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"Sharing logistics in urban freight transport: a study in 5 sectors"

J.H.R. van Duin^{a,b}, N. van den Band^a, A. de Vries^a, P. Verschoor^a, M. el Ouasghiri^a,
P. Warffemius^a, N. Anand^a & H.J. Quak^{c,d}

^aRotterdam University of Applied Sciences, Heijplaatstraat 23, 3089 JB Rotterdam, The Netherlands

^bDelft University of Technology, Jaffalaan 5, 2628 BX Delft, The Netherlands,

^cBreda University of Applied Sciences, Mgr. Hopmansstraat 2, 4817 JS Breda

^dTNO, Anna van Buerenplein 1, 2595 DA Den Haag

Abstract

Many new logistics initiatives arise based on the principles of resource sharing through crowdsourcing. Sharing unused and/or underused resources can deliver new efficiencies in the logistics value chain in an industry where efficiency is the name of the game. The benefits of applying sharing economy concepts in logistics in terms of higher efficiency, lower costs, less congestion and lower CO₂ emissions seem easy to realize for both industry and society. While the sharing economy offers promising opportunities to start new businesses, the sharing economy is not without its challenges. Themes such as strict liability, insurance, transparency, and employee protection can hinder the progress of the sharing economy. Most difficult of all, the pace of technological innovation and social change often exceeds regulatory frameworks, resulting in banned services and protests from those working in traditional industries. Among five sectors in urban freight transport, i.e. city logistics, construction logistics, transportation & warehousing (retail logistics), healthcare logistics, and service logistics sharing concepts are studied over for the entire city of Rotterdam. Based on our main case study findings it can be observed that within the sectors of urban freight transport quite some differences exist with respect to the sharing maturity. Therefore a dedicated implementation plan is needed for each sector. This paper has shown what are the next steps to be taken for each sector and how the knowledge transfer can be established.

Keywords: Sharing economy; Sharing logistics; City logistics

1 Introduction

In today's business companies see the opportunities arising from the on-demand economy. The on-demand economy challenges start-ups and established companies with new business models and creates new ways to engage with customers (Colby & Bell, 2016). The on-demand or 'sharing economy' is a term that describes digital platforms that connect consumers to a service or product through a mobile application or website (Cockayne, 2016). Existing businesses must embrace the on-demand economy and transform their service and delivery systems to meet consumer demand. In this new economy, consumers are demanding more and more from these platforms (thanks to Amazon and other large companies) and 70% of them want it to be delivered quickly, leading to many small deliveries and a decrease in the average shipment (for example Gorillas with a time span of 10 minutes delivery).

About 55% of the world's population lives in urban areas, a share that is expected to increase to 68% by 2050 (UNESCO, 2019). Residents, companies, commuters, and visitors to cities demand more and more goods. In addition, the sector contributes to employment, business growth, the functioning of services such as waste collection, and economic growth in general (Dablanc et al., 2014). This calls for more space for logistics activities in cities that are increasingly absent due to accommodating the growth of people in cities. This pushes logistics real estate out of the city and leaves less space for storage in the city. In the literature, we come across this under the name 'sprawl'. As a result, the average size of shipments is decreasing and the number of delivery vans in cities is increasing.

At the same time, climate change and air pollution in city centres are forcing logistics practices to stop generating emissions in city centres in the Netherlands by 2025/2030. The largest city logistics flows can be found in catering, construction, retail, and facility products (Otten et al., 2016); these account for more than 50% of the freight vehicles in the city. The parcel sector accounts for 5% of urban freight traffic and is growing rapidly due to

the digitization of ordering methods used by consumers (B2C) and businesses (B2B). In order to realize these ambitions, it is necessary to make a change to a more efficient and environmentally friendly logistics operation (Web1, 2018).

Within the logistics industry, the sharing economy is seen as one of the disruptive developments. Many new logistics initiatives are based on the principles of resource sharing through crowdsourcing. Resource sharing or the so-called “sharing economy” was first mentioned in 2008 and denotes the collective consumption that arises from sharing, exchanging, and renting resources without owning them (Lessig, 2008). Sharing unused and/or underused resources can deliver new efficiencies in the logistics value chain in an industry where efficiency is the name of the game. The benefits of applying sharing economy concepts in logistics in terms of higher efficiency, lower costs, less congestion, lower CO₂ emissions seem easy to realize for both industry and society (Gesing, 2017).

In transportation, it is possible for logistics companies to transport more freight for less money by sharing vehicles and routes in a way that is fast, convenient, and more environmentally friendly. It would enable transport and logistics professionals to make better use of underutilized resources to optimize routes, streamline planning and reduce CO₂ emissions. In addition to greater operational efficiency, sharing unused and/or underused resources can also help solve other problems plaguing the industry, such as (urban) congestion and a shortage of qualified drivers. In warehousing, the sharing economy ensures better utilization and billing in existing shared customer warehouses. Finally, the sharing economy presents new and creative ways to do business and realize internal efficiencies with on-demand workforce models and logistics data sharing.

Although the sharing economy offers promising opportunities to start new businesses, the sharing economy is not without its challenges. Themes such as strict liability, insurance, transparency, and employee protection can hinder the progress of the sharing economy. Most difficult of all, the pace of technological innovation and social change often exceeds regulatory frameworks, resulting in banned services and protests from those working in traditional industries.

From a scientific point of view, emerging streams such as sharing business models, existing responses to sharing economy start-ups, the role of information and communication technologies (ICTs) as a facilitator of sharing, the importance of and mechanisms for developing trust in sharing economy- initiatives and the potential social and economic and environmental benefits of sharing economy activities analysis unexplored paths in management and sustainability literature (Muñoz & Cohen, 2016). Ocicka & Wieteska (2017) identify the following strategic success factors for sharing development:

- the need for links between business strategies of partners participating in sub-projects;
- management of collaborative relationships, including partnerships with external partners, such as logistics services or technology suppliers;
- integration of economic, social, and environmental objectives into logistics and supply chain management to achieve long-term sustainable performance.

However, to our knowledge, the aspect of urban sharing has not yet been sufficiently explored, and therefore it is interesting to examine the range of sharing activities from highly commercial to non-monetary, community-based in line with McClaren and Agyeman (2015), to a broader interpretation of the emerging space in the urban context (Geissinger et al., 2019). Geissinger et al. (2019) also emphasize that it would also be interesting to explore in-depth the sustainability effects of the sharing economy at the meta-level. The spread of the sharing economy into new sectors, reasons for diffusion patterns, and the emergence of new platforms are further routes for interesting future studies.

That is why the following research question has been formulated: 'How can we deploy sharing economy concepts on existing urban freight transport themes (namely: city logistics, construction logistics, warehousing, healthcare and service logistics) in order to improve sustainability, quality of service and efficiency? '

The research approach of the sharing logistics project is a typical practice-oriented design research. The design oriented research has a flow of knowledge that is built up with a literature study that contributes to (generic)

solutions (Aken & Andriessen, 2011). The main research principle is that inter themes comparison will provide us obtain more generic insight in the value of different sharing concepts. Deeper understanding/learning of generic insights and triangulation among these themes helps to identify the conditions under what kind of circumstances the new sharing concepts could work in practice. Concepts which have proven their value already in one theme, might be interesting for application in other themes. Finally, this will lead to more generalized knowledge on the application of sharing concepts.

Likewise, we follow the same research protocol within the themes. A multiple case study has been chosen as the research method. Case studies as methods fit the exploratory nature of this research (Yin, 2009). When the theoretical basis for research is still limited, which is the case for sharing concepts, case studies are generally a

suitable method (Edmondson & McManus, 2007). The participating companies are investigated as separate cases, after which the insights and results of the different companies are compared in cross-case analysis.

This paper outlines the research executed in the five themes) (Van den Band & Van Duin, 2021; de Vries & Van Duin, 2021; Irajifar & van den Aker, 2021; Ouasghiri, Westerman & Moeke, 2021; Warffemius, de Nijs & Buurman, 2021). The paper ends with the conclusions and recommendations.

2 Sharing in city logistics

From a logistics perspective, there are opportunities within the city to make better use of office space, storage space, transport space, vehicles, personnel, and software, in such a way that unused capacity is not lost. In order to fully experience sharing opportunities, a living lab has been set up with the following parties Kappa Koerier (a local logistics service provider), Goods Hubs Netherlands (a national logistics service provider), Seval E-Cargo (supplier of an electric vehicle), DOCKR (Rental service company for light electric freight vehicles), Routigo (Planning/routing software for light electric freight vehicles), Local Markets (Union of market tradesmen) and GroenCollect (Collector of green waste). In the period February to August 2020, these parties explored how the living lab could best be set up. The living lab had to meet the following core values; it had to be future-proof, logistics had to be operated sustainably, it had to be a distinctive concept, education had to be involved, the Rotterdam business community had to be properly involved, and the impact had to be justifiable both quantitatively and qualitatively (Van den Band & Van Duin, 2021; RDMCoE, 2021).

Five Logistics Management students from Rotterdam University of Applied Sciences operated the Sharing Hub together. The assignments they received were, on the one hand doing research for one of the business partners in the field of Sharing Logistics, and on the other hand, researching Sharing Logistics possibilities and applications in practice by running the hub. The sharing hub was run from the North-West business park. The building belongs to Kappa Koerier that has additional 50m² of office space and 150m² of warehouse space available. Kappa Koerier also had several modes of transport such as electric e-NV200s that were partly unused. In addition to Kappa Koerier, GroenCollect became the logistics partners of the sharing hub. As the name suggests, GroenCollect collects high-quality green waste from the city center (usually restaurants). In addition, Routigo's route planning software was put into use, specifically developed for the light electric freight vehicles (LEVVs) that are also allowed to use the bicycle paths. Goods hubs in the Netherlands and Local Markets also took care of the logistics assignments. All these parties together made it possible to start the research in a living lab environment with the sharing hub (Van den Band & Van Duin, 2021; Goud, Siegelaar, Nieuwdorp, Van Rijswoud & Smit, 2021).

During the pilot, which started on September 1, 2020 and ran until January 31, 2021, services were performed for Kappa Koerier, GroenCollect, Dutch Goods Hubs, Giraffe Coffee, Support Your Locals, Simon Lévelt, Municipality of Rotterdam, Local Markets, Local Craft Beer, Netherlands Bagels and FlorisGifts. The main services performed are the collection and dispatch of parcels, the collection of returns, short-term stock storage, and light Value Added Logistics (VAL) activities. Figure 1 shows an overview of the vehicle kilometres distribution, CO₂ savings, the number of stops, the number of kilometres driven and the number of parcels delivered. The excess capacity of vehicles, loading space, office space, warehouse space, personnel, knowledge, and software has been shared with the logistics partners in the export of services. The social impact associated with a sharing hub consists of joining the forces of local (logistics) entrepreneurs, making better use of overcapacity, reducing the number of inner-city movements, reducing CO₂ emissions, and being a connecting factor for the inner city. Our research shows that a sharing hub can be profitable, but it requires a good value proposition, entrepreneurial strength, investment in the network, and good marketing. Differentiated collaborations and services seem to provide the best value proposition for a sharing hub because a broad target group of partners and parties can then be reached (Van den Band & Van Duin, 2021).

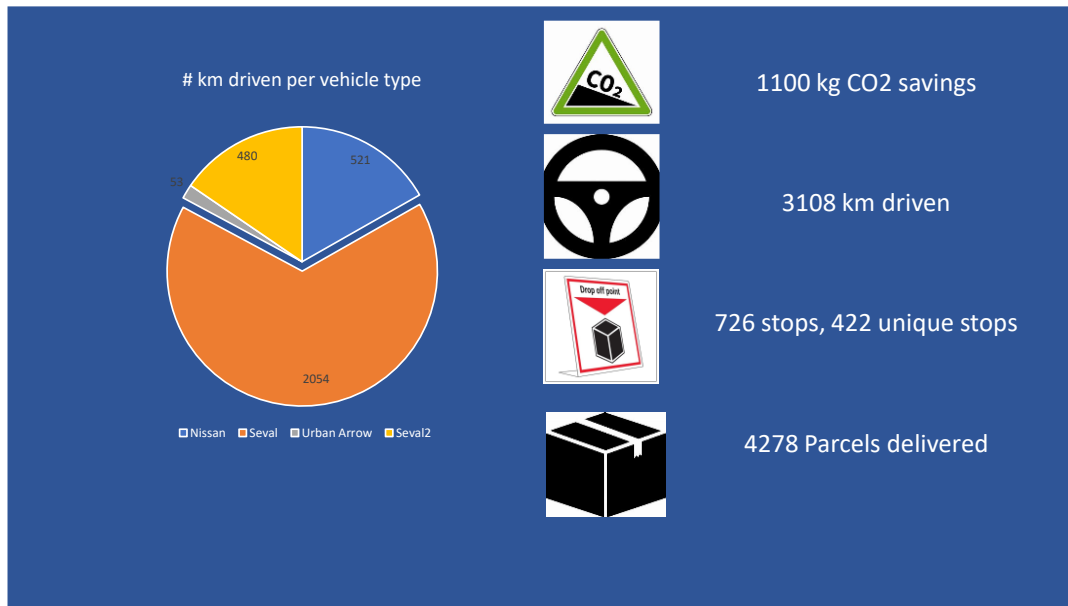


Figure 1. Display of the number of kilometres driven per type of vehicle, the number of kilometres, the CO₂ savings, the number of stops and the number of parcels delivered.

3 Sharing in construction logistics

In recent years, a lot of research has been done into construction logistics solutions and the application of construction logistics hubs. These solutions are often applied to large new construction projects on construction sites that are difficult to reach and are often initiated by large construction companies (De Bes - van Staaldhuizen et al., 2018; SUCCESS, 2017). SMEs in construction logistics have limited opportunities to organise these solutions themselves, partly because the costs are relatively high and the revenue model is unclear. One of the possibilities for these SME companies is the application of sharing economy concepts where trucks and vans in particular for the delivery of personnel, material, and equipment can be shared. This can lead to lower operational costs and more sustainable use of resources. In addition, one of the major challenges for the future of construction is the increase in inner-city construction and the increasing environmental requirements. From 2025, the zero-emission zone will be phased in in major cities in the Netherlands for city logistics (Municipality of Rotterdam, 2019; Green Deal ZES, 2014). This leads to major investments by companies in the medium term in zero-emission vehicles. Sharing these means of transport can be a new revenue model that can prevent overlapping investments.

In the study, 22 interviews were conducted with construction companies, suppliers, transporters, local authorities, and interest groups. Four knowledge sessions were held with parties from the construction logistics sector, during which findings from the interviews were validated and feedback was given on the interim results of the study. Subsequently, surveys were conducted among construction companies, suppliers, and transporters. Observations and measurements were made during the delivery of construction sites for further quantitative in-depth study of the business cases. Unfortunately, the response was too limited to extract quantitative data from this, however, the outcome of some questions does reinforce the picture that emerged from the literature, the interviews, and the knowledge sessions.

The interviews revealed, among other things, the potential for sharing production resources. Construction companies indicate that improvements in construction logistics should have an effect on the productivity of construction workers. This productivity is currently estimated at 40% and the improvement potential through the use of construction logistics concepts provides a 40% productivity improvement (De Bes - van Staaldhuizen et al., 2018). The interviews and knowledge sessions also show that the potential for sharing construction buses is particularly high. Literature, interviews, and observations have shown that the construction buses are loaded for approximately 35%, with a combination of material and equipment. It has also been found that the construction bus is stationary at the construction site for an average of 8 hours. This means that the bus is mainly only used for transport to and from the construction site, which is also indicated by Topsector Logistiek. The observations have shown that 30% of construction workers are not dependent on the (construction) bus. In addition, TNO (2020) has calculated that there is a 25% reduction potential in the number of movements of construction buses.

Both the suppliers and the transport companies indicate that the utilization of trucks can be improved. According to TNO (2020), the load factor of the trucks is a maximum of 50%. In various scenarios, TNO (2020) has calculated the potential of 75-90% in load factor by applying decoupling points.

Construction companies determine the construction logistics solutions for each project individually and specifically. This way of working doesn't allow a structural approach to construction logistics. The ad hoc

character in the sector results in inefficiencies in the chain, yet these inefficiencies often form the revenue model of suppliers and transporters. The characteristics of the delivery also ensure that the load factor of the trucks is limited and is mainly only high in the morning and decreases during the day. A limiting factor for making better use of production resources is that, according to the carriers, delivery cannot take place throughout the day; often morning delivery is requested.

Four solutions emerge from this research from the perspective of sharing economy concepts. Firstly, there are options for using white label concepts, such as white label trucking or a white label hub. The call from parties in the construction logistics chain is to create a level playing field so that competition can take place on the same principles. Such a 'white label' concept may provide a level playing field because costs and investments can be reduced and flexibility can be increased by making better use of production resources. In order to be able to apply such sub-concepts in the construction logistics chains, information sharing between the parties is important. The construction companies and transporters, in particular, indicate that there are many opportunities. Construction companies already work with regular partners on multiple projects and often work with framework contracts with suppliers. The information shared with suppliers concerns detailed delivery information such as the type of goods, the batch, the number, and the loading and unloading date. One obstacle, however, is that information is mainly shared low-tech, via telephone and E-mail.

Construction companies seem to have an important role in sharing information as they prepare, manage and adapt construction plans. However, small construction companies and freelancers often work from day to day, which means that they cannot take on this role. The second solution could therefore be that these construction companies are supported to improve the planning of the material flows. The third solution is that from an area perspective it is possible to gain insight into the construction projects that are underway. An area-oriented approach can contribute to a better understanding of demand and focus on bundling flows. Local authorities can play a guiding role in this through incentive schemes, pilot projects, and local regulations.

Finally, sharing economy concepts can be applied to the material, equipment and personnel flows that are now supplied via construction vans. Examples include shared transport capacity, equipment lockers on the construction site, and the use of shuttle busses.

4 Sharing in warehousing

In the warehousing sector 70% of warehouses with overcapacity have no solution for situations in which they have storage space available situationally (Been, 2021). Some warehouses are familiar with the possibility of offering their situationally unused storage space to the market, whether or not via a digital platform (such as Stockpots, Compose, etc.), and therefore they are able to reduce costs and/or increase their income. With the continued and highly fluctuating growth of e-commerce shipments and the changing expectations of consumers, traditional warehousing models are beginning to fall short. In general, increasingly smaller quantities are sent to individual customers, and it is not always possible to predict in advance how the demand will develop geographically.

On-demand warehousing is a concept that makes it possible to better spread the risks of situationally strongly fluctuating demand for storage capacity, usually facilitated via a digital platform by offering the possibility to temporarily increase or decrease the – situationally – strongly fluctuating demand for storage capacity. A crucial aspect of on-demand warehousing is being able to unlock situationally available, unused, storage capacity and/or overcapacity of other relevant assets so that these can be converted into active income and profit, by offering them to other parties. While shared warehousing is believed to be an innovative approach to addressing existing warehousing inefficiencies, it is certainly not yet common practice.

About 200 companies were interviewed in the field of warehouse sharing. A research proposal and/or research report has been drawn up for approximately 50 companies in which we have investigated the operational (and financial) feasibility of making underutilized capacity available situationally. In the conversations with executives, it became very clear that the resource storage, warehouse capacity often has an overcapacity of 15%-30%. A clear value proposition emerges here in which an attempt is made to convert the unused and underutilized storage capacity of existing assets from a cost item to revenue and profit by offering this space to other parties.

While the benefits of adopting on-demand concepts based on the concepts of the sharing economy are certainly obvious in terms of increased efficiency, lower costs, higher revenues, and less congestion. Profitable business models and their implementation through digital platform providers seem straightforward, however, it is only used to a limited extent. Juridical liability, mutual trust, regulation, and storage requirements are generally identified as the main reasons for their reluctance to collaborate in this area. In order to overcome these risks and challenges, the parties have set certain conditions and drivers such as standard certifications, other services, lower costs, and reduction of effort. Furthermore, the research has shown that especially small to medium-sized companies/start-ups are attracted to the solutions of platform providers. Major market players such as Syncreon and Amazone have already set up their own network from which they can benefit with minimal effort.

Therefore it is concluded that the subject of shared warehousing is practiced to a limited extent by parties in the market. However, because the needs/requirements differ per company and their partners/customers,

collaborating on a concept of shared warehousing via a platform provider is only limited to certain market segments (e.g. conditioned storage).

5 Sharing in healthcare logistics

At five healthcare institutions, it was investigated whether the medical devices and means of transport could be shared. The five studies show that there is a working basic structure and process flow through which the resources find their way to the user via a functioning control system. However, the research also shows that there is hardly any ownership of aid and transport resources (Ouassghiri, Westerman & Moeke, 2020) in the long-term care. In addition, it appears that the institutions studied do not or hardly exchange resources 'transcending location'. This is because purchasing budgets are often location-specific. This results in minimal registration of use, low utilisation rates, and relatively high stocks. A significant part of the stock consists of dead/non-moving stock of medical devices that have not been returned to the supplier. To the research, a sixth institution was involved at the last minute. This is not a healthcare institution, but a company that specialises in cleaning in healthcare. The business case in this specific study is not about sharing physical resources, but about sharing personnel capacity. Can cleaners take over the registration task of health care providers through smart technology?

Research by students (Stighel van der, 2019; Erkelens, 2020) shows that a sharing potential of 30 to 36% is possible. This can be explained by excess inventory and the loss of assets. However, this concerns relatively 'soft' data. From the business side, a value proposition consists of '*inside the invoice value*' (= saving or value) and '*outside of the invoice value*' (= extra value that you do not receive an invoice for, but that you do experience) (Barnes, Blake & Pinder, 2009).

Inside the invoice value sharing in healthcare:

- Savings on unnecessary inventory costs (interest, space, risk).
- Savings on purchase costs by sharing.
- More reuse and less waste.
- Savings on means of transport costs (maintenance, fuel, and depreciation).
- Have the registration of medical devices done by cleaning staff (= cheaper).

Outside the invoice value sharing in healthcare:

- As healthcare personnel is allowed to perform more primary process tasks, they feel valued, motivated, and more professional, resulting in lower turnover, fewer drop-outs, and absenteeism due to illness.
- Centralised planning in a district of different transport movements provides more interaction and change of daytime activities, so fewer lonely clients.
- Contribution to more connection and collaboration between colleagues, especially when it comes to sharing between locations.

The healthcare institutions Careyn and Laurens are open to implementing sharing under the conditions that registration of assets and streamlining of purchasing budgets are arranged. Purchasing and storage of the researched aids take place in a decentralised manner. The ZZG group has created its own marketplace, but the care institutions Carinova, Pleyade and the ZZG group have unfortunately (partly due to Corona) put the development of asset sharing at low priority. The municipality of Deventer, in collaboration with Carinova and HAN, is developing the 'Routigo App', a platform to streamline passenger transport.

Hago Zorg sees the concept of sharing as an extension of their service platform, which is illustrated in the video: Track and Trace on the cleaning cart (Hago Zorg, 2020). This film shows that the cleaning staff registers and locates the 'tagged' medical devices using a 'smart scanning tool' installed in the cleaning cart while walking through the wards. The emphasis is now on cleaning and maintenance. The registration information can be collected centrally by Hago Zorg and in a later phase Hago Zorg can potentially take on a 4PL role based on this data when it comes to asset management and determining the sharing potential. Two student groups investigated the status of registration and asset management of the medical devices at two of Hagozorg's customers in long-term care. One group found that there is certainly potential for Hagozorg to add value and to unburden long-term care. The other group concludes that a 3PL can support the asset manager in the field of cleaning, localisation, and positioning of the assets (Blok, et al., 2021). Both groups noted a reasonable trepidation and reluctance to open up about asset management in long-term care, but the positive part of this research is that they both have shown interest in the research data and the first step towards implementation has been taken.

The fact that the examined institutions are not (entirely) open to sharing is mainly explained by a lack of knowledge about the advantages and disadvantages of sharing. In addition, the institutions find it difficult to oversee the financial impact of sharing. This is because purchasing budgets and stocks are organised in a decentralised manner. Partly through the efforts of students, it was investigated under which conditions a national platform for B2B sharing in healthcare could be successful. This platform has now been launched, see: deelpatform.intrakoop.nl (FLOOW2, 2021).

The company cases show that the long-term care institutions studied organise the use of aids and means of transport in different ways. In a positive sense, the cross-case analysis of all investigated institutions shows that

the perceived level of service with regard to the availability of resources or transport (activities) is good to reasonable. In addition, the studies show that there is awareness of the problem among healthcare professionals and facility managers. During the research into organizing the provision of resources and means of transport, however, bottlenecks were also found at the institutions involved, which are discussed below, after which a discussion is concluded about possible solutions that have not yet been investigated or of which the investigations have not yet been concluded (Ouasghiri, et al., 2020).

When organising the deployment of aid and transport resources, there is insufficient insight into the availability and demand for these resources that transcends location. This is mainly due to the fact that the availability and use of these resources are not centrally registered. Difficult communication and differences in financing and budgeting do not help either. As a result, the exchange of resources is hardly possible. This directly feeds an experience of scarcity. The result is that unnecessary material is purchased or leased (Paksoy, 2020).

Increased transparency in resource demand and supply contributes to the ability to exchange resources at the organizational level. This enables care providers to more effectively link the needs of clients to the availability of these resources. It is assumed that organising an internal marketplace contributes significantly to greater transparency in supply and demand. An important precondition for the marketplace is a system to register centrally resources. At the moment, insight into the use of the tools is insufficiently transparent as the usage is simply not registered. Another precondition is the central management of budgets for the purchase of resources. Decentralized budget structures for resources appear to significantly impede exchanging between the locations of an institution. Ouasghiri et al. (2020) argue for a single digital marketplace for the (auxiliary) resources of all long-term care institutions, like the national sharing platform <https://deelpatform.intrakoop.nl>.

6 Sharing in service logistics

Service logistics is about all logistics activities that are required to allow capital-intensive systems (assets) to function as optimally and undisturbed as possible after sale to the customer (after sales service) during their entire life cycle (up to and including decommissioning or reuse) (Top Sector Logistics, 2021). After-sales service (servitization) is becoming increasingly important. Many machine users already expect their supplier to provide services such as installation, maintenance, repair, and replacement. In the literature, two main reasons are mentioned why after-sales service is becoming increasingly important in the business-to-business market (Akkermans et al., 2016, Jalil, 2011). Firstly, new machines and systems are becoming more and more complex, which means that maintenance is also becoming more and more complicated. It is therefore becoming too expensive and complicated for a growing group of users to do the maintenance themselves. Secondly, it is becoming more and more complicated to have existing systems meet the increasingly strict requirements in the field of safety, the environment, and reliability.

Due to the increasing need to use rather than own a product, manufacturers are challenged to develop service-based business models. Manufacturers who retain ownership of their product or machine bear a greater responsibility in its end-of-life phase. Discarded machines are thus better used as valuable raw materials for new or 'refurbished' ones. Together with services such as maintenance, overhaul, and upgrading (which extend the life cycle of the machine), this is an incentive for sustainability (Akkermans et al., 2016; ABN-AMRO, 2016). The shift from ownership to pay-per-use is also at the heart of logistics concepts based on the sharing economy (Gesing, 2017). Three student teams have conducted research on concrete case studies from logistics practice. The study involved collaboration with three companies from the port of Rotterdam. The case studies were done at Huntsman Holland (process industry), Evides industrial water (process industry), and Alstom (Original Equipment Manufacturer).

At Huntsman, it concerns the development, production and supply of chemical products such as polyurethane. The production facilities and installations are the key resources and they must be used as optimally as possible (maximum availability, minimum disruptions). Safety has the highest priority. Inspection and safety checks are therefore carried out frequently and meticulously. Most maintenance is carried out on a planned (periodic) basis (preventive maintenance) based on inspection reports. Parts necessary for the maintenance of the installations (such as valves, shut-off valves, pumps) are purchased by Huntsman itself, managed on its own site, and stored at 16 different locations. After receipt, the parts are registered. However, at which of the 16 locations the parts are subsequently stored is not always registered. Huntsman's question is to reduce the risk that a scheduled maintenance job cannot start because a repair part is missing. In terms of making even better use of assets (tangible and intangible), this involves sharing maintenance and usage data (by Huntsman) and thereby making even better use (by Huntsman) of the producer's knowledge about use and maintenance and linked to spare parts management. Huntsman could, for example, agree with a manufacturer that remanufactured pumps and other critical spare parts will not be delivered until the maintenance job starts. In terms of the sharing economy, this is about sharing and therefore making even better use of available storage capacity (by the pump manufacturer).

At Evides, this concerns both installations on their own sites, but also installations at the customer. The installations are the key resources and must be used as optimally as possible (maximum availability, minimum disruptions). Evides has a service-based business model in which the customer pays purely on the basis of use.

Evides' installations have built-in sensors that transmit usage and maintenance data. Management and minor maintenance of the installations are done by their own process technicians. Planned maintenance is done by their own M&TS employees (Maintenance & Technical Support). Evides' question is how, when distributing the work orders among the process technicians and M&TS employees, it is possible to take even better account of minimizing the number of kilometres to be driven in order to optimize the ratio between travel time and time for maintenance. Fewer kilometres driven also means environmental benefits through lower CO₂ and nitrogen emissions. However, these gains are not achieved by sharing an asset. The case study at Evides did not lead to a sharing logistics concept.

In the Alstom Ridderkerk case study the focus is on one customer and one product, namely the RET (public transport provider in Rotterdam) and the 'Citadis 2' tram. It is about managing and supplying spare parts and wearing parts for this tram. The RET carries out the maintenance inspection and checks itself, orders the necessary spare parts from Alstom on time, plans the maintenance itself, and employs its own technicians for this. If Alstom does not have critical spare parts on stock, it could lead to an unexpected long downtime of a tram or metro. Alstom's question is how spare part management can be better organised in order to minimize the chance of being out of stock and "no sales".

In the Huntsman and Alstom cases, the sharing logistics concepts are profit-driven. Both for the user of the units and for the user of the trams/metros, it can lead to efficiency gains in terms of maximum availability, minimum disruptions, or a guaranteed uptime. Environmental benefits are also possible. Maintenance, overhaul, and upgrading (which extend the life cycle of the assets) are an incentive for sustainability. If the manufacturer remains the owner of its units or trams/metros (and the customer starts paying purely for use: power-by-the-hour), the manufacturer bears a greater responsibility in the end-of-life phase. Discarded pumps, valves, trams, or metros are thus better utilized as valuable raw materials for new or refurbished units. In both case studies, however, this is not yet the case. In each case study, the manufacturer and user are at the beginning of the servitization maturity model (ABN-AMRO, 2016; Atos, 2011). For the two OEMs from the case studies, this means new opportunities to add value for the customer and to distinguish themselves from the competition. The biggest challenges for implementing the sharing logistics concepts do not lie with investing in technology and developing a data-sharing platform. That is already there to a greater or lesser extent. The biggest challenges will lie with the trust between the collaboration partners to share data about business processes.

7 Conclusions & recommendations

The research shows how fragmented the concepts of the sharing economy are picked up within the urban freight themes and shows that the actual implementation of sharing concepts has different stages of maturity (see Table 1).

Domain	Sharing Maturity-level	Resource sharing	Barriers	Drivers	Implementation Now/Future
City Logistics	Medium	Hubspace, LEFVs	Trust, competition	Greendael ZES	White Label hubs
Construction Logistics	Very low	Personel, Busses	Culture, small enterprises, trust, communication	Greendael ZES, Game development	Construction hub,
Warehousing	Medium	Warehouse space	Fragmented periods of capacity, trust	Maturity in ICT	Many platforms
Health care	Low	Medical equipment, beds, Oxygen-pumps	Decentral cost structures, unknow locations, trust	Experiences Covid 19,	National platform,
Service Logistics	Medium	Equipment usage, s	Trust, strong position of OEMs	Maturity in ICT	OEM platforms

In construction logistics, for example, it is striking that the sharing options for construction workers, construction buses (to transport personnel to the construction site), and the transport of materials to the construction site are recognised. Triggered by this, the need arises for white label service providers to actually take up these sharing services, because the companies themselves are too busy carrying out their own projects. In order to tackle this adequately, it is necessary that planning information must be shared with each other. This is still a big challenge because this sector has many small SMEs who communicate with emails and telephone calls.

The warehousing research theme should ideally be a theme that lends itself well to the use of sharing concepts. With overcapacity averages of 15-20%, there are clear opportunities for sharing. The willingness to explore these opportunities is quite high. Out of the 200 companies, an in-depth additional feasibility study has also been carried out for 50 companies. The 80/20 rule that is preached in education often turns out to be unbiased in practice. Yet, only limited use is made of digital platforms where supply and demand for warehouse space meet. Liability, mutual trust, regulation, and storage requirements were generally identified as the main reasons for their reluctance to collaborate in this area.

For care logistics, the study has shown that there is hardly any ownership of aid and transport resources (Ouasghiri, Westerman and Moeke, 2020) in long-term care. In addition, it appears that the institutions studied do not or hardly exchange resources 'transcending location'. This happens because purchasing budgets are often location-specific. This results in minimal registration of use, low utilization rates and relatively high stocks. More transparency and decentralized procurement create the possibility of introducing a single digital marketplace for the (auxiliary) resources of all long-term care institutions at regional level. The good news here is that a national sharing platform is already operational (<https://deelplatform.intrakoop.nl>) that can be used by all healthcare institutions in the Netherlands.

In service logistics it should be noted that in every case study the manufacturer and user are still at the beginning of the servitization maturity model (ABN-AMRO, 2016; Atos, 2011). For OEMs new opportunities arise to add value for the customer and to distinguish themselves from the competition. The biggest challenges lie with the trust between the collaboration partners to share data about business processes

In city logistics we see that the pressure to be able to supply is increasing for the city center. As a result, we see a growing demand for white label hubs within and just outside the ZE zone of the city. The use of LEFVs and electric vans is increasing as a result. The associated investments in vehicles, space/location and personnel mean that a sharing hub can be profitable, but this requires a good value proposition, entrepreneurial strength, investment in the network, and good marketing. Differentiated collaborations and services seem to provide the best value proposition for a sharing hub because a broad target group of partners and parties can be reached (Van den Band & Van Duin, 2021). The maturity of the sharing concept is certainly growing in city logistics.

In general, we can say that the maturity of sharing in contemporary concepts is still in its infancy. However there are very few good initiatives to be discovered in every sector which proof the essence that sharing principles can provide profitable business models. To guide the companies trust is the crucial principle that needs to be tackled. For research this means that gaming development of illustrating sharing principles and explaining best practices are the next steps needed to bring companies to a higher level of sharing maturity.

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