



Upscaling cargo bike sharing in cities: A comparative case study

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ABSTRACT

Urban mobility transitions are essential to mitigate climate change and improve the quality of life in cities. Cargo bikes (CBs) show promise in replacing motorised vehicles due to their lower carbon intensity, space efficiency, and ability to reduce air and noise pollution. CB sharing relieves users from purchase and maintenance costs. However, it is mainly adopted by individuals with high environmental awareness. Barriers to CB sharing stem from the urban infrastructure, individual mobility choices, and the design of CB sharing organisations (CBSOs). This article analyses upscaling pathways for CB sharing, i.e., increasing their use by a broader audience and reshaping the urban mobility regime. It delivers a comparative case study analysis of two CBSOs: Grätzlrad, Vienna, and LastenVelo e.V., Freiburg. Data was collected through academic and grey literature review and 15 semi-structured interviews with CB sharing stakeholders and experts. The analytical framework is informed by strategic niche management, viewing CB sharing as a niche innovation in the urban mobility regime. The article enhances understanding of CB sharing, the interaction of CBSOs with key actors, and their scalability. CBSOs should increase the availability of shared CBs while reducing the organisational effort required from users. New ways of CB sharing, e.g., integration in shared mobility hubs, should be explored. Municipal actors play a crucial role in upscaling and ensuring that CB sharing reaches a diverse user base. The findings are useful for academia, practitioners and policymakers working with CB sharing and other sustainable urban mobility solutions.

1. Introduction

Current mobility systems in industrialised cities are unsustainable. The dependence on heavy motorised vehicles causes congestion, accidents, noise, air pollution and occupies space (EC, 2021), (Nieuwenhuijsen, 2020). This influences urban living quality and human health negatively. It is estimated that 20% of premature deaths could be prevented if urban transport planning considered health recommendations on increased physical activity and reduced air pollution, noise and heat (Mueller et al., 2017). Moreover, emissions from transport account for 24% of global greenhouse gas emissions contributing substantially to climate change (Solaymani, 2019). Transport is the only economic sector in the EU where the emissions have increased since 1990 (eurostat). This amplifies the need to transform urban mobility systems towards sustainability.

Shifting away from cars to other mobility modes can reduce emissions and increase accessibility, economic activity and improve health (Javaid et al., 2020). Cargo bikes (CBs) are one alternative mobility solution, which can replace heavier motorised vehicles, especially for the last-mile deliveries and private logistics (Wrighton and Reiter,

2016). CBs are a single or multi-track transport for goods or people with a maximum width of 1 m, total weight of 250 kg and speed of 25 km/h, potentially with electrical support (Pucher, 2019). While complex political, socio-economic and cultural factors influence private mobility choices and should be considered when transforming urban mobility systems, technically CBs could replace up to 51% of intra-urban motorised transport trips and 77% of private shopping, leisure, and commuting trips, where goods are transported (Wrighton and Reiter, 2016).

Due to individual ownership of CBs being often impractical or expensive, CB sharing emerged as an alternative offering access to CBs while relieving their users from purchase and maintenance costs (Mont et al., 2020). The increased accessibility and affordability of a low-carbon mode of transport could also contribute to making urban mobility systems more socially just (Schwanen, 2021), (Mullen and Marsden, 2016). Despite its potential to counter the dominant regime of individually owned motorised vehicles and contribute to urban sustainability transitions (Meelen et al., 2019), CB sharing remains a niche choice for private logistics, and it is still used only by early adopters. While almost one third of the German population imagines using CB sharing, just 2% use CBs (Sinus-Institut, 2021). The early adopters have

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Abbreviations:

CB	cargo bike
CBSO	cargo bike sharing organisation
MLP	multi-level perspective
SNM	strategic niche management

high environmental awareness, use bicycles as the primary mobility means (Becker et al., 2018), are male and have higher average education (Becker et al., 2018), (Dorner et al., 2020), (Hess and Schubert, 2019). Despite the increasing number of cargo bike sharing organisations (CBSOs), they do not reach all population groups, remain below their potential and occupy a niche within the urban mobility regime (Hess and Schubert, 2019). At the same time, capitalising on CB potential and the existing “vibrant social network” through upscaling CBSOs is important to advance more sustainable urban mobility systems [14, p. 163]. Upscaling is making CBSOs broadly available (Kemp et al., 2000) and moving from “experimentation to mainstream” (Van den Bosch and Rotmans, 2008). It should not be mistaken for scaling up solely in the sense of impacting higher institutions (Moore et al., 2015).

While there is growing research on the sharing economy business models (Curtis, 2021), (Curtis and Mont, 2020), (Netter et al., 2019), (Guyader and Piscicelli, 2019), bicycle sharing (van Waes et al., 2018), (Ma et al., 2018) and cargo bikes for urban logistics (Gruber et al., 2014), (Hofmann et al., 2017), the literature on cargo bike sharing for private logistics is limited. The emerging research focuses on technical (Steenberg, 2017) or geographical aspects of CB sharing (Haj Salah et al., 2021). Some studies evaluate the uptake and impact of experimental CB sharing schemes, e.g., LARA share in Vienna, Austria (Dorner and Berger, 2020), and TINK in Constance and Norderstedt, Germany (Scheffler and Bleh, 2018). Still, the literature on CB sharing mainly focuses on its potential and user demographics (Becker et al., 2018), (Dorner et al., 2020), (Hess and Schubert, 2019), (Becker and Rudolf, 2018), (Bissel and Becker, 2022), (Dorner, 2020) and only marginally touches on the factors to upscale CB sharing (Becker et al., 2018), (Dorner et al., 2020), (Hess and Schubert, 2019), (Dorner, 2020), (Schmidt and Sikora, 2022) without offering a systemic perspective on pathways for upscaling CBSOs in cities. While some insights can be gained from the literature on bicycle sharing (van Waes et al., 2018), CBs address other mobility needs than regular bikes.

Departing from these knowledge gaps, the urgent need to advance sustainable urban mobility and the unfulfilled potential of CBSOs, the aim of this article is to uncover the upscaling pathways for CB sharing in cities. Empirically this explorative research focuses on CB sharing in Austria and Germany due to the growth of cargo bike sharing in these countries in the past decade (Forum Freie Lastenräder), (Carracedo and Mostofi, 2022).

Section 2 presents the literature review on CB sharing and its potential for urban sustainability and upscaling. Section 3 explains theoretical premises and develops a conceptual framework for this study. Methodology (Section 4) is followed by Results and Discussion (Section 5), where the upscaling pathways for CB sharing in cities are uncovered. Section 6 concludes the article and provides implications for future research and practice.

2. Cargo bike sharing: potential for urban sustainability and upscaling

2.1. Organisation and sustainability potential of cargo bike sharing

CB sharing emerged within the broader sharing economy trend (Mont et al., 2020). It implies temporary access to CBs through rental or borrowing while reducing the costs for users. Sharing can also be a

sustained solution for those who need a CB occasionally and it can decrease household car ownership (Dorner, 2020). Indeed, almost half of the trips made with shared cargo bikes would have been otherwise made by car (Becker and Rudolf, 2018). CB sharing creates innovative links between the established elements in cities, i.e., (electric) cargo bikes and the sharing economy, and therefore represents a socio-technical innovation (Hess and Schubert, 2019).

In station-based systems, CBs are located at fixed points and accessed via a platform, such as a website or app. This process requires minimal effort from users, involves no social interaction, and typically includes a monetary transaction between the host and user through the app. In host-based systems, CBs are provided by individuals or organisations, such as small businesses or municipalities, and access may be free or paid. These systems require more coordination and individual arrangements. Host-based systems are the most common for free CB sharing and, so far, have proven more effective than anonymous automated sharing due to their personal touch (Ghebregiabiher and Poscher-Mika, 2018). Until now, CB sharing was mainly organised through citizen driven CBSOs in host-based systems. In the last 10 years 168 non-profit citizen driven CBSOs were founded mainly in Germany, Austria, Sweden and the UK. Next to these mission driven CBSOs, several municipal and commercial actors have included CBs in their regular bike sharing schemes and a few companies have specialised in CB sharing.

Studies show that CB sharing has the potential to reduce car ownership. In one of the largest quantitative studies on CB sharing in Germany and Austria, data from 931 users of 30 CBSOs was analysed (Becker and Rudolf, 2018). Most respondents intended to use a CB again, while a much smaller group considered purchasing a CB (Becker and Rudolf, 2018). The finding that almost half of the trips would have been made by car otherwise (Becker et al., 2018), (Dorner, 2020) provides a strong basis for the potential of CBSOs for sustainable urban mobility. Different studies found that people used a CB for the first time through the sharing scheme (Becker and Rudolf, 2018), (Dorner and Berger, 2020). This shows that CBSOs often serve as the first contact point with CBs. Moreover, the increased visibility of CBs on the streets was shown to raise awareness about CBs as a mobility option (Becker et al., 2018).

While several studies highlight the emission reduction potential of CBs for commercial logistics, only a few estimate the reduction potential for private use (Carracedo and Mostofi, 2022). The reduction potential depends on factors such as modal shift and local electricity mix. In the sample by Becker & Rudolf (Becker et al., 2018) 920 kg of CO₂ emissions were saved through 425 avoided car trips. CBSO “fLotte” in Berlin contributed to saving 70 t of CO₂ from 2018 until May 2022 as 38% of trips with shared CBs replaced a car trip (Schmidt and Sikora, 2022). Studies on CB use for commercial last-mile deliveries found emission reduction potentials of ca. 60% compared to deliveries by conventional vehicles (Vasiutina et al., 2021). While there is a need to estimate the emission saving potential from replacing car trips with cargo bike trips for private logistics in different contexts, it is evident that cargo bikes can play a role in sustainable urban mobility transitions.

2.2. Barriers and opportunities to upscale cargo-bike sharing

CBs have been gaining importance in national and urban cycling planning. Purchase incentives for CBs are offered in over 70 cities in Germany and over 20 cities in Austria (cargobike.jetzt). German National Cycling Plan 3.0 states that urban cargo and commercial transport should shift to bicycles (BMDV, 2022). In Austria, the National Cycling Plan 2015–2025 focuses on offering more CBs through sharing systems (klimaaktiv, 2015). Still, as mentioned in the Introduction, the uptake of CB sharing has been slow and occurred among a specific group of early adopters.

Barriers to use CBs and CB sharing stem from within a CBSO, such as convenience for the users, availability of CBs and awareness about the offer, as well as from external factors, such as urban infrastructure. A review of factors influencing the adoption of low carbon transport

modes found that individual-level factors, e.g. values, habits and demographics, social factors, e.g. social norms and peer pressure, and infrastructure all significantly influence travel mode choice (Javaid et al., 2020). Barriers to use CBs are similar to those for regular bikes in cities, but there are additional barriers connected to the specifics of CBs, for example their size. A review on e-cargo bike use in urban areas found cycling infrastructure, safety concerns, risk of theft, practicalities of transporting children and high purchase costs of 2000–5000€ as the main barriers for cargo bike adoption (Carracedo and Mostofi, 2022). In research from Germany, the main reason for the lack of interest to use CBs was car ownership by the respondents (Sinus-Institut, 2021).

While CB sharing lowers high purchase costs, other barriers originate from sharing with the most common ones being irregular need of CBs, the organisation of the sharing and the availability of other means of transport (Hess and Schubert, 2019). Non-users mentioned safety concerns due to unsuitable infrastructure for CBs as the second most important barrier. In the evaluation of flotte CBSO in Berlin, the limited opening hours by the hosts and the high organisational effort of the host-based system were identified as barriers (Schmidt and Sikora, 2022).

To encourage the uptake of CB sharing by broader audiences, Dorner and Berger (2020) found that non-users could be motivated with emotional arguments, e.g., the pleasure of driving a CB. They also mention a “critical mass of supply and demand” (p. 10) required to improve infrastructure and organisational challenges of sharing systems, such as insurance for CBs. Other upscaling factors include CB location (Dorner et al., 2020), (Becker and Rudolf, 2018), CB availability (Bissel and Becker, 2022) and the safety of cycling infrastructure (Hess and Schubert, 2019), (Becker and Rudolf, 2018). The lack of public investment and support are seen as a barrier for CB upscaling (Becker and Rudolf, 2018). Dorner & Berger (Dorner and Berger, 2020), Dorner (2020) and Becker and Rudolf (Becker et al., 2018) highlight the need for further research on how to reach target groups beyond the early adopters.

Upscaling of the sharing economy has been analysed using the institutional theory lens, e.g., institutional work of sharing economy organisations (Zvolska et al., 2019a) and municipalities (Mont et al., 2018), institutional logics (Grinevich et al., 2019), (Frenken et al., 2020) and institutional change (Laurell and Sandström, 2016). Research on sharing cities uses urban governance perspectives to elicit pathways for sharing economy development and institutionalisation (Ma et al., 2018), (Voytenko Palgan et al., 2021), (Bernardi and Diamantini, 2018), (Palm et al., 2019), (Vith et al., 2019). Still, most of these studies either discuss the sharing economy phenomenon broadly without diving into sector specificity or focus on large multinational platforms such as Airbnb and Uber.

Hess and Schubert (2019) suggest using the socio-technical transitions approach and specifically the multi-level perspective (MLP) to research CB sharing. CBSOs can be seen as a socio-technical innovation or as a niche, therefore, the MLP, which recognises the complexity of transitions with its many interactions between the levels instead of “[I]near cause-and-effect relationships or simple drivers” (Geels, 2019) is a suitable analytical framework. Van Waes et al. (van Waes et al., 2018) applied the MLP to study the upscaling of bike sharing. They analysed the business models and the socio-technical context to assess the scalability of different sharing systems for bicycles and conclude that particular types of bike sharing schemes are more scalable than others (van Waes et al., 2018). While the study has proven the feasibility of applying the socio-technical transitions perspective to the analysis of bike sharing, its findings have limited relevance for CB sharing since CBs fulfil different functions. Moreover, van Waes et al. (van Waes et al., 2018) analyse the effects of introducing a bike sharing scheme in a city *ex-post* and not in a predictive manner for upscaling (O Tuama, 2015). This research applies approaches from the transitions theory (Section 3) to both study the transition dynamics of CB sharing up to date (Section 5.1) as well as prescribe pathways to upscale CB sharing in cities

(Section 5.2).

3. Theoretical underpinnings and conceptual framework

Since CBSOs are conceptualised as a socio-technical niche innovation, which we argue needs upscaling to advance urban sustainability transitions, it is relevant to ground the conceptual framework for this study in the approaches from the transitions theory: the multi-level perspective (MLP) (Geels, 2011), (Geels, 2002) and the Strategic Niche Management (SNM) (Schot and Geels, 2008), (Smith and Raven, 2012), (Seyfang and Smith, 2007).

The MLP describes three levels of socio-technical systems: the landscape, which is the external context for interaction, the regime, which constitutes of the rules for activities, and niches, which are protective spaces for innovation (Geels, 2002). The MLP was applied to study the dynamics and stakeholder interactions of the socio-technical urban mobility regime (Canitez, 2019), (Geels, 2012), (Moradi and Vagnoni, 2018). The currently dominant regime puts a focus on individually owned motorised vehicles (Meelen et al., 2019), (Medina-Molina et al., 2022) and CB sharing is a niche innovation to make the transport system more sustainable and socially just.

Changes within the regime can only be incremental, while niches with their room for learning, experimenting and forming social networks can advance radical innovation (Geels, 2002) by providing “the seeds for systemic change” [55, p. 472] and unlocking “old styles of thinking” [58, p. 332]. However, for a transition the innovation needs to get out of its niche and be able to withstand the pressures of the regime. Upscaling niches means scaling it from the niche level to the regime level (Raven et al., 2010), which is the focus of the strategic niche management (SNM) perspective.

SNM “arguably appears a subset of [MLP]” and it is used to explain pathways for the upscaling of innovations [60, p. 236]. The niche of CB sharing is already attractive to its early adopters, and experiences from the niche can inspire upscaling it to the next user groups (Kemp et al., 2000). SNM helps understanding the institutional embedding of innovations through the network formation, coordination of policies and the establishment of shared values and belief systems (Kemp et al., 2000). SNM research shows that upscaling niche innovations depends not only on niche dynamics, but also on the “socio-institutional context” [61, p. 1] and that niches should be linked with external processes, e.g., a broader sustainable mobility agenda (Schot and Geels, 2008). In other words, to capture a systemic perspective it is important to study the mobility systems in which CBSOs are embedded.

SNM has been applied to different types of niche innovation, e.g., community energy (Ruggiero et al., 2018), community currencies (Seyfang and Longhurst, 2015) and permaculture communities (Maye, 2016). These studies use SNM to analyse the success of and constraints to niche upscaling. Initially, SNM was mainly used for the *ex-post* analysis of case studies to later derive a policy advice (Schot and Geels, 2008). The potential of prescriptive SNM for ongoing projects and experiments has been highlighted (Schot and Geels, 2008). This research attempts to do both: analyse to what extent the case study CBSOs have been nurtured and developed (Section 5.1) and thereupon prescribe what would be needed for their upscaling (Section 5.2).

The niche development process undertakes three steps: shielding, nurturing and empowering (Smith and Raven, 2012). First, niches are *shielded* from the outside pressures, then *nurtured* through learning, expectation management and network building, before finally being *empowered* to become competitive outside of the protective space (Smith and Raven, 2012). Since CBSOs already have early adopters and they are functioning within the broader urban mobility regime, shielding is less relevant to understand the pathways for upscaling CB sharing. This research will therefore mainly focus on the processes of nurturing and empowering.

While niche nurturing focuses on the internal niche dynamics, empowering requires interaction with the outer context and the regime.

Smith and Raven (2012) use the strategies of “fit-and-conform” and “stretch-and-transform” to describe how niches can be empowered to make them compatible with the regime or change it. It is important to consider if the process or the outcome is disruptive to the regime. If the innovation is radically different from the current regime, it will be shielded until it becomes competitive at the regime level (Raven, 2007). An alternative strategy is that the niche starts closer to the regime and then changes it from within. Geels’ describes a “fit-stretch pattern” where innovations must fit in the regime at the start of the transition and as they become more adopted, they can stretch the regime [(Jenkins et al., 2019), p. 689]. “Fit-and-conform” and “fit-and-transform patterns”, however, bear a higher risk of co-optation, - a process where powerful incumbent actors integrate or assimilate niche innovations into their existing structures and agendas, reducing the potential for more radical, transformative change (Schot and Geels, 2008; Smith and Raven, 2012). All niche empowering strategies are seen as a continuum, as most niche development pathways appear somewhere in-between (Raven, 2007).

Different pathways for empowering niche innovations have been described. Upscaling CB sharing is seen as empowering the CB sharing niche to move from “experimentation to mainstream” (Van den Bosch and Rotmans, 2008) or from local niche projects to a global field of niches, where the local niches interact and share cognitive rules (Schot and Geels, 2008). A useful typology for upscaling pathways includes the processes of growing, replication, accumulation and transformation (Naber et al., 2017). *Growing* refers to the niche growth within the same context. *Replication* refers to niches being replicated in other contexts. *Accumulation* means that niches in different contexts are linked to each other. Finally, *transformation* is connected to the niche-regime interaction continuum and means that niches cause change in the regime (Naber et al., 2017). Fig. 1 synthesises the key concepts from SNM and it will be used as a conceptual framework in this study.

4. Methodology

4.1. Research approach and case study selection

Since there are no established ways to upscale CB sharing, qualitative approach is suitable to understand and interpret how such upscaling may occur (Schreier, 2012). Specifically, a comparative case study analysis of two CBSOs - LastenVelo e.V. in Freiburg, Germany, and Grätzlrad in Vienna, Austria – form the core of this research. The small number of cases in case-based research facilitates developing a theory, i. e., developing pathways for upscaling CB sharing, rather than testing it

(Perri and C. Bellamy, 2012).

The cases were chosen to be similar enough but sufficiently different for comparison, analysis and theory development. Both CBSOs are in bicycle-supportive cities (Freiburg and Vienna) with presumably favourable conditions for their development. Freiburg, a city with a well-known bicycle culture, is ranked as the third most bicycle-friendly city among German cities with 200 000–500 000 inhabitants (adfc, 2020). Bicycles constitute 30% of a modal split in Freiburg (Freiburg im Breisgau). Vienna has been ranked the ninth most bicycle-friendly city in an international ranking (Copenhagenize, 2019). However, bicycles only make up 9% of the modal split (Wien) featuring a different degree of bicycle adoption to that in Freiburg.

Both CBSOs mediate access to CBs in cities through online platforms thereby reducing transaction costs in sharing for their users. They seek to contribute to sustainable mobility transitions and raise awareness of CBs as a mobility choice. Still, the two CBSOs have several distinct features. LastenVelo e.V. is a station-based system while Grätzlrad is a host-based (or free floating) one (van Waes et al., 2018). While both could be classified as collaborative community platforms [23, p.1657], (Curtis and Mont, 2020), LastenVelo e.V. is a citizen-driven CBSO, which have been at the forefront of CB sharing, while Grätzlrad is municipally organised, which helps understand the role of public actors in CB sharing. These distinct design features of the two cases are important to provide ground for contrasting findings and consequently, theoretical replication (Yin, 2018). While this research does not include a case of a commercial CB sharing platform, which are limited today, this perspective is captured through the interviews with commercial CB sharing actors since such platforms are seen as having potential in urban sustainable mobility transitions (Schmidt and Sikora, 2022).

The sustainability performance of the case study CBSOs is high. Their unconventional and diverse revenue streams, lack of formal review systems and thereby user interaction, and reliance on volunteers and hosts limit their scalability. Innovating business models, for example, by adding a fixed price, however, carries risks such as user backlashes (Curtis, 2021). While the two CBSOs add significant environmental and social value to their respective urban mobility regimes and have functioning business models at their current scale, it is questionable if they can be upscaled sufficiently to fulfil the potential of CB sharing in each of the cities. This is another reason why they were chosen for in-depth study within in this research.

We start by providing general insights on the embeddedness of CB sharing in the urban mobility regime in Austria and Germany by applying the strategic niche management (SNM) perspective and niche nurturing approach in particular (Smith and Raven, 2012) to understand

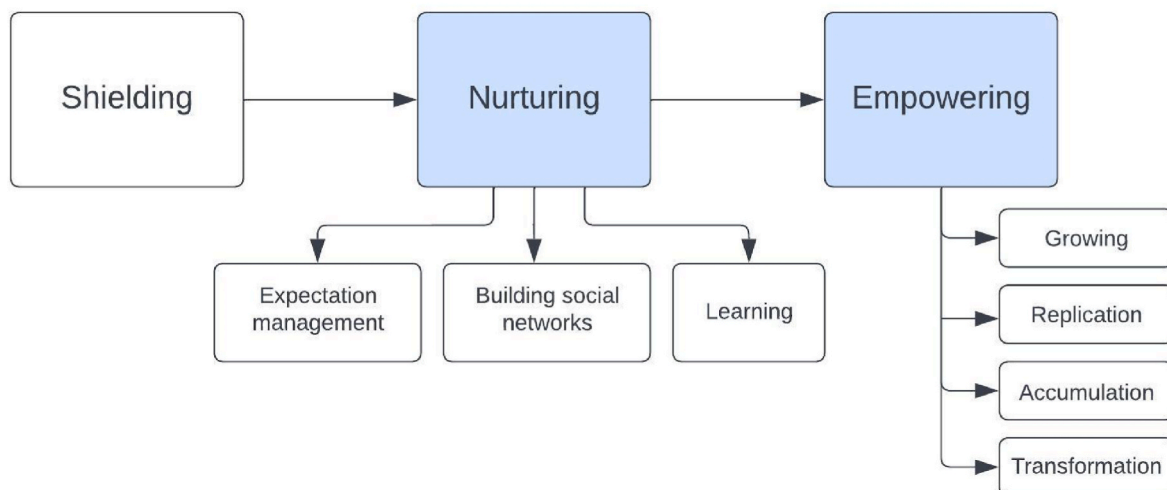


Fig. 1. Conceptual framework for niche upscaling.

Source: Authors’ elaboration based on (Kemp et al., 2000), (Geels, 2002), (Smith and Raven, 2012), (Naber et al., 2017)

the interaction between the CBSOs and the established and emerging urban mobility actors, i.e., local authorities, CB advocacy organisations, other citizen-driven and commercial CBSOs, and academia (Section 5.1.1). Building on these findings and by examining the empowering of CB sharing niches (Fig. 1) (Section 5.1.2), we identify and systematically analyse the pathways to upscale CB sharing (Section 5.2).

4.2. Research methods

A systematic literature review was conducted in February–May 2023 to capture the existing knowledge on CB sharing, gain information on the case study CBSOs and develop the conceptual framework. First, the literature on cargo bike sharing was synthesised. The strings “cargo bike sharing”, “cargo-bikesharing” and “shared cargo bikes” were used to search in the Google Scholar and JSTOR databases. The results were filtered for academic articles on CB sharing for private logistics in the German speaking area. In the final selection, only five original articles remained: (Becker et al., 2018), (Hess and Schubert, 2019), (Dorner and Berger, 2020), (Dorner et al., 2020) and (Dorner, 2020). They reference each other, and no additional articles were found through snowball sampling, i.e., the academic literature on CB sharing is limited and it was possible to analyse it in full. Supplementary articles on the use of CBs for commercial logistics and individual CB ownership provided relevant context, for example, on urban infrastructure required for CBs. Grey literature in the form of evaluations of CBSOs, such as Grätzlrad (Berger et al., 2019), TINK (Scheffler and Bleh, 2018) and fLotte Berlin (Schmidt and Sikora, 2022), offered additional insights.

Finally, to develop the conceptual framework, the literature on the MLP and SNM was reviewed. Next to the fundamental literature on the theories, original research articles applying the MLP and SNM to grassroot organisations and especially bike sharing were selected. Pathways for upscaling were extracted and summarised in the conceptual framework (Fig. 1), which was applied to analyse the case study data and then refined based on the findings from the interviews (Fig. 2).

To identify relevant stakeholders, stakeholder maps were developed for each of the cases based on the literature and revised iteratively during stakeholder interviews. The mapped stakeholders were interviewed to cover all relevant perspectives on each organisation. The CBSOs’ websites, the website of the Union of the Commons Cargobikes initiatives and the websites of the CB advocacy organisations were used to triangulate interview findings and collect additional information on the current dynamics and conditions for CB upscaling.

Fifteen semi-structured interviews with CB sharing stakeholders and experts were conducted face-to-face (5), online (9) and via telephone

(1). They lasted 15–60 min. To align the interview questions with the aim of the study while allowing for participants’ opinions, the interviews were semi-structured. The questions centred around the themes: introduction/current work, business/organisational model, potential of CB sharing, carriers for CB sharing, upscaling CB sharing and further stakeholders. The interviewees included practitioners from the case study CBSOs and an additional CBSO in Vienna, a municipal bicycle manager, members of CB and bicycle advocacy groups, commercial CB sharing practitioners and academic experts in CBSOs and the sharing economy. All interviews but one were held in German, and direct quotes to illustrate the findings were translated by one of the authors. The interviews were audio-recorded, and comprehensive notes on key observations were taken by the interviewer. The interviews were pragmatically transcribed to fit the research needs (Evers, 2011). Interviewees were anonymised and are referenced by abbreviations in this article. The interviews were analysed using NVivo 12 qualitative analysis software. The categories from the conceptual framework (Fig. 1) served as theoretically informed deductive codes, while the subcodes were developed inductively. The categories were iteratively reviewed and, if needed, merged or split. When the codebook was finalised, all coded material was checked for coherence with the final codebook to avoid a potential shift of code meanings (Creswell and Creswell, 2018). Interview data was triangulated with academic and grey literature on CB sharing, and the intercoder reliability was tested with an independent researcher coding the selected passages using the same code book as the authors. The results were then compared and found consistent (Creswell and Creswell, 2018).

5. Results and Discussion

5.1. Strategic niche management of cargo bike sharing

This section presents empirical data analysis using the SNM conceptual framework (Fig. 1) to arrive at how the niches of CB sharing have been nurtured and what will be needed to empower them. An overview of 20 inductive sub-codes, which were developed under the three deductive codes of *nurturing* and four of *empowering*, is presented in Fig. 2. The sub-codes reveal the aspects relevant for nurturing CB sharing and those that will be important for its empowering. This analysis draws on both the empirical findings from the case studies and case cities and on more general findings from other CBSOs, CB sharing stakeholders and academic experts.

First, we analyse the niche nurturing (Section 5.1.1) followed by the niche empowering (Section 5.1.2) of CB sharing to then arrive at the

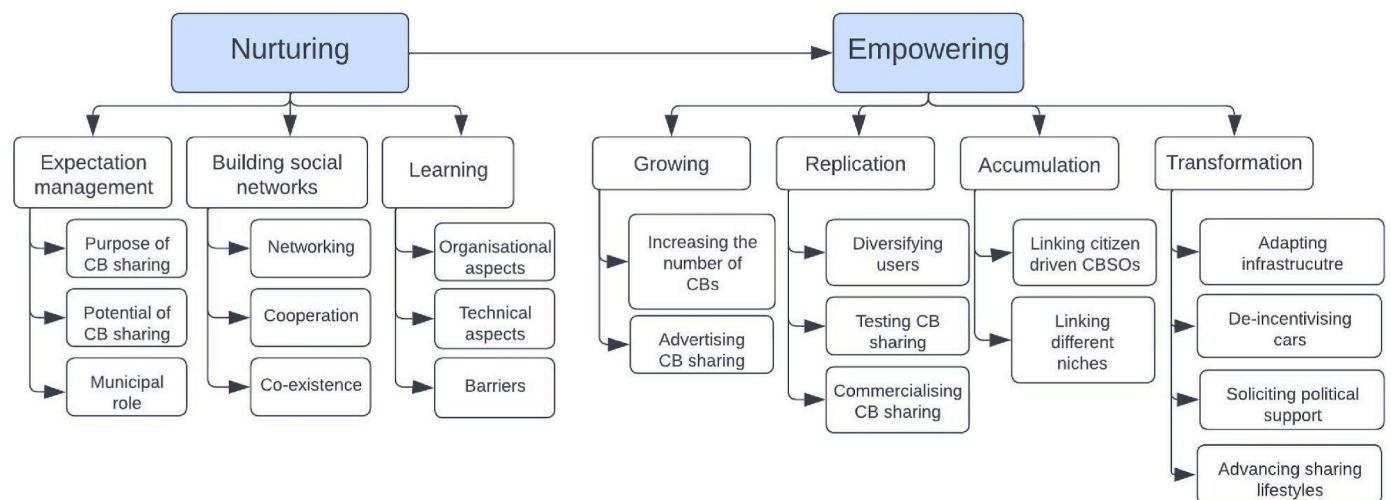


Fig. 2. Conceptual framework with inductive sub-codes. Source: Authors’ elaboration

upscaling pathways for CB sharing (Section 5.2).

5.1.1. Niche nurturing of cargo bike sharing

To understand how CB sharing is embedded in the urban mobility regime we analyse the niche nurturing of CB sharing, which consists of expectations management, building social networks and learning (Figs. 1 and 2) (Schot and Geels, 2008).

5.1.1.1. Expectations management. Three reoccurring subcodes emerged from the interviews under this theme: **the purpose of CB sharing**, its **potential** and **the role of municipal** funding. There is a relative conformity among the interviewees who see **the potential** of CB sharing for sustainable urban mobility by replacing cars, which not only reduces emissions and noise but also improves road safety, reduces the need for car parking and improves neighbourhood connectivity. The two interviewees explain:

“Municipalities need to know what CB sharing can contribute with to make mobility socially accessible and reduce the emissions of the transport sector. There are effects on climate, the environment and space requirements. This needs to be communicated much more” [CCBS2].

“CB sharing could solve many of the current problems in urban transport. For example, lack of parking places, pollution and safety. CBs can change a lot” [CCBS1].

Still the expected **purpose of CB sharing** by the interviewees varies from a regular mobility offer to increasing awareness and acceptance of CBs, e.g., by providing users with a possibility to try them. The expectations how CB sharing should be funded differ too. While different actors favour **municipal subsidies** for CB sharing or including it in the public transport [GAO, AAO, CCS2, R1, R2, SER1], two experts were sceptical of the full public funding and rather advocated for commercial solutions with public support to ensure that the offer becomes accessible for everybody, e.g. through subsidised pricing schemes for low-income groups, and does not prioritise profits over social and environmental goals [SER1, R2]. According to the municipal bike manager of Freiburg, “[i]t would be nice if the city did not have to finance [CB sharing] forever, because the city needs to be economic with the tax money” [MBF]. Such diversity of expectations constrain the upscaling of CB sharing.

5.1.1.2. Building social networks. As CB sharing is growing and more actors are involved, building social networks becomes more important to help the CB sharing niche compete within the urban mobility regime pressures. Under this theme, the interviewees discussed **networking** and **cooperation** between various stakeholders and **co-existence** of different types of CBSOs. CBSOs generally have well-established local **networks** and good relationships amongst each other. Networks exist locally, e.g., in the case of LastenVelo e.V., and on the national level between CBSOs within the Union of the Commons Cargobikes initiatives. The union is a key actor for networking and encouraging cooperation, however, it is still forming itself: “It should keep that looseness, but we need a firm structure” [UCC1]. One of its goals is stronger networking and a more formal welcoming of new CBSOs, while guaranteeing the independence of the member CBSOs [UCC1]. Other cargo bike advocacy organisations connect CB sharing actors. For example, cargobike. jetzt and the association “Zukunft Fahrrad” organise a conference “Cargo Bike Sharing Europe” in Cologne, where all CB sharing stakeholders “communicate about who offers what to which users” [GAO].

Within the social networks of CBSOs, municipal actors are seen as especially important due to their authority within the urban mobility regime. Municipalities **cooperate** with CBSOs in different ways. This cooperation is beneficial for both sides as CBSOs get support for upscaling while helping address some of the urban mobility challenges. For example, the City of Freiburg supports LastenVelo e.V. with parking

spots and does not create legal barriers [MBF], which is appreciated by the CBSO [LV]. The City of Freiburg also cooperates with the local commercial bike sharing operator nextbike to include CBs in their offer [MBF]. Municipally financed CBSOs exist in other German-speaking cities. The CBs of Berlin-based CBSO flotte are financed by the municipal districts, while the German Cyclists Association adfc together with volunteers are responsible for the sharing and repairs [GAO]. One commercial CBSO highlights the benefits of cooperation for the city as CBs make “citizens happy and the city better” by contributing to the mobility transition [CCBS2].

Surprisingly, commercial CBSOs are not seen as competing with free ones but rather **co-exist** with them thereby enriching the CB sharing landscape. A “*flourishing landscape of different cargo bike projects*” [GR1] would help reaching different target groups [SER1]. Interviewees agreed it was beneficial having different types of CBSOs and that it would also be beneficial to have different ways of organising CB sharing in the future to reach diverse user groups.

To summarise, CBSOs are still a niche actor within the urban mobility regime, but they have networks amongst each other and good relationships with powerful actors, such as municipalities.

5.1.1.3. Learning. In the protected niche environment lessons about the design and the barriers of the innovation can be learnt. The interviewees discussed learning with regards to **organisational** and **technical aspects** and related **barriers** for upscaling of CB sharing. Free CBSOs, e.g., LastenVelo e.V., are mainly seen as the means for CB sharing to enter the urban mobility regime [GAO] by raising awareness of CBs and making cities interested [CCBS2, MBF]. However, their capacity to facilitate high density station-based CB sharing is questionable [CCBS1, R1]. Similarly, the scalability of host-based sharing, e.g., Grätzlrad, is doubted. Host-based sharing offers personal support for people using a CB for the first time [AAO, GAO, R2], creates social control on treating the CBs well [GRH, GAO] and the “*hosts transmit the spirit and enthusiasm for CBs*” [GAO]. However, it is “*rather complicated regarding the organisation and effort*” and “*reaches its boundaries quite fast*” [R2]. Host-based sharing is dependent on the host and if the host has less time and resources, the users risk losing access to CBs [R2, GR1]. Generally, various stakeholders agree that citizen driven CBSOs have limited scalability because of the high organisational effort and reliance on volunteers [R1, CCBS1].

Overall, from the **organisational perspective**, station-based CB sharing is found as more promising to provide CBs for more people. In a dense station-based system the users have “security that they can drive their kid to school on the next day” [CCBS2] and that “cargo bikes can be rented spontaneously and without previous reservation” [R2]. Free-floating CBSOs could offer even more flexibility for the users but would face the challenge of refilling logistics (i.e., re-locating the CBs equally to all stations), which is the largest cost in free-floating sharing systems [GAO, CCBS2]. Moreover, most CB trips are round trips and therefore the need for a free-floating system is limited [CCBS1].

As for the learning about **technical aspects**, the booking software is key, and it would benefit from professionalisation since “most people do not want to spend too much time thinking about mobility” [R1]. The Commons Bookings platform by the Union of the Shared Cargobikes initiatives is one example of pooling resources to provide software access also to smaller initiatives who can not afford their own platforms [UCC1]. The programmers work voluntarily, and any professionalisation would require increased financial and human resources. The **barriers** stem from the limited resources of free CBSOs, but also the lack of familiarity with the concept of sharing goods, as one interviewee explains: “*As a society, we are not used to pay-what-you-want and to sharing goods*” [R1].

5.1.2. Empowering of cargo bike sharing

To analyse the upscaling pathways of CB sharing, we use the four

empowering patterns by Naber et al. (2017): growing, replication, accumulation and transformation (Figs. 1 and 2).

5.1.2.1. Growing. Growing describes niche growth within the same context, which in the case studies means **increasing the number of CBs** by increasing the numerical or geographical scale of CBSOs, as well as increasing their popularity through **advertising CB sharing**. Growing through **increasing the number of shared CBs** was seen as necessary for upscaling: *“If there is just one CB per district, people will never rely on it”* [CCBS1]. With a sufficient density, people are more inclined to use shared CBs as part of their mobility routines [CCBS1, CCBS2]. A higher density would also increase the visibility of CB sharing within the city [R2]. As discussed in 5.1.1, a larger number of CBs is more easily handled through station-based sharing and could be complemented with host-based sharing to accommodate for new users. A co-existence of different types of CBSOs could address different user groups and together create a higher density of shared CBs.

Increasing the number of CBs needs to be supported by increasing the popularity of CB sharing. While commercial CBSOs invest in **advertising**, free CBSOs have limited resources and need municipal support. For example, in Freiburg the municipality includes information about LastenVelo e.V. in the welcome bag for people who move to Freiburg [LV]. Moving to a new place opens a window of opportunity as people need to transport things and might therefore change their mobility routines more easily.

5.1.2.2. Replication. Through replication, shared CBs can be introduced and adapted to other contexts, for example, small communities. The analysis revealed the **diversification of users**, offering organisations to **test CB sharing**, and **commercialising CB sharing** as key sub-themes for replication of CB sharing. Free CBSOs often do not have resources to **diversify** their user base, and commercial actors first need to make a business case. Grätzlrad as a municipally organised CBSO stands out with its intensive efforts to reach out to the broader user groups. The Union of the Commons Cargobikes initiatives plans to have a *“container with four CBs owned by the Union that will be transported through Germany, so that also smaller municipalities can try it out”* [UCC1], which in turn opens a possibility to engage more users. To make other actors interested in operating CB sharing, different initiatives to **test CB sharing**, e.g., trial days, have been developed. In addition, **commercial CBSOs** can be seen as a way of replication, as they address different users than the community or public platforms and make professionalise CB sharing. However, they have different motivations than free CBSOs.

5.1.2.3. Accumulation. Accumulation describes the process of niches in different contexts being **linked** to each other. This was observed **between different citizen driven CBSOs and different sustainable mobility niches** in one urban mobility regime. The Union of the Commons Cargobikes initiatives plays an important role for accumulation by **connecting different CBSOs** and can be seen as an intermediary organisation (Naber et al., 2017). The Union can do boundary work between the CB sharing niche and local and national political actors. **Linking different niches** by, for example, cooperation of CBSOs with other stakeholders interested in sustainability transition of the urban mobility regime are also beneficial. For example, shared CBs could be integrated in shared mobility hubs, public transport or housing complexes. One interviewee explains that the mobility transition *“won’t be possible without ... other forms of mobility, such as cars, scooters, regular bikes. The mix must be right”* [CCBS1].

5.1.2.4. Transformation. Transformation means that niches change the regime by being upscaled (Naber et al., 2017). This theme was seen by the stakeholders as **adapting infrastructure** to CBs, **de-incentivising cars**, **soliciting political support** for CBs and **advancing sharing lifestyles**. Infrastructure is a key field in which urban policy and

planning could support the upscaling of CB sharing. Many interviewees stress that biking infrastructure is inadequate and that cities need restructuring from car-centricity to include diverse mobility modes. As CBs are becoming more popular, first signs of adapted **infrastructure** emerge, e.g., broader paths and designated parking spots for bikes.

Apart from the infrastructure adaptation, some interviewees argue for **car de-incentivisation**. To make the infrastructure compatible with CBs and enable urban mobility transitions, cities need to *“repurpose some of the existing road space for cargo bikes”* [UCC1] and make private car ownership *“more difficult and less attractive”* [CCBS1]. Here **political support** for CBs is key, and it can be achieved by CBSOs uniting their voice. As such, the Union of the Commons Cargobikes initiatives seeks to *“reach out to politicians and show them we are a strong association with motivated citizens who are advocating for the mobility transition”* [UCC1]. Cooperating with other actors of shared mobility and public transport to lobby for the shared goal of sustainable mobility transition is also important. Advancing **sharing lifestyles** can be achieved through e.g. including CB sharing in shared mobility hubs integrated in housing projects.

5.2. Upscaling pathways for cargo bike sharing

The analysis of SNM of CB sharing (Section 5.1) contributed to understanding niche nurturing and niche empowering of CB sharing. Here we build on these findings to propose upscaling pathways for CB sharing. While the results on niche empowering (Sub-section 5.1.2) are the most relevant for this purpose, the analysis of niche nurturing (Sub-section 5.1.1) feeds into the description of upscaling pathways.

Niche nurturing describes the development of the CB sharing niche until now, i.e., how it is embedded in the urban mobility regime and how CBSOs interact with different stakeholders. The Union of the Commons Cargobikes initiatives was found to be an important actor for lobbying on a national level while municipal actors play a key role for the local upscaling. Municipal actors can support CB sharing in multiple ways: through regulation, funding, infrastructure provision and adaptation, raising awareness and increasing visibility of CB sharing while assuring the accessibility of CB sharing for all. For example, in the Grätzlrad case the municipality targets group-specific communication, funding of the CBs and active integration of diverse citizen groups. Free CBSOs should consider cooperating with larger stakeholders, such as municipalities, carsharing providers or commercial CBSOs to upscale while preserving their mission. Potential ways for cooperation with municipalities are a shared non-profit limited liability company or public tendering. To create a common ground for upscaling of CB sharing and making it successful, it is important that the relevant stakeholders communicate about their expectations on the future of CB sharing and the municipal role in the upscaling processes. Generally, CBSOs were found to have good relationships with different stakeholders, which is a promising precondition for the upscaling.

When it comes to **niche empowering, growing** by increasing the number of CBs in a CBSO and thereby their density is necessary for upscaling. Interviewees reflected on the type of organising CB sharing that may be the most suitable for upscaling, the required technical improvements and the most relevant actors to organise it. Station-based sharing is found as more likely to provide shared CBs to many people, the booking software needs to be more professional and user-friendly and, again, cooperation with other stakeholders, such as municipalities, is advisable. Increasing the number of CBs needs to be accompanied with increasing resources for personnel. Station-based CBSOs could be complemented with host-based CB sharing that specifically addresses new users and creates social cohesion. As CBSOs are becoming more professional, the social justice perspective should be emphasised to ensure that CBs become accessible for all. The Grätzlrad case shows that municipal actors can take an active role in including and working with diverse user groups.

For **accumulation** the Union of the Commons Cargobikes initiatives

plays an important role in connecting different CBSOs and moving from local niches towards a global niche. As the Union is becoming more formalised, they can represent the interests and mission of free CBSOs more strongly and perform boundary work between CBSOs and the urban mobility regimes. At the same time, collaboration with other niche actors seeking to challenge the current regime are also beneficial.

Importantly, there are other ways to upscale CB sharing than just increasing the number of organisations. Through the **replication** and **transformation**, shared CBs can be integrated into shared mobility hubs, housing projects and public transport. A co-existence of different types of CBSOs could address different user groups and together create a high density of shared CBs.

5.3. Discussion

Concerns have been raised about the applicability of the “managerial thinking” of SNM to pluralistic grassroots organisations [72, p. 829], such as LastenVelo e.V. Free CBSOs can be seen as a grassroots social innovation because it is a bottom-up sustainable innovation that is driven by the “interests and values of the communities involved” [53, p. 585]. SNM is criticised for having been developed for commercial innovations, while grassroots organisations have different “values and ambitions” [73, p. 248]. However, there is some evidence that SNM is helpful to also explain grassroots innovation dynamics (Seyfang and Longhurst, 2015), which this research has demonstrated.

In this context, it is worth noting that community-based sharing economy organisations, unlike their commercial counterparts, are not always interested in expanding their activities (Zvolška et al., 2019b). These organisations aim to avoid the institutional complexity that arises from the clashing of community, market, and corporate logics (Bauwens et al., 2022) and to preserve their social and environmental value. We argue that, in such cases, the upscaling of grassroots organisations should primarily occur through accumulation and transformation pathways. These pathways, unlike growth and replication, focus less on increasing size and scale, such as the number of members, vehicles, or locations. Instead, they emphasize building connections among organisations and with other actors while maintaining the current scale and form of these grassroots initiatives.

The conceptual framework could have been built from a different theory. SNM theory is suitable to analyse sustainable innovations, but different patterns for niche development are described in the literature. This research chose to apply the four patterns by Naber et al. (2017), as they are comprehensive and include many aspects from other theoretical perspectives. Its usefulness was confirmed in the analysis, but different analytical frameworks for upscaling innovations could also be tested for their applicability. For example, the application of the “fit-and-conform” and “stretch-and-transform” strategies could reveal more on the niche-regime interactions (Smith and Raven, 2012), while the classification of scaling out, scaling up and scaling deep might provide further insights on the different dimensions of upscaling (Moore et al., 2015). A useful overview of amplification processes for future research can be found in Lam et al. (2020).

Reflecting on the theory used, the empowering patterns of growing, replication, accumulation and transformation by Naber et al. (2017) were helpful to analyse the niche development of CBSOs with some limitations. Structuring the results within niche nurturing and niche empowering provide initial insights into how the niche has developed and what may be required for the upscaling of CB sharing in the future. The four empowering patterns were present in stakeholder descriptions of niche empowering. Growing was seen as important for upscaling, replication requires experimentation, but it is hindered by the limited resources of CBSOs, and accumulation is primarily facilitated through collective action by the Union of the Commons Cargobikes initiatives. Transformation fits well with the mission-driven CBSOs, and it is displayed in demands for changing infrastructure, mobility models and consumption lifestyles. However, there were some aspects that fitted

into several categories. For example, cooperation between different CBSO stakeholders can be both seen as niche nurturing through building social networks and as niche empowering through accumulation. In this research, this was addressed by considering it as both, an element of nurturing and empowering, however, there may be a risk of analytical fuzziness. Analytical fuzziness would have been problematic, if the networking aspect had only been considered as a part of niche nurturing and thereby its importance for empowering the niche would have been overseen. That is why, it was important to verify the assignment of the inductive subcodes to the deductive categories.

This article focuses on capturing and categorising a diversity of pathways to upscale community-based CB sharing but does not delve deeply into any specific pathway, providing only brief descriptions and examples. As mentioned in Section 3, niche upscaling depends on both niche dynamics and the broader socio-institutional context and regime processes. This research addresses this by analysing the upscaling of CB sharing through transformation and emphasising the need for infrastructural, political, socio-economic, and cultural changes to build more sustainable urban mobility systems. Such systems would embrace CB sharing in cities and challenge the current regime of car ownership.

We argue that CB upscaling is more likely when urban mobility infrastructure favours modes other than cars, such as by designing wider paths for bicycles and pedestrians. Another option is integrating CB sharing into shared mobility hubs within housing projects. Additionally, car travel and ownership should be discouraged through legal and economic policy instruments to enable CB upscaling. However, these solutions face implementation barriers due to regime pressures and path dependencies, making political support crucial. Therefore, collective action by CBSOs and other sustainable urban mobility actors is key to uniting their voices and lobbying for a sustainable mobility agenda in the city.

It should also be noted that there is no singular academic conceptualisation of upscaling pathways. While this is normal for a developing research field such as sustainability transitions studies, it needs scholarly attention (Augenstein et al., 2020). Augenstein et al. (2020) call the lack of a common definition of upscaling the “Babylon dilemma”. An alternative conceptualisation of upscaling patterns describes four types along their geography, required upfront investments and complexity of stakeholder interactions (Grinevich et al., 2015). Within that categorisation, CBSOs could be classified as “local value potentially global” (Type 2), as they are embedded locally and require conscious effort to be upscaled globally. Across the types it was found that the more upscaled sharing economy organisations have more trustworthy and transparent platforms (Grinevich et al., 2015). This is in line with the demand for more professional booking software for CBSOs. However, our choice of theory remains justifiable as the patterns by Naber et al. (2017) allowed for a more nuanced analysis of the niche development of CB sharing.

Reflecting on the methodology and generalisability, it must be noted that case studies have limited generalisability. However, interviews with various CBSO stakeholders and academic experts provided a broader perspective on CB sharing. The semi-structured nature of the interviews makes the study difficult to reproduce, but more structured interviews would have limited the range of possible answers and findings, contrary to the purpose of this exploratory case study research. The small number of cases allowed for interviews with all stakeholders and an in-depth analysis of upscaling pathways.

Applying the analytical framework to more cases, such as the largest CBSO in Germany, flotte Berlin, a CBSO in a rural area, or a commercial CBSO, might have revealed additional barriers to upscaling or empowering patterns. However, interviews with experts, CB advocacy organisations and the Union of the Commons Cargobikes initiatives provided a more general perspective of the CB sharing landscape.

While the findings of this article are primarily generalisable to the cities in the Global North with established biking infrastructure and culture, such as those similar to Freiburg and Vienna, the proposed

pathways for CB upscaling are also informative for the cities in the Global South aiming to develop bicycle and CB sharing solutions.

6. Conclusions, practical implications and future research

6.1. Conclusions

This research aimed to uncover the upscaling pathways for CB sharing in cities. CBSOs occupy a niche status in the urban mobility regime but have good relationships with different stakeholders, especially the municipal actors, which is an important precondition for upscaling. Regardless of the type of CBSO, municipal support is crucial. Municipal mobility managers can limit and support CBSOs through regulation, provision of funding and information, and infrastructure planning and adaptation. They can act as niche managers and take the lead on CB sharing (Grätzlrad) or do boundary work between the CBSO and the regime (LastenVelo e.V.). While municipal governments might be unwilling to financially support citizen-organised CBSOs long-term, they have the shared goal of an urban transport transition and can also support the CBSOs through creating favourable legal and structural conditions. If CBSOs become commercialised, municipalities play an important role in keeping the offer socially just and accessible for all, i. e., by providing subsidies, prescribing that shared CBs are located all over the city and adapted to different needs. Overall, networking and exchange between CBSOs as shown through the Union of the Commons Cargobikes as well as with other actors in the local urban mobility regime is crucial for upscaling CBSOs.

This article tested the suitability of SNM for grassroot innovations. We confirmed the empowering patterns by [Naber et al. \(2017\)](#) as helpful to analyse the upscaling of a grassroot innovation like CB sharing. Our results provide insights into how the CB sharing niche has been nurtured in the last ten years and what is needed for empowering and upscaling it in the future. This study confirmed that CBSOs need to become more professional and user-friendly to upscale. The trade-off between “remaining in a small, alternative and unique niche versus growing in size and striving for broader societal adoption” can also be called the “scaling-aversion dilemma” [75, p. 145]. For countering this dilemma, municipal authorities could assure that CB sharing becomes accessible and socially just, e.g., through regulation and availability of public funding. In addition, upscaling of community-based CBSOs wishing to preserve their social and environmental value could primarily occur through accumulation and transformation pathways rather than growing and replication.

Importantly, niche upscaling depends on both niche dynamics and the broader socio-institutional context and regime processes. To contribute to the urban sustainable mobility transitions, new technologies, e.g., electric bikes and shared vehicle fleets, need to “supplement rather than complement dirty technologies” [77, p. 1056]. To fulfil its potential for replacing cars and reducing emissions the upscaling of CB sharing should be integrated in the regular urban mobility planning. Infrastructure adaptation, policy push measures discouraging car travel and ownership as well as socio-economic and cultural changes are important to build more sustainable urban mobility systems that would embrace CB sharing and challenge the current regime of car ownership.

To conclude, CB sharing has a potential to make urban mobility more sustainable, but a higher density of shared CBs and less organisational effort for the users are required for CBSOs to reach a broader user group. Until now, CB sharing has mainly been driven by citizen-led organisations, which have limited resources for upscaling. Instead of simply increasing the number of shared CBs, new ways of sharing CBs, such as integrating them into public transport, mobility hubs or housing complexes, should be explored. A variety of types of CBSOs will be beneficial to reach different user groups. To support upscaling of CB sharing, the stakeholders should communicate about their visions for the future of CB sharing, seek ways to align these visions and collaborate. Municipal actors play a key role in the upscaling of CB sharing, not least by assuring

that CBSOs reach diverse user groups.

6.2. Implications for future research and practice

The findings of this research are relevant for studies exploring the upscaling of shared mobility systems and other sustainable urban innovations.

As new types of CBSOs emerge, e.g., community based CBSOs, their business models and scalability need investigation. Departing from the efforts of Grätzlrad to reach diverse user groups, different strategies to motivate additional user groups could be evaluated and compared. Moreover, an environmental and social impact analysis of CB sharing, including the sustainability performance of commercial CBSOs, could validate its potential, provide arguments for municipal support of CB sharing and open further opportunities to upscale CB sharing in different contexts.

This article has focused on capturing and categorising various pathways to upscale CB sharing. Future research could analyse these upscaling pathways in-depth. Specifically, focusing on the transformation pathway is crucial to identify conditions and measures necessary for regime change, alongside other niche nurturing and empowering processes. Future research could also explore upscaling pathways in different geopolitical contexts to enrich the framework and identify factors that facilitate or constrain CB sharing, which may not have been captured due to this study’s geographical scope.

The findings of this research are also relevant for CB sharing stakeholders and municipal mobility managers seeking to include CB sharing in their urban mobility regime, as well as other grassroot sharing organisations interested in upscaling. As such, to advance upscaling, CB sharing practitioners should consider continuing and strengthening the exchange with other stakeholders including CB advocacy organisations, academia, and local authorities. CB sharing practitioners should highlight the potential of CB sharing and its contribution to sustainable urban mobility to encourage municipalities increase their support. The Grätzlrad case provided inspiration of what municipalities can do: target group-specific communication, support funding of CBs and actively integrate different citizen groups. Moreover, regulations prescribing the integration of CB sharing into housing complexes help municipalities support CB sharing without extra cost. Apart from such “pull measures”, “push measures” in the form of legal and economic policy instruments discouraging car travel and ownership, as well as the adaptation of urban infrastructure to accommodate CBs, are needed. Free CBSOs should consider cooperating with larger stakeholders, such as the municipality, carsharing providers or commercial CBSOs to upscale, while preserving their mission. Potential ways for cooperation with the municipality are a shared non-profit limited liability company or public tendering.

Overall, this research solidifies the claim that CB sharing can significantly contribute to the transition to sustainable urban mobility and showcases pathways for its upscaling. By clearly communicating the potential of CB sharing, strengthening collaboration, mobilising more resources, enhancing biking infrastructure, and discouraging car travel, CBs can replace cars for many trips and make sustainable mobility accessible to all. This would result in a diverse landscape of CBSOs and the normalisation of CB sharing in cities.

CRedit authorship contribution statement

Kaja Zimmermann: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yuliya Voytenko Palgan:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Copilot and DeepL services in the writing to improve readability and language. After using these services, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Data availability

The authors do not have permission to share data.

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