Westin, Margareta; Johansson, Charlotta; Berggård, Glenn

Article

Constraints to the transition to fossil-free passenger transport: As perceived by rural inhabitants

Research in Globalization

Provided in Cooperation with:
Elsevier

Suggested Citation: Westin, Margareta; Johansson, Charlotta; Berggård, Glenn (2024) : Constraints to the transition to fossil-free passenger transport: As perceived by rural inhabitants, Research in Globalization, ISSN 2590-051X, Elsevier, Amsterdam, Vol. 8, pp. 1-12, https://doi.org/10.1016/j.resglo.2024.100218

Research in Globalization 8 (2024) 100218

Contents lists available at ScienceDirect

Research in Globalization

journal homepage: www.sciencedirect.com/journal/research-in-globalization

Constraints to the transition to fossil-free passenger transport – As perceived by rural inhabitants

Margareta Westin *, Charlotta Johansson, Glenn Berggård

Department of Civil, Environmental and Natural Resources Engineering Division of Architecture and Water, Luleå, Norrbotten 971 87, Sweden

ARTICLE INFO

Keywords:
Accessibility
Fossil-free
Mobility
Sub-arctic
Rural
Capability approach
Sustainable transport
Sparsely populated
Conversion factors
Decarbonization

ABSTRACT

Passenger travel by car currently accounts for a significant part of greenhouse gas emissions, but reducing dependency on the car in rural areas while ensuring accessibility is challenging. This study offers a user perspective on the constraints to fossil-free mobility in a remote rural area of Sweden, drawing on focus group discussions with inhabitants of six rural settlements.

The study took place in Västerbotten and Norrbotten, Sweden's two northernmost regions where the climate is sub-arctic, population density low, and car dependence high.

It explores constraints including the shift from personal and individual responsibility for transport to more collective solutions. Both contextual and individual aspects impact on people's ability to change, including social networks, working arrangements, socioeconomic preconditions, and personal flexibility.

Introduction

The negative impacts of transport, particularly the car, on climate change have long been recognised. The challenge is to phase out the use of fossil fuels and achieve a transition to a more sustainable transport system overall (Banister, 2008; Chapman, 2007). In this paper we use the term 'fossil-free transport' to refer to forms of transport which are not dependent on fossil fuels. This study focuses on this transition in remote rural areas in Sweden, "landsbygd", which are characterised by low population density, built-up areas with fewer than 200 inhabitants, and long distances between places. This study utilises the inter-related concepts of perceived accessibility, mobility, and capabilities. The term accessibility often focuses on reaching different activity opportunities. Perceived accessibility can be defined as *"how easy it is to live a satisfactory life with help of the transport system"* (Lättman et al., 2016, p.36). Mobility is the use of the transport system from an origin to a destination. Capabilities are the ability to achieve and do things, e.g. reach a destination or get an education.

Accessibility in rural areas is often conditional on mobility, i.e., being able to get to other places. Due, settlement structures in rural areas are often spread. Services are often far away, and this creates 'car dependency' (Farrington & Farrington, 2005; Gray et al., 2001; Mattioli, 2014; Moseley, 1979; Shergold et al., 2012). Also, local services such as shops, schools and healthcare are often relocated to urban centres, which increases distance and dependency on transport. Many rural areas also face challenges related to depopulation and an ageing population (ibid). The combination of a small population with a diversity of travel needs makes it difficult to provide the solutions that are considered normal in urban areas, such as public transport (Poltimäe et al., 2022; Vitale Brovarone & Cotella, 2020). However, difficulties in getting around can limit social inclusion, and those without a car are particularly vulnerable (Carroll et al., 2021; Mattioli, 2014; Shergold et al., 2012). Improving accessibility involves finding alternatives to the car (Vitale Brovarone & Cotella, 2020). There are tensions between achieving the transition to fossil free transport and ensuring secure accessibility for rural populations (Mattioli, 2016). Under current conditions, limiting car use reduces accessibility unless suitable alternative transport is provided (Lättman et al., 2020). Some have argued that achieving the transition involves reducing unnecessary travel (Mattioli, 2016), while others emphasise the need to reduce emissions overall and address the sustainability of different alternatives (Poltimäe et al., 2022; Tønnesen et al., 2022).

Much of the literature on transport options focuses narrowly on specific solutions or target populations. Examples include: conversion to electric cars (Halbey et al., 2015; Jones et al., 2020) and demand responsive mobility alternatives (Schasché et al., 2022), and shared

* Corresponding author.
E-mail addresses: margareta.westin@ltu.se (M. Westin), charlotta.m.johansson@ltu.se (C. Johansson), glenn.berggard@ltu.se (G. Berggård).

https://doi.org/10.1016/j.resglo.2024.100218
Received 22 December 2023; Received in revised form 18 March 2024; Accepted 5 April 2024
Available online 8 April 2024

mobility through e.g., car-sharing (Hult et al., 2021; Lygnerud & Nilsson, 2021; Psarra et al., 2021) and school buses (Stanley & Stanley, 2021). Target populations include tourists (Martín Martín et al., 2019), age groups (Graham et al., 2018; Ryan & Wretstrand, 2019; Shergold et al., 2012), and residents of particular places (Berg & Ihlström, 2019). Other work focuses on particular transport purposes, such as business travel (Jones et al., 2020) and commuting (Sandow & Westin, 2010), or on particular technologies such as apps or online platforms (Mitropoulos et al., 2021).

Some research does, though, take a more comprehensive approach, for instance framing multimodal mobility solutions (Bauchinger et al., 2021). In order to meet the varying needs of different people, mobility solutions need to be devised holistically and work together (Lättman et al., 2020; Poltimäe et al., 2022). Furthermore, addressing users' perception would give a greater understanding of the transition and what will be needed to achieve change. There is less understanding of fossil-fuel alternatives from a user perspective, which is crucial for gauging individual perceptions. Many insights into fossil fuel-free alternatives lacks a user perspective. A literature review on demand-responsive transport (Schasché et al., 2022) identified that there is less attention paid to what influences users' choices and acceptance. Even though this is essential to understanding the preconditions and constraints faced by the people who are expected to change their transport behaviors. This study addresses two gaps: perspectives from the rural inhabitant of perceived constraints of using fossil-free transport options and a holistic focus on fossil-free alternatives for accessibility through mobility.

Regardless of the modes of transport, to be an attractive alternative, they need be able to provide sufficient accessibility. An adequate level of service quality, such as ease of use, safety, and flexibility, is essential. For example, it has been established that for public transport and ride-sharing services, safety and reliability are essential. Detailed examples show the importance of the punctuality of buses, that comprehensive information is provided onboard, and about how the mode of transport fits with peoples travel needs (Friman et al., 2020b, 2020a; Poltimäe et al., 2022). Deficiencies in service quality make it challenging to choose fossil-free transport options. These can be constraints affecting individual opportunities to travel and achieve accessibility with fossil-free alternatives. Knowing more about what are perceived as constraints gives a better opportunity to address issues and find solutions. Equally, service poverty and transport poverty are often common in rural areas compared with urban areas, Which increases constraints and reduces alternative solutions.

The starting point is that transition to fossil free options will need a combination of solutions. Since this study focuses on fossil-free alternatives, electric cars and other alternative car fuels have been included. The aim of this study is to offer a nuanced user perspective on the constraints people face in using fossil-free mobility alternatives to meet their need for accessibility, in what is sometimes described as one of the toughest rural areas in Europe, in order to better understanded what will enable such transport to be accepted and work in the future. The focus is on real-life situations in rural areas, and it is based on dialogue with inhabitants from areas with strong car dependence and ownership. The research questions address constraints In a rural context 1) relation to *access* to fossil-free mobility options for accessibility 2) *using* fossil-free mobility options for accessibility.

The article is structured as follows: section 2 presents earlier literature and theoretical perspectives. Section 3 presents material and methods, and section 4 addresses results, which are structured according to the capability approach as a conceptual framework. Section 5 discusses the result and method. Section 6 summarize shortly the conclusions of the results and future research needs.

Earlier studies and theoretical perspectives

Constraints on fossil-free travel in rural areas

It is well-established that public transport services must be attractive to users in terms of price, frequency of services and connections between them, and safety and comfort both on the journey and at transport hubs and stops. Often referred to as service quality (Friman et al., 2020b; Redman et al., 2013). Information availability is also crucial. In rural areas, public transport infrastructure is often poor quality or altogether absent (Berg & Ihlström, 2019; Soder & Peer, 2018). For example, pedestrian walkways to bus stops are often perceived as unsafe, and bus stops are often seen as limited in environmental protection and lacking adequate space. Common problems also include low frequencies of bus service and long travel times. Journey's requiring changes between buses are also problematic because, if a connection is missed, it can take a very long time to reach a destination (Berg & Ihlström, 2019).

Electric cars have the challenge of range anxiety, which is particularly problematic in relation to long or unplanned journeys (Jones et al., 2020). Meanwhile, car-sharing for example co-riding and on-demand schemes struggle to serve the diverse needs of different users, travelling at different times, to different locations (Hult et al., 2021; Lygnerud & Nilsson, 2021; Poltimäe et al., 2022). Here it is difficult to ensure the supply matches demand during certain times, such as weekends and peak hours. It also relies on many actors cooperating in service delivery, where responsibility is unclear. When no operator coordinates available vehicles, it becomes challenging to ensure a suitable level of service, such as co-riding services (Lygnerud & Nilsson, 2021). For these reasons, most transport alternatives are more time consuming and less convenient than the private car.

Different people have different transport needs and, for example, families with children find it difficult to plan sufficiently to rely on public transport. Knowledge and experience of the available transport options is also important (Hult et al., 2021; Berg & Ihlström, 2019). Psychological aspects, such as norms and habits may also come into play. This could mean that even if alternatives to the car exists, people may prefer to use the car because they are used to doing so (Olsson et al., 2019).

Accessibility, Mobility, & capabilities

Geurs & van Wee (2004, p. 128) define accessibility as; "*the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)*". Four considerations for accessibility are: (1) land-use, (2) transport, (3) temporal(time), and (4) individual factors (Geurs & Van Wee, 2004). The individual factors can be further divided into: (a) socio-economic demographic factors, (b) attitudes, preferences, and needs, (c) person-specific flexibility, and (d) people's capabilities (Van Wee, 2022). There is also an important distinction to be made between perceived and actual accessibility. Pot et al (2021) refer to the latter as 'calculated accessibility', and it can differ significantly from perceived accessibility. However, people act on the basis of their perceptions rather than the actual or 'calculated' situation (Lättman et al., 2018; Pot et al., 2021).

Capability refers to whether people are able to access or to do something, for example, get an education or participate in society (Sen, 1992). Rather than means, it focuses on well-being and freedom of choice. Circumstances and context determine what capabilities it is considered reasonable or important to have (Sen, 1992). Research on capabilities mostly focuses on people's ability to do something, rather than whether or not they actually do it. However, many other factors also shape people's ability to participate in society, including age, socioeconomic situation, social networks, and where they live (Sen, 1992; Vecchio & Martens, 2021).

Mobility is a common construct which relates to accessibility and capability. One definition is *'ease of movement'* (Preston & Rajé, 2007, p.

154) between places. It addresses the actual movement from origin to destination, often with different means of transport. Accessibility usually requires some form of mobility, but not always. High mobility does not necessarily lead to high perceived accessibility (Olsson et al., 2021), as the barriers to accessibility may relate to factors other than mobility.

Conceptual framework

This study is framed around a capability approach, utilizing the notion of 'accessibility-as-capability' as per Vecchio (2021). The focus is not on vehicles themselves but on what they help people to achieve. The ability to get around is a prerequisite for participation in society. While transport alternatives (resources) may be available, people must also be able to use them, and this depends on their situation. In this study, resources are defined as *"material and immaterial means that directly or indirectly shape a person's possibility for mobility and accessibility"* (Vecchio, 2021., p.841), and further disaggregated into private or public mobility resources (the transport system) and activity opportunities (the land use system). How these resources translate (conversions factors) into social participation and well-being depends on social, personal, and environmental/contextual factors. The framework has been adapted to reflect this study's focus on alternatives and strategies for fossil-free mobility in a specific rural context (see Fig 1.).

Our modifications to this framework relate to replacing fossil-based resources with alternatives, causing conditions to change. There are constraints on both resources – whether fossil-free alternatives are available – and conversion factors – the aspects that limit people's use of the available resources. This framework helps to illustrate and unpack constraints and conversion factors into distinct categories, and relate different aspects of accessibility to those used in other models.

Resources are often described as the *"means to achievement"* (Sen 1992, p 33), the availability of which increases one's ability to achieve one's goals. 'Mobility resources' are the resources that the transport system offers (Vecchio & Martens, 2021). Which resources are available and relevant to people varies according to the context and personal circumstances. Someone may appear to have resources available but be unable to use them, and vice versa (Sen, 1992; Vecchio & Martens, 2021).

Materials and methods

Case description

The study focuses on the geographical area of Västerbotten and Norrbotten, Sweden's two northernmost regions. Both are distinctly rural regions, with the lowest population density in Sweden and one of the lowest in Europe. Car dependency and ownership is high. The area has a sub-arctic climate as the Arctic Circle passes through Norrbotten. Winter temperatures are below freezing, and daylight hours are short in winter and long in summer. For further key characteristics see Table 1.

The empirical data for this study comes from focus groups in six case area settlements: Gunnarsbyn (with surranding villages), Moskosel, Kittelfjäll, Varuträsk, Kålaboda, and Lavsjö (Fig. 2). These settlements are all classified as "smaller localities," i.e., a cluster with a maximum of 199 inhabitants (SCB, 2023c). Our focus groups also included some households who lived in the surrounding areas, slightly outside of these settlements. They are also defined as being within a "sparse rural" municipality " by the Swedish Agricultural Agency or having a journey of over 45 min to the closest town with a population of 50 000 or more (Jordbruksverket, 2022). The settlements closest to a city are Varuträsk, followed by Gunnarsbyn. Kålaboda is a distinctly agricultural village located on the coast between the two northern cities of Skellefteå and Umeå. Kittelfjäll, Moskosel, Gunnarsbyn, and Lavsjö are all "inland municipalities" and among the most sparsely populated areas, as most of the region's population lives in coastal areas. Kittelfjäll and Gunnarsbyn also have a vital tourism industry. Kittelfjäll is a mountain resort whose population swells seasonally. Fig. 2 shows a map of the area, and Table 2 provides further description.

Research design & implementation

Focus group interviews were conducted with 41 participants in the six settlements outlined above. As noted by Barbour & Kitzinger (2011p.5), *"any group discussion may be called a 'focus group' as long as the researcher is actively encouraging of, and attentive to, the group interaction"*. Thoughts are exchanged and build on each other (Barbour & Kitzinger, 2011; Flick, 2018). For this study, the focus group discussions

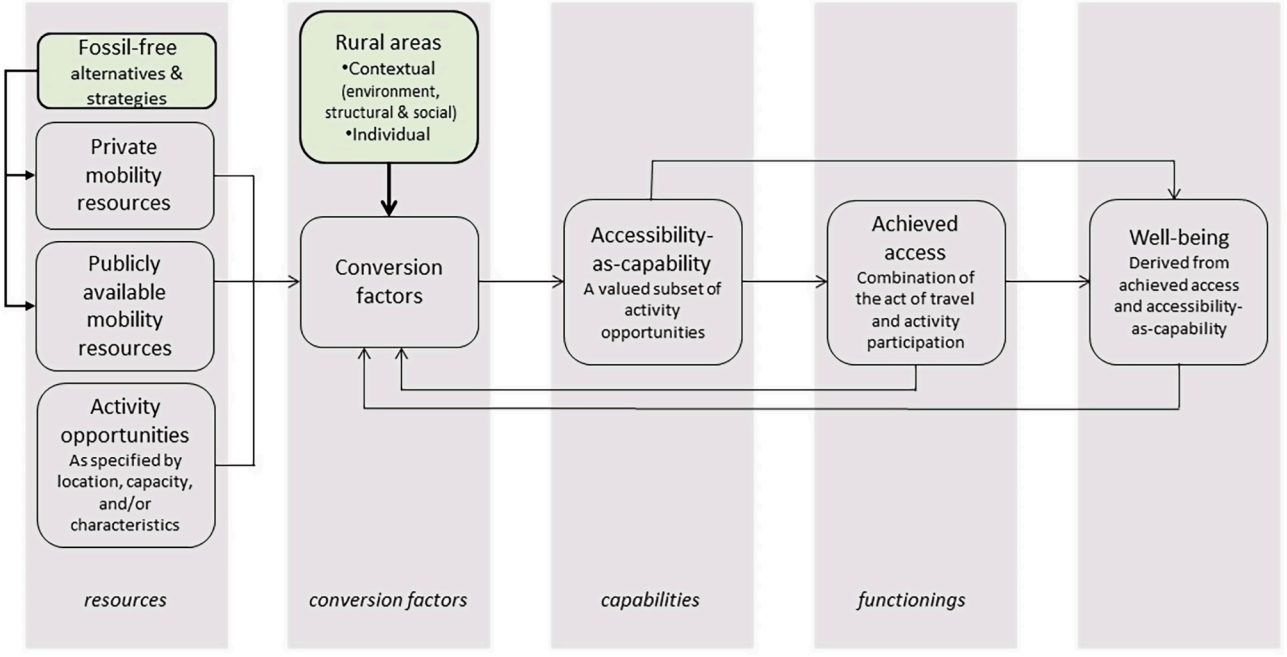

Fig. 1. Conceptual framework (capability approach) and focus for this study (green parts). grey original framework (based on a figure fromVecchio & Martens, 2021). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 1
Description of Västerbotten and Norrbotten (Regionfakta, 2023; SMHI, 2017a, 2017b, 2023a, 2023b).

	Square km	Population	Population density (sq. km)	latitude	Average annual temperature	Average days of snow
Västerbotten	54 665	276 295	~5,1	63° – 65°	~ −2° to 3°	150 – 225
Norrbotten	97 239	249 177	~2,6	65° – 67°	~ −3° to 4°	150 – 225
Total	151 904	525 472	~3,5			

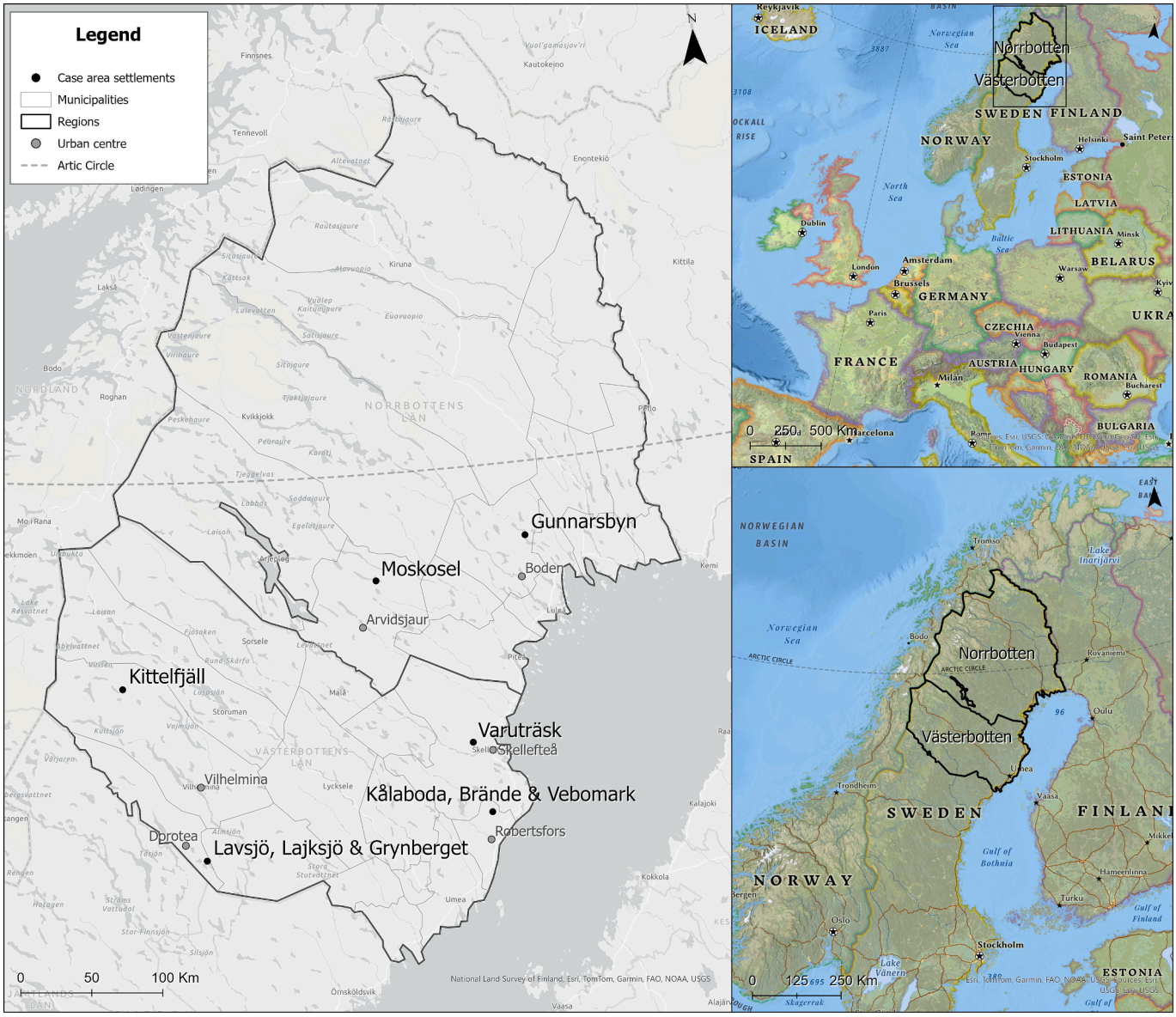

Fig. 2. MAP of NORRBOTTEN, VÄSTERBOTTEN, AND THE SETTLEMENTS.

Table 2
Description by settlement (Regionfakta, 2023; SCB, 2022, 2023b, 2023a, 2023c).

	Gunnarsbyn with surranding villages	Varuträsk	Lavsjö /Lajksjö	Kittelfjäll	Kålaboda/ Brände/ Vebormark	Moskosel
Population[1]	211	97	54	69	75	163
Municipality and municipal centres	Boden	Skellefteå	Dorotea	Vilhelmina	Robertsfors	Arvidsjaur
Population municipality (2022)	28,048	74 402	2 413	6393	6759	6111
Population density of municipality	7,0	10,9	0,9	0,8	5,2	1,1
Population of closest urban centre (2020)	16,832	36,388	1320	3356	2010	4457
Distance to municipality "centrum"	~41 km	~15 km	~10—26 km	~114 km	~24—32 km	~43 km

[1] Based on "småort", a cohesive settlement with 50 to 199 inhabitants. There may be additional single households outside, more scattered in the surrounding area, statistics for these are missing. Statistics from 2022, except for Kittelfjäll, which is from 2015.

were guided by a semi-structured interview guide which enabled us to steer the conversation towards the topic under consideration, and cover all essential areas, but still allowed the discussions to develop organically based on what participants highlighted. The questions were not asked in a strict order but were included as support and adapted according to how the discussions progressed. The interview guide can be found in Appendix 1. It is divided into two main parts. First, the discussions started by addressing travel that participants makes today, and second whether these could be conducted with less or no use of fossil fuels. The participants were given the opportunity to describe the travel they take today; by this, a concrete basis was created for further discussion about fossil-free travel. The structure and follow-up questions were inspired by Galletta (2013), first posing broad questions, then follow-up questions about the nuances of what they had said, finally moving toward closure by going back to points expressed earlier, aspects not previously addressed, or anything else that would benefit from further exploration. The questions were pre-tested with people not involved in the research project, and modified where they were felt to be overly complex.

The research took an iterative approach based on a flexible preliminary implementation plan. The intention was for focus groups to be conducted in a relatively consistent manner, but the villages' different conditions and adaptations to coronavirus restrictions meant that both physical on-site and digital meetings took place (see Table 3). During the physical meetings participants were able to draw on maps to illustrate their points. One of the settlements (Kittelfjäll) chose to hold digital meetings because participants were spread out and many were part-time residents. During digital meetings, maps were not used to simplify participation. Rather, the focus was on discussion. The disadvantage of using different methods with different groups was outweighed by the benefits of enabling some focus groups to meet in person.

Participants

Two methods were used to recruit participants: tips from local contacts such as from the respective settlement associations, and advertising on local bulletin boards and Facebook pages. People were also encouraged to invite each other (snowball approach). Where there were many participants, they were divided into smaller groups and an additional colleague helped to lead the discussions. Around 41 people participated in total, the smallest group involving three people and the largest 14 people. See Table 4 for a description of participants. Anyone with a relationship with the relevant village was welcome to participate. Information about the research project and the request to record proceedings were provided in the invitation emails and at the start of the focus group sessions.

Analysis

Focus group discussions were transcribed, then categorised using the 'accessibility-as-capability' framework above, and then analysed further in the broader context of other literature using deductive content analysis (Mayring, 2000). It is the occurrence of stated aspects that has been categorized, not the frequency of these. This was done primarily with the software Nvivo. Firstly general constraints were identified; then resources and activity opportunities were distinguished from conversion factors, and codes assigned; then the resulting categories were coded into further subcategories. Next, the points raised in these subcategories were regrouped iteratively, and then a resulting text was created before the codes were re-assessed and adjusted. These steps were all conducted by a single researcher but at each stage findings were discussed and agreed with the other two researchers.

Table 3
Implementation of focus groups by settlement, location and methods.

Settlements	location	Material
Moskosel	On site	Maps, post it notes
Gunnarsby	On site	Maps, post it notes
Varuträsk	Digital	–
Lavsjö /Lajksjö/Grynberget	On site	Maps, post it notes
Kittelfjäll	Digital	–
Kålaboda/Brände/Vebormark	Digital	–

Table 4
Implementation of focus groups in the settlements, participant information.

Settlements	Number of total participants	Number of groups	Short population demographic description[2]
Moskosel	7	2	Pensioners, parents, young adults, middle-aged. 3 female, 4 male
Gunnarsbyn	14	3	Mostly middle-aged and retired, some youth. 6 male, 9 female
Varuträsk	3	1	Middle-aged, retired, 2 female, 1 male
Lavsjö /Lajksjö	5	2	Mostly parents, young adults and younger middle-aged. 4 female, 1 male
Kittelfjäll	9	1	Mix, residents and part-time residents. Pensioners. With and without children. 5 male, 4 female
Kålaboda	3	1	Young adults, mothers and middle-aged. 3 female

[2] All groups included both employees and self-employed people. To respect participants' anonymity, given the small size of these villages, no further details about participants will be published.

The conversion factors are categorised into individual and contextual factors. Contextual factors are further divided into social, structural, and environmental factors. Identified constraints are qualitatively described separately for the sake of clarity but, despite being presented this way. it is good to be aware that they often actually occur in combination.

A limitation of the analysis is that it only considers constraints as described by participants, and does not strive for complete coverage. Vecchio & Martens (2021) summarises the challenge of identifying conversion factors as follows:

> *"Given that conversion factors are highly personal, and may strongly vary over time, it is impossible to obtain a "complete" understanding of conversion factors for even a sample of the population. Each study into accessibility levels across a population can thus at best work with some set of proxies for these factors.(p.11)"*

Results

Resource related constraints

Private mobility resources

The focus group discussion about private mobility using fossil-free resources dealt primarily with the car as a means of transport, particularly the electric car. However, biofuel was also mentioned, and participants had different views on which of these options has more potential. The characteristics of the car itself was important to many: for instance, its capacity to carry luggage and pull trailers, and its endurance, range, ground clearance, and suitability for handling poor quality roads, snow, and other conditions. Not everyone had access to a car with these features, but some participants did. However, participants differed as to which functions and requirements matter most. Some argued that most journeys could be made with a smaller electric car or that some electric cars meet these requirements. An electric car owner said: *"I get to Skellefteå [a regional city] by driving on this battery. But not any further than that, it's 200 km. But I mean for my trips that I do daily or weekly or like most of the time, that's all well and good."* Others argued that very few

electric cars could handle their requirements and that hydrogen or other biofuel alternatives had a better chance of coping with the cold weather and long distances in rural areas.

Participants raised concerns about the infrastructure needed to run a car, such as appropriate electric chargers at home, which further requires access to the right level of amps, and a garage to protect the car from snow and cold weather. Bicycles and kick-sledges, both usually private, were also discussed but to a lesser extent. See Table 5 for a summary of topics discussed.

The car dominated the discussions, irrespective of type of trip, travel purpose, context, and whether other options such as public transport were available. People did not necessarily prefer the car – some did, others did not – but it nonetheless recurred as a point of reference.

Public mobility resources

The focus group discussions revealed that the availability of public mobility resources shapes whether fossil-free options are available. Firstly, and obviously, travelling by public transport requires that public transport is available. For most participants, access to any local collective transport solutions was scarce or non-existent. Secondly, infrastructure shapes which means of transport are available, whether collective or individual. For instance, the availability of biofuel or charging stations affects whether fossil-free car use is feasible, and access to stations and bus stops is needed for public transport. Many participants live tens of kilometres from such facilities. For longer journeys access to and information about parking facilities and connectivity options are important. The design of and facilities at bus stops and train stations was described as important, even if they are remotely located. For example, the focus groups in several settlements discussed the facilities and design of the train stations in the nearest cities, such as access to parking and opening hours for parking garages close to the railway station garages. A quote: *"There is a parking garage. But it is closed at certain times. And then the question is, when the train arrives in the evening if the garage is closed, you can't get the car out"*. See Table 6.

Activity opportunities

Participants discussed not just the mode of transport but also how various options worked in relation to the locations they needed to reach. In one example a parent addresses a complicated situation for her senior high school child: *"had to leave class I think 30 or 35 min before the last class…… to be able to get home… The people at the school refused. And you know they had a big meeting, couldn't get it together. Transport provider refused."* Many of the participants were used to travelling long distances in their everyday life. For example, several lived many hours' journey from the nearest hospital. Opinions about the feasibility of different transport options varied depending on the activity concerned and how frequently they undertook it.

Participants concluded that whether or not a trip could be made through fossil-free means depended on the specific characteristics of the relevant activity: for instance, the nature of a workplace, location of a service, and fixed vs flexible visiting or opening hours. Digital solutions such as new self-service technologies were also highlighted whether or not local alternatives were available also mattered to participants, although only as one of several considerations. See Table 7.

Table 5
Constraints concerning availability or lack of private mobility resources.

	Constraints	More detailed
Access to low/zero fossil fuel car (or other vehicle) (HVO, biogas, electric, ethanol, hybrid)	Equipment around the car	Access to appropriate power source (amps required). Loading possibilities for electric car at home Garage for the car
	Access to car suited to "local conditions" – the function of the car	Range must be good enough (primarily electric but other fuels also mentioned) Ground clearance, four-wheel drive
	Equipment or space to bring luggage – transport capacity	Capacity to pull a trailer (engine power/kite hook / four-wheel drive/ground clearance). Car with cargo space
Lack of access to smaller vehicle	No motor, such as bicycle, kick sledge, skis (bike most common) Micro-vehicles such as electric bicycles	Bike that pulls a trailer

Table 6
Constraints concerning availability or lack of public mobility resources.

	Constraints	More detailed
No or shortage of:	Public transport or other collective mobility solutions	Lack of buses / Too far to closest bus stop Lack of train Lack of public transport overall Connection possibilities on public transport / connecting services available, with timing that aligns with the departing mode of transport
	Car rental opportunities	
	Road space for unprotected users	Bike, walking, kick sledging, ski track.
Surrounding Infrastructure	Publicly available information about available options, delays, & accessibility features'	Child seats on buses & disability friendly.
	Commuter parking in various forms	Facilities for heating engine and charging, for long term parking Cost, opening hours, security of the parking space
	Access to fuel stations – electric chargers and other fossil-free fuels	Total lack of, or very long distances between charging locations – especially fast charger The number of chargers in one place / how long it takes to wait and charge Variable availability of charging option depending on car brand and capacity of the power grid

Conversion factors – Individual

Personal circumstances greatly affected participants' capacity to travel using fossil-free modes. Similar issues were raised across most of the focus groups, regardless of location (see Table 8).

Economic circumstances, time, and flexibility were recurrent themes in the discussions. Fossil-free alternatives were seen as unaffordable for many, particularly electric cars with the right attributes for the context, even though those who owned them said that they were cheaper to run in the long term. Train travel was also sometimes felt to be too expensive.

Flexibility is often related to collective travel solutions but also as example biking, for instance where there is a single bus departure in the morning rather than a frequent service. Participants' needs for flexibility related to their life circumstances. For instance, families with children felt more pressed for time and more need for flexible transport options

Table 7
Constraints in relation to availability or lack of resources due to activity opportunities.

Constraints	More detailed
Distance to or lack of service	Options to conduct errands locally – often not possible Some close, some remote Limited opening hours
Adaptation at the workplace	Lack of access to shower (to use after e.g. bicycling to work) Whether or not job must be performed in a particular place Fixed or flexible working schedules
Available opening and visiting hours	Whether it is possible to adapt visiting hours/ appointment times to align with e.g. bus timetable Limited opening hours
Access to agents and digital stores	Unable to select delivery locations close to home Different suppliers have different delivery locations Missing delivery agent for some delivery companies

Table 8
Individual conversion factors – constraints.

Constraints	More detailed
Level of flexibility	Person's ability to adapt the journey to available timetable, plan in advance, and deal with unpredictable situations.
Related to individual physical capacity	Need for assistive equipment to move – this is missing Limited (physical) ability Elderly Sick
Life situation/socio-economics	Have young children to take care of Do not have the flexibility to adapt Do not have time Cannot afford
Psychological perspective	Integrity Perceived safety Attitude, opinions, and trust Personal prior knowledge of fossil fuel-free alternatives Habits and mindsets

than pensioners, who expressed that they had more time and capacity to adapt to the transport options available. A parent with limited time and flexibility said, *"If I don't have to go on to other activities and transport children, I think I could cycle more often."*.

Physical ability was raised as a further potential constraint, for instance relating to old age, injury, disability, or the need to travel with equipment. For example, one participant said it could be possible to take the bus sometimes, but it was difficult with child seats: *"The buses do not have rear-facing child seats. Or, well, some. But the bus schedule does not say which bus has a rear-facing child seat"*. Physical limitations can also create dependency on other people, limiting a person's options to those available to the person helping them.

Other individual aspects mentioned related to psychological perspectives such as personal integrity, prior knowledge, habits, mindset, and attitude. Perceptions of constraints are shaped by habits, attitudes, personal integrity, perceived safety, and prior knowledge of different fossil fuel-free alternatives. Related to pre-knowledge, one electric car user said: *"There is nothing unpleasant about it because I understand what it all is and how it works. But I fully understand people who find it unsafe because they haven't familiarized themselves with how it works."*.

Conversion factors – Contextual

Environmental

Although participants were accustomed to the weather in this sub-arctic region they frequently mentioned the environment as placing exceptional demands on transport infrastructure (See Table 9). They felt that conditions varied from those further south, and that each season had its own challenges and advantages.

Some participants expressed feeling safer walking when it was light, and pointed out that they avoid walking when it is dark outside, which applies throughout the winter.

The local topography can cause slippery conditions which place higher demands on cars. Participants felt that most reasonably-priced electric cars lacked the power to cope with hills in the winter and 'spring-winter' seasons.

Winter conditions entail snow, cold, and sometimes icy roads. This affects the perceived requirements of cars: they should have four-wheel drive, studded tires, sufficiently high ground clearance, driving power, and a good range. The Answer regarding the car's functions could be short, for example: *"Yes god, you have to have at least one four wheel drive car."* For example, a car must be able to tow a heavy trailer in both snow and cold, over long distances. Others said that the weather is not a major problem for most of their needs, and a small car generally works well. Many collective fossil fuel-free alternatives involve travelling a certain distance outdoors and waiting in the cold, for example, walking to and waiting for the bus. Cold requires some preparation in the form of the right clothes, and participants expressed that there is a limit to how long travellers can wait outside for public transport (where it exists). One said: *"It is not obvious to go out in minus 35C degrees and stand and wait for the bus, and then you have to stand there for 25 min, and then you get a text that the bus is not coming."* Further, some expressed that it can be difficult if they are carrying items that should not freeze, such as fresh vegetables.

Road quality and road maintenance were also highlighted as having an effect on the requirements of electric cars. Some perceived that a larger car (for example, station wagon or SUV) was preferable where roads are poor or badly maintained, causing conditions which a small electric car might not be able to cope with.

Structural

In this study, 'structural' aspects are those that relate to societal structures at a larger scale, i.e. the broader systems that shape society. Structural aspects such as this generally remained in the background of the discussions: see Table 10. For example, participants mentioned investments that do not materialise or are de-prioritised, an example about buss connections: *"You can forget that municipalities and regions would expand some bus connections because they are already on their knees."*.

They also highlighted rules relating to eligibility for particular transport services (e.g. school buses) which differ between municipalities, making travel across borders more problematic. Other problems relating to public transport included traffic planning, exchanges that do not function well, unreasonably long journey times, inappropriate departure times, and poor reliability of both services and information

Table 9
Natural or environmental conversion factors – constraints.

Constraints	More detailed
Distances	In general, long distances
Topography	Hilly Sometimes, it is difficult to go from one valley to another.
Season/Climate	Weather; Snow, Cold Daylight & darkness
Road quality and maintenance	Snow removal Poor management of roads & cracks and similar

Table 10
Structural conversion factors – constraints.

Constraints	More detailed
Rules and regulation	Jurisdiction (geographical and/or organisational "borders") Fossil-free fuel alternatives too costly Rules about access (e.g. to transportation services)
Deficiencies in traffic planning (public transport)	Exchange between modes of travel does not work Excessive travel time Timetables do no align with travellers' needs Difficult or different ticket systems for public transport Low reliability
Structure in society	Individualistic society
Urban norm	Society favours cities and disadvantages rural areas. Different conditions and expectations are placed on urban versus rural areas.

provision.

Some respondents argued that society today is more individualistic than in earlier times, and that it is challenging to find collective solutions because many people focus on their own interests and not the common good. One said: *"I think it's about you being so used to just looking after yourself and like if you lived in a different type of society, you would perhaps get used to everyone shopping on Mondays. And then that co-riding car also make a stop at the shop on Mondays, and everyone gets to do their shopping. yeah, but sort of."* Furthermore, a more individualistic society weakens local communities, affecting communication and cooperation.

Social

Participants expressed that their social context was vital for their ability to adapt to fossil-free transport. Specific aspects that emerged were: working arrangements, local community spirit, social network, and other people's stories (Table 11).

Participants' work requirements varied widely, and many raised these as decisive factors in their capacity to travel by fossil-free means. Working arrangements affect all modes of transport but have a particularly strong bearing on the use of collective modes. Strict working hours make it difficult to adapt to collective modes, whereas those who control their own hours and workplace are more able to do so. As example one said *"I finish at a quarter past nine in the evenings. Not many people go at that time."* Different working hours in different jobs makes shared solutions more problematic. Those who were perceived to have more flexibility included researchers, civil servants, and some entrepreneurs, while those working shifts, in services, or other time-and-place specific roles had less.

Good communication and cooperation between members of the local community are important to some modes of transport such as carpooling, co-riding, or running errands for each other. However, some expressed that there is little communication or collaboration between neighbours. Without good communication it is difficult to know what opportunities for collaboration – e.g. running errands – might exist, particularly beyond your own family and social network.

Table 11
Social conversion factors – constraints.

Constraints	More detailed
Working arrangements	Location & possibility of working from home Time requirements & flexibility Having different working hours
Community spirit	Communication Cooperation Associations
Social network	Family and relatives Friends
Other people's stories and experience	The stories that are shared

Similarly, the families and relatives were addressed as having an impact. While some have relatives, family, and friends who can stand up and help, others lack this safety net that can help with transport of various kinds. Or as in following example argue the kid when getting older can sleep over at relatives: *"So then they get to live with my mum and dad, rather than us driving. Stress home from work, cook, run down the next activity."*.

Repeatedly, when discussing fossil-free alternatives, inhabitants referred to not only their own experiences but also the stories of others. People who are in similar situations may share their experiences of a travel mode, positive or negative, before trying it themselves.

Discussion

Method

Fig. 3 present and illustrates the applied parts of the framework. The framework has been used to address and categorize what the participating rural inhabitants related to and perceive as constraints concerning their accessibility with fossil-free mobility, which addresses both resources and constraint-related conversion factors.

Using the capability approach to analyse how rural inhabitants use resources to achieve accessibility enables to build perspective on how the different constraints interact. The capability approach was chosen among other frameworks because it covers many different aspects of people's perceived constraints in mobility, including both resources and conversion factors. Different dimensions of accessibility are revealed by different methods and frameworks, and not all of them can be measured (Pot et al., 2021). We cannot claim that the situation participants describe is objectively accurate, but it is important to map the aspects that they perceive as significant. It is already recognized that the study area is a remote area which offers limited options for transport. It is also well-established in the literature that accessibility to services and opportunities depends on how different resources interact (Geurs & Van Wee, 2004; Vecchio & Martens, 2021).

Conducting focus groups is challenging as it requires getting people to participate, and having interest and time. Preferably, all meetings should have been at sites, however it has not been possible in all cases. Being on site is good as it makes participants more comfortable, partly as it is a familiar surrounding but also not all people are comfortable with digital technology. Conducting focus groups also allows people to reflect on their conditions in their context which in this case is the settlements. A strength of meeting people in person in discussions is that it gives opportunities to catch their perspectives and let them develop and share their thoughts. It catches nuances which more statistical methods such as survey might have difficult to capture. The paper should hence be seen as adding nuances rather than having a complete answer.

In this study, a limited number of settlements were included. It is not excluded that similar conditions may exist in larger urban areas, but this has not been discussed in this study. By considering aspects and constraints among residents in rural areas to achieve fossil-free transport, a knowledge base is created to consider this more equally in planning or policies that concern both city and rural settings. It can help provide a range of views to consider in considering the conditions for rural travellers, independent of geographical location and context.

Resources

Our results provide a concrete and practical list of resource-related problems related to the potential for fossil fuel-free travel. In terms of public mobility resources, our results align with earlier findings about resource-related issues. In short, there is a lack of collective resources such as public transport (Farrington & Farrington, 2005; Mattioli, 2014; Moseley, 1979; Tønnesen et al., 2022; Vitale Brovarone, 2022), and those services which do exist seem to offer poor service quality, and thus

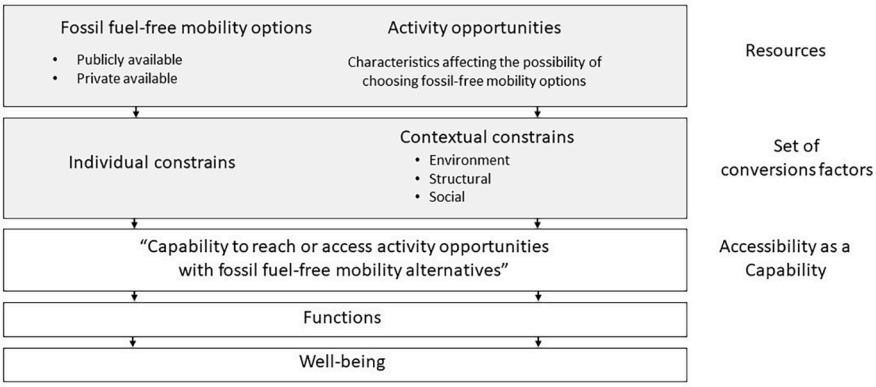

Fig. 3. Application of the framework.

attract users (Berg & Ihlström, 2019; Friman et al., 2020b; Redman et al., 2013). Few alternative mobility solutions are available, such as ride-sharing or flexible demand-responsive transport (Poltimäe et al., 2022; Schasché et al., 2022). In the absence of other options, travellers prefer the car and there is a high level of car dependency (Carroll et al., 2021; Mattioli, 2014; Moseley, 1979). In terms of private mobility resources, participants focused on electric vehicles, which provoked concerns including range anxiety, the perceived unsuitability of electric cars to local driving conditions, and the ability to carry luggage or other loads (Franke et al., 2012; Jones et al., 2020; Smith et al., 2012).

Regarding activity opportunities, participants discussed a range of practical and concrete concerns. They felt that there is a mis-match between when transport is available versus the opportunities for specific activities. The mis-match issue agrees well with Vecchio's framework (2021); for people to have the capability to take part in various opportunities and services, it is about both the character of the activity and the transport system. These must match. For example, if someone has an appointment at the health centre at 8.00, it will not work if the bus arrives at 8.30.

Distinguishing between private and public mobility resources generates some interesting insights. For inhabitants of remote or sparsely populated rural areas, accessibility is often conditional on people taking responsibility for their own mobility, usually by means of a fossil-fuel car (Mattioli, 2014). However, when participants considered the challenges to fossil-free alternatives, many of these where somewhat public in nature – relating to wider society or the local community – for example, public transport or car sharing. Even the electric car, which could, for those who can afford it, replace the fossil-fuel car, involves developing public resources such as charging infrastructure. In short, this requires a transition to more public mobility resources in a context where people's current dependence on meeting their own mobility needs individually is partly explained by the lack of public alternatives. This raises questions about the level at which responsibility lies, and what might be involved in getting people who are accustomed to taking individual responsibility to depend more on shared, public systems.

Conversion factors – Contextual constraints

Although many people would like to travel more by fossil-free means, this is seen to be particularly difficult in rural areas which already face general accessibility challenges. Reducing car dependence and emissions and making alternative solution possible involves addressing social aspects (Schasché et al., 2022; Poltimäe et al., 2022; Vitale Brovarone & Cotella, 2020). This may seem obvious, but it is important to note because much of what the participants raised as barriers may not, at first glance, appear to be about the transition to fossil-free modes. Rather, they are already-existing accessibility issues which relate to the tough context: road quality, road maintenance, snow ploughing, severe cold, snow, hills, long distances, and darkness. Such concerns framed participants' concerns about alternative transport solutions, including the electric car. Hence, as an example, the technical features of electric cars were important.

The structure of society and its processes were discussed in most villages. Structures may not have had a direct impact, but many referred to them while discussing other problems, generally as constraints. The areas was seen as often down prioritised. Overall, participants were aware of a negative, self-reinforcing dynamic in rural areas involving the disappearance of services, making the areas less attractive.This process of marginalisation is well-known in the literature, including a pattern of rural inhabitants becoming increasingly dependent on travelling to other places to meet their need (Farrington & Farrington, 2005; Gray et al., 2001; Moseley, 1979; Vitale Brovarone & Cotella, 2020). Many of the practical issues participants referred to, such as deficiencies in public transport, journey times, changes, ticket systems, and regulations, have been described in previous research as structural problems in which policies and regulations are too inflexible to implement the alternative solutions that are needed today (Berg & Ihlström, 2019; Hult et al., 2021; Poltimäe et al., 2022).

Collaboration is a common theme in discussions around alternative mobility solutions. Communication is central to making mobility solutions work, and is shaped by the strength of the local community. In this study, some participants believed that this differed between villages where there is already good communication, whether through face-to-face relationships or e.g. a Facebook page, it is easier to ask for help – for example, ask someone to run an errand when they are already making a particular journey. Some participants expressed the wish to collaborate more with neighbours in this way, but felt that such communication did not really exist. Other social networks such as family and relatives can play a similar role. It is worth considering what this means for villages that do not have this level of shared commitment or expect such responsibility to be taken locally. In the broader field of social innovation, relying on community solutions is seen as risky, and those where there is insufficient involvement become further marginalized (Bock, 2016; Lindberg, 2021). Hult et al (2021) question whether it is reasonable to expect communities to coordinate their transport needs. At the same time, local involvement is essential to take advantage of local knowledge and understand local needs. Historically, many innovative solutions to social problems have originated from civil society like local communities (Bock, 2016; Lindberg, 2021). Similarly, it may not be reasonable to expect family members to help meet transport needs, particularly where families do not live close together.

Conversion factors – Individual constraints

In line with previous research on accessibility, socio-economic aspects were found to be critical to shaping people's access to a car, and therefore their mobility. Which also has been described by Moseley, (1979); Brake and Nelson, (2007); Graham et al., (2018). Participants'

discussions around electric vehicles centred on concerns about affordability.

Preferences and attitudes are also essential: a typical comment during the focus groups was *"that which is wholly or partly in the head"*. Perceptions of the different modes of travel varied among participants, and they set different limits for different travel options. For example, some could be positive about electric cars but believe less in carpooling, while others expressed the opposite. Some expressed that preconceived notions and a negative attitude towards fossil-free alternatives make the transition more difficult, and that a positive attitude facilitates it. Nonetheless, each participant seemed to have a 'comfort limit', where which the desire to travel fossil-free intersected with their attitudes and experience. Some already used fossil-free modes, while others had tried hard to do so but given up due to the challenges.

Participants' discussions repeatedly returned to flexibility. Earlier literature has shown that the car is popular because it offers travellers flexibility (Berg and Ihlström, 2019; Poltimäe, et al., 2022) and solutions such as public transport or ride-sharing are typically seen as insufficiently flexible to adapt to people's needs (ibid). However, as some participants expressed, flexibility also relates to their ability to adapt to the alternatives available. Those with more power over their own time and those with more time were more able to choose options other than the fossil-fuel car. In terms of capabilities, this is about having enough flexibility to choose the fossil-free transport option. It is also consistent with van Wee's (2022) assertion that flexibility relates to many aspects, including individual characteristics, land use, transport system, and temporal flexibility, meaning both individuals' flexibility about their travel time, and flexibility in opening times, working hours, or time tables. A similar way of describing it is about abilities to plan everyday life according to the travel opportunities available. In the future it is important to improve the capability to plan travel in rural areas, depending on the character of available mobility options, location of activities and services and individual preconditions.

Conclusions

This study offers the perspectives of rural residents regarding fossil-free solutions for mobility. Bringing about a transition that is both fossil-free and caters for basic mobility need will require action on many fronts. Shifting to fossil-free passenger transport adds a further layer of complexity to an already complex accessibility challenge in rural areas. This study addresses a restricted number of settlements of rural areas, and a small number of participant and should be seen in perspective of that.

Transitioning to fossil-free transport involves not just changing fuel types but is also often associated with a transition to the use of more public resources. Many fossil-free alternatives are based on more collective solutions, including creating the infrastructure for electric cars and other alternatives. This needs to take place in a context where people's accessibility is currently dependent on the private car. Involving rural residents in developing appropriate solutions is both necessary and challenging. A lot of knowledge is available locally to make the transition possible. However, necessary capacity is not always available locally, and they are also affected aspects outside the villages and their direct influence.

Residents' capabilities for handling change are shaped by the intersection of their individual conditions and the context, both of which are multilayered. An important part concerns the possibilities for planning one's travel, where flexibility is critical. This could be that rural inhabitants have the ability to plan their time and travel according to available options, or the available transport options or activities are flexible.

The context for this study is unique, yet some of the challenges it faces are shared by other rural areas. For people who already find it difficult to get around in their daily lives, it is difficult to see past the potential problems that exist around fossil-free alternatives which may make it even more difficult. It is important to identify solutions which not only improve accessibility and improve transport but also reduce the need to travel. Future research should investigate how to address the constraints, but also investigate other settlement and contexts to understand the diversity of condition in different rural areas.

CRediT authorship contribution statement

Margareta Westin: Term, Conceptualization, Methodology, formal analysis, investigation, data curation, Writing- Original draft preparation, visualization. **Charlotta Johansson:** Term, Conceptualization, Methodology, Investigation, Data Curation, Writing - Review & Editing, Supervision, Project administration, Funding acquisition. **Glenn Berggård:** Term, Conceptualization, Methodology, formal analysis, investigation, data curation, Writing - Review & Editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The study has been granted by the Swedish Transport Administration (Grant ID TRV2019/6293). We would also like to express our appreciation to all participants who shared their time with us, and to those who gave us access to local meeting points.

Appendix 1

Guide for questions during focus groups. The original guide is on Swedish and this is a translation.

Questions	Potential sub-questions
Section 1 – Addressing Travel Needs and Behaviour Today.Using maps as help to illustrate and draw on	
What trips/travel are you taking today?	• Short, Long, common, seldom, work, free time? • Which means of transport, and which fuel? • Does it change with time and seasons? • Does it change with life/age?
Why are you making these trips?	• Describe the reasons/purpose of addressed trips.
Are there transport related issues already today?	• Describe these problems.
Section 2 – Addressing the transition to fossil fee alternatives, need and challenges. Mostly based on previously discussed trips	
How can future demands for freedom from fossil fuels affect your travels?	• What technology is useful? o What are the challenges with different technology? • What can technology not help with?

(*continued on next page*)

(*continued*)

Questions	Potential sub-questions
What future changes do you potential see based on traveling fossil-free?	• Describe the issue/fear (the scenario they address) e.g. if not working. Addressing as example: • Short distances, long distances • Common, Seldom • Daytime, Evening • Season
Are there alternatives to transport based, when there are no fossil fee alternatives?	• What first vs. last thing would you change/stop doing?
Rounding of and summary: Are there aspects we haven't touched on that affect rural areas and how to achieve fossil-free passenger transport?Or something els to add?	

References

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy, 15*(2), 73–80. https://doi.org/10.1016/j.tranpol.2007.10.005

Barbour, R., & Kitzinger, J. (2011). Developing Focus Group Research. *SAGE Publications Ltd*. https://doi.org/10.4135/9781849208857

Bauchinger, L., Reichenberger, A., Goodwin-Hawkins, B., Kobal, J., Hrabar, M., & Oedl-Wieser, T. (2021). Developing Sustainable and Flexible Rural-Urban Connectivity through Complementary Mobility Services. *Sustainability, 13*(3), 1280. https://doi.org/10.3390/su13031280

Berg, J., & Ihlström, J. (2019). The Importance of Public Transport for Mobility and Everyday Activities among Rural Residents. *Social Sciences, 8*(2), 58. https://doi.org/10.3390/socsci8020058

Bock, B. B. (2016). Rural Marginalisation and the Role of Social Innovation; A Turn Towards Nexogenous Development and Rural Reconnection: Rural marginalisation and the role of social innovation. *Sociologia Ruralis, 56*(4), 552–573. https://doi.org/10.1111/soru.12119

Carroll, P., Benevenuto, R., & Caulfield, B. (2021). Identifying hotspots of transport disadvantage and car dependency in rural Ireland. *Transport Policy, 101*, 46–56. https://doi.org/10.1016/j.tranpol.2020.11.004

Chapman, L. (2007). Transport and climate change: A review. *Journal of Transport Geography, 15*(5), 354–367. https://doi.org/10.1016/j.jtrangeo.2006.11.008

Farrington, J., & Farrington, C. (2005). Rural accessibility, social inclusion and social justice: Towards conceptualisation. *Journal of Transport Geography, 13*(1), 1–12. https://doi.org/10.1016/j.jtrangeo.2004.10.002

Flick, U. (2018). *An introduction to qualitative research* ((6th ed.).). SAGE Publications.

Franke, T., Neumann, I., Bühler, F., Cocron, P., & Krems, J. F. (2012). Experiencing Range in an Electric Vehicle: Understanding Psychological Barriers: EXPERIENCING RANGE. *Applied Psychology, 61*(3), 368–391. https://doi.org/10.1111/j.1464-0597.2011.00474.x

Friman, M., Lättman, K., & Olsson, L. E. (2020a). *Carpoolers' Perceived Accessibility of Carpooling. Sustainability, 12*(21), 8976. https://doi.org/10.3390/su12218976

Friman, M., Lättman, K., & Olsson, L. E. (2020b). Public Transport Quality, Safety, and Perceived Accessibility. *Sustainability, 12*(9), 3563. https://doi.org/10.3390/su12093563

Galletta, A. (2013). *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication*. NYU Press.

Geurs, K. T., & Van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: Review and research directions. *Journal of Transport Geography, 12*(2), 127–140. https://doi.org/10.1016/j.jtrangeo.2003.10.005

Graham, H., De Bell, S., Flemming, K., Sowden, A., White, P., & Wright, K. (2018). The experiences of everyday travel for older people in rural areas: A systematic review of UK qualitative studies. *Journal of Transport & Health, 11*, 141–152. https://doi.org/10.1016/j.jth.2018.10.007

Gray, D., Farrington, J., Shaw, J., Martin, S., & Roberts, D. (2001). Car dependence in rural Scotland: Transport policy, devolution and the impact of the fuel duty escalator. *Journal of Rural Studies, 17*(1), 113–125. https://doi.org/10.1016/S0743-0167(00)00035-8

Halbey, J., Kowalewski, S., & Ziefle, M. (2015). Going on a Road-Trip with My Electric Car: Acceptance Criteria for Long-Distance-Use of Electric Vehicles. In A. Marcus (Ed.), *Design, User Experience, and Usability: Interactive Experience Design* (pp. 473–484). Springer International Publishing. https://doi.org/10.1007/978-3-319-20889-3_44.

Hult, Å., Perjo, L., & Smith, G. (2021). Shared Mobility in Rural Contexts: Organizational Insights from Five Mobility-as-a-Service Pilots in Sweden. *Sustainability, 13(18), Article 18*. https://doi.org/10.3390/su131810134

Jones, A., Begley, J., Berkeley, N., Jarvis, D., & Bos, E. (2020). Electric vehicles and rural business: Findings from the Warwickshire rural electric vehicle trial. *Journal of Rural Studies, 79*, 395–408. https://doi.org/10.1016/j.jrurstud.2020.08.007

Jordbruksverket. (2022). *Vår definition av landsbygd* [Text]. Jordbruksverket. https://jordbruksverket.se/stod/eus-politik-for-jordbruk-och-fiske/var-definition-av-landsbygd.

Lättman, K., Friman, M., & Olsson, L. E. (2016). Perceived Accessibility of Public Transport as a Potential Indicator of Social Inclusion. *Social Inclusion, 4*(3), 36–45. https://doi.org/10.17645/si.v4i3.481

Lättman, K., Friman, M., & Olsson, L. E. (2020). Restricted car-use and perceived accessibility. *Transportation Research Part D: Transport and Environment, 78*, Article 102213. https://doi.org/10.1016/j.trd.2019.102213

Lättman, K., Olsson, L. E., & Friman, M. (2018). A new approach to accessibility – Examining perceived accessibility in contrast to objectively measured accessibility in daily travel. *Research in Transportation Economics, 69*, 501–511. https://doi.org/10.1016/j.retrec.2018.06.002

Lindberg, M. (2021). *Social innovation i civilsamhällets organisationer—Kunskapsöversikt och policyrekommendationer*.

Lygnerud, K., & Nilsson, A. (2021). Business model components to consider for ridesharing schemes in rural areas – results from four Swedish pilot projects. *Research in Transportation Business & Management, 40*, Article 100553. https://doi.org/10.1016/j.rtbm.2020.100553

Martín Martín, J. M., Guaita Martínez, J. M., Molina Moreno, V., & Sartal Rodríguez, A. (2019). An Analysis of the Tourist Mobility in the Island of Lanzarote: Car Rental Versus More Sustainable Transportation Alternatives. *Sustainability, 11(3), Article 3*. https://doi.org/10.3390/su11030739

Mattioli, G. (2014). Where Sustainable Transport and Social Exclusion Meet: Households Without Cars and Car Dependence in Great Britain. *Journal of Environmental Policy & Planning, 16*(3), 379–400. https://doi.org/10.1080/1523908X.2013.858592

Mattioli, G. (2016). Transport needs in a climate-constrained world. A novel framework to reconcile social and environmental sustainability in transport. *Energy Research & Social Science, 18*, 118–128. https://doi.org/10.1016/j.erss.2016.03.025

Mayring, P. (2000). *Qualitative Content Analysis*. Qualitative Social Research.

Mitropoulos, L., Kortsari, A., & Ayfantopoulou, G. (2021). A systematic literature review of ride-sharing platforms, user factors and barriers. *European Transport Research Review, 13*(1), 61. https://doi.org/10.1186/s12544-021-00522-1

Moseley, M. J. (1979). *ACCESSIBILITY: THE RURAL CHALLENGE*. Methuen and Company Limited, Article Monograph: Publication of. https://trid.trb.org/view/148143.

Olsson, L. E., Friman, M., & Lättman, K. (2021). Accessibility Barriers and Perceived Accessibility: Implications for Public Transport. *Urban. Science, 5*(3), Article 3. https://doi.org/10.3390/urbansci5030063

Olsson, L. E., Maier, R., & Friman, M. (2019). Why Do They Ride with Others? Meta-Analysis of Factors Influencing Travelers to Carpool. *Sustainability, 11*(8), 2414. https://doi.org/10.3390/su11082414

Poltimäe, H., Rehema, M., Raun, J., & Poom, A. (2022). In search of sustainable and inclusive mobility solutions for rural areas. *European Transport Research Review, 14*(1), 13. https://doi.org/10.1186/s12544-022-00536-3

Pot, F. J., Van Wee, B., & Tillema, T. (2021). Perceived accessibility: What it is and why it differs from calculated accessibility measures based on spatial data. *Journal of Transport Geography, 94*, Article 103090. https://doi.org/10.1016/j.jtrangeo.2021.103090

Preston, J., & Rajé, F. (2007). Accessibility, mobility and transport-related social exclusion. *Journal of Transport Geography, 15*(3), 151–160. https://doi.org/10.1016/j.jtrangeo.2006.05.002

Psarra, F., Piccoli, A., Karachaliou, E., Trendafili, K., Spyridopoulos, K., Masson, B., Frangulea, C., Hohenwarter, M., Streit, G., Karaberi, C., Raptis, O., Laranjeira, C., & Santos, E. C. V. (2021). Sustainable Shared Mobility Interconnected with Public Transport in European Rural Areas. In C. Zachäus, & G. Meyer (Eds.), *Intelligent System Solutions for Auto Mobility and Beyond* (pp. 130–142). Springer International Publishing. https://doi.org/10.1007/978-3-030-65871-7_10.

Redman, L., Friman, M., Gärling, T., & Hartig, T. (2013). Quality attributes of public transport that attract car users: A research review. *Transport Policy, 25*, 119–127. https://doi.org/10.1016/j.tranpol.2012.11.005

Regionfakta. (2023). *Areal och befolkningstäthet—Regionfakta*. http://www.regionfakta.com/Norrbottens-lan/Geografi/areal-och-befolkningstathet/.

Ryan, J., & Wretstrand, A. (2019). What's mode got to do with it? Exploring the links between public transport and car access and opportunities for everyday activities among older people. *Travel Behaviour and Society, 14*, 107–118. https://doi.org/10.1016/j.tbs.2018.10.003

Sandow, E., & Westin, K. (2010). *Preferences for commuting in sparsely populated areas*.

SCB. (2022). *Tätorter i Sverige*. Statistiska Centralbyrån. https://www.scb.se/hitta-statistik/sverige-i-siffror/miljo/tatorter-i-sverige/.

Scb. (2023a). Kommuner i siffror. *SCB*. https://kommunsiffror.scb.se/.

Scb. (2023b). SCB:S öppna geodata. *Statistiska Centralbyrån*. https://www.scb.se/vara-tjanster/oppna-data/oppna-geodata/.

Scb. (2023c). Smaller localities. *Statistiska Centralbyrån*. https://www.scb.se/mi0811-en.

Schasché, S. E., Sposato, R. G., & Hampl, N. (2022). The dilemma of demand-responsive transport services in rural areas: Conflicting expectations and weak user acceptance. *Transport Policy, 126*, 43–54. https://doi.org/10.1016/j.tranpol.2022.06.015

Sen, A. (1992). *Inequality Reexamined*. Oxford University Press.

Shergold, I., Parkhurst, G., & Musselwhite, C. (2012). Rural car dependence: An emerging barrier to community activity for older people. *Transportation Planning and Technology, 35*(1), 69–85. https://doi.org/10.1080/03081060.2012.635417

SMHI. (2017a). *Normalt antal dygn med snötäcke per år | SMHI*. https://www.smhi.se/data/meteorologi/sno/normalt-antal-dygn-med-snotacke-per-ar-1.7937.

SMHI. (2017b, March 20). *Normal årsmedeltemperatur | SMHI*. SMHI. https://www.smhi.se/data/meteorologi/temperatur/normal-arsmedeltemperatur-1.3973.

SMHI. (2023a). *Vinter | SMHI*. https://www.smhi.se/kunskapsbanken/vinter-1.22843.

SMHI. (2023b, June 23). *Norrbottens klimat | SMHI*. SMHI. https://www.smhi.se/kunskapsbanken/klimat/klimatet-i-sveriges-landskap/norrbottens-klimat-1.5008.

Smith, N., Hirsch, D., & Davis, A. (2012). Accessibility and capability: The minimum transport needs and costs of rural households. *Journal of Transport Geography, 21*, 93–101. https://doi.org/10.1016/j.jtrangeo.2012.01.004

Soder, M., & Peer, S. (2018). The potential role of employers in promoting sustainable mobility in rural areas: Evidence from Eastern Austria. *International Journal of Sustainable Transportation, 12*(7), 541–551. https://doi.org/10.1080/15568318.2017.1402974

Stanley, J., & Stanley, J. (2021). The school bus: An opportunity for improving rural mobility. *Journal of Rural Studies, 88*, 337–345. https://doi.org/10.1016/j.jrurstud.2021.08.008

Tønnesen, A., Knapskog, M., Rynning, M. K., & Groven, K. (2022). Planning for climate-friendly transport in Norwegian rural areas. *Transportation Research Part D: Transport and Environment, 102*, Article 103156. https://doi.org/10.1016/j.trd.2021.103156

Van Wee, B. (2022). Accessibility and equity: A conceptual framework and research agenda. *Journal of Transport Geography, 104*, Article 103421. https://doi.org/10.1016/j.jtrangeo.2022.103421

Vecchio, G., & Martens, K. (2021). Accessibility and the Capabilities Approach: A review of the literature and proposal for conceptual advancements. *Transport Reviews, 41*(6), 833–854. https://doi.org/10.1080/01441647.2021.1931551

Vitale Brovarone, E. (2022). Accessibility and mobility in peripheral areas: A national place-based policy. *European Planning Studies, 30*(8), 1444–1463. https://doi.org/10.1080/09654313.2021.1894098

Vitale Brovarone, E., & Cotella, G. (2020). Improving Rural Accessibility: A Multilayer Approach. *Sustainability, 12*(7), 2876. https://doi.org/10.3390/su12072876