

The Business Model Canvas is a visual framework that gives an outline of the essential building blocks of a business model, with key components such as customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.

Business Model Canvas was used to emphasise the differences in the three business models derived from the three separate scenarios created using Scenario Planning. By building these business model canvases for different identified business models, the readers get an understanding of how each business model is different and see the differences in the components of the business model canvas.

The decision to use this framework is due to its ability to provide a visual and easy-to-understand representation of different business models of Cologistics Hub solution and providing a structured approach to business development. Additionally, these business model canvases can be used as a guidebook or a reference for future cologistics projects.

The business model canvas allows the readers to identify the strategic and operational differences between different scenarios and different business models while providing a deeper understanding of the added values and the target customer types.

Here is a brief explanation of each component of the Business Model Canvas:

Customer Segments

Customer segments section represent the different groups of identified stakeholders the Cologistics hub service can be offered to. Each scenario may have different and unique combination of customer segments based on the services provided.

Value Propositions

The value propositions describe the added values the Cologistics hub solution offers to each customer segment.

Channels

Channels in the business model canvas refers to the methods in which communication is performed with stakeholders and customers.

Customer Relationships

Customer relationships in the business model canvas show how the business interact with the customers.

Revenue Streams

Revenue streams in the business model canvas represent how the revenue from the business is generated. For example, it can usage based, commissions or subscription based.

Key Resources

Key resources are the assets that are essential to develop and implement the Cologistics hub solution. These assets include physical infrastructure, digital infrastructure, regulatory permissions/compliance etc.

Key Activities

Key activities are the actions needed to operate the Cologistics hub solution, involving supply chain management, waste management coordination, and collaboration with stakeholders. Key activities might vary across the three scenarios, owing to the differences in customer segments, key partnerships, and channels.

Key Partnerships

Key partnerships involve collaborations and support from various stakeholders and organisations, in addition to the customer segments, required for the successful implementation and smooth functioning

of the Cologistics hub solution. These partnerships may include technology providers, infrastructure developers, regulatory authorities, and various service providers, among others. The partners and their roles can differ from one scenario to another.

Cost Structure

The cost structure contains all the financial outlays associated with implementing and operating the Cologistics hub solution. Depending on the scenario and the business model, the cost structure may vary in terms of infrastructure investments, resource allocations, and operational expenditures. The cost structure and financial analysis is outside the scope of this research and therefore, not addressed in depth.

3.2.3 Operational Flow Diagrams

Operational Flow Diagrams are diagrammatic representation of the operations, and they are used in the analysis to represent the material flow, money flow, and information flow for different types of good flows within the Cologistics hub ecosystem. The online whiteboard tool called Miro is used for mapping the operational flow diagrams. Different types of good flows, such as Business-to-Business (B2B), Business-to-Consumer (B2C), and Peer-to-Peer (P2P), are indicated with different colours with a clear distinction between the different types of flows.

The diagrams provide a general operational overview which is helpful for establishing a functional Cologistics hub. Different stakeholder types are also represented in different blocks. The primary purpose of these Operational Flow Diagrams is to create an in-depth understanding of the overall operations within the Cologistics hub.

The Operational Flow Diagrams focuses on the operations in Scenario 3 which includes all three Business Models discussed. As the most complex model, it contains of all varieties of good flows, including B2B, B2C, and P2P.

3.2.4 Ecosystem Mapping

Ecosystem Mapping is a research methodology, or a framework introduced by (Uhrdin & Engwall, 2022) for analysing and understanding the relationships and interactions between different actors within a specific ecosystem. According to Uhrdin & Engwall, (2022), a business ecosystem is a complex network of organizations, individuals, and institutions that are interconnected and interdependent while offering a service and delivering added value to customers. In this report, Uhrdin & Engwall, (2022), they use the concept of the business ecosystem to analyse the roles and relationships of different actors in the ecosystem.

The Ecosystem Mapping tool/framework helps identifying the key players, their roles, and how they interact with one another. It helps to achieve better understanding of the service offering and the interaction of various stakeholders in the ecosystem by mapping the value proposition offered by each stakeholder to the business or service offering. By mapping the ecosystem, the areas of improvements can be pinpointed, and corresponding strategies can be developed to address them. (Uhrdin & Engwall, 2022)

In this this, Ecosystem Mapping is employed in a different way compared to the report, Uhrdin & Engwall, (2022) to examine the Cologistics hub ecosystem present in Scenario 3. Ecosystem mapping helped identifying how the added values created by service offerings of the stakeholders benefit themselves in exchange for their involvement in the ecosystem.

3.2.5 Multi-criteria Decision Analysis

The Multi-Criteria Decision Analysis (MCDA) was used as a means of comparing the alternatives of Business as Usual (BAU) and Cologistics Hubs under various criteria relevant to the stakeholders. The survey was sent to the representatives from each stakeholder group. Also, please note that the stakeholder types: Residential Real Estate Properties, Commercial Real Estate Properties, Construction Companies and Property Developers are grouped into a single group 'Real Estate' for the Multi-Criteria Decision Analysis to simplify. The following methodology was employed to guide the decision-making process by systematically analysing stakeholder opinions and comparing how each alternative performs against selected criteria.

1. Problem Identification

The method aims to determine the viability of Cologistics Hubs compared to the business-as-usual approach for various stakeholders and the importance of different factors when it comes to choosing a logistics and waste management solution.

2. Criteria Selection

Criteria relevant to the research question were identified based on the analysis conducted so far in the research process which are:

1. Quality of logistics service.
2. Quality of waste management service.
3. Sustainability.
4. Future legislative changes.
5. Cost-effectiveness.
6. Customer reach/service.

3. Survey Design and Data Collection

A survey was developed to capture stakeholders' pairwise comparisons and ratings for each criterion. The first part of the survey aims to collect data to rate different criteria against each other to be able to calculate the weights. A brief description of the survey was given shown in Figure 3 below and a brief explanation for every factor was given before the respondents rated the criteria against each other shown in Figure 4 below.

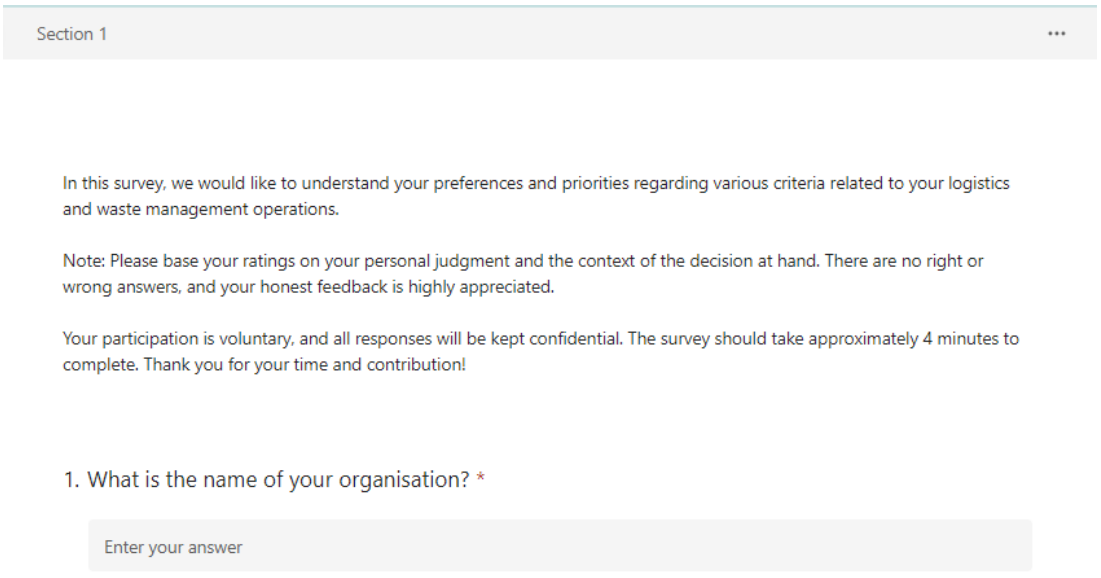

Figure 3. Survey Section 1 - Description

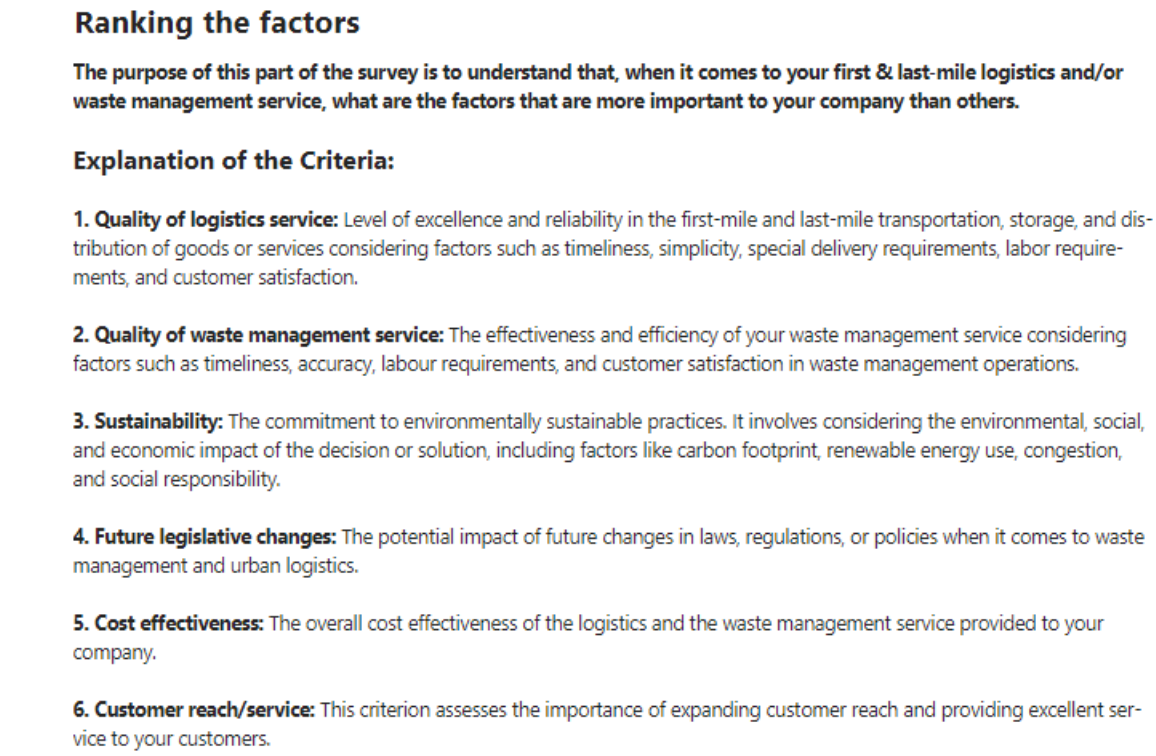

Figure 4. Survey Section 1 - Criteria

Then the respondents were asked to rate every criterion against each other ranging from 1 to 9 as shown in Figure 5. This is to calculate the weights based on Analytic Hierarchy Process.

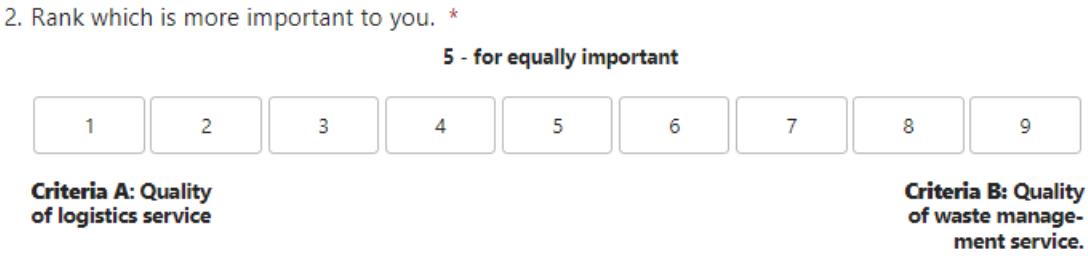

Figure 5. Survey - Ranking

And in the final section of the survey, the respondents were asked to rate each criterion in their current 'Business-as-usual' solution and the Cologistics hub solution on a scale of 1-5. Before making the respondents rate the Cologistics hub solution, an explanation was provided so the respondents can rate based on their perception. The description provided is shown in Figure 6.

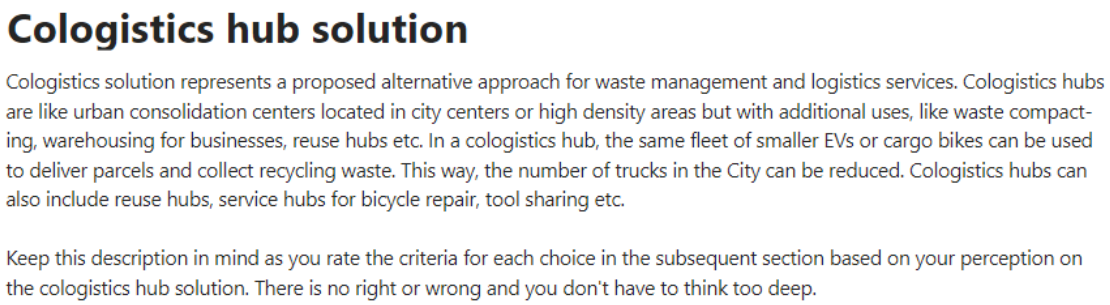

Figure 6. Survey – Cologistics Hub Explanation

The full survey is shown in Appendix 2.

4. Data Collection

The survey was made on Microsoft Forms and administered to representatives from each stakeholder group, and clear instructions were provided for filling out pairwise comparison questions and providing ratings as shown above.

5. Data Analysis

Survey responses were collected and compiled. Average values for each pairwise comparison were calculated to determine the relative importance of each criterion. Pairwise comparison matrices were constructed for each level of the hierarchy.

6. Weight Calculation

The Analytic Hierarchy Process (AHP) method was used to calculate weights for each criterion based on average values from pairwise comparisons. The geometric mean of each row in the matrices was calculated and normalised, resulting in the weights of the criteria. This was done with Microsoft Excel.

7. Alternative Evaluation

Relevant sub-criteria for BAU and Cologistics Hubs were identified. Weighted scores for each sub-criterion were calculated by multiplying the corresponding weight and rating provided by the representative. Overall scores were obtained by summing up the weighted scores for each alternative. The online tool, Multi Criteria Decision Making Calculator from Revoledu is used for the calculation of the final scores. Multi-Criteria Decision Making Calculator (revoledu.com)

8. Interpretation and Comparison

The results were interpreted by comparing the overall scores of BAU and Cologistics Hubs alternatives, analysing the findings based on their rankings, and determining which alternative performed better according to the chosen criteria.

9. Discussion and Conclusion

The implications of the results, limitations, and potential areas for further research were discussed. The findings were summarised, and conclusions were drawn based on the MCDA analysis.

Applying MCDA in this manner allowed for a comprehensive decision-making process, considering multiple criteria and stakeholder perspectives to determine the viability and attractiveness of the Cologistics hub solution and allowed for a better understanding of the importance of different identified factors.

Total number of survey respondents: 12

3.3 Ethical Considerations:

The research is conducted with the utmost respect for ethical principles, ensuring the confidentiality and anonymity of the participants. The informed consent of interviewees is obtained before each interview, with the assurance that the collected data will be used solely for this study. Any direct quotes from participants or sensitive information are anonymised in the final report to protect the privacy and identity of the respondents.

4.0 Findings

The findings from the data collection process are discussed in this section with the helpful of the conceptual frameworks discussed in the previous section.

Figure 7 summarizes how the findings are represented in various conceptual frameworks.

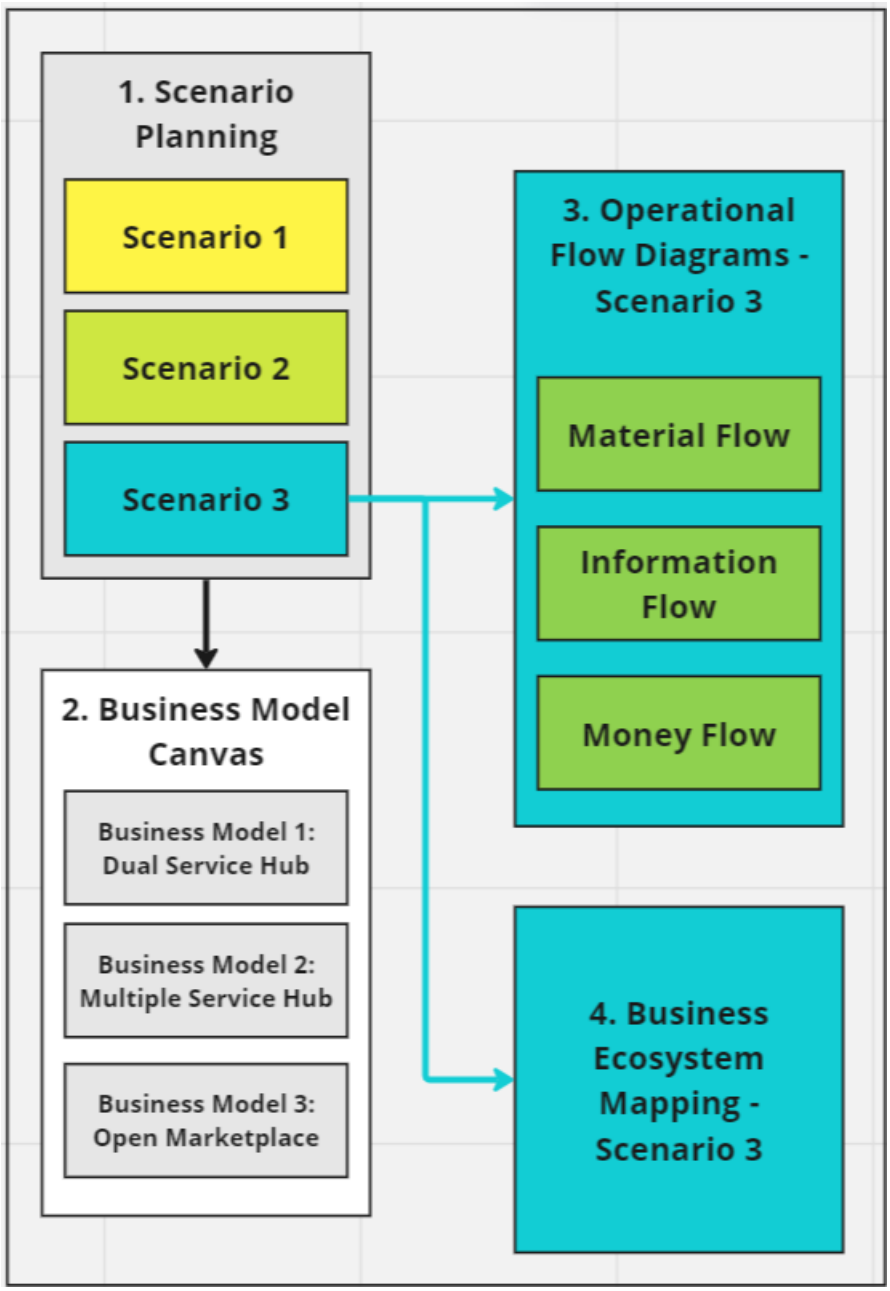

Figure 7. Representation of Findings Structure.

4.1 Scenario Planning

The scope of the scenario planning is limited to the stakeholders of the projects and some external stakeholders who were involved during the research. From the data collection process, the stakeholder types in Cologistics hubs are categorised into:

1. Waste Management
2. Delivery Companies
3. Residential Real Estate Properties

4. Commercial Real Estate Properties
5. Construction Companies and Property Developers
6. Retail
7. Third-Party Services and other Businesses.
8. Government and Citizens

The identification and categorization of stakeholders in Cologistics hubs were primarily rooted in their potential as customers for a Cologistics hub solution. Stakeholders were initially identified based on their relevance and potential interest in utilizing or benefiting from Cologistics hub. Then, these stakeholder types were categorized into distinct groups based on their specific needs, operational roles, and relevance to the logistics, waste management and other services offered within Cologistics hubs ecosystem.

Based on the research, 3 scenarios are developed from various identified driving forces. These driving forces were identified based on stakeholder requirements, mainly focusing on the 'jobs to be done' and the pain points of different stakeholders.

4.1.1 Driving Forces

By focusing on the jobs and the pain points, the needs of the stakeholders are identified, and the driving forces are identified. This approach made sure that the driving forces identified the real needs in their core business and operations of the stakeholders involved and significantly reduced the impact of their bias and interest towards establishing a Cologistics hub project. This is essential to ensure that the driving forces contributing to the development and scalability of Cologistics hubs fit into the core business and operations of potential stakeholders. Mainly the interview process focused on understanding the 'jobs to be done' and the pain points of stakeholders along with other mentioned data collection methods, these are some of the identified driving forces for planning future scenarios for the scalability of Cologistics hubs based on the approach discussed above.

1. Electrification of last-mile delivery vehicles.
2. Restrictions on the size of vehicles in city centres.
3. Zero emission zones.
4. Rising last-mile delivery costs.
5. Rising sustainable practices among delivery companies.
6. Stricter regulations on waste management.
7. The rising rate of e-commerce.
8. Need for simpler delivery and waste management operations for businesses.
9. Increased government efforts for collaboration.
10. Rise of companies offering circular economy solutions.
11. Increase in cargo bike usage for last-mile deliveries.

4.1.2 Scenarios

Based on these driving forces, three scenarios are developed. These scenarios show the step-by-step process starting with Scenario 1 being the simple one and Scenario 3 being the ultimate one. Then for each scenario, a business model is formulated and suggested along with the system flows in the next sections.

4.1.2.1 Scenario 1 – Third party last mile service: Delivering goods for delivery service providers.

In this scenario, the waste management company provides last-mile logistics as a third-party service to the delivery companies. The waste management company uses the Cologistics hub as an urban consolidation centre for the parcels. The parcels are sorted if required and loaded into the smaller EVs and delivered to the customers of the delivery service providers. These customers may be both businesses and individuals. Älskade Stad with Ragn-Sells and Bring is a perfect example of this scenario. Therefore, this is a current scenario.

For this scenario, there needs to be an agreement between the waste management company and the delivery companies. In Älskade Stad, there is just one delivery company however, there can be multiple providers which can deliver part of their last-mile deliveries via Cologistics hubs. Älskade Stad works well also due to the marketing aspect involved with the initiative. However, for multiple companies to collaborate on such an initiative would be more difficult. From an interview with the biggest delivery provider in Sweden, it is found that when it comes to other delivery companies doing last-mile delivery for them, there is a strong hesitation. It is mainly due to the data sharing aspect of such a collaboration however, they were moderately positive towards a third-party company doing it for them through a Cologistics hub. At first glance, a Cologistics hub solution may look like it only provides green marketing as added value for delivery service providers. However, with all 3 interviews and research, more significant added values are identified which are the primary motivations for collaboration with delivery service providers and can also generate further interest. These added values are discussed in-depth in section 4.5.

For this scenario, Business Model 1: Dual-Service Hub from section 4.2, is suggested. The number of stakeholders in this scenario can be as low as 2 with just a waste management company and a delivery service provider for it to work. In this case, with just 2 stakeholders, the space for the hub can be rented either by the waste management company or the delivery provider and the information can be sent via API to either of their IT systems. It must be noted that in Älskade Stad, the operational workers and the drivers use both Ragn-Sells' IT system and Bring's IT system independently to do their operations. They currently use two different smartphones/devices to scan the barcodes on the parcels. This operation can be potentially streamlined with data exchanges or with a unified IT infrastructure. Additional stakeholders in this scenario can include a real estate property that provides the space for the hub and is directly involved in the business operations of the Cologistics hub, an IT infrastructure provider and the municipality which can play different roles.

4.1.2.2 Scenario 2 – Customer pull: Taking care of the customer's incoming deliveries.

In this scenario, in addition to providing last-mile logistics as a third-party service to the delivery companies to deliver the goods to their customers, the service is also provided to residential and commercial real estate properties to manage their receiving deliveries. These properties should be located in the service zone surrounding the Cologistics hub. This scenario is created based on the need for reduced complexity while performing goods deliveries and waste collection. Both commercial and residential real estate properties are facing problems managing deliveries when multiple delivery providers deliver goods at different times. This requires a lot of effort and labour for the property managers and/or tenants to manage which created the need for them to have a single player manage the deliveries. The added values for the real estate properties are discussed in detail in section 4.5.

In the case of Ragn-Sells, they have been providing the service of managing the incoming deliveries to their customers who are located in the same premises of the waste management hub. This service has been a part of their regular "City services" offerings for a few years. The parcels which are to be delivered to these businesses are received in the hub, and then Ragn-Sells performs the last-metre delivery to the premises of these businesses. This delivery service is combined with the waste management service offered to the same customers. However, the new proposed scenario includes offering this service in the entire service zone of the Cologistics hub and not just limited to the premise of the hub. This service offered to businesses and properties creates more flows out of the hub in addition to the flows created by delivering the goods for delivery providers.

To provide the services in Scenario 2, an agreement with the delivery company is needed similar to that of Scenario 1 and agreements with the end customers to receive and manage their deliveries are also needed. Therefore, this scenario requires to have 2 different business models. Therefore, both Business Model 1: Dual-Service Hub and Business Model 2: Multi-Service Hub need to be deployed for this scenario which will be discussed in Section 4.2.

4.1.2.3 Scenario 3 – Open market: Logistics + Warehousing as a service.

In this scenario, the last-mile logistics and city hub warehousing is provided as an open service to any business or individuals within the service zone. This is enabled using an IT platform through which the customers can avail of this service. In this scenario, the hub performs more than just a collection point for deliveries and waste management. This scenario can also include third-party services such as service stations, reuse stations and other services mentioned in Section 4.1.3 integrated into the physical and digital infrastructure of the hub. In this scenario, third-party services can make use of the physical and digital infrastructure of the Cologistics hub solution to offer their service and create added value through the hub ecosystem. One example can be a bicycle repair shop opening up in the hub and utilizing the logistics service to receive bikes, repair them and ship them back. Another example can be a cargo bike company offering to deliver last-mile deliveries. Circular economy model companies such as tool sharing, cloth sharing companies and so on can also make use of the logistics and warehousing services offered by the Cologistics hub. In this scenario, the Cologistics hub ecosystem needs to maintain a considerable amount of inflow and outflow in the hub to be able to offer this service to everyone in the zone. Therefore, it is essential to still have the flows that are generated by delivery companies, real estate properties and other businesses.

Since this scenario requires all such flows, it needs to have all three identified business models Business Model 1: Dual-Service Hub; Business Model 2: Multi-Service Hub and Business Model 3: Open Marketplace incorporated. These three business models are discussed in Section 4.2.

4.1.3 Third-Party Services

Through the data collection channels, these are some of the identified third-party services that can make use of the Cologistics hub's logistics services, warehousing services and/or the space in the hub for their operations. As briefly discussed in section 4.1.2.3, these third-party services play a crucial role in Scenario 3. The added values that these third-party services can receive by being part of the Cologistics hub

ecosystem are discussed in section 4.5.7 however the importance of these identified added values can vary significantly depending on the type of business of these third-party services.

- **Reuse Stations**: The hub can be utilized for reusing items which are collected as waste or to be reused.
- **Repair Stations**: Repair stations offering repair services for various items can make use of the Cologistics hub space and the logistics service for their operations.
- **Product Sharing Services:** Services such as tool sharing, rental clothes, bicycles etc. can use the space and the logistics services of the Cologistics hub along with the digital infrastructure. This will contribute to the increase in the circular economy.
- **Mobility Services:** Mobility Services such as e-scooters and on-demand bike sharing services can use the Cologistics hubs for their operations. This also includes recharging the batteries and refitting them onto their vehicles when required.
- **External Delivery Services:** External delivery services such as Cargo bikes, Autonomous delivery vehicles or Drone deliveries can make use of the Cologistics hub infrastructure to offer services and as a test bed to test their technology.

4.2 Business Models

These 4 business models are identified and developed mainly based on the type of stakeholders, the services offered through the hub and based on the business agreements.

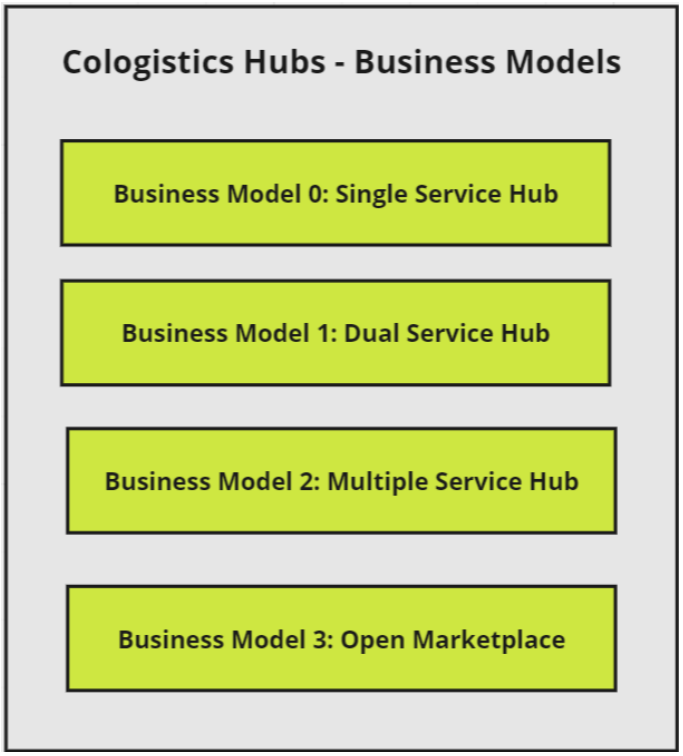

Figure 8. Cologistics Hubs – Business Models

4.2.1 Business Model 0: Single Service Hub

Business model 0 represents a traditional Urban Consolidation Center where the delivery service provider owns or leases the hub to perform delivery consolidation and perform last-mile deliveries from the consolidation center. This is a single-service hub as the hub and the vehicle fleet are used only to provide the delivery service. This Business model is just shown to depict a UCC and is not relevant to this study where we analyze Cologistics hubs.

4.2.2 Business Model 1: Dual Service Hub

Business model 1 represents a dual service Cologistics hub where the hub is utilized for consolidation of last-mile deliveries along with waste management. In this business model, there is an agreement between the waste management company and one or more delivery companies. According to the agreement, the waste management company will perform the last-mile deliveries on behalf of the delivery companies. In this case, the inflow to the hub is generated by parcels coming in, waste collection and the reverse logistics of the deliveries and the outflow from the hub is generated by waste transport and some parcels going out. For this service, the waste management company can be compensated monetarily, or they can turn profits from the waste generated from these deliveries. Älskade Stad is the perfect example of a Dual Service Hub since the Älskade Stad initiative follows a very similar business model with an agreement between the waste management company, Ragn-Sells and the delivery company, Bring.

The business model canvas for Business model 1: Dual Service Hub is shown in Figure 9.

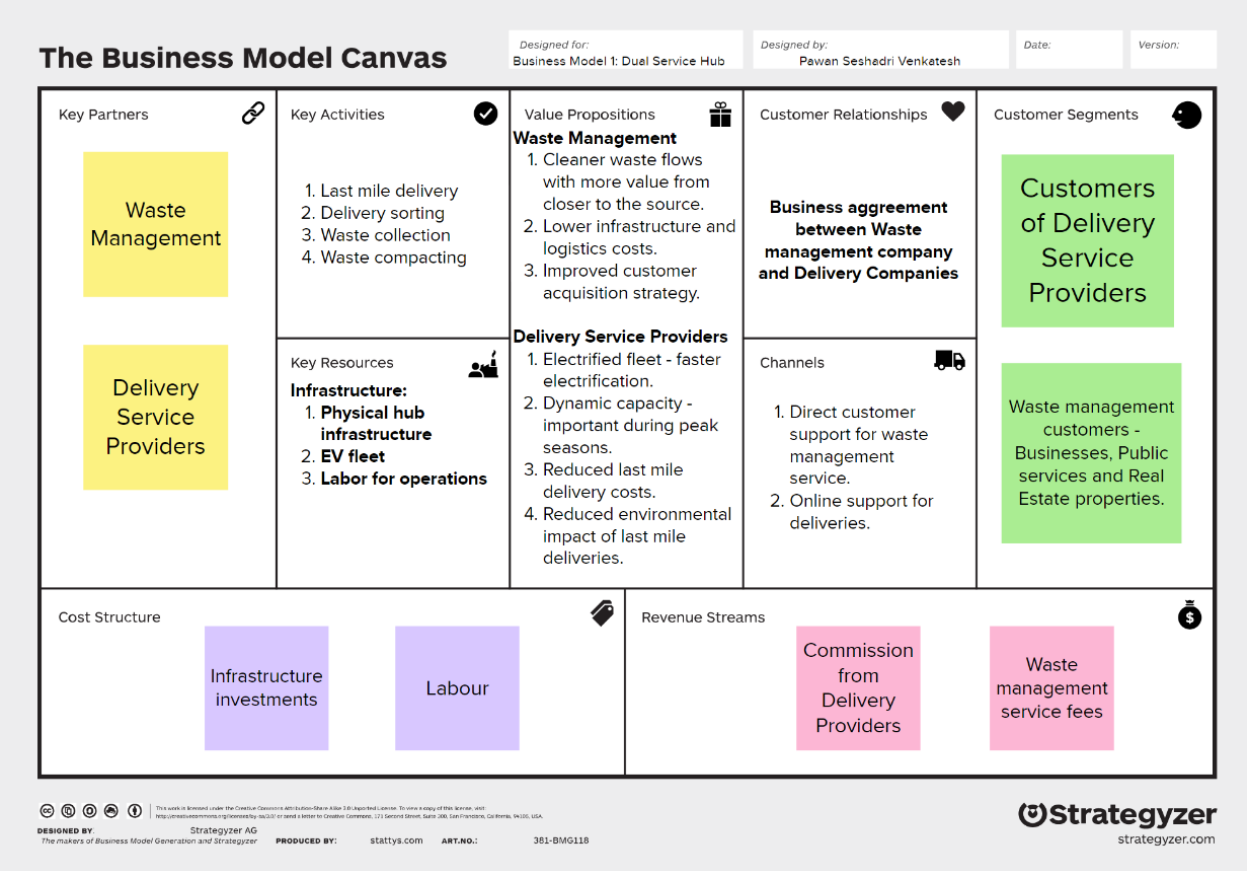

Figure 9. Business Model Canvas: Dual Service Hub

4.2.3 Business Model 2: Multiple Service Hub

In this business model, the waste management company will generate flows by providing services to businesses such as retail, real estate properties, construction companies and public service buildings. For providing the delivery and waste management services to these businesses through an individual agreement with them, a certain amount of service charge will be charged. Since the companies are responsible for managing their waste, they would have to hire a waste management company anyways and with the Cologistics service, their delivery needs are also taken care of and create additional added value to them.

The business model canvas for Business model 2: City Services Model is shown in Figure 10.

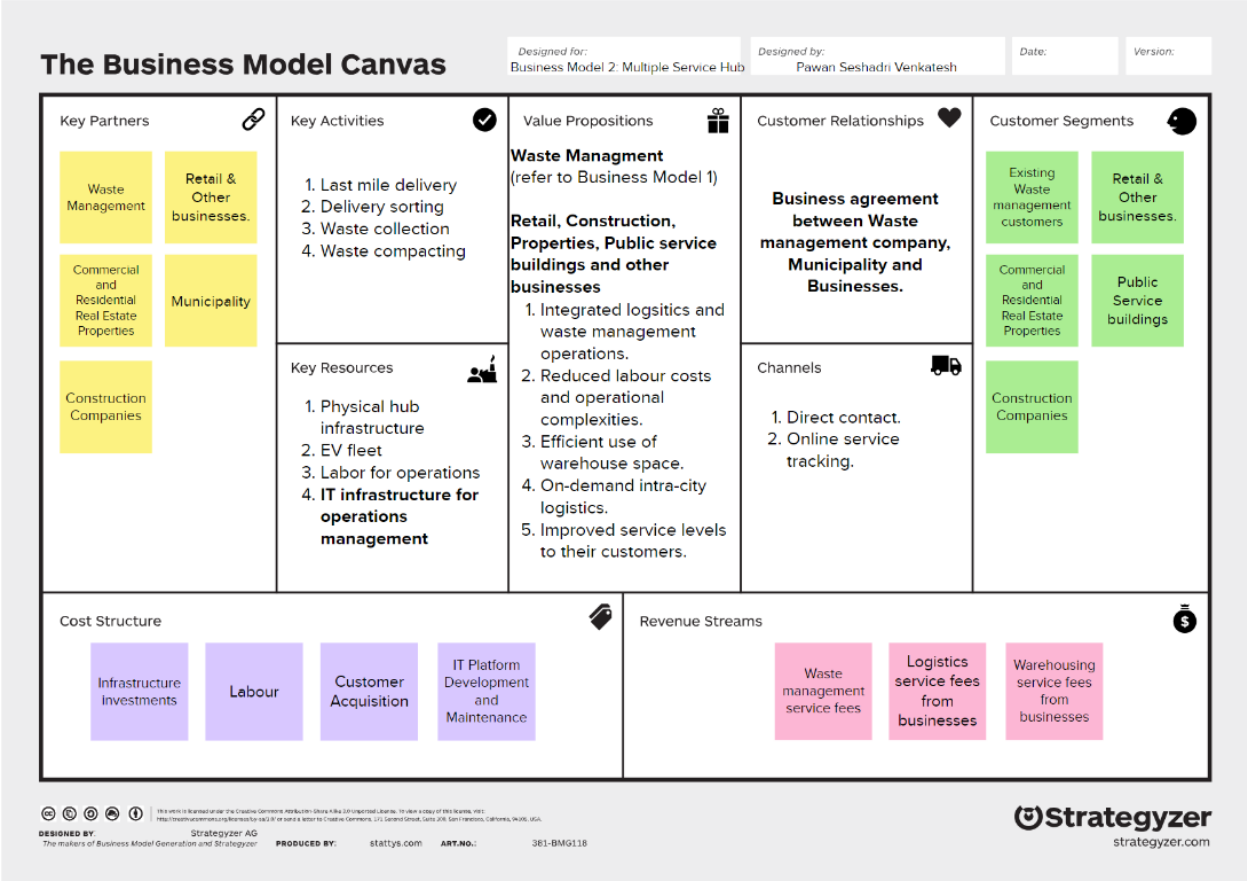

Figure 10. Business Model Canvas: Multiple Service Hub

4.2.4 Business Model 3: Open Marketplace

This business model represents an open marketplace with the help of a digital platform. The logistics and warehousing as a service are offered through the digital platform to everyone in the service area where businesses and individuals can make use of it. The establishment of a digital platform or an IT system will be essential for enabling delivery service providers, businesses, and individuals to opt for logistics and city warehousing services. The key difference between the multiple service hub and the open marketplace is

that the city services model is limited by the number of agreements businesses have with the waste management companies whereas the open marketplace is open for all businesses and individuals in the service area. To offer this logistics and warehousing as a service to every business and individual located in the service area and make it easily scalable, simpler processes are required instead of individual agreements via businesses. Therefore, a sophisticated digital platform or IT system is required to manage orders, send and receive data from various delivery platforms and also perform operational planning is required.

The business model canvas for Business Model 3: Open Marketplace is shown in Figure 11.

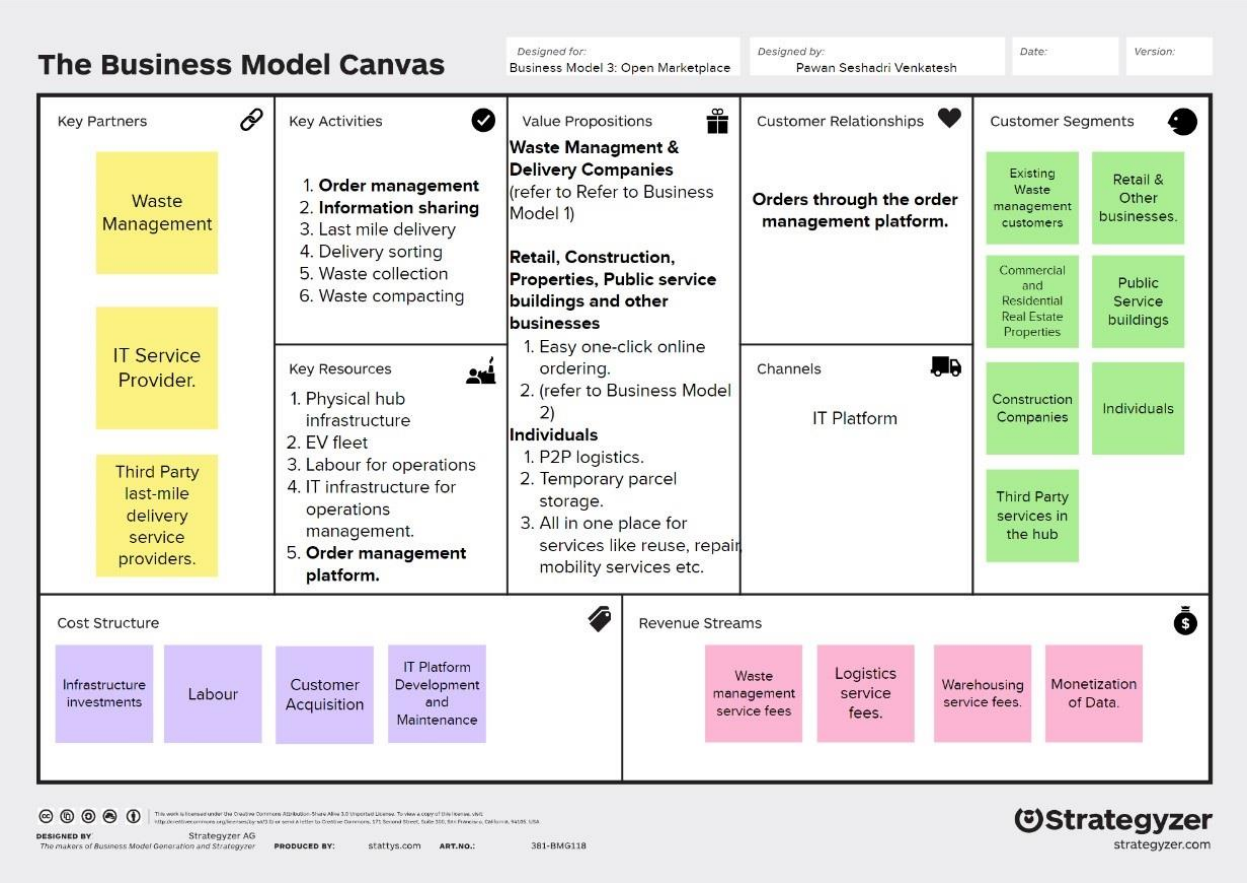

Figure 11. Business Model Canvas: Open Marketplace

4.2.5 Business Models in different Scenarios

To summarize the business models suggested for each scenario,

Scenario 1: Business Model 1

Scenario 2: Business Model 1 + Business Model 2

Scenario 3: Business Model 1 + Business Model 2 + Business Model 3

Scenario 1 only needs to have Business Model 1. Scenario 2 needs to have both business models 1 and 2. Scenario 3 must include all three business models. This is represented in Figure 12.

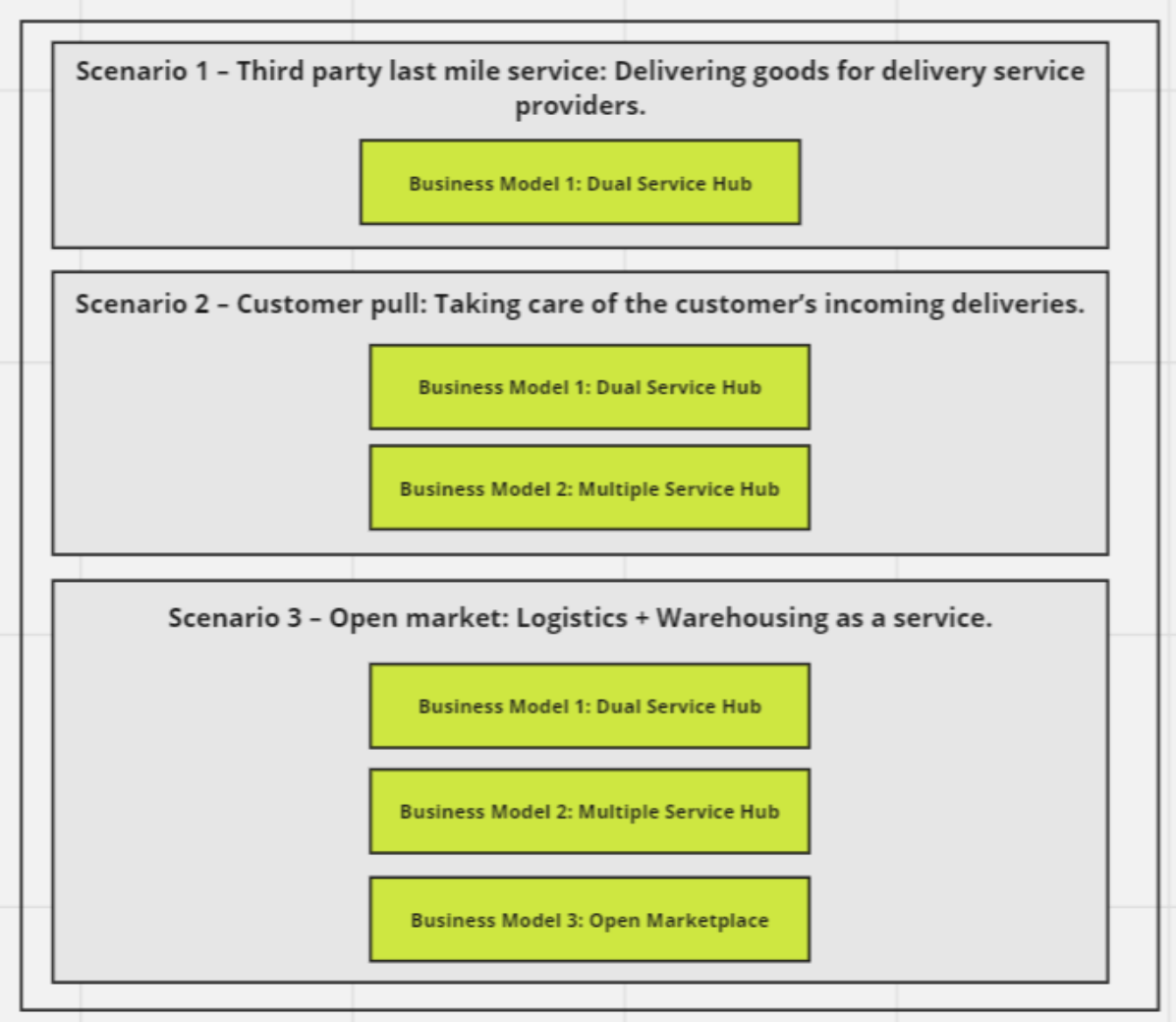

Figure 12. Scenarios and respective Business Models

4.3 Operational Flow Diagrams

For the open market model, which can include all different types of goods' flows, the operational flow diagrams are modelled and shown. These diagrams show three types of flows which give a deeper understanding of the operations of a Cologistics hub. These flows are.

1. Material flow
2. Information flow
3. Money flow

The terms referred to in the diagrams:

- B2B – Business-to-Business

- B2C – Business-to-Customer

4.3.1 Material flow

They show the flow of different kinds of goods as well such as

1. Parcels B2C – The parcels that are delivered to the individuals living in apartments or houses.
2. Parcels B2B – The parcels that are delivered to the businesses such as commercial buildings, public services, and construction sites.
3. Waste – The recycling waste and other waste picked up from the residential real estate properties, commercial buildings, public services, construction sites, and the waste from the service hub.
4. Reuse – The items that are to be reused.
5. Services – The items to and from the service hub.

As seen in Figure 13 below, the Cologistics hub contains 4 sections, the delivery hub, waste collection hub, re-use hub and service hub. The Delivery hub will be responsible for unloading, delivery consolidation, sorting and loading into vehicles. The waste collection hub is where the waste and recycling materials are collected, sorted, and compacted. If any items received in the waste collection hub can be re-used or services, they are sent to the re-use hub and the service hub respectively. The re-use hub is where the re-usable items are collected, sorted, and stored. From the re-use hub, either individuals can directly come and buy/collect items or they can browse through the digital platform to choose items they want, and it can be delivered through the delivery hub and the vehicle feet to their residence. Re-use hub is provided separately from other service hubs since it can allow citizens/individuals to come, browse and shop for or collect the re-usable items they need. The service hub will be the station for all the other services in the Cologistics hub such as repair stations, item sharing, mobility services etc. A service hub is where third-party businesses can set-up their required infrastructure. As you see in the operational flow diagrams, depending on the type of materials, different hubs are utilized. This categorization will be a foundation for more complex construction planning and also operational planning of Cologistics hubs.

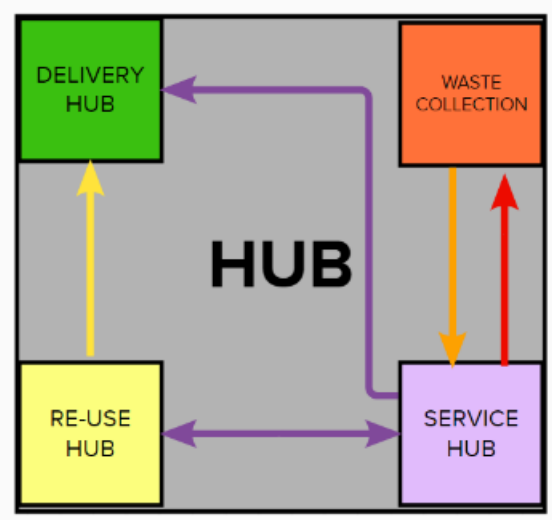

Figure 13. Internal Operational Flows of a Cologistics Hub

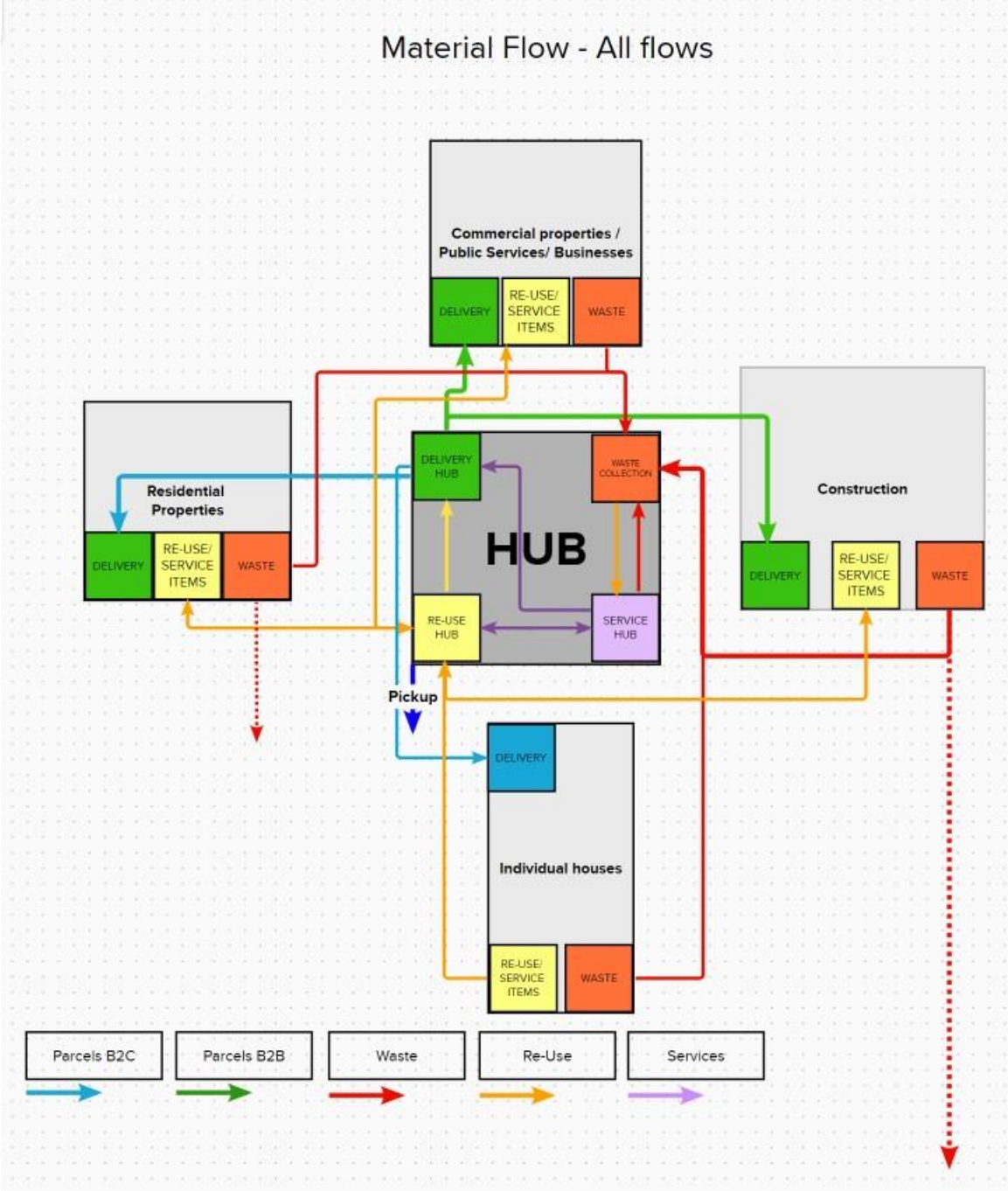

Figure 14. Operational Flow Diagram – Material Flow – All Flows

Figure 14 shows the material flows of all types of flows in the Cologistics hub in the Scenario 3.

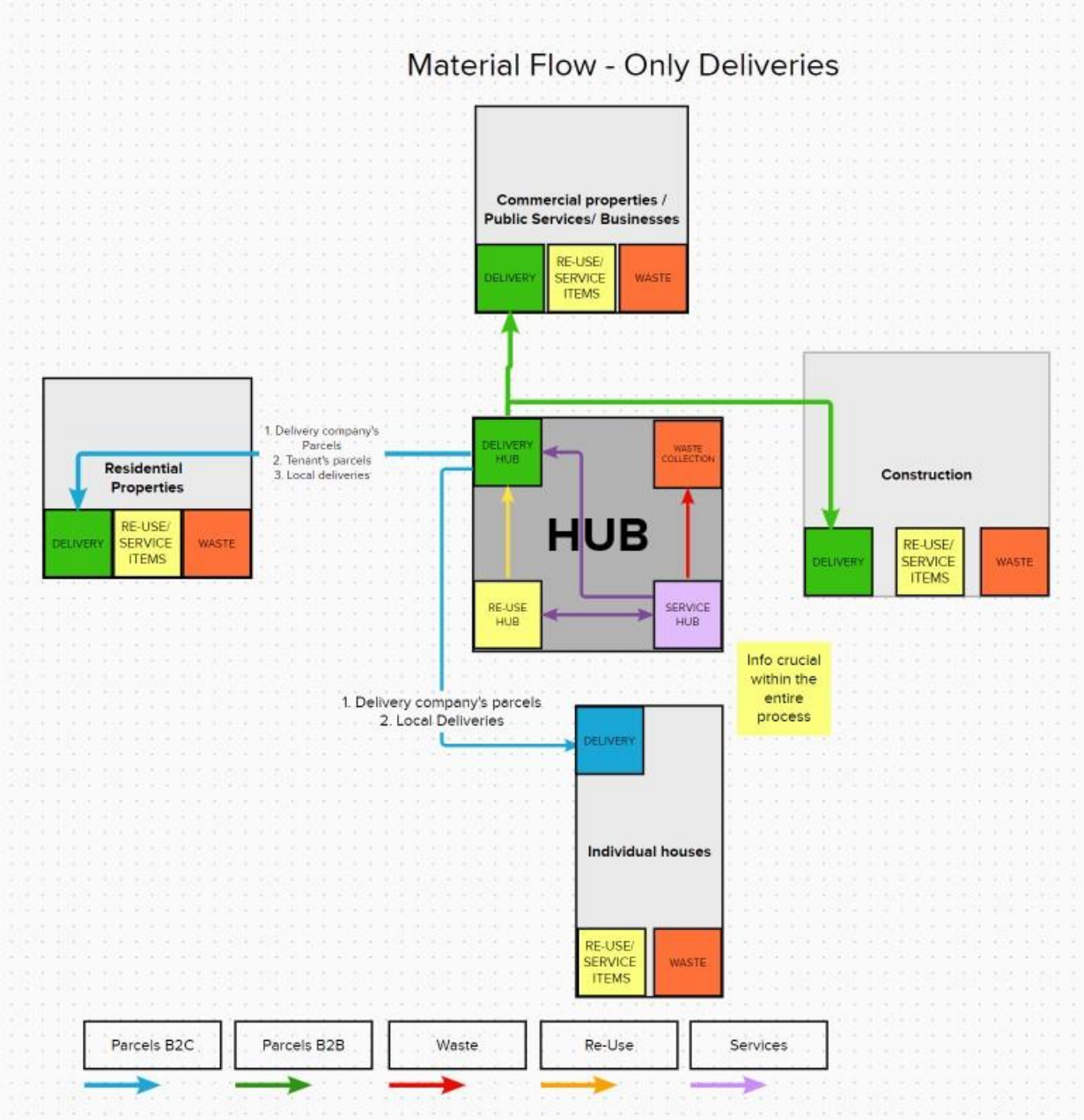

Figure 15. Operational Flow Diagram – Material Flow – Deliveries

Figure 15 shows only the delivery flows in the Cologistics hub operations.

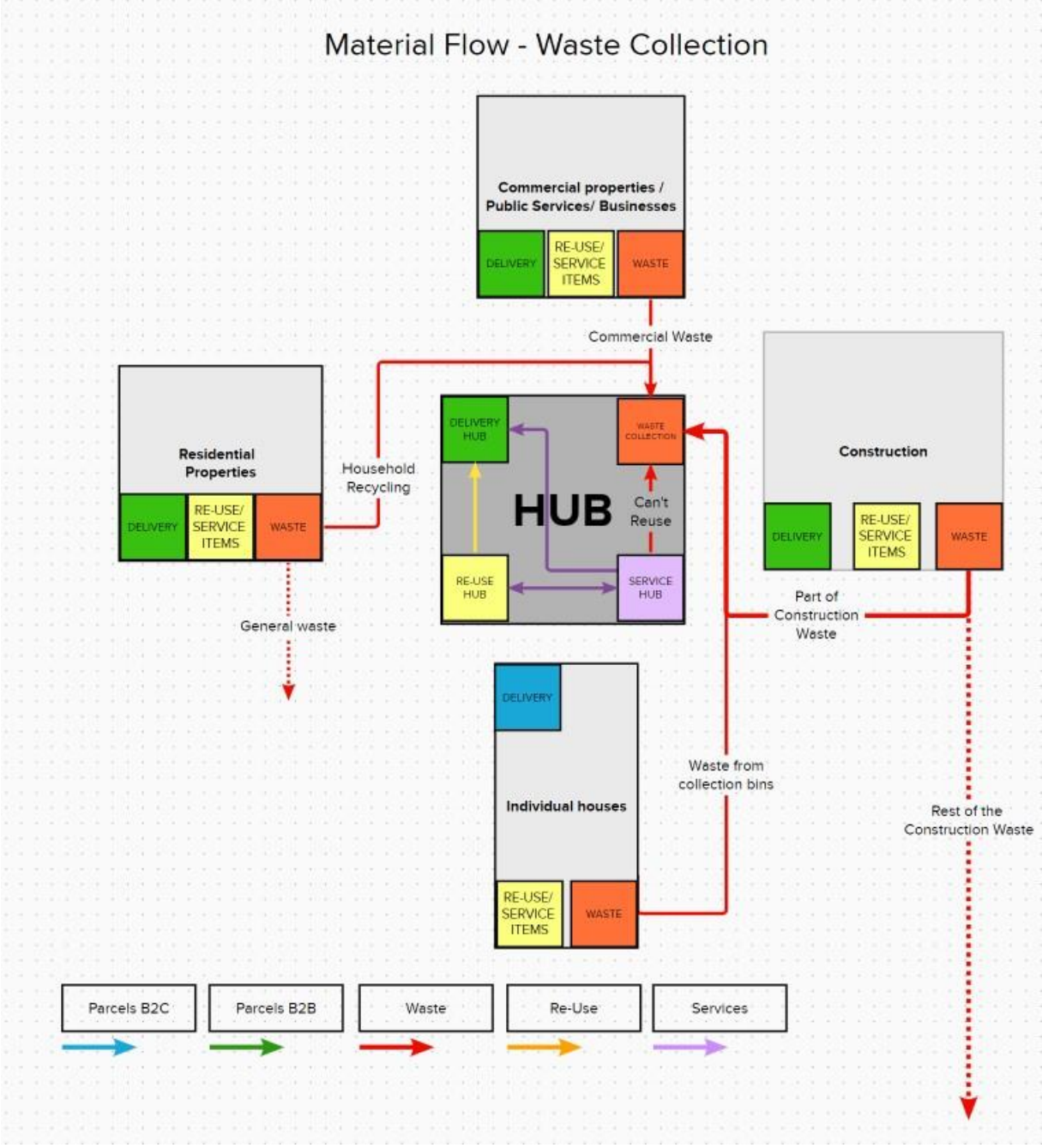

Figure 16. Operational Flow Diagram – Material Flow – Waste Collection

Figure 16 shows only the waste flows in the Cologistics hub operations.

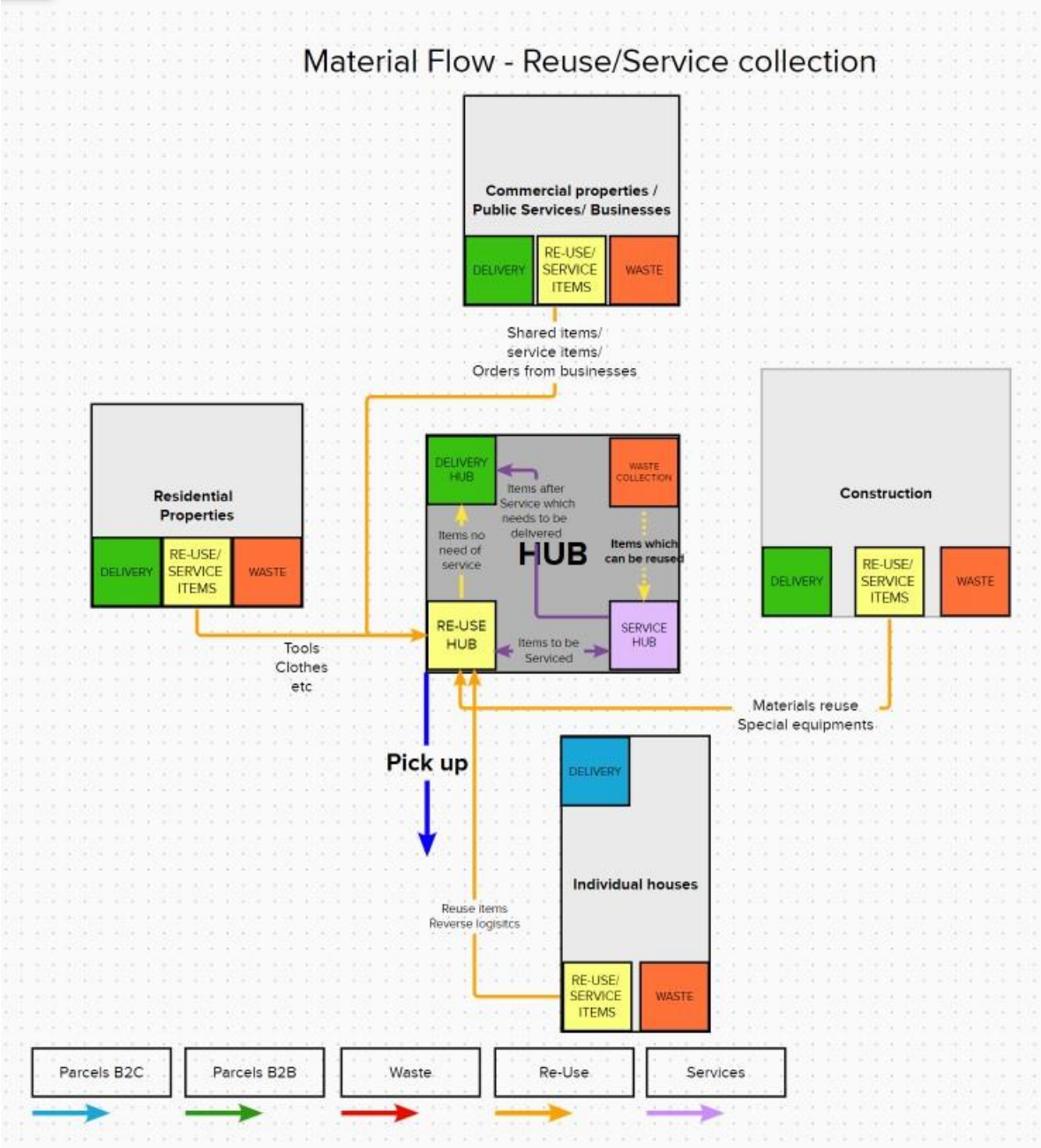

Figure 17. Operational Flow Diagram – Material Flow – Reuse/Service

Figure 17 shows the re-use/service flows in the Cologistics hub operations.

4.3.2 Information Flow

These figures show the information flow required for the functioning of the Cologistics hub. The blue dotted lines show the business agreements and the red dot lines show the information flows that are essential but not through the Cologistics hub system. 'Agreements' in these diagrams refer to the business agreements between the different stakeholders.

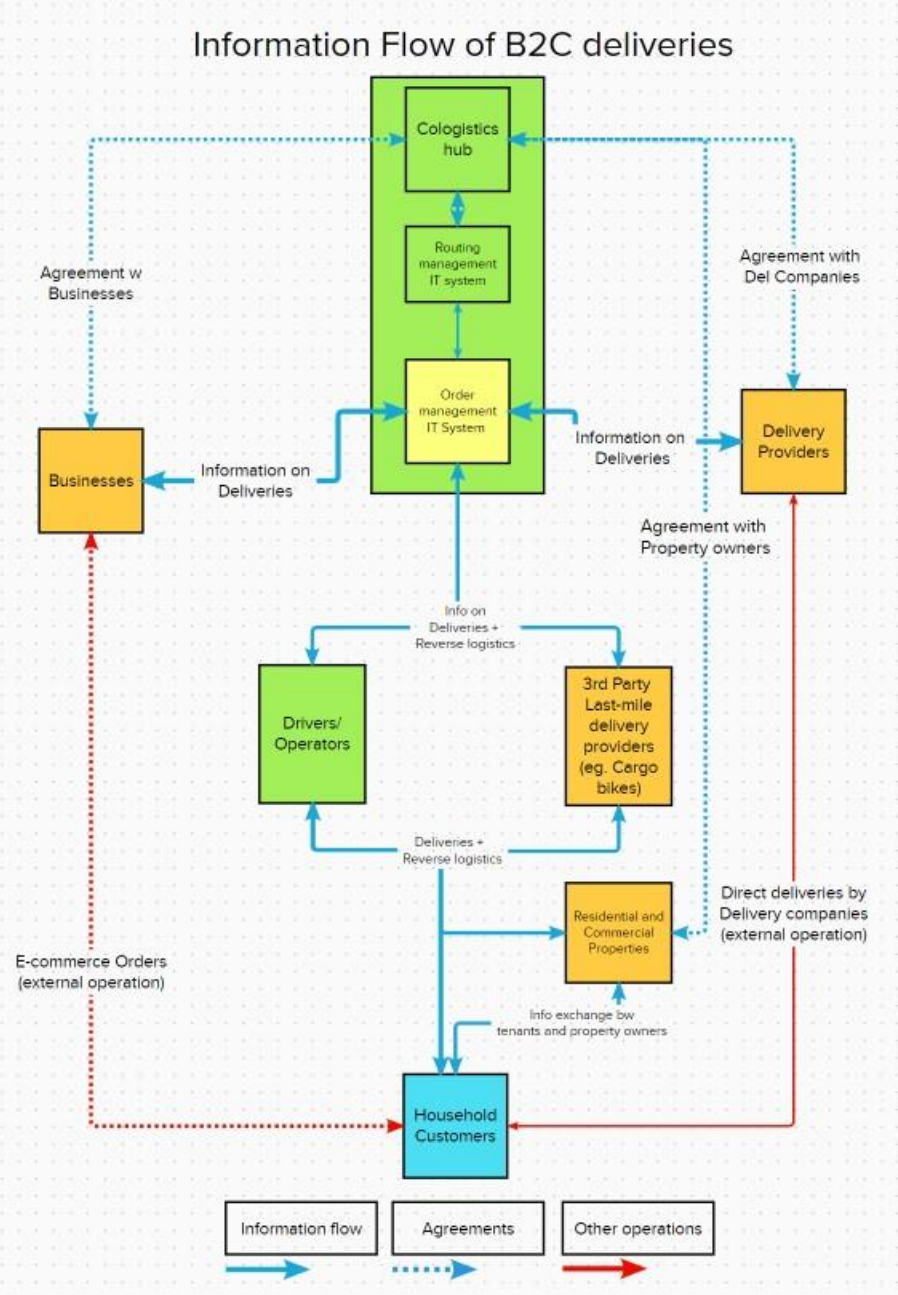

Figure 18. Operational Flow Diagram – Information Flow – B2C Deliveries

Figure 18 shows how the information flows when B2C deliveries are performed. B2C deliveries are the deliveries that are delivered to the individual household customers.

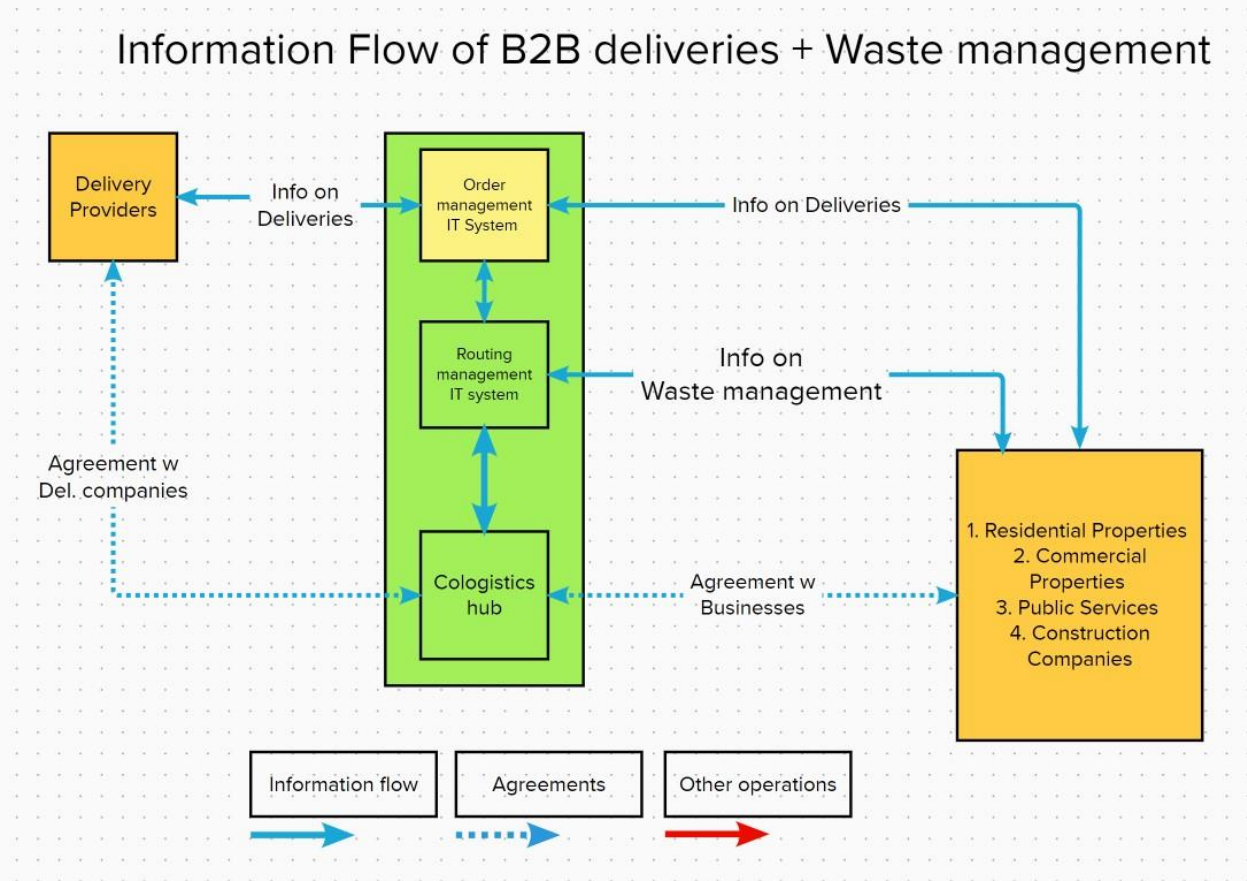

Figure 19. Operational Flow Diagram – Information Flow – B2B Deliveries + Waste

Figure 19 shows the information flow when B2B deliveries and B2B waste management operations are performed.

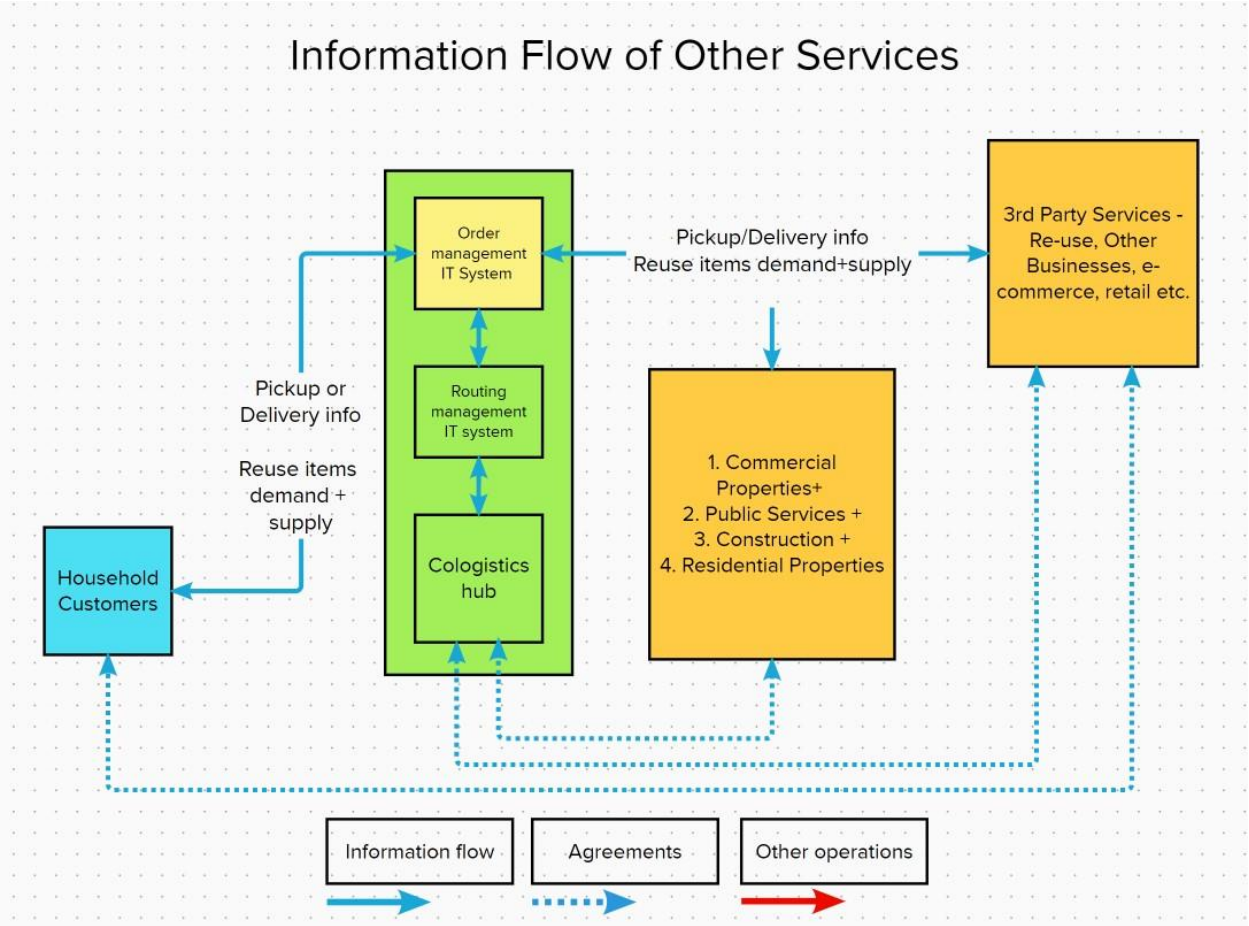

Figure 20. Operational Flow Diagram – Information Flow – Services

Figure 20 shows the information flow when added services such as re-use or third-party services such as repair, shared items etc. are provided.

4.3.3 Money Flow

The money flows show the different types of monetary flows happening in the system among the stakeholders. This gives a brief idea about the cost and the revenues from the business models but mainly this is mapped to guide designing the digital infrastructure to accommodate all the money flows in the system. Figure 21 shows the money flow occurring in Scenario 3 between all the stakeholder types.

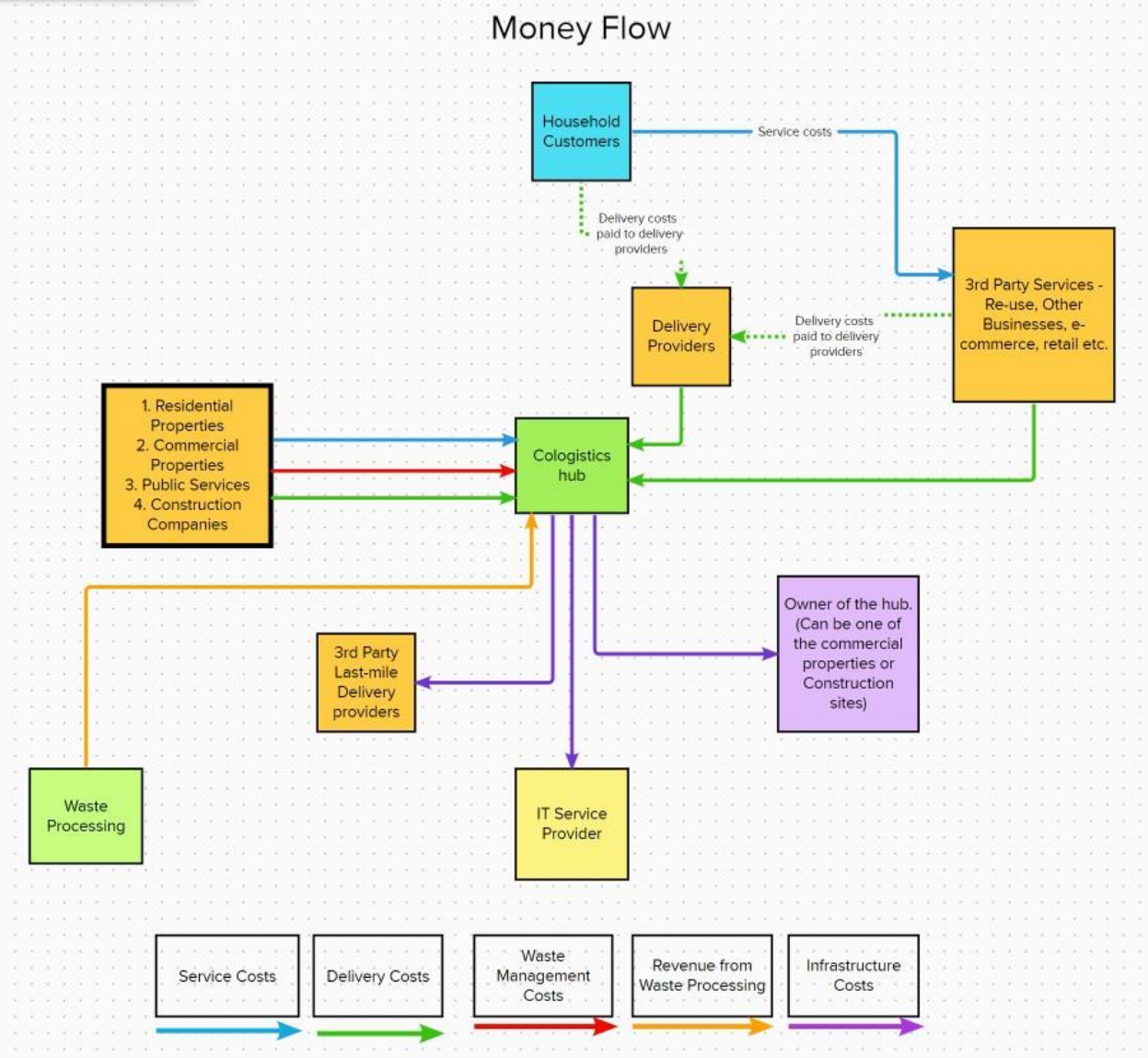

Figure 21. Operational Flow Diagram – Money Flow – Services

Figure 22 below represents the money flow only in the open marketplace business model which is just Business Model 3 and not Scenario 3. Figure 22 is shown to represent the money flow occurring through the digital platform offered for third-party services in Business model 3: Open marketplace model. This diagram eliminates all the other types of money flows occurring based on Business models 1 and 2. This diagram can be helpful for organizations who only want to build a lean open marketplace Cologistics hub solution.

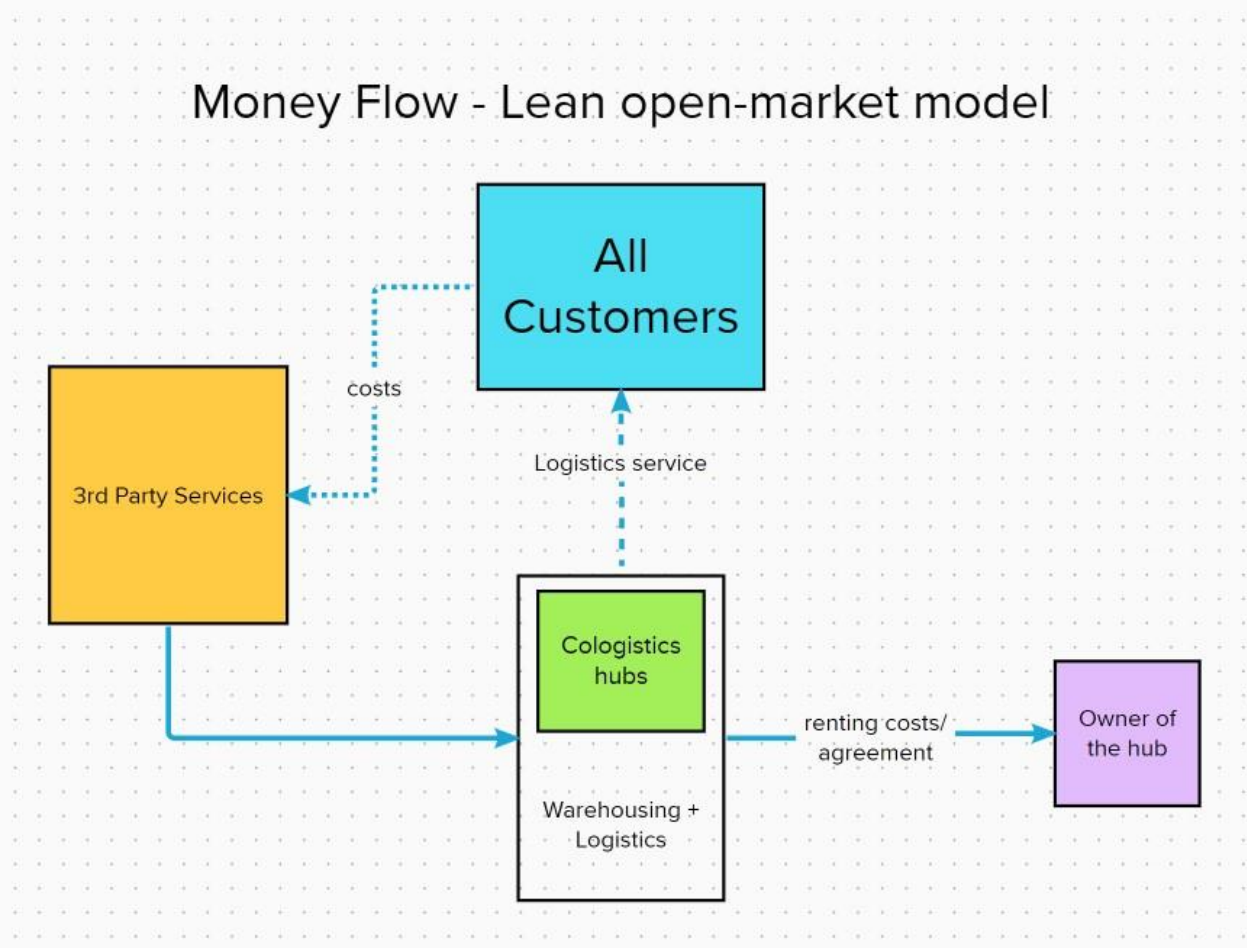

Figure 22. Operational Flow Diagram – Money Flow – Lean Open marketplace model

4.4 Business ecosystem map

Business ecosystem mapping is performed for Scenario 3 with all identified stakeholders, all three business models and all types of flows involved. This gives a good representation of the business environment. The Business Ecosystem Mapping for Scenario 3 is shown in Figure 23 below. The ecosystem map shows four sections. The first section, the left most, shows the value propositions. This section highlights various 'added valued' of the Cologistics hub solution. They are shown in different colours to map the individual value propositions to the stakeholder it benefits.

For example, the value proposition "On-demand services" coloured in red represents an added value for the stakeholder segment of Individual households and the stakeholder group of Retail, Construction, Real Estate Properties, Public Service Building and Other businesses. This shows that these stakeholders benefit from on-demand services offered to them and therefore it is a value proposition for these stakeholders. Likewise, the stakeholder segment of third-party services benefits from both the space offered to them in the hub and the logistics + warehousing service they can get from the Cologistics hub solution.

The stakeholders are shown in the second section. These stakeholders have offerings and activities that are essential for the functioning of the Cologistics hub which are shown in the third section. The offerings/activities listed can be offered or fulfilled by one or more stakeholder groups. For example, the hub infrastructure required for the Cologistics hub can be provided either by a commercial real estate company or the waste management company. Several stakeholders contribute to good inflows and outflows to and from the hub. These can also be identified with the colour of the arrows matching the colour of the stakeholder group.

All these offerings/activities make up a functioning Cologistics hub. The Cologistics hub has the operations of logistics, waste management and other services which creates value proposition for the primary and secondary stakeholders in the ecosystem. This represents that the hub solution generates value for most of the stakeholder groups involved in the ecosystem.

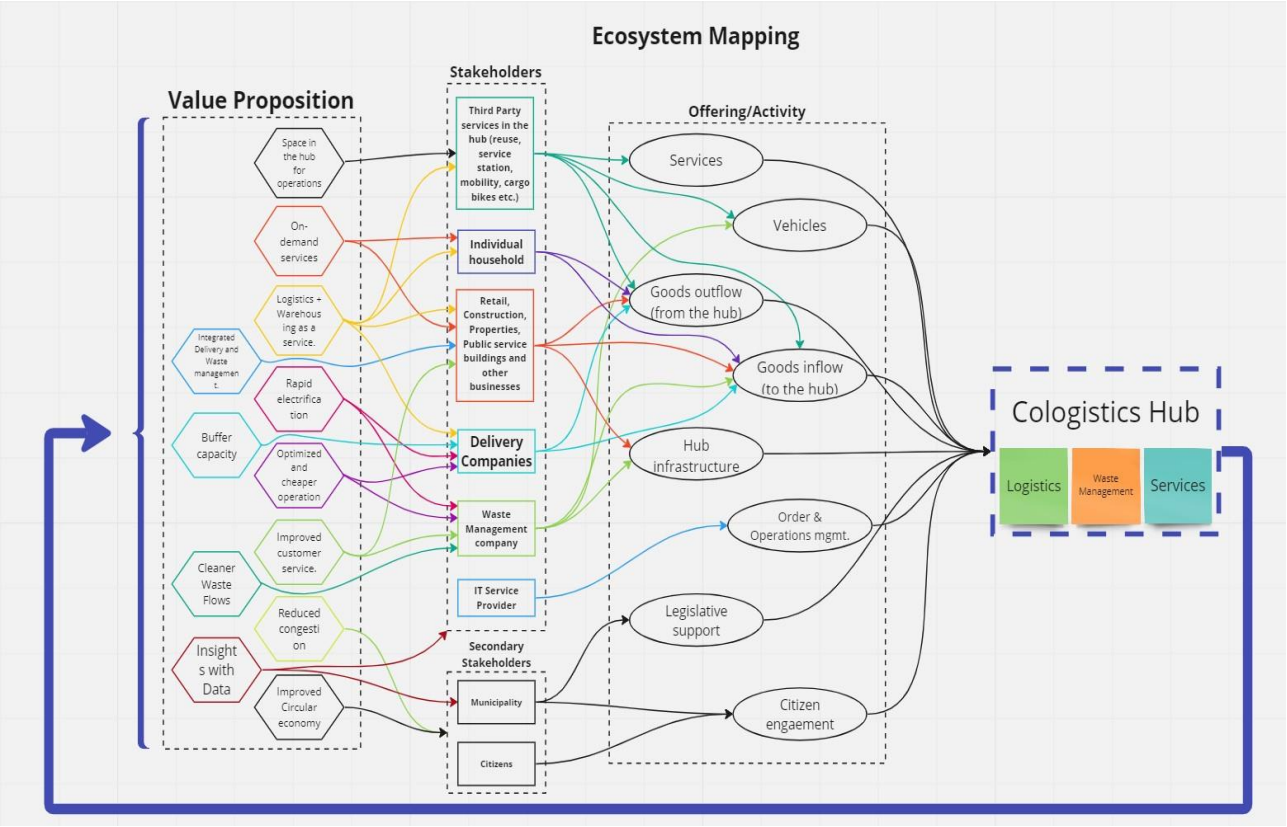

Figure 23. Business Ecosystem Mapping

4.5 Added values of Stakeholders.

Through the interviews and literature survey, the added values of Cologistics hubs for different stakeholders are identified. These added values are mainly derived from identifying 'jobs to be done' and the needs of the stakeholders and how can these needs be solved with the Cologistics hub solution.

4.5.1 Waste management

Waste management companies offer waste management solutions to their customers which are mostly businesses. Since the businesses are responsible for the disposal of their waste, they pay for the services of waste management companies to deal with them. Recycled materials have an economic value, and

waste management companies make money selling these materials in the commodity market. Through the Cologistics hub operations, waste management company would be able to collect different material types such as papers, plastics, metals, rubber along with e-waste and hazardous waste. The type of waste that a waste management company collects depends on the company's ability to deal with that particular type of waste. The added value for waste management companies in the Cologistics hub solution is.

1. Cleaner waste flows: Through the implementation of Cologistics hubs, waste management companies have better access to cleaner waste materials, need less sorting and are closer to the source. Cleaner waste flows reduce the cost of recycling especially due to the high costs involved in the sorting process.
2. Lower infrastructure costs: Since the Cologistics hub solution has a shared use of city hubs, it costs lower for waste management companies to establish the city hubs. City hubs are required for waste management companies with a fleet of smaller EVs as the hubs contain infrastructure for waste compacting and then bigger trucks are used to take them away to the waste management centre outside the city.
3. Lower logistics costs: Due to the shared usage of the EV fleet which collects the waste from their customers, the operational costs are lower for waste management companies offering this service to deliver goods.
4. Customer acquisition: With the Cologistics hubs, performing deliveries to new customers who are mainly businesses, the sales pipeline gets bigger for a waste management company and customer acquisitions become much easier and potentially cheaper. This is one of the most important added values that the waste management company gets by operating the Cologistics hubs.

4.5.2 Delivery companies

Delivery companies are key players in the Cologistics hub ecosystem. The delivery companies have a complex and extensive logistics network, but their last-mile deliveries are still not optimised and cost the most. They must comply with the local regulations on delivery times. With inputs received from interviewing 3 major delivery companies in Scandinavia, complying with the local regulations and rapid electrification are the major challenges for them. These companies have ambitious sustainability targets and reducing CO_2 emissions created during last-mile deliveries is for them one of those sustainability targets. Therefore, electrification and reducing the total number of trips for last-mile deliveries are essential. With an incentive of making the last-mile delivery process financially cheaper, more optimised and environmentally sustainable, delivery companies are highly interested in the Cologistics hub solution which has potential scalability and financial sustainability and provides the added values listed below that former UCC projects have not fulfilled.

1. Accelerated electrification of the last-mile fleet: Due to rapid electrification happening in the logistics industry and regulations getting stricter on the type of vehicles used to deliver last-mile deliveries, delivery companies need rapid electrification. This need also arises when their competitors are electrifying rapidly, and it is a risk for delivery companies to stay non-electrified, especially when the whole industry is electrifying and poses a potential risk of running out of business when customers opt for more environmentally friendly options. Electrification, however, can be very expensive. For legacy logistics companies, which generally run on minimal profit margins, these can be vast investments with returns taking multiple years to break even. However, with the use of shared Cologistics hubs, sharing the fleet of electric vehicles for last-mile deliveries can reduce the investment costs into electrification of their last-mile fleet significantly and can

even eliminate it in the case of waste management companies or other third-party services like cargo bikes delivering these goods for the logistics companies. This added value, solving the need for rapid electrification, is critical in attracting delivery providers towards the Cologistics hub solution.

2. Buffer capacity during peak seasons: Delivery companies have varying frequency of deliveries depending on the time of the day, month, or year. This varying demand can be caused by various reasons, such as whether it is summer, winter, or holiday season. To provide services throughout the year without disruption of service, delivery companies have a more significant number of vehicles in their fleet and hire labourers during these seasons. These are additional costs for the delivery companies; most of the time, these additional vehicles and labourers remain idle. This is highly inefficient and expensive. Offering delivery service through Cologistics hubs during this peak capacity can provide delivery companies with a dynamic capacity for them to deliver during peak times. This also solves their problem of maintaining an extra fleet and workforce stationed only to fulfil the peak-time demand.
3. Compliance with local regulations on low-emission vehicles: There is an increase in regulations regarding the type of vehicles entering cities. One such regulation is low emission zones. With such regulations increasing, delivery companies need vehicle fleets to comply with these regulations. The shared electric fleet of the Cologistics hub can provide vehicles that comply with these regulations solving the need for delivery companies.
4. Reduced last-mile logistics costs: Last-mile deliveries cost the most for delivery companies, and they are also highly inefficient due to low fill rates. A shared vehicle fleet can optimise this with smaller vehicles, more flows and higher fill rates, significantly reducing the cost of last-mile deliveries for delivery providers.
5. Sustainability KPIs improvement: Delivery companies must comply with sustainability targets set by external bodies and internally. These sustainability targets can be emissions, energy usage or others. Cologistics hubs and their shared fleet can help delivery companies meet these Sustainability targets and reduce environmental impact.

4.5.3 Residential Real Estate Properties

Residential real estate properties in the Cologistics hub ecosystem create a lot of inflows and outflows from and to the hub. Residential real estate properties need waste management services and also deliveries to their residents. The property managers pay for waste management as it is their responsibility, and it gets costly for them if the residents do not separate and sort the waste. Sometimes, penalties are imposed on residents for improper sorting which limits the problem significantly. Once the waste is sorted and appropriately stored in the respective space, it is then the responsibility of the municipality to come and collect them. They come and collect them up with a particular frequency. When the waste bins are filled sooner than expected, the property managers have to pay for private service for the waste pickup. This situation happens rarely, but it is an expensive affair for property owners when this happens. Also, some of these waste materials are valuable for waste management companies which can recycle them and turn profits with them. With the vehicles from Cologistics hubs, this waste can be collected and monetised while also delivering their residents' parcels. The added values for residential real estate properties are:

1. Integrated logistics and waste management operations: Real estate properties face a problem dealing with multiple delivery providers and as mentioned above, they have waste management

needs. Property managers need one company to perform both deliveries and waste collection. Cologistics hub solution addresses this need and offers them an integrated solution.

2. Reduced labour costs and operational complexities: Due to multiple delivery providers and uncertainty in waste management pickups, there are a lot of operational complexities that property managers face which also require them in some cases to employ people at the property to monitor and manage the incoming and outgoing vehicles that offer delivery services. The Cologistics hub solution will reduce such complexities.

4.5.4 Commercial Real Estate Properties

Commercial Real Estate properties also face very similar problems that residential real estate properties face. For commercial real estate companies, the need for a proper waste management service is much greater than for residential real estate properties as in the case of commercial real estate, the businesses are responsible for taking care of their waste generated. Commercial real estate properties have a strong need for an integrated delivery and waste management system like that of residential real estate properties. In addition, they need to establish a waste management procedure in their properties. Without a proper waste management process or a standard procedure, the operations of waste management can be highly complex and tricky to deal with. This causes inconvenience to their tenants which results in reduced customer satisfaction. The tenants in such properties usually receive a lot of deliveries. These deliveries are delivered by multiple delivery providers multiple times during the day which costs a lot of labour hours for the property managers or receptionists to deal with these deliveries. Cologistics hub solutions can significantly reduce these costs and operational complexities. In addition, commercial real estate properties can provide space for the operations of the hub which will ensure smooth logistics and waste management operations for their tenants and create value to the zone around the hub acting as the central point where deliveries are consolidated, and other services are offered. The added values for commercial real estate properties are:

1. Efficient Waste Management and Delivery Processes: Cologistics hubs offer the potential for real estate companies to streamline their waste management and delivery processes. By centralizing waste collection and delivery coordination, these hubs can help reduce the time and effort required by property managers and tenants to handle these tasks individually. This increased efficiency can lead to improved tenant satisfaction and operational effectiveness.
2. Operational Cost Reduction: By consolidating waste management and delivery services, real estate companies can potentially reduce operational costs. Cologistics hubs could help optimize waste collection routes and delivery schedules, leading to cost savings in terms of fuel consumption, labour, and resources. Additionally, the possibility of outsourcing certain tasks to specialized service providers within the hub can further contribute to cost reduction.
3. Security and Access Control: Commercial real estate companies share security concerns associated with allowing external delivery personnel into buildings. Cologistics hubs can serve as a secure point of exchange for deliveries, mitigating potential security risks by limiting access to certain areas of the property. This added security can contribute to a safer and more controlled environment for both tenants and property managers.
4. Standardised waste management processes: The absence of consistent waste management systems poses operational challenges. By implementing standardized processes, real estate

companies can enhance operational efficiency, provide reliable waste disposal experiences, and align with environmental expectations.

5. Tenant Satisfaction and Convenience: Cologistics hubs can enhance tenant satisfaction by providing a convenient solution for waste disposal and deliveries. By offering a well-organized hub, property managers can ensure that tenants have a reliable and easily accessible location for their waste disposal needs. This convenience can positively influence tenant retention rates and overall tenant experience.

4.5.5 Construction Companies and Property Developers

Construction companies have a great need for logistics but most importantly, they produce many construction waste materials, which they must pay for and get rid of. These construction waste materials have a high potential to be reused or recycled. During the construction stage, the companies acquire third-party services to deal with their construction waste and do not know how this waste is dealt with. They do have some excess materials left over after construction, but they are usually the right amount and used for repair. They are interested in reducing waste generation and more efficient disposal from construction projects which can be remanufactured or recycled. Construction companies can generate a significant amount of inflow into the Cologistics hub. Construction companies can also incorporate the Cologistics hub solution in their development and planning to utilize the hub during the construction phase for storage and utilize the hub as a fully functioning Cologistics hub. New property developments can integrate the Cologistics hub into their development plan, offering the residents and businesses in the property zone all the added values that the hub can generate for individuals and businesses however, it has to be planned properly in Residential buildings to avoid high traffic flow, generate noise or disrupt the peace to the residents. The addition of these hubs in the property also creates value for the residents with all the third-party services in addition to the delivery and waste management service. The added values for construction companies and property developers are:

1. Integrated logistics and waste management operations.
2. Logistics and warehousing as a service.
3. Early development planning.

4.5.6 Retail

Retail companies can be a crucial part of the Cologistics hub ecosystem however, it is important to understand that most of the retail stores are franchises and not owned by the central corporation. For e-commerce, retail chains have a separate supply chain that delivers goods from a central warehouse situated generally outside the city. The online orders are fulfilled by trucks delivering goods from these warehouses. This is an expensive process and has environmental consequences. The number of trips of these trucks can be reduced significantly with the use of warehouse spacing in the Cologistics hub.

1. Efficiency and Cost Savings: One of the primary added values of Cologistics hubs for retail companies is the potential for increased efficiency and cost savings. By consolidating various logistics operations, such as deliveries, waste management, and compacting, within a single hub, retail companies can optimize their resources when delivering their goods to various stores located in the town. This optimization results in reduced operational costs due to shared transportation and improved route planning, leading to decreased fuel consumption and vehicle maintenance expenses.

2. Stock rebalancing: Since retail stores are generally not directly owned by the retail chain but rather franchised to different owners, the retail stores are not connected, and they do not communicate. With a digital platform that the Cologistics hub may offer in the future, the retail stores can have means to communicate with each other and stock optimization can be done collectively or even rebalanced among the stores.
3. Last-Mile Efficiency: By strategically locating Cologistics hubs in or near urban centres, retail companies can address the challenge of last-mile delivery. This is particularly important for urban environments where traffic congestion and parking restrictions are common. These hubs can serve as distribution points for smaller electric vehicles, bicycles, or even autonomous delivery bots, increasing the efficiency of last-mile deliveries. Currently, deliveries made by retail chains to individual households are directly delivered from their warehouse outside the city centre to their doorstep using big trucks. This part of the last-mile operation can be done using Cologistics hubs which is potentially faster, cheaper, and also causes less congestion.
4. Competitive Differentiation: Embracing Cologistics hubs can serve as a competitive differentiator for retail companies. Being able to offer efficient, environmentally friendly, and convenient delivery services sets them apart in a market where consumers are increasingly conscious of sustainability and convenience.
5. Electrification: Just like delivery companies, retail chains also own or lease their vehicles and manage their logistics operations. The transition to electric vehicles faces challenges in terms of infrastructure and regulations, particularly in urban areas. This transition is crucial to improve the environmental impact of logistics operations, but the transition costs the retail companies a lot to invest in new vehicles. Cologistics hubs with shared EVs help them with cheaper and rapid electrification.

4.5.7 Third-Party Services and other Businesses.

All these added values discussed so far for the categorised stakeholders also apply to any other type of business utilizing the logistics and warehousing as a service solution provided by the Cologistics hub. Companies that offer services such as repair workshops, reuse, rental items etc. can benefit from the Cologistics hub. These are some of the added values that such third-party services benefit from the Cologistics hub solution:

1. Operational efficiency: Cologistics hubs streamlines the logistics process, reducing the complexities of warehousing, storage, and distribution.
2. Scalability: Cologistics hubs provide scalable solutions, allowing third-party businesses to expand or downsize their operations based on demand.
3. Location Advantage: Hubs are strategically located to serve specific areas efficiently. Third-party businesses can take advantage of these prime locations, ensuring faster delivery to customers and reducing transportation costs.
4. Technology Integration: Many Cologistics hubs are equipped with advanced technology for tracking inventory, managing orders, and optimizing routes. Third-party businesses can tap into these systems to enhance their operations and provide better visibility to their customers.
5. Enhanced Customer Experience: Quick order processing, accurate inventory management, and efficient deliveries contribute to an improved customer experience. This can lead to higher customer loyalty and positive word-of-mouth referrals.

4.5.8 Government and Citizens

For the city municipality, as secondary stakeholders, and primary stakeholders in some cases/projects, they benefit from Cologistics hubs as they can bring several added values to them and their citizens. These added values and benefits extend beyond the improvements in the efficiency of logistics and waste management in the cities. Government/Municipalities can play a wide range of roles in the cologistics hub ecosystem. Government entities can either be a facilitator, a secondary stakeholder helping to improve private partnerships and create a platform for private entities to collaborate. Or the government entities can be an overseer, a primary stakeholder, which oversees the entire functioning of the hub through public-private partnerships and ensure the functioning of the cologistics hub. The role of government in cologistics hub ecosystem, thus can be in varying level, from very active to no involvement. However, based on the interviews and other data collection methods, it can be concluded that government involvement and public-private partnerships are essential for faster scalability. For government to be actively involved, there must be positive added values from the cologistics hub solution for the government bodies and the citizens. From the research, listed below are the added values identified for the government and citizens:

1. Efficient Traffic Management: During the interview with a representative from Stockholm Stad, they highlighted the challenge of fragmented goods transportation within the city, leading to increased traffic congestion. Cologistics hubs can offer a solution by consolidating deliveries from multiple suppliers into a single hub along with reducing the total number of trips made for waste collection, which helps reduce the number of vehicles on the road. This consolidated approach allows traffic authorities to better manage traffic flows, minimizing congestion and enhancing overall urban mobility.
2. Data-Driven Decision-Making: The city authorities currently lack comprehensive data about the movement of goods and the flow of delivery vehicles within the city. Cologistics hubs facilitate collaboration between governments, delivery companies, waste management companies, private businesses, real estate owners and other stakeholders. By collaborating with companies to share anonymized data, they can gain insights into delivery patterns, preferred routes, and peak hours. Governments can leverage the hub's central role to encourage data sharing, leading to better-informed policy decisions, optimized route planning, and more efficient urban logistics operations. This data-driven approach enables informed decision-making for optimizing traffic.
3. Collaborative Urban Planning: Collaboration and data sharing not only helps with the decision-making related to optimizing traffic and urban logistics operations but also can be key for urban planning. As seen in the Jernhusen Malmö project, where the development of the whole development area is planned to work well with the Cologistics hubs, this can also be extended to the city where future urban planning of new areas and replanning of existing ones can take into account the data gathered from collaborative Cologistics hubs and can be designed for the operations of the Cologistics hubs. The collaborative approach also fosters a more holistic urban planning process. By involving different parties in discussions about logistics and mobility, the government can develop solutions that cater to the needs of all stakeholders, ensuring an integrated urban ecosystem.
4. Reduced dependency on Government or City funding: The city authorities and government-funded innovation agencies such as Vinnova are cautious about creating incentives or funding solutions that transport companies might become dependent on, and particularly wary of funding

new Urban Consolidation Centre projects which fail after the funding stops. They believe in encouraging the market to find solutions on their own to ensure long-term viability. A Cologistics hub with a profitable business model can reduce this dependence on government funding and can create a sustainable and sustainable collaborative urban logistics solution.

5. Economic Development: Cologistics hubs can attract businesses and industries that prioritize coordinated and streamlined delivery processes. As the city becomes more attractive to businesses due to its efficient logistics infrastructure, economic growth and job creation can result, benefitting both the government and the citizens.

All the added values discussed in the section 4.5 give an overview of the benefits that every type of stakeholder in the ecosystem receives by being part of the Cologistics hub solution. These added values are identified after careful analysis of the interviews which focused on gathering the pain points of the stakeholders and understanding the 'jobs to be done'. By identifying them, an assessment into understanding which factors

5.0 Perception of Cologistics hub and Implementation Strategy

In this section, the perception and acceptance of Cologistics hubs is discussed first and then the suggested strategy to implement a Cologistics hub solution is given.

5.1 Perception/Acceptability of Cologistics Hub

In addition to the analysis of the business and operations side of a Cologistics hub with the conceptual frameworks in Section 4.0, we also looked into the perception and acceptability of Cologistics hubs among the relevant stakeholders. The interviews with stakeholders, although primarily to understand the stakeholders' needs and identify 'jobs to be done', helped to understand the perception of these stakeholders towards Cologistics hubs. Through these interviews, many factors were identified which are important for their business and operations.

From the identified factors based on the analysis of data collected, the six factors are qualitatively determined to be the most common and relevant factors for all the stakeholders and the survey is taken to determine the most important factors among them. The survey results show which factors are considered more important based on the pairwise comparison as mentioned in Section 3.2.5. From the 12 responses with the survey selectively sent to the representatives, these are the results of the first part of the survey where the Analytical Hierarchical Process is used to calculate the weights of different factors.

5.1.1 Results of Analytical Hierarchical Process

These aggregated results show that the stakeholders give considerable importance to all factors with the most importance given to the future legislative changes related to logistics and waste management, followed very closely by the Quality of Logistics Service and Customer reach/service.

Future legislative changes = 21.36%

Quality of logistics service = 20.19%

Customer reach/service = 17.66%

Cost-effectiveness = 14.94%

Quality of waste management service = 13.78%

Sustainability = 12.07%

The following table shows the results of the Analytical Hierarchical Process when the stakeholder types are segmented.

Table 3. Importance of various factors among different Stakeholder types

Factor	Total Average	Waste Management	Delivery Companies	Real Estate	Retail	Third-Party
Quality of logistics service	20.19%	19.50%	31.23%	18.19%	5.29%	21.96%
Quality of waste management service.	13.78%	15.39%	6.05%	10.54%	40.37%	15.53%
Sustainability	12.07%	13.85%	16.92%	12.32%	9.38%	7.02%
Future legislative changes	21.36%	12.32%	6.84%	30.88%	24.43%	15.06%
Cost-effectiveness	14.94%	22.29%	25.07%	12.04%	3.05%	14.33%
Customer reach/service	17.66%	16.65%	13.90%	16.03%	17.47%	26.11%

As seen in Table 3, the waste management stakeholder type prefers cost-effectiveness the most along with the quality of logistics service as important factors for the Cologistics hub. The survey takers belonging to the waste management category have been involved in Cologistics hub projects for a long time which played a part in their survey inputs while other stakeholders have had lesser exposure and knowledge about Cologistics hubs and its operations. As expected, the quality of logistics service is the most important factor for Delivery Companies, followed by Cost-effectiveness. Real Estate Developers consider the future legislative changes in logistics and waste management practices to be the most important factor as the regulations are getting stricter for real estate developers to follow. For Retail companies, the quality of logistics service seems to be of the least importance as Retail chains generally have their fleet of vehicles and warehouses for e-commerce and store deliveries. However, Retail companies consider the quality of waste management service to be the most important factor for them which can be due to the amount of waste generated in their store. These are some of the explanations based on the insights received from the interviews but there could be many other reasons for these results.

5.1.2 Business-as-usual vs Cologistics hub

The calculated weights along with the average rating of each factor in cologistics hub solution and the current business-as-usual solution of the stakeholders are used to rank the cologistics hub solution versus the business-as-usual solution. The obtained results are shown below.

Rank 1: Cologistics hub = 3.428

Rank 2: Business-as-usual = 3.188

MCDM	Quality of Logistics Service	Quality of Waste Management Service	Sustainability	Future Legislative Changes	Cost Effectiveness	Customer Reach/Service	Weighted Sum	Rank
Criterion Weight	0.202	0.138	0.121	0.214	0.149	0.177		
Cologistics Hub	3.58	3.67	3.42	3.58	3	3.25	3.428	1
Business-as-usual	3.25	3	3.08	3.25	3	3.42	3.188	2

Table 4. MCDA Results

This shows that the stakeholders perceive the Cologistics hub solution to be slightly better. Although this does not conclude that Cologistics hubs are or will be better at the determined factors or as a whole, but rather an indication that the relevant stakeholders perceive it in a better way compared to their business-as-usual solution. As you see in Table 4, the stakeholders on average perceive Cologistics hubs to be better at all the factors except cost-effectiveness and customer reach/service. This shows that the stakeholders are positive about a potential Cologistics hubs solution and perceive that it could be better than their business-as-usual solution.

The MCDA is also performed with the weights determined by stakeholder segments: Retail, Delivery companies and Real Estate but with the same average scores for each alternative. These results are displayed in Appendix 3.

5.2 Strategy to implement a Cologistics hub.

This section gives a step-by-step strategy for implementing a Cologistics hub solution based on the methodologies and the conceptual frameworks used in this study. When a private organisation or municipality wants to implement a new Cologistics hub solution, these are the basic steps that are suggested for them to follow. These steps can help with the starting stage of the implementation. The suggestions are based on the findings of this research. The strategy suggested may not be perfectly suitable for every Cologistics project or initiative depending on many other factors such as the location, legislative framework etc.

Steps to follow.

1. Map the list of interested stakeholders: The first step when formulating a Cologistics hub solution is to map the list of stakeholders involved in the new ecosystem. Use the list provided in section 4.1 to match stakeholders with stakeholder types.
2. Identify their needs and the driving forces: Once the stakeholder types in the ecosystem are identified, understand their needs to identify the driving forces. Section 4.1.1 gives you an overview of the driving forces for Cologistics hub projects.
3. Match the scenarios: When the driving forces are identified, use scenario planning to create a scenario which is based on the identified driving forces. The three scenarios provided in this research in Section 4.2 gives you a reference and one of them can also be chosen if it matches your Cologistics hub's driving forces.
4. Implement the suggested business models: Based on the built or chosen scenario, implement the business models suggested in Section 4.3 or build your business model suitable for the scenario you have developed.
5. Fulfil the infrastructure and operational requirements: Build the operational flow diagrams or refer to the diagrams constructed in Section 4.4. The operational flow

diagrams give you the foundational knowledge of the infrastructure and operational requirements of a Cologistics hub.

6. Get Stakeholders on board: Construct a Business ecosystem map or refer to the one constructed in Section 4.5 and identify all the added values of stakeholders. Identifying the added values/value proposition to stakeholders will help get stakeholders on board. Section 4.6 shows the identified added values for all stakeholder types through this research. In addition, the business ecosystem map also helps identify the role of each stakeholder and their service offering to the functioning of a Cologistics hub. This sets the responsibility and defines the role of every stakeholder in the ecosystem which is essential for the functioning of the Cologistics hub.
7. Start: With the implementation strategy formulated with requirements fulfilled, start the Cologistics hub.

These steps provide a simplified approach for implementing a Cologistics hub and can act as a guide for organisations willing to set up a Cologistics hub and must start from ground zero. However, it is also important to consider that the optimal strategy varies a lot depending on many factors such as the geographical location, legislative framework, amount of willingness among the stakeholder etc. and this may not be suitable for everyone to follow.

6.0 Conclusion

This study addresses the research gap in recognising the type of urban logistics hubs that are not just urban consolidation centres but are also used as waste collection points along with other integrated services. After addressing this, this study also defines this new type of urban logistics hub and justifies the need for a new term and definition. Along with defining this type of hub, this study also addresses the challenges faced in urban logistics and urban consolidation centres.

After defining Cologistics Hubs, the research questions pertaining to the Cologistics hubs are answered. Here is the list of research questions and sub-research questions and an explanation of how they are approached, answered, and represented in this study.

RQ1. What additional services/businesses can be integrated into the Cologistics hub in addition to deliveries and waste management?

1a. What will be the third-party services which make use of the hub for their operations?

Through the data collection methods, some of the third-party services which can be integrated into a Cologistics Hub ecosystem are identified. Reuse stations can be one of them. Reuse stations can make use of the Cologistics hub's warehousing and logistics infrastructure for reusing items which are collected as waste or to be reused. These reusable items can be picked up from the hub or can be delivered using the logistics service. Repair stations such as laptop repair service or bicycle repair service can also be established in the hub to offer repair services to the individuals and businesses in the zone. Product sharing services such as tool sharing services, clothes sharing etc. can also make use of the cologistics hub ecosystem to offer their services. The reuse, repair and sharing services encourage circular economy in the locality, adding value to the cologistics hub. Mobility services such e-scooter or bike sharing companies can also make use of the hub as

a third-party for parking, charging the batteries or the logistics service to rebalance the fleet in the area. Another type of third-party services which can be integrated into the cologistics hub ecosystem are the external delivery providers such as cargo bike services which can fulfill the logistics requirements of the hub operations which is a business opportunity for such external delivery providers.

1b. How are the stakeholders' current logistics, warehousing, and waste management operations and what are the added values gained by the stakeholders with the Cologistics hub service?

To identify the added values for different stakeholders, their current operations and the challenges in it especially related to logistics, warehousing and waste management operations were understood from the data collection process. It is identified that many parts of the stakeholders' operations can be improved with cologistics hubs. One such important identified operational challenge is delivery companies have a busy peak-weeks where they require additional fleet and additional staff to operate and cologistics hubs can offer 'buffer' capacity to delivery companies to perform last-mile deliveries during the peak periods. Another identified operational challenge would be for commercial real estate companies which face challenges dealing with the incoming parcels or deliveries from different delivery providers, different times throughout the day and cologistics hubs can solve this for them, creating value. The added values along with the insights into the operations were discussed in depth along with representing the added values in the conceptual frameworks of the Business model canvas and the Business ecosystem mapping.

RQ2. What do the operational flows look like for the hub solution?

2a. What do the system's material flow, information flow and money flow look like and what are the corresponding infrastructural requirements?

The operational flow diagrams for the cologistics hub system are built to understand the operational and infrastructure requirements. Three types of flow diagrams, material flow, information flow and money flow are built and represented. The material flow diagrams provided an understanding of variety of streams such as B2B parcel deliveries, B2C parcel deliveries, waste flows, re-use flows and service flows. Representing these streams in the material flow diagrams provided insights into the foundational infrastructure requirements for a cologistics hub. Along with that, categorizing these streams into deliveries, waste and re-use/services and representing them separately in flow diagrams provided easier understanding of the flow of materials in each category. With the material flow providing foundational understanding of physical infrastructure requirements, the information flow diagrams are built which provided the understanding for digital infrastructure requirements. Similarly, the money flow diagrams provide an insight into business model and the requirements for fulfilling payments and money flow between the stakeholders. The different types of flow diagrams, material flows, information flow and money flow represented in Figures 14 to 22 in section 4.3.

2b. Which factors are the most important for stakeholders when choosing the hub solution over other alternatives?

The factors which are important to stakeholders are identified through all the data collection channels and the first part of the MCDA survey answered which factors are more important than the other and to what extent when it comes to choosing a Cologistics hub over their business-as-usual solution. The survey results showed that the businesses, when choosing their logistics and waste management solution considered 'Sustainability' as the least important factor while the future legislative changes is considered to be the most important factor. This shows that it is essential that the cologistics hub solution is considered a generally attractive solution over their business-as-usual solution mainly due to the changes in the future legislations when it comes to logistics and waste management. Quality of logistics is the second most important factor with a slightly lesser weight, followed by 'Customer reach/service'. The quality of waste management service is only considered the 5th most important factor out of total of 6 factors, only followed by 'Sustainability'. The sustainable solutions are preferred more due legislative requirements rather than just the sustainability aspect of the solution. Overall, the factors, ranked from most important to least important as considered by the stakeholders: Future legislative changes, Quality of logistics service, Customer reach/service, Cost-effectiveness, Quality of waste management service and Sustainability.

RQ3. What are the most feasible strategies to operationalise the business models for scalability given the context mentioned in questions 1 and 2?

a. What are the different scenarios based on the needs?

Identifying the needs of different stakeholders and the driving forces helped developing three scenarios. Scenario 1 is derived from the needs of delivery companies to rapidly electrify their flet to comply with the future legislative requirements along with the need for buffer capacity. Therefore Scenario 1 is the scenario where the last-mile deliveries of goods are performed as a third-party contractor to a delivery service provider. Scenario 2 is derived from the needs of businesses and real estate companies having the need for coordinated logistics. Therefore, Scenario 2 is to take care incoming deliveries for businesses and real estate managers. Scenario 3 is derived from the need of citizens and municipalities need for a collaborative urban logistics solution in their cities and therefore, the open market scenario is developed. These are shown in section 4.1.

b. For different scenarios, how could the different business models look like for the hub provider?

Based on the type of stakeholders, the services offered through the hub and based on the business agreements, 4 different business models are identified and 3 of them are relevant and explored in this study. Business model 0: Single service hub refers to a traditional urban consolidation center and not explored in this study. Business model 1: Dual-service hub, Business model 2: Multi-Service hub and Business model 3: Open marketplace model are the business models pertaining to cologistics hubs and the business models are shown in business model canvas framework for better understanding. Business model 1: Dual-service hub is the business model used for Scenario 1. Scenario 2 required both business models 1 and 2. Scenario 3 requires the Business models 1, 2 and 3. Business model 1 is an agreement between a waste management company and a delivery

service provider to perform the delivery of last-mile goods in the city. Business model 2 is an agreement between a waste management company and a business or real estate management to receive the deliveries to the hub on their behalf and perform coordinated last-metre deliveries to them. Business model 3 is a digital platform solution where businesses and individuals can opt for the logistics services within the service zone. The business models with the help of the Business Model Canvas framework and the business models pertaining to different scenarios are shown in section 4.2.

3c. What does the collaboration ecosystem with different stakeholders look like?

The collaboration ecosystem for different stakeholders, how they interact with each other and the added values they get are represented with the conceptual framework, Business ecosystem mapping represented in section 4.4. This framework provides an understanding of what the collaboration ecosystem with different stakeholders looks like. The stakeholders are grouped and the offering or their activity contributing to the operations and functioning of the hubs are mentioned. The added values generated from the Cologistics hubs are also mentioned and the stakeholders that benefits from certain added values are marked. Here you can see the added values that benefit multiple stakeholder groups that they generated through their activity or offering to the Cologistics hub ecosystem.

Finally, after addressing these research questions, the study recommended a step-by-step strategy based on the conceptual frameworks used in this research for organisations to implement a scalable Cologistics hub solution.

6.1 Limitations

The list of stakeholders, stakeholder types, driving forces based on needs, scenarios, added values, business models, and operational and business requirements mentioned in this study are identified to the best of the researcher's knowledge and are by no means, exhaustive. The interviewees and survey takers who participated in this study had varying levels of knowledge on the topic of Urban logistics, Urban Consolidation centres, Cologistics hubs and other related topics with some interviewees and survey takers having experience working on Cologistics Hubs projects which may have influenced the results showing positive perception of Cologistics hubs. The interviewed individuals and their companies were selected with utmost effort to be representative examples of different identified stakeholder groups however it is important to note that the data collected from the interviews of the selected individual representative of the company is limited by their ability to communicate about the needs and operations of their company to the best of their knowledge. The data collection methods employed throughout this research are primarily qualitative and the analysis is performed by the researcher with the best efforts to avoid bias and view the data from both positive and negative perspectives. However, the study is not completely devoid of any bias. The companies and the representatives' prior involvement or current involvement in Cologistics hub projects may have contributed to positive bias towards Cologistics hubs. Since first part of the interview was conducted without giving explanation on Cologistics hubs, the interviewees with no prior involvement or knowledge on Cologistics hubs may have assumed what a Cologistics hub is, from the name and may have created positive or negative bias towards based on their perception of a traditional urban consolidation centre. The number of interviews and the survey entries can be much higher for better data collection however, due to time constraints and less responsiveness from many stakeholders, only a limited number of interviews were done, and survey entries were collected. The number of interviews

done were 10 and the number of survey respondents were 12. Among the 12 survey respondents, 9 of them were interviewed before they took the survey, therefore, they had a better knowledge on Cologistics hubs than the other 3. The research is performed in Stockholm and the data collection process involved interviews with 9 Swedish organizations and 1 Norwegian organization, therefore this research is more specific to the Scandinavian context. With different legislative support and political landscape, the role of government/municipality may vary however, except for the role of the government and their needs, the research can be transferable to other cities in the world with similar urban logistics challenges.

6.2 Further research scope

With more time, more stakeholder interviews and survey entries can lead to a further understanding of the factors that are important for every stakeholder type. By developing the business models even further, focusing more on the Financials, the costs of Cologistics Hub operations can be determined, which can also lead to understanding the revenue generated and assessing the economic feasibility of Cologistics Hubs for different stakeholders even further. This understanding of economic feasibility will be the most important factor in assessing the scalability of Cologistics Hubs. The revenue and cost structure will determine the profitability of Cologistics hubs. The study identified that the stakeholders perceive the Cologistics Hub to be almost equally cost-effective as their business-as-usual solution however, the data collected were not sufficient to assess the economic feasibility qualitatively or quantitatively for stakeholders. Existing Cologistics hubs like Älskade Stad can be analysed to understand the impact it has on the city by assessing the environmental and social costs along with other relevant KPIs for a liveable city.

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Appendix

Appendix 1. Interview Questionnaire

1. Can you give an overview of your logistics operations now?
2. What are the pain points/barriers with your current logistics operation?
    a. In terms of storage,
    b. Schedule,
    c. Frequency,
    d. Labour,
    e. Size of deliveries
    f. Institutional/legal barriers?
    g. Others?
3. What other 3rd party services can benefit from this Cologistics hub service?
4. What are the factors that are important to you while choosing your logistics provider?
5. What are the added values that you think your business will benefit from a Cologistics hub, other than the environmental aspect of it?
6. What are some of the Need-to-have solutions that you wish for? i.e., Solutions that you think you are absolutely in need of to solve the problems that you are facing in your current operations.
7. What are some of the Nice-to-have solutions that you wish for? i.e., Solutions that you think would be helpful to optimise or improve your current operations.
8. Would you be open to the idea of shifting full or part of your logistics operations to our service, with similar costs and all the added values mentioned above?
9. How valuable is it for your company, the environmental and social benefits that are created in a Cologistics hub solution opposed to conventional logistics?
10. What are the requirements necessary for your operations when it comes to using a Cologistics hub?
11. Multi-criteria analysis survey questionnaire.

Appendix 2. Multi-Criteria Analysis Survey

The full survey is shown as screenshots below, in the same order.

Section 1

In this survey, we would like to understand your preferences and priorities regarding various criteria related to your logistics and waste management operations.

Note: Please base your ratings on your personal judgment and the context of the decision at hand. There are no right or wrong answers, and your honest feedback is highly appreciated.

Your participation is voluntary, and all responses will be kept confidential. The survey should take approximately 4 minutes to complete. Thank you for your time and contribution!

1. What is the name of your organisation? *

Enter your answer

Section 2 ...

Ranking the factors

The purpose of this part of the survey is to understand that, when it comes to your first & last-mile logistics and/or waste management service, what are the factors that are more important to your company than others.

Explanation of the Criteria:

1. Quality of logistics service: Level of excellence and reliability in the first-mile and last-mile transportation, storage, and distribution of goods or services considering factors such as timeliness, simplicity, special delivery requirements, labor requirements, and customer satisfaction.

2. Quality of waste management service: The effectiveness and efficiency of your waste management service considering factors such as timeliness, accuracy, labour requirements, and customer satisfaction in waste management operations.

3. Sustainability: The commitment to environmentally sustainable practices. It involves considering the environmental, social, and economic impact of the decision or solution, including factors like carbon footprint, renewable energy use, congestion, and social responsibility.

4. Future legislative changes: The potential impact of future changes in laws, regulations, or policies when it comes to waste management and urban logistics.

5. Cost effectiveness: The overall cost effectiveness of the logistics and the waste management service provided to your company.

6. Customer reach/service: This criterion assesses the importance of expanding customer reach and providing excellent service to your customers.

Instructions:

For each question, you will be presented with a pair of criteria.

Please indicate your preference or importance between the two criteria based on the following scale:

- **1: Criterion A is much less important than Criterion B.**
- **3: Criterion A is slightly less important than Criterion B.**
- **5: Criterion A and Criterion B are equally important.**
- **7: Criterion A is slightly more important than Criterion B.**
- **9: Criterion A is much more important than Criterion B.**

Select the rating that best reflects your preference or importance for each criterion pair.

2. Rank which is more important to you. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of logistics service

Criteria B: Quality of waste management service.

3. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of logistics service

Criteria B: Sustainability

4. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of logistics service

Criteria B: Future legislative changes

5. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of logistics service

Criteria B: Cost effectiveness

6. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of logistics service

Criteria B: Customer reach/service

7. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of waste manage-ment service

Criteria B: Sustainability

8. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of waste management service

Criteria B: Future legislative changes

9. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of waste management service

Criteria B: Cost effectiveness

10. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Quality of waste management service

Criteria B: Customer reach/service

11. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Sustainability

Criteria B: Future legislative changes

12. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Sustainability

Criteria B: Cost effectiveness

13. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Sustainability

Criteria B: Customer reach/service

14. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Future legislative changes

Criteria B: Cost effectiveness

15. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Future legislative changes

Criteria B: Customer reach/service

16. *

5 - for equally important

1	2	3	4	5	6	7	8	9

Criteria A: Cost effectiveness

Criteria B: Customer reach/service

Section 3

Rate your Business-as-usual solution

Business-as-usual refers to the current or existing logistics and waste management practices and processes that are typically followed in your organization or industry. It represents your current solutions.

17. Quality of logistics service *

1	2	3	4	5

Very bad — Very good

18. Quality of waste management service *

1	2	3	4	5

Very bad — Very good

19. Sustainability *

What is your perception of the current solutions' sustainability practices?

1	2	3	4	5

20. Future legislative changes *

How much do you think your current business-as-usual services will be compliant or able to adapt with future legislative changes?

1	2	3	4	5

Very little Very much

21. Cost effectiveness *

How Cost effective do you think your current business-as-usual services are?

1	2	3	4	5

Very little Very much

22. Customer reach/service *

How good is your current business-as-usual service is enabling growth and/or enables you provide a good service to your customers?

1	2	3	4	5

Very bad Very good

Section 4

Cologistics hub solution

Cologistics solution represents a proposed alternative approach for waste management and logistics services. Cologistics hubs are like urban consolidation centers located in city centers or high density areas but with additional uses, like waste compacting, warehousing for businesses, reuse hubs etc. In a cologistics hub, the same fleet of smaller EVs or cargo bikes can be used to deliver parcels and collect recycling waste. This way, the number of trucks in the City can be reduced. Cologistics hubs can also include reuse hubs, service hubs for bicycle repair, tool sharing etc.

Keep this description in mind as you rate the criteria for each choice in the subsequent section based on your perception on the cologistics hub solution. There is no right or wrong and you don't have to think too deep.

23. Quality of logistics service *

What is your perception of the cologistics hub solution's Quality of logistics service?

1	2	3	4	5

Very bad — Very good

24. Quality of waste management service *

What is your perception of the cologistics hub solution's Quality of waste management service?

1	2	3	4	5

Very bad — Very good

25. Sustainability *

What is your perception of the cologistics hub solution's sustainability practices?

1	2	3	4	5

Very bad — Very good

26. Future legislative changes *

How much do you think cologistics hub solution will be compliant or designed with future legislative changes in mind?

1	2	3	4	5

Very little — Very much

27. Cost effectiveness *

How cost effective do you think that Cologistics Hub solution will be?

1	2	3	4	5

Very little — Very much

28. Customer reach/service *

How much do you think cologistics hub solution can improve your growth and improve your service quality to your customers?

1	2	3	4	5

Very little — Very much

End of Survey.

Appendix 3. Results of MCDA with different weights.

The results shown in section 5.1 used the average of weights determined by all stakeholders. The results here show the same MCDA calculations but with weights determined based on the average of specific stakeholder types.

MCDM	Quality of Logistics Service	Quality of Waste Management Service	Sustainability	Future Legislative Changes	Cost Effectiveness	Customer Reach/Service	Weighted Sum	Rank
Criterion Weight	0.312	0.06	0.169	0.068	0.251	0.139		
Cologistics Hub	3.58	3.67	3.42	3.58	3	3.25	3.367	1
Business-as-usual	3.25	3	3.08	3.25	3	3.42	3.167	2

Figure A3.1 MCDA – Weights determined by Delivery Providers.

MCDM	Quality of Logistics Service	Quality of Waste Management Service	Sustainability	Future Legislative Changes	Cost Effectiveness	Customer Reach/Service	Weighted Sum	Rank
Criterion Weight	0.182	0.105	0.123	0.309	0.12	0.16		
Cologistics Hub	3.58	3.67	3.42	3.58	3	3.25	3.447	1
Business-as-usual	3.25	3	3.08	3.25	3	3.42	3.2	2

Figure A3.2 MCDA – Weights determined by Real Estate Companies.

MCDM	Quality of Logistics Service	Quality of Waste Management Service	Sustainability	Future Legislative Changes	Cost Effectiveness	Customer Reach/Service	Weighted Sum	Rank
Criterion Weight	0.053	0.404	0.094	0.244	0.031	0.175		
Cologistics Hub	3.58	3.67	3.42	3.58	3	3.25	3.526	1
Business-as-usual	3.25	3	3.08	3.25	3	3.42	3.155	2

Figure A3.3 MCDA – Weights determined by Retail Companies.

All these results show that Cologistics Hubs are still ranked first despite varying importance to each factor.