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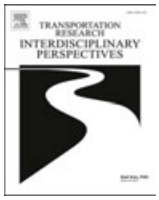

Socially resilient mobility planning: Main challenges and design implications

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ABSTRACT

As mobility systems evolve, their design must enable people to adapt to disruptions in their daily lives and routines, making social resilience a vital yet underexplored focus. This is why this study investigates the question: *What are the challenges when designing for social resilience in local mobility services?* Semi-structured interviews with seven mobility experts revealed the need for a shift from prioritising organizational resources to enhancing social capacity, emphasising individuals' strengths and established routines. The main challenges for urban planners and developers to achieve this were identified through a lack of guidelines for incorporating social sustainability into mobility planning, that in turn renders difficulties in employing qualitative methods tailored for enabling citizen and stakeholder engagement, as well as developing deeper understandings of local, social life. These findings are illustrated in this article through five design implications, each highlighting strategies to integrate social resilience into mobility systems, ensuring they are responsive and supportive of the communities they serve.

Introduction

The nature of future mobility systems remains uncertain for mobility actors due to evolving technology, shifting societal needs, regulations, and economic- and financial factors (Li et al., 2024). In today's socio-technical society (Keck & Sakdapolrak, 2013), the implementation of new policies and regulations inevitably disrupts established routines for many individuals (Chang et al., 2024), which indicates that citizens are highly affected by changes in mobility systems, some more than others. The design of mobility systems from a social sustainability perspective has raised critical questions about goals, policies, and purposes that impact mobility justice, inclusion and equity (Grieco, 2015). Mobility planners already have to rethink personal mobility to reduce existing inequalities in access and accessibility and address barriers and challenges systemically. Quantifiable key performance indicators (KPIs) about congestion, public transport capacities and efficient route planning of different mobility solutions (Vergragt & Brown, 2007; Grieco, 2015) are not the only indicators of quality.

Mobility tends to include more than a simple transportation option from A to B (Chang et al., 2024) and can be understood as a complex system where mobility actors lack experience in approaches and decision making (Willnat et al., 2024). This calls for changes to decision-making structures so that they prioritize the users of these systems (the citizens) and include both current users and, even more importantly, non-users who have historically been excluded from these mobility systems. It also calls for methods that explore mobility systems not merely through the technical aspects of a particular service, but rather through the interdependencies between social, technological and political subsystems of mobility which includes norms, culture and a variety of behavioral aspects (Sustar et al., 2020). For example, these methods could leverage speculative co-design activities that reimagine futures emphasizing the human experience perspective, which facilitates shared discussion, reflection and formation of future mobility alternatives (Sustar et al., 2020).

Mobility projects often include a sustainable vision but fail to contribute to sustainability in practice (Andruetto et al., 2024), and disparities in service availability, reliability, quality, infrastructure access, and trust in technology related to social aspects of sustainability remain widespread (Dillahunt & Veinot, 2018). This underscores the necessity to rethink the design of mobility systems, emphasizing the role of social dependencies and values in mobility and transcending traditional efficiency- and technology-centric practices (Jeekel, 2017; Resmini et al., 2021; Ebbesson, 2022; Mekonnen, 2024) as mobility services and products are part of a grander system of actors (Uteng et al.,

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2019). Additionally, mobility projects often include a wide variety of actors and stakeholders, which further complicates the evaluation of success (Willnat et al., 2024; Baek et al., 2015), leading to potential misunderstandings and trade-offs being made through decisions related to mobility planning and development (Balcells et al., 2024).

Social sustainability in itself is a rather broad and ill-defined concept (Jeekel, 2017), and one that introduces an additional layer of complexity because it usually includes multiple social justice and equity perspectives to account for social infrastructure and social capital (Cuthill, 2010). However, as the concept centers on the sustainability of shared human practices, this paper focuses on "social resilience" as a crucial element in the design of mobility solutions that allow people to anticipate and manage the coming changes to future mobility due to the need to reduce emissions and provide multiple transport options. Furthermore, social resilience can be seen as a characteristic of a sustainable society as it may assist in assessing citizens' allocation of resources for positive outcomes in a social system (Baek et al., 2015). Therefore, social resilience can be seen as a necessary component of a future society where consequences of socio-economic changes make communities vulnerable as social relations and technical implementations influence each other (Baek et al., 2015).

Social resilience is a central concept in disciplines like ecology (Walker et al., 2004), psychology (Masten, 2001; Tugade & Fredrickson, 2004; Lindberg & Swearingen, 2020), and sociology (Endress, 2015), and it responds well to calls for making social perspectives more prominent in the development of future mobility systems and services. Social resilience focuses on how people navigate unfavorable situations and change them to forge favorable outcomes (Vyas & Dillahunt, 2017), and on enhancing adaptive abilities by confronting rather than avoiding risks (Benzies & Mychasiuk, 2009). Recognizing the role of social resilience shifts the conversation away from merely coping with or adjusting to technological advancements (Keck & Sakdapolrak, 2013): it illuminates the value that resides in the web of relationships that ties together individuals, families, and communities, emphasizing how people navigate through and prepare themselves for not only familiar challenges but also unforeseen and uncertain futures (Keck & Sakdapolrak, 2013).

Social resilience carries significant implications for the design of mobility solutions that are conceptualized and developed to support adaptability and community well-being. As a dynamic process (Benzies & Mychasiuk, 2009; Vyas & Dillahunt, 2017), social resilience requires attention to its continuous evolution over time, for both individuals and communities. Mobility planners and designers may also find it difficult to map available resources and assets, since individuals are not always aware of what is available (Karusala et al., 2019; Resmini et al., 2021) and may have an incomplete understanding of the system (Baek et al. 2015). No defined or tested guidelines or even explicit examples exist for evaluating social resilience (Comes, 2016; Vyas & Dillahunt, 2017; Karusala et al., 2019), and while attempts to operationalize it have been made (Nurain et al., 2024), further research is needed to address its elusiveness in design processes. The context- and situation-dependent nature of social resilience (Santos et al., 2018; Copeland et al., 2020) complicates efforts to define how systems influence it. Systemic design, however, stands as a notable exception in addressing these challenges, with Baek et al. (2015) demonstrating how resilience assessment within a system can guide redesign efforts directed at improving the way the system performs.

This paper explores social resilience as a potential approach to operationalizing social sustainability in the design of mobility systems. We present an analysis of interviews with mobility experts to answer the research question: *what are the challenges when designing for social resilience in local mobility services?*

Furthermore, we discuss possible design implications of these challenges and present tentative suggestions for how they may be addressed. The following section describes social sustainability in mobility systems and research on design for social resilience in more detail.

Literature

In this section, we present the context of our research focused on social resilience in design through the explanation of mobility systems. Further on, we communicate a background for social resilience before continuing with the concepts' relation to design.

Social sustainability and mobility systems

Mobility-related development is often framed and communicated through models that are engineering-focused and in which social sustainability is partially neglected or downplayed in favor of economic or ecological sustainability (Uteng et al., 2019). Rebalancing this picture has led to acknowledging that the role of social sustainability in mobility issues goes beyond its direct implications, such as transport poverty and accessibility (Marsden et al., 2007), to include broader accountability in participation and well-being (Lucas & Stanley, 2013). This indicates the need to adopt more systemic approaches to understand social sustainability in relation to mobility and transportation design (Uteng et al., 2019). The mere adoption of new mobility services will not automatically lead to a boost in social sustainability. Rather, a shift from tech-oriented perspectives on mobility and social sustainability is needed to understand and complement existing, numbers-driven evaluations (Uteng et al., 2019) so that real change can be achieved.

This becomes clear as shared mobility sheds light on a variety of inequalities in service availability, reliability, quality, infrastructure access, and trust in technology (Dillahunt & Veinot, 2018). Even though significant potential is shown in sharing-based mobility concepts, the knowledge about peoples' preferences in relation to shared mobility remains limited (Krueger et al., 2016), leading to mismatches between organizational intentions and the traveler's co-modality way to navigate opportunities (Resmini & Lindenfalk, 2021; Resmini et al., 2021). To align with desires and promote adoption, shared mobility services should encapsulate social awareness (Machado et al., 2018). Schaefer et al. (2022) outline the primary motivators for users adopting shared mobility, which include financial reasons, convenience and lifestyle choices that foster community engagement and a sense of belonging. In addition, following Pink et al. (2019), a social perspective is used to conceptualize shared mobility as not just a means of transportation, but rather as a dynamic system where community engagement, reciprocity, and environmental consciousness converge. Each shared mobility model brings forth unique opportunities and challenges and understanding them can provide insights into developing innovative solutions that are socially inclusive and reflective of peoples' everyday lives and values (Dillahunt & Veinot, 2018).

Social aspects of sustainability add to the already existing complexity of mobility planning. As economic and environmental aspects are often focused, mobility experts find it challenging to develop mobility services, such as mobility hubs, in "problematic" areas (Andruetto et al., 2024). This can be related to the low use of civic engagement in mobility projects generally, but specifically in terms of supporting informal transportation options (Hasselwander et al., 2022). These informal transportation options often stem from civic engagement which includes ways in which citizens participate in shaping communities' futures (Hasselwander et al., 2022). This calls for further research on social aspects of sustainability within mobility systems to foster a possible integration of known practices into mobility systems.

As it stands today, the main problem is that design of mobility products, services, and systems in general is stuck in a normative aspect of design where a broader perspective of social values and society-centered perspective is neglected (Verlinghieri & Schwanen, 2020). This leads to a disconnection from the core of social resilience, which is how people learn, develop, support, and educate themselves and others as an emerging process related to change – such as the example of moving away from the privately owned car. As social sustainability aspects are put at the center of mobility systems, a greater responsibility of

how mobility is designed can be reached to address roles, power dynamics and inequalities manifested in the system that is mobility (Verlinghieri & Schwanen, 2020).

Social resilience

Social resilience is interpreted as the emergent property of being able to face change by leveraging human relationships, abilities, and resources (Endress, 2015; Karusala et al., 2019). It extends beyond coping strategies or adaptive capacity as it includes preparation for uncertainty (Cutter et al., 2016; Keck & Sakdapolrak, 2013). A social resilience perspective recognizes and builds upon peoples' existing practices and strengths, considers how people produce favorable outcomes in unfavorable situations (Vyas & Dillahunt, 2017) and explores how the design of services and systems can be informed and improved by a nuanced and comprehensive understanding of existing routines and actions.

Thus, considering social resilience as a situated and dynamic process is crucial, emphasizing the influence of cultural and contextual aspects and noting that social resilience can manifest either a learned response to everyday situations or an integral component in daily life (Benzies & Mychasiuk, 2009). The reciprocal and dynamic nature of social resilience highlights building blocks, or categories, that include individuals (skill sets, education), families (social support, social services), and community (involvement, mentors) (Benzies & Mychasiuk, 2009). For example, when individuals know they can rely on each other's support in solving challenges as a group (Lyons et al., 2016), a more self-reliant, sustainable culture is likely to emerge within the broader community. By implementing reciprocal mechanisms focused as much on establishing relationships as on sharing resources and knowledge, lasting, socially resilient cultures can be fostered within communities, families, and individuals that transcends mere efficiency (Vylas & Dillahunt, 2017), thereby recognizing the collaborative relations needed for social resilience to be enhanced (Comes, 2016). However, such an approach is not without its challenges. Often, participants may not be fully aware of the possibilities and resources available for use (Vyas & Dillahunt, 2017), or these resources and possibilities may differ within the community (Karusala et al., 2019). Social resilience is also highly contextual and situational, making it hard to "measure" it through standardized metrics, something that could force planners into normative trade-offs regarding what is considered resilient for the specific community (Copeland et al., 2020). Therefore, the understanding of social resilience as a process in the making may be lost (Vyas & Dillahunt, 2017).

In summary, social resilience is the ability of individuals, families, and communities to prepare for, withstand, and grow from change. It is strengthened through social support networks, shared resources, and learning. By exploring mobility from the perspective of social resilience, future solutions are more likely to meet the diverse needs of community members. This inclusivity can support people by ensuring that transportation is not a barrier to accessing essential services and opportunities. Therefore, the interrelation between social resilience and mobility can be seen as a shift in the sense of ownership that can lead to socially resilient responses to disruptions and change. As social resilience is highly situational and contextual, it may be understood through co-defining characteristics and aspects related to the local commons of the people which are impacted by new solutions (Baibarac & Petrescu, 2019). However, as social resilience floats over time, more research is needed on how processes can be open enough for people to continue developing tools and practices that sustain and even improve social resilience after project end date (Baibarac and Petrescu, 2019).

Methods

The methodology of this study is grounded in a qualitative research approach based on semi-structured interviews (Patton, 2002) and a bottom-up thematic analysis process (Braun & Clarke, 2006). The approach aims to identify and explore challenges when designing for social resilience in local mobility services and to discuss how these challenges can be addressed. Interviews were conducted with seven mobility experts from six European countries, each possessing at least two years of professional involvement in mobility projects. The experts were contacted via two Horizon Europe co-funded mobility projects aiming to accelerate the transition to climate neutrality by reinforcing mobility solutions based on integration of digital technology supporting new mobility services, sharing schemes, active transport modes, and micro-mobility. The projects' aim is to lead the transition to more efficient, sustainable, resilient, and inclusive mobility systems.

The selected group of mobility experts (Table 1) ensured informed and experienced contributions to the research question by providing diverse and expert-level insights into the dynamics of mobility and social sustainability practices. Hence, the methodological approach also created a foundation for discussing how identified design challenges could be addressed based on related research and the insights provided by the respondents in the discussion. Furthermore, this approach enabled the authors to articulate the implications of the study's findings for design practice and suggest avenues for future research in informatics.

Based on related research, we identified the following themes used as a starting point guiding the interviews (Fig. 1): Activities (methods used), involvement (who is involved, who is left out?), collaboration partners (who are considered collaboration partners, and what are their roles?), components of a speculative dream project (what would a dream project look like?), and social sustainability (social values incorporated in the project, or what kind of social impact the project had/has).

From these themes related to project experiences, topics related to social resilience could be discussed, such as *Human abilities and resources, Consideration of existing routines and practices, Dynamic process of social resilience, Relationships between individuals, Groups and communities,* and *Assisting people to prepare for, cope, and learn from project outcomes*.

The themes were used to capture the experts' experiences when handling the social relations between and values of individuals, groups, and communities. The topics captured instead social resilience as a process: contextual and situational aspects such as resources and relationships tied to specific situations and related to how people affected by the project could prepare, handle, and learn from implementations and outcomes. Together, the themes and topics created a foundation to relate the findings to social resilience. However, as the interviews were semi-structured, and social resilience is a vast and complex concept, the themes and topics primarily acted as a starting point and were followed by probing questions based on the respondent's answers. This utilization of themes and topics in combination with semi-structured questions led to participants interpreting the questions based on their experiences. The "Zoom" video conferencing platform was used to conduct the interviews, which were recorded with the participants' informed consent.

The subsequent transcription of the recordings facilitated a comprehensive thematic analysis. Following Braun and Clarke (2006) step-by-step guide for thematic analysis, the initial stage of analysis involved familiarizing with the data, where preliminary observations such as "*Key objectives differing from social values*", "*No budget for digging deep*" and "*Which coordination actions are useful*" were noted. These observations led to the creation of initial codes like "*Car-norm protection*", "*Objective-first approach*", and "*Crazy soft value people*". These codes were

Table 1
Study participants, including profession and country of work.

Name (pseudonym)	Profession	Country
Aarne	Mobility plan leader	Estonia
Herman	Mobility planner	Spain
Gabriella	Mobility planner	Spain
Ian	Mobility planner	Belgium
Sara	Mobility Service Designer	Belgium
Frida	Mobility Sustainability consultant	Sweden
Cornelia	Mobility Service Designer	Sweden

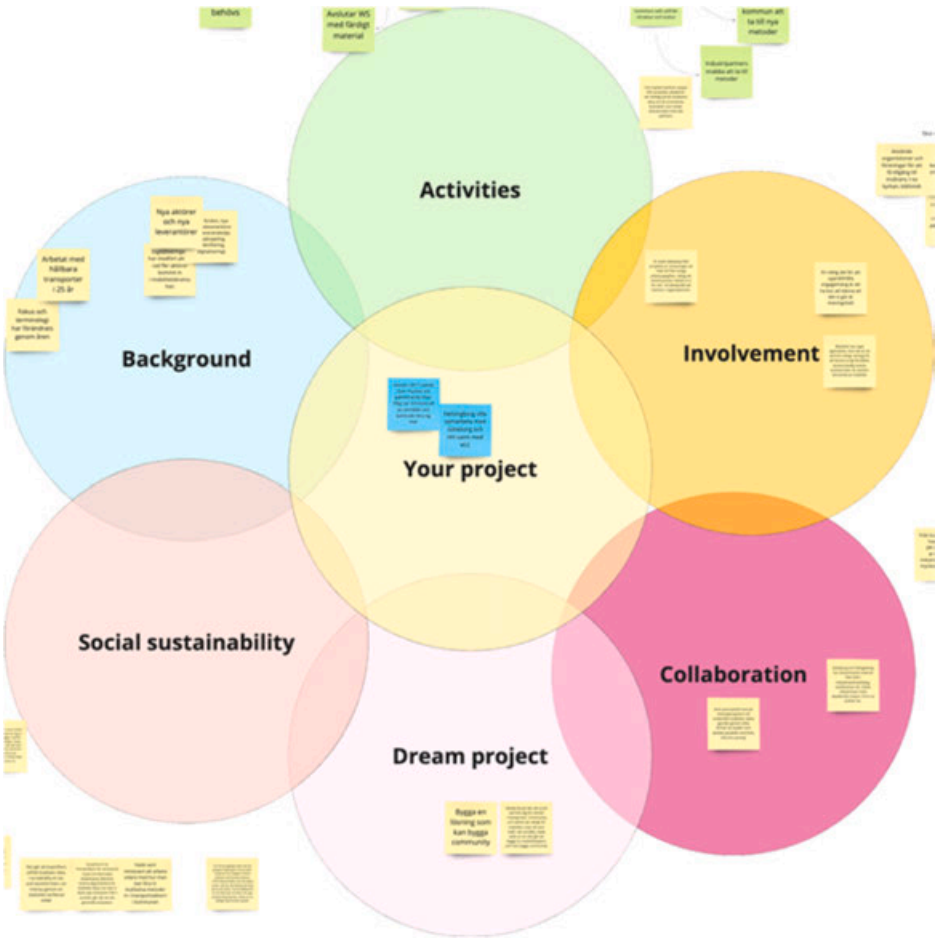

Fig. 1. Interview categories visualized in Miro.

then meticulously collated into categories based on their interrelations, resulting in themes such as "*Understanding citizen routines*", "*Engaging citizens*", "*Securing mandate and political trust to drive innovation and change*", "*Prioritizing social sustainability*", and "*Convincing broad networks of stakeholders*". These themes were then cross-referenced and contextualized within the existing body of literature to solidify the connection to existing research and theoretical underpinnings. Furthermore, the inclusion of specific codes and themes in this section demonstrates the data-driven nature of the study, ensuring that the findings were anchored in real-world experiences and perspectives of the interviewees (Corbin and Strauss, 2015). Two examples of this process are visualized below in Table 2. Further research data could be made available on demand.

The analytical process can be described as bottom-up, allowing the research team to develop themes grounded in the data and reflect the findings in related research through a discussion. With a shared background in design and informatics, the research team maintained reflexivity to acknowledge and minimize their influence on the research process. Ethical considerations, particularly informed consent and data privacy were meticulously managed, and accommodations were made for participants' preferences, such as excluding video data upon request.

Table 2
Examples of the thematic analysis process.

Data extract	Coded for	Theme
"Projects must show real results; people taking the bike, taking that step, going into the app, or so on. We make assumptions about this, rules by thumb, that people that now bike owned a car, or that the ones sharing car now got rid of their own."	Real, measurable results Assumption-based design	Understanding citizen routines
"We have a lot of people in the hierarchy protecting us from crap above. We can start a project and know that failing is an option. […] in a lot of cities they don't have the opportunity, with the funding, politics etc. It's a lot about the role we are allowed to play. Right now, we have political and financial support, but next election may mean something else."	Hierarchy-protection Role allowed to play Political support	Gaining mandate and political trust to innovate and initiate change

Limitations

Exploratory interview studies that rely on small homogeneous samples have intrinsic limitations. However, in this explorative study, the authors wanted to investigate mobility experts' views to identify challenges when designing for social resilience in local mobility services and provide insights on how these challenges can be addressed. As such, the study does not aim to get a coherent quantitative view of possible challenges. Instead, the paper tries to understand the nature of identified challenges for designing for social resilience and create insights that can be used to discuss the implications related to these when designing mobility solutions. Another limitation is the context-specific nature of findings in exploratory qualitative studies, which limits their ability to

be generalized across broader populations. However, rather than aiming for statistical generalisation, the qualitative data derived from this study can be used to generalize concepts, specific implications, or insights, as suggested by Walsham (1995). Another possible limitation is that the subjective nature of semi-structured questions may lead to misinterpretations. To mitigate this risk, the researchers asked follow-up questions to try to avoid the risk of misinterpretation of the questions and the participants' answers. Furthermore, all authors were involved in the analysis to alleviate the risk of subjectively interpreted data.

Findings

This section presents the findings from interviews with mobility experts on the challenges of designing for social resilience in local mobility services. The analysis identifies five key challenges in planning new mobility solutions that impede the integration of social resilience in the design process: Understanding citizen routines, Engaging citizens, Securing mandate and political trust to drive innovation and change, Prioritizing social sustainability, and Convincing broad networks of stakeholders.

Understanding citizen routines

A recurring theme in the interviews was the difficulty of integrating qualitative, often described as 'soft,' values. Attempts to incorporate these values were met with criticism, being perceived as costly and incompatible with traditional project metrics. As Frida articulates, organization's find it challenging in leveraging narratives based on empirical fieldwork since they often lack statistical significance for project partner meetings. This is followed by Sara's take on projects still being "engineer-dominant".

> *"It's a challenge to communicate narratives based on qualitative data, which makes it hard to get bearing in the organization when the data is not statistically significant" – Frida.*
> *"KPI-reporting is polluting itself. If you can't measure it, it doesn't exist. In that sense, projects are still engineer-dominant. They are not disruptive in any sense" – Sara.*

Furthermore, if empirical data is gathered in qualitative manners, Herman expresses a struggle in maintaining the relevance of this type of data. For example, the resource-intensive action of continuously engaging with community members or citizens are seen as impractical. This often leads to developers turning to online surveys, which themselves are hard to motivate for citizens to address. Additionally, projects are often including grander partners for global goals which makes it even harder to make use of qualitative data.

> *"We work with a behavioural model of people's satisfaction related to the use of [mobility service] through surveys with maybe 7–8 questions. The problem is that it is hard to motivate people to answer surveys, and they seem to answer only when they are angry or want to complain. And it's hard to keep updated with this information. The cost is high, and it's hard to do regularly. Another great area (apart from user satisfaction) is due to emissions. This is also a need from the European Commission, the Neutral City 2030, so we have a lot of indicators in this part; number of users, satisfaction, and technical indicators for emission" – Herman.*

Another problematic aspect relates to the hierarchy which highlights the potential ranking of data, meaning qualitative studies and methods are often used as a complement when main objectives are succeeded.

> *"First, we always need to show how we succeed with objectives, then we can focus on other things […] Some people in our team are trying to look at these soft values. We can ensure some points, but when it comes to representation it's much harder to create insurance. How can we communicate the value of soft data to people that decide? Sometimes we work as mystery shoppers, using bikes to contrast the feedback we have gotten. To be there and get a new perspective on the reality of data" – Gabriella.*

In attempts to educate and spread knowledge on how to approach and communicate methodologically approach empirical situations within projects, acts of "cross-pollination" are made as a bridge of communication between different stakeholders located around Europe. However, projects happen to be constrained by the necessity of demonstrating immediate, tangible outcomes, such as increased bike or smart city-app usage, leading to shallow assumptions about citizen behaviour. Gabriella and Sara understand that behaviour can vary significantly even within demographic groups but have a hard time in motivating qualitative approaches.

> *"People show different commitments and behaviours even in the same age groups, depending on social environments" – Gabriella.*
> *"Projects must show real results; people taking the bike, taking that step, going into the app, or so on. We make assumptions about this, rules by thumb, that people that now bike owned a car, or that the ones sharing car now got rid of their own" – Sara.*

The analysed theme articulates challenges of advocating and mapping out qualitative methods for understanding social values of citizens due to the necessity of putting tangible, quantitative factors first. As experts indicate, a shift towards project goals that can embrace and operationalize the qualitative fabric of social aspects is needed.

Engaging citizens

In designing mobility systems, strategic communication and resource management are crucial elements to exemplify the benefits of design processes. This theme explores how mobility design experts address challenges related to resource knowledge, emphasizing the critical role of effective communication strategies in fostering public engagement and ensuring sustainable project outcomes. One key challenge for transport planners is crafting a compelling narrative that resonates with the community. For example, Ian emphasizes the significance of how mobility services are "packed" and communicated to citizens. For transport planners and designers, this involves more than merely providing information; it's about creating a story that aligns with the social and cultural contexts of the community in attempts to foster a connection and sense of belonging. This narrative approach is essential not only for selling the idea but for embedding these services within the daily lives of the community, enhancing their current ways of doing.

> *"Communication, participation – that is the key. The mobility narrative – how we pack stuff, how we communicate and how we sell it (to our citizens)" – Ian.*

Gabriella points out the reliance on "external tools for sharing information" as a method to bridge the gap between the services and the community. For designers, selecting the right tools—whether digital platforms, community workshops, or interactive urban installations—becomes a critical decision that can influence the project's ability to engage with the public effectively. These tools must be chosen and designed to accommodate the community's preferences, ensuring accessibility and ease of use. The challenge of maintaining a consistent and transparent flow of information is highlighted by Gabriella who notes the difficulties in ensuring that communications are both understood correctly and appropriately detailed. Designers must work to create systems that facilitate not only internal alignment among various stakeholders but also promote transparency with the public. This dual focus ensures that mobility services are both strategically sound and publicly endorsed.

> *"It's not often being understood in the right way, or it's confidential to share, but we can exchange internally to make sure we are working in the same direction" – Gabriella.*

The necessity of robust communication plans is crucial, as articulated by Herman. Designers must consider these plans as foundational elements of the design process, integrating them from the outset to ensure continuous and effective dialogue with the community. Keeping these channels updated is as critical as the design of the services themselves, as outdated information can lead to disengagement and reduced resilience.

> *"It doesn't make sense to dedicate time and money if you are not planning for [a] communication plan to what is the real investment and the calls you defined for the city – this is a crucial element for a successful strategy. However, our channels [towards citizens] are not always updated" – Herman.*

Beyond functionality, there is a significant educational component to mobility design. As Gabriella suggests, part of the designer's role is to educate the community about the advantages and functionalities of the services provided. This educational approach not only informs but also empowers users, enabling them to fully leverage the resources available for enhanced resilience. True engagement is achieved when community members feel they are part of the design process. Gabriella emphasizes that engagement strategies should be designed to make people feel included and invested in the projects. This can be facilitated through participatory design processes, where community members are involved in the design decisions, fostering a sense of ownership and responsibility towards the implemented mobility solutions.

> *"Part of our work is about educating people, citizens, and reaching engagement is through making people feel they are part of the project" – Gabriella.*

This theme reveals a complex interplay between internal resource management and external communication strategies. While experts strive to optimize organizational capabilities to support mobility services, the effectiveness of these services hinges on their ability to communicate and educate the public effectively. Bridging this gap between internal resource alignment and external citizen engagement remains a critical challenge for professionals in the field, pointing to the need for innovative methods that can enhance both aspects simultaneously.

Securing mandate and political trust to drive innovation and change

In mobility, an emphasis on metrics often influences decision-making, with experts expressing concern that this focus may stifle creativity and overlook innovative ideas that do not align with predefined goals. This tension highlights a broader challenge: balancing the demand for measurable success with the need for innovative exploration. Nevertheless, some urban environments have developed supportive structures that encourage creative experimentation. For instance, as noted by Ian, some cities benefit from strong political and financial backing, which provides a degree of security that allows for more adventurous projects. This support is, however, contingent on the political climate, which can shift with new elections, potentially altering the level of support or strategic direction.

> *"We have a lot of people in the hierarchy protecting us from the crap above. We can start projects and know that failing is an option. […] In a lot of cities they don't have the opportunity, with the funding, politics, etc. It's a lot about the role we are allowed to play. Right now, we have political and financial support, but next election may mean something else" – Ian.*

Within these supportive environments, experts describe a unique organizational culture where safety nets protect the creative process. These safety nets often manifest as hierarchical buffers that shield innovators from external pressures, enabling them to experiment and even fail without dire repercussions. Ian highlights how this setup promotes honest communication among colleagues, where critical feedback is encouraged to refine ideas without the fear of jeopardizing one's position.

However, maintaining these advantageous conditions requires continuous effort, particularly in nurturing relationships with key political stakeholders. As Ian points out, collaborating with all stakeholders involved, including politicians, is crucial for securing ongoing support and navigating the complexities of municipal governance. This political engagement ensures that projects are not only shielded from external pressures but also aligned with broader city goals. Furthermore, Aarne motivates the existing structures and views regarding what is considered successful through the lack of common ground regarding mobility services due to lacking proof of concepts.

> *"I feel [that] there is a lack of understanding from a political level [regarding mobility services] which highly relates to the missing proof of concept" – Aarne.*

Furthermore, when faced with resistance from upper management, some experts find alternative pathways to push forward their initiatives. For instance, Ian describes how circumventing traditional barriers by engaging directly with technology departments can help in advancing project ideas that management might initially oppose.

> *"I always find a way into the tech department to start talking with them instead when management is against [our idea]" – Ian.*

Through these discussions, it becomes evident that while KPIs provide a clear framework for evaluating success, they also pose significant challenges to fostering genuine innovation in mobility services. The insights from mobility experts underline the necessity of flexible, supportive structures that can accommodate and even encourage creative risk-taking, thereby enriching the project development process and ultimately leading to urban mobility services that support social resilience.

Prioritizing social sustainability

This theme underscores the challenge of prioritizing social sustainability in mobility planning, highlighting the tensions between quantifiable metrics and user-centred approaches. Urban mobility projects frequently encounter difficulties in identifying precise moments of success or key transition points. As Sara observes, project teams often default to measurable metrics, such as reductions in emissions. While these indicators are quantifiable and undeniably valuable, they fail to encompass the broader spectrum of impacts on mobility users. This reliance on tangible data underscores a critical methodological gap, necessitating the development of alternative success indicators that more accurately capture the multifaceted experiences of users. Sara remarks,

> *"Of course we have [an] understanding of when something is a success or not, but pinpointing the exact transfer points and so on is tough, so we often turn to the 'decrease of emissions' since it's now easier to measure."*

The challenge is further compounded by infrequent user engagement, as highlighted by Ian and Aarne, who emphasize the limitations of relying on annual surveys. This approach hampers the capacity to respond dynamically to users' changing needs and preferences over the course of a project. Consequently, this inflexibility risks delaying necessary adjustments to better align with user requirements and failing to detect subtle shifts in travel behaviours.

> *"We do yearly surveys, and we base our assumptions on that. We also had a desktop researcher picking out functions that we found most interesting. We don't invent new things, it's more about benchmarking. Learning and seeing, by doing. What is it that they say, 'good artists copy, great artists steal'? You see something happening in another market and translate it to your own use case" – Ian.*

Addressing the financial and logistical challenges in measuring project impacts, Cornelia draws attention to the difficulty of assessing both the internal effects of projects and their impacts on people due to

resource limitations. This scarcity of resources can hinder comprehensive evaluations, diminishing the capacity to iterate and refine designs based on detailed user feedback.

The design process frequently suffers from inadequate initial user involvement, where projects tend to be more idea-driven rather than user-centered, as described by Cornelia. This early exclusion of users can result in designs that fail to align fully with user needs, underscoring the necessity for more robust, user-involved methodologies from the project's outset.

> *"It also costs money to measure both the effect internally, and the effect on people. We have nothing there now […] We aren't present with people at the start of the process. A lot of things, sadly, are idea-driven. The most common thing is interviews, and there's not a lot of them. And I mean, exploring takes time, and I get so frustrated over the fact that it's not done properly. That is why we started developing methods and ideas for the involvement of people, but in retrospect we were neglected" – Cornelia.*

Despite existing challenges, there are initiatives to enhance direct user involvement, such as observational activities and conversations, as discussed by Cornelia. These methods aim to deepen the understanding of user needs but often face internal resistance, highlighting the need for greater support and validation of user-centered approaches within project teams.

> *"A lot of people think that "oh, now we're done" after implementing something, but that's kind of the problem, that we don't know what effect it will have in, for example, ten years" – Cornelia.*

This theme illuminates the critical need for mobility design processes to integrate more consistent and meaningful user involvement strategies from the beginning. Addressing resource constraints and fostering an environment supportive of innovative user involvement techniques are crucial for developing more resilient and effective mobility solutions that truly meet the everyday life of mobility users. This approach advocates for a design paradigm that is as dynamic and adaptive as the social and technological landscapes it aims to serve, promoting a more inclusive and responsive framework for urban mobility.

Convincing broad networks of stakeholders

The theme of motivating new design processes in mobility services highlights the shift towards inclusive, iterative innovation methods, as noted by experts. A key aspect of this shift is the challenge of convincing a broad network of stakeholders, essential for addressing broader societal impacts and engaging with users' cultural contexts. Cornelia describes an organisational move towards a bottom-up innovation approach, centered on grassroots movements and citizen cultures. Initially seen as outliers, these innovators encountered cultural resistance when introducing learning and iteration into the design process. To facilitate this shift and garner broader acceptance, they developed structured processes that demonstrated the value and rationale behind their approaches. This endeavor highlights the necessity of internal advocacy and education to foster cultural change within organizations.

> *"We started a shift in how we think about innovation, towards more bottom-up, but we were seen as the crazy people when we started talking about grassroots and citizens' cultures and learning and iteration. It was only us two in the whole organization. We created processes to show structure in our work and how we think to make colleagues understand and thereby change culture […]. It's a challenge that requires collaboration between different departments, and that becomes a too big of a question regarding who owns it" – Cornelia.*

Integrating new design processes also presents organizational challenges, particularly in collaboration across different departments. As noted by Cornelia, the complexity of determining ownership for these cross-functional initiatives can hinder progress, reflecting a broader challenge within organizations to break down silos and foster cooperative engagement in innovative practices.

Cornelia also touches on the challenges associated with being a support function in the realm of soft values within mobility projects. While they can provide structures and frameworks for project teams, the actual implementation of these strategies varies significantly. This variability often stems from a lack of understanding about how to effectively integrate soft values into projects and the difficulty of measuring the direct impact of these initiatives on service users. This situation underscores the need for enhancing competency and providing clear guidelines on executing user-centered design processes.

> *"What makes my job (with soft values) challenging is that we are a support function, we don't actually run the projects. People come to us, like, 'we want to do this', and we have to create a structure for how they could work with it. But then it's very different how well this is carried out. It's partly about the knowledge of how to do it, but it's also very hard. It takes time, and we don't really know how it will affect people using a service. Then, we don't know how to measure the input from a colleague against the effect on people (using a service)" – Cornelia.*

Furthermore, Cornelia and Aarne discuss the financial aspects of pursuing innovative projects that aim to create desired social effects. The emphasis is on the importance of establishing baseline metrics to measure future projects against, illustrating the need for strategic planning and resource allocation to kickstart initiatives that prioritize social impact. This approach not only justifies the financial investment in such projects but also sets a foundation for assessing their effectiveness and guiding future decisions.

> *"You have to convince some partners to join in, and they need certain aspects to measure, but there just is no proof of concept to show them meaning we cannot guarantee certain impact" – Aarne.*

This theme underlines the importance of evolving design processes to be more inclusive, iterative, and reflective of user needs and cultural contexts. By challenging traditional models and advocating for a bottom-up approach, designers can better address the complexities of modern urban mobility. Success in this area requires not only innovative thinking and process restructuring within organizations but also a concerted effort to improve cross-departmental collaboration, enhance the implementation of support functions, and establish clear metrics for evaluating social impact. These insights highlight a pathway toward more dynamic and responsive design practices that can effectively meet the diverse needs of communities and foster a more socially resilient urban environment.

Summary of findings

To summarize, the findings pinpoint themes that are interconnected by the need for a holistic, inclusive approach to mobility design that prioritizes citizen engagement, fosters political and stakeholder support, and integrates social sustainability to drive meaningful innovation and change. The interviewees identified several challenges in designing mobility systems. They struggled to understand citizen mobility patterns and found it difficult to incorporate qualitative methods, which were seen as lacking statistical significance and long-term relevance. As a result, qualitative insights were often not used in decision-making, and online surveys were preferred over more engaging forms of citizen involvement.

According to this study, the lack of trust and criticism towards qualitative approaches stems from an engineer-dominant perspective where local and qualitative empirical insights may clash with project goals and drivers. Furthermore, as mobility projects often include a wide variety of stakeholders and actors, there is already a high level of complexity regarding the orchestration of processes and tasks. According to some interviewees, arguing for qualitative methods as a complement to existing and established approaches might be seen as a way to create even more complexity. Inclusive and participatory approaches

might also lead to diffuse understandings of ownership between involved actors and stakeholders, resulting in a feeling of less control. As a final note, the interviewees are not always involved in the operative parts of a project, which creates challenges in ensuring that alternative approaches are carried out well.

The lack of citizen engagement in the design and development processes leads to assumptions about user behaviour and, in the worst case, decisions that are solution-driven from a technical perspective instead of a problem-driven approach based on users' needs, wants and goals. The participants in the study also point to the unavailability of tools that allow sharing and visualisation of data and project outcomes with the public. This lack of tools leads to prioritizing communication plans over citizen engagement, which often fails to speak to citizens in a way that motivates participation or the feeling of being invited and involved in shaping outcomes that affect their everyday lives.

Mobility projects often follow traditional methods for project execution and success evaluation, with a focus on gaining political trust and mandate for innovation. Interviewees noted that collaborations prioritize stakeholders, especially politicians, whose views sometimes outweigh those of end-users. They also faced challenges engaging stakeholders due to the lack of proof of concept for alternative mobility solutions, relying on personal networks to foster innovation. While emissions-based data advancements dominate sustainability discussions, social sustainability is often overlooked, with a lack of methods to integrate it into design. Citizens are rarely involved early on, limiting user-centered ideation, and projects are often considered complete at implementation, excluding users from the process. Finally, interviewees felt they were adapting existing solutions based on market insights rather than creating new alternatives. In the next section we will illustrate these findings through five design implications, each highlighting strategies to integrate social resilience into mobility systems, ensuring they are responsive and supportive of the communities they serve.

Discussion

Modern mobility systems are designed to address urban growth and environmental concerns, focusing on efficiency and engineering principles. However, the policies and regulations that accompany technological advances often disrupt citizens' established mobility routines, potentially threatening the social fabric of communities (Verlinghieri & Schwanen, 2020; Keck & Sakdapolrak, 2013). Supporting social resilience in response to these changes is crucial, requiring design processes that incorporate both proactive and reactive strategies to help communities adapt. This approach not only mitigates disruption but can also enhance well-being during transitions. The findings of this study further support the need for user-centric methods in mobility design, as well as pinpointing the challenges to implement this approach, highlighting the importance of social resilience in creating inclusive, accessible, and equitable solutions that strengthen social bonds and facilitate positive change (Resmini et al., 2021). Our study highlights the complexities of engaging citizens and other stakeholders, particularly through the interconnection between developing mobility solutions, securing political mandate, and prioritizing social sustainability within development processes (see Fig. 2).

Main challenges for developing socially resilient mobility

Below, we explain this interconnectedness by discussing these three main challenges in relation to previous research and then present five implications for design, illustrating how these challenges could be operationalized and overcome in practice.

Main challenge 1: Lack of routines and opportunities for citizen and stakeholder engagements

Current mobility practices often prioritize stakeholder wellbeing over citizen engagement, largely due to the need for political trust and mandate (Lucas & Stanley, 2013). As mobility systems become more complex, involving a wider range of actors, trust from diverse stakeholders may further overshadow citizen perspectives. This study supports findings by Krueger et al. (2016), which highlight the limited understanding of citizens' preferences, with few implemented mobility concepts available as proof. Additionally, as Dillahunt & Veinot (2018) note, mobility models present both opportunities and challenges specific to different citizen groups, underscoring the need for deeper insights into informal transportation options driven by civic engagement (Hasselwander et al., 2022). However, this responsibility often falls on a few mobility planners, hindering innovation and as noted by Verlinghieri & Schwanen (2020), mobility planners often overlook social values. Our findings indicate that this lack of opportunities for citizen engagement is compensated by prioritizing communication, though these communications are often outdated and lack depth due to the absence of tools for sharing insights or data. As Vyas & Dillahunt (2017) and Karusala et al. (2019) suggest, citizens may be unaware of a project's status or how to engage, risking their education and awareness of available resources. This lack of engagement can disconnect citizens from the project, undermining social resilience and sustainability (Lyons et al., 2016). And even though communication plans are prioritized over actual citizen engagement, our findings suggest that they may fail to speak to citizens in a way that motivates participation, the feeling of being part of something, or adoption of mobility alternatives caused by a lack of understanding of citizens throughout the project processes. Additionally, inclusive and participatory approaches risk creating diffuse ownership among stakeholders, leading to a perceived loss of control (Vyas & Dillahunt, 2017). As our study demonstrates, the lack of citizen engagement often results in assumptions about user behaviour, reinforcing a solution-driven approach rather than one based on users' actual needs (Resmini et al., 2021). Furthermore, the absence of tools to share and visualize data leads to prioritizing communication plans over genuine citizen engagement, which fails to motivate meaningful participation (Karusala et al., 2019). Our findings suggest that this lack of routines and opportunities to engage the citizens and other stakeholders in collaborative processes leads to, as well as is due to, the next identified main challenge: difficulties for mobility planners to integrate, employ and scale qualitative methods in their work (see next section).

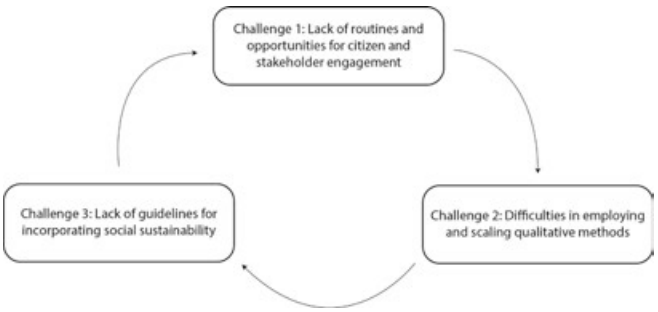

Fig. 2. The findings show that the challenges with developing socially resilient local mobility services are interconnected through a lack of guidelines for incorporating social sustainability that renders difficulties in employing qualitative methods tailored for citizen and stakeholder engagement.

Main challenge 2: Difficulties in employing and scaling qualitative methods

Chang et al. (2024) highlight that mobility implementations disrupt established routines, making social resilience essential for citizens in a constantly evolving socio-technical society (Baek et al., 2015). However, our study finds that understanding citizen routines is hindered by the difficulty of employing qualitative methods, which are often seen as lacking statistical significance and relevance. This results in a preference for online surveys, which, while useful for initial insights, fail to capture the broader social aspects of mobility. As social resilience builds on existing practices (Vyas & Dillahunt, 2017), excluding social aspects in

mobility planning risks missing key opportunities for a sustainable transition. Despite calls for more inclusive methods (Uteng et al., 2019; Sustar et al., 2020, the dominance of engineer-driven, numbers-focused approaches persists, disconnecting local insights from broader project goals. Thus, the lack of statistical tools to capture detailed mobility transitions further weakens the data, making even numerical approaches vague and leading to potentially inaccurate assumptions about citizens' needs.

Furthermore, the findings of this study support the argument that the lack of trust in qualitative methods arises from an engineer-dominant perspective, where local, qualitative insights often clash with project goals (Hasselwander et al., 2022). This issue is compounded by the complexity of mobility projects involving multiple stakeholders, with some interviewees expressing concerns that incorporating qualitative methods could add unnecessary complexity (Uteng et al., 2019). Building on Uteng et al. (2019), we argue that designers and mobility planners would benefit from integrating social considerations as a core element of mobility system design, rather than treating qualitative studies on these aspects as mere complements to existing practice. It is important to note that mobility planners still lack the statistical tools to accurately track transitions between transport alternatives. Findings suggest that even though mobility planners can compare the number of citizens using a particular transport mode on different days, they still lack deeper detail, rendering even data-driven arguments at times as imprecise as qualitative, local insights sometimes are criticized to be. This statistical reliance fosters assumptions about citizens that may be inaccurate, and the perceived critique of qualitative data's relevance could instead serve as a lens to question potentially outdated assumptions based on a single annual online survey. As Copeland et al. (2020) communicates a worry of normative trade-offs for what is considered resilient without knowing the citizens of a specific community, findings indicate a worry in making trade-offs for the greater mobility system. This leads up to our final identified main challenge, the lack of guidelines for incorporating social sustainability in mobility planning.

Main challenge 3: Lack of guidelines for incorporating social sustainability

This third main challenge builds on the previous two in terms of how lack of routines and difficulties in tailoring methods that are designed to capture the processual and evolving nature and qualities of social life, both hinder the development of, as well as suffer from a lack of, guidelines for how to incorporate deep understandings of what builds local social sustainability into mobility planning. In terms of choosing social sustainability, the complexity of integrating social aspects into mobility design is exacerbated by the simplicity of measuring emissions, which are often prioritized over more difficult-to-measure social impacts (Andruetto et al., 2024). Findings align with previous research (Comes, 2016; Vyas & Dillahunt, 2017) suggesting that mobility planners lack clear guidelines for incorporating social sustainability. As mobility planning remains driven by overarching standards, it risks excluding citizens and perpetuating inequalities (Grieco, 2015). This study also reflects concerns about the exclusion of citizens from decision-making and the focus on project completion rather than long-term adaptation, which could hinder social resilience (Cutter et al., 2016; Keck & Sakdapolrak, 2013). The findings in this study also indicate that projects seem to be perceived as finished once a mobility solution has been implemented. This has consequences for the well-being of affected citizens as they further imply the need for adaptation and coping, rather than education and preparation for change (Cutter et al., 2016; Keck & Sakdapolrak, 2013). An alternative approach could involve educating citizens to sustain projects post-implementation (Baibarac and Petrescu, 2019). Finally, as mobility systems grow increasingly complex, the study highlights the challenges planners face in managing cross-departmental collaboration. This complexity can hinder decision-making and quality assurance, particularly when incorporating social values into the process (Willnat et al., 2024). Balcells et al. (2024) further illustrate the potential for misunderstandings and trade-offs that can complicate the impact on citizens.

Supportive policy and design implications

Drawing from the foundational work of Dillahunt & Veinot (2018), the conversation extends to understanding a broad spectrum of barriers and facilitators that influence mobility. These include critical aspects such as affordability, individual capabilities, interpersonal trust, care or reciprocity, trust in technology, service availability and eligibility, spatial and temporal matches, the congruence between transportation mode and physical needs, service reliability and quality, and access to necessary infrastructure. Dillahunt and Veinot (2018) advocate for supportive policies and design principles to address mobility barriers and enhance inclusivity, social efficiency, and responsiveness. These principles aim to improve access to essential services like employment, healthcare, and food, while reimagining transportation as a collaborative, community-focused system that enhances well-being. This approach aligns with mobility research trends emphasizing community-centric and adaptive solutions, offering valuable guidance for shaping resilient and accessible mobility systems in Europe.

In contributing to this burgeoning research on designing for social resilience, we will now illustrate our findings of our study as design implications, derived from the analysis of expert interviews and informed by prior research. Each design implication is centered on the integration of social resilience within the mobility planning process, whether through adaptive design, empowerment in decision-making, cultivation of proactive capacities, or development of novel metrics for social resilience. These implications underscore the imperative of adopting a comprehensive, inclusive approach that prioritizes flexibility, empowerment, grassroots innovation, and the operationalization of social values pertinent to social resilience in design. Moreover, they advocate for designs that not only endure over time but also function as catalysts for community thriving amidst change. Hence, designing for social resilience could be seen as engaging in a socio-technical system where design and people influence each other (Baek et al. 2015). As our findings suggest, designing for social resilience in mobility systems is hindered by lack of guidelines, mandate, political trust, and difficulties for mobility planners to prioritise and employ tailored qualitative methods for social sustainability (see Fig. 2). We conclude this section by presenting implications for how to develop design processes for mobility solutions that address the identified challenges and encapsulate the multifaceted attributes of social resilience (see Fig. 3).

Central to meet up with the identified challenges is to develop qualitative metrics (#1) that encapsulates the multifaceted attributes of social resilience. Our study suggest that this can be achieved by developing guidelines through rethinking resources (#2) and reconsidering trade-offs (#3), while at the same time develop an approach to citizen engagement that create deeper understandings of citizens existing routines (#4) as well as fostering citizen proactivity (#5). We describe these implications in further detail below.

#1 developing qualitative metrics

This implication entails translating intangible aspects of social resilience into measurable design criteria by developing qualitative metrics to evaluate social resilience, such as social network strength and self-reliance while recognising social resilience as a dynamic, evolving process (Benzies & Mychasiuk, 2009; Vyas & Dillahunt, 2017) that complicates multi-stakeholder evaluations in mobility projects (Willnat et al., 2024).

#2 rethinking resources

Mobility planners must consider not only organisational resources for specific contexts but also the assets accessible to individuals within communities, as these are critical for social sustainability and resilience, requiring awareness of contextual resources (Vyas & Dillahunt, 2017) and attention to intra-community differences (Karusala et al., 2019).

Fig. 3. Implications for how to develop design processes for mobility solutions that address the identified challenges.

#3 reconsidering trade-offs

Mobility planners must consider how trade-offs in defining social sustainability affect social resilience, ensuring project KPIs do not override locally important aspects, thereby addressing dynamics and inequalities (Verlinghieri & Schwanen, 2020) and contributing to sustainability in practice (Andruetto et al., 2024).

#4 understanding existing routines

As social resilience is an ongoing process, mobility planners should design for transitions between stages of change, enabling gradual adjustments to existing routines and supporting informal transportation options to foster citizen participation (Hasselwander et al., 2022).

Fostering citizen proactivity

Beyond reactive measures, this implication emphasises building communities' proactive capacity to transform threats into opportunities for innovation and growth through experimentation, innovation, and exploration, thereby enabling understanding and addressing current and future problems to achieve favourable outcomes (Vyas & Dillahunt, 2017).

Conclusion

This paper explores social resilience as a potential approach to operationalizing social sustainability in the design of mobility systems by answering the research question: what *are the challenges when designing for social resilience in local mobility services?* The study presents *Lack of routines and opportunities for citizen and stakeholder engagements*, *Difficulties in employing and scaling qualitative methods*, and *Lack of guidelines for incorporating social sustainability* as three major challenges. We suggest that central to meet these challenges is to develop qualitative metrics that encapsulate the multifaceted attributes of social resilience. This can be achieved by developing guidelines through rethinking organisational resources to also include community assets and reconsidering project KPI trade-offs so that they don't override local values. At the same time, we also argue that it is important to develop an approach to citizen engagement that creates deeper understandings of citizens existing routines as well as fostering pro-active communities with capacities to transform threats into opportunities for innovation. These findings contribute to understanding why social sustainability often remains a vision without tangible impact in mobility planning, highlighting the necessity of contextual knowledge to fully comprehend social resilience in complex, evolving systems. However, it is worth noting that the study includes semi-structured, exploratory interview studies that rely on small homogenous samples with a context-specific nature. This implies that further research could explore the identified challenges by scaling study findings through expert interviews and analysis of global and local mobility projects for examples and implementations investigating social sustainability aspects further. As implementations in complex systems remain numbers-driven, the understanding of the citizens affected by them are more crucial than ever.

Limitations and future work

This study specifically focuses on social resilience in the context of mobility systems. Even though participants were asked to share their experiences of practice for social resilience, none of them were directly familiar with the concept. As an additional limitation, all participants interviewed for the study work with mobility in western Europe. This may indicate certain common views on how to design, develop and implement mobility solutions and their ancillary services. Further research is needed on how to incorporate community resource-sharing motivations into mobility service design and support intangible transitions through proactive mechanisms. Understanding these challenges will enable exploration of trade-offs in defining social resilience from both community and designer perspectives, focusing on context-specific processes and methods for operationalizing, evaluating, and scaling resilience frameworks in design. Our hope is that our suggested design implications encourage further research on how to meet these challenges specifically, but also bring inspiration to planners and designers submerged in complex systems.

Use of generative AI or AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT and Grammarly to improve readability and language of single sentences. After using these tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article.

CRediT authorship contribution statement

Oliver Weberg: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Jesper Lund:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Vaike Fors:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Andrea Resmini:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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