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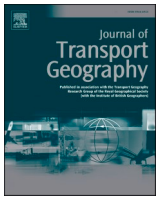

Perceived walkability and daily walking behaviour in a "small city context" – The case of Norway

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ABSTRACT

Walking is essential for environmentally friendly transport, vibrant street life, and public health. Due to the short distances, small cities should have great potential for walking; however, the car still dominates in many places. Moreover, whether and how conditions related to a Northern European location play a role in perceived walkability and subsequent walking behaviour in small cities has rarely been studied. This paper aimed to answer what characterizes walkability in the context of a small city in Norway, using Narvik, Kongsvinger, and Steinkjer as case studies. The investigation is based on a mixed methodological approach, including a survey with public participation geographic information systems (PPGIS), followed by a qualitative investigation with focus group interviews with families. The results suggest that walking for commuting purposes is considered a realistic option by most residents, although the car is used for most trip purposes, indicating that there exists an unfulfilled potential for walking. Results from the walkability assessment with PPGIS suggest that for a positive walking experience, perceived walkability includes a range of walkability indicators of a distinct nature that interact. The interviews provided explanations about important incentives in the cities that encourage the use of cars at the cost of making it attractive to walk. Good access by car stimulates its use despite short distances, and its dominance prevents fulfilling pedestrians' needs regarding calm surroundings and space reserved for vibrant street life and vegetation. Fragmented infrastructure limits parents' confidence in their children's safety. Lighting and maintenance are important in the winter to ensure walkability.

1. Introduction

Walkability has attracted much attention in academic literature due to its potential contribution to walking activity and, consequently, to health and well-being, urban vitality, sustainable urban development, and mobility. However, limited attention has been given to walkability in the context of small cities. Due to short distances inherent to their size, small cities should have great potential for walking, yet cars dominate in many places. Additionally, whether and how conditions related to a Northern European location, with its seasonal variations such as harsh winters, influence perceived walkability and subsequent walking behaviour in small cities has rarely been studied. This paper focuses on perceived walkability and daily walking behaviour in the context of three small cities in Norway (considered here those with 10,000–20,000 inhabitants in the densely populated area).

Walkability has been defined in several ways (see review by Shashank and Schuurman, 2019), but a straightforward way to understand walkability is to define it as the ability of the surroundings to support and stimulate walking. Walkability can be assessed in three main ways: 1) Objective Spatial Measurements uses geographic information systems (GIS), statistical data, and, more recently, image-based deep learning (e.g. Bartzokas-Tsiompras et al., 2023; Frank et al., 2010; Koohsari et al., 2018; Li et al., 2022; Liao et al., 2020; Rundle et al., 2019); 2) Subjective Evaluations/Audits by Researchers/Experts involves evaluations and audits conducted by researchers and experts (e.g. Næss et al., 2019; Lee and Talen, 2014; Moura et al., 2017) and 3) Subjective Evaluations by Residents gathers residents' perceptions of how attractive their surroundings are for walking (perceived walkability) through surveys and

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interviews (e.g. Adkins et al., 2012; Cerin et al., 2006).

It is argued that walkability in general, and perceived walkability in particular, may encourage walking in all types of settings and for different population sizes (De Vos et al., 2023; Thielman et al., 2015; Wasfi et al., 2017).

Although numerous studies have explored the connection between the built environment, walking behaviors, and pedestrian experiences, most of these studies have focused on cities that are larger and located at a distance from the cities examined in this study. It has been proposed that walkability is significantly influenced by context, including geographical and scale factors (Ingebrigtsen et al., 2018). Due to this limited focus on contextual relevance, the evidence remains inconclusive. This includes understanding which characteristics of the built environment are most significant, how and why they impact pedestrian experiences and subsequent walking behaviors, their interrelationships, and variations across different contexts such as city size and geographical location. Therefore, there is a lack of knowledge regarding how these effects and mechanisms related to the built environment and walking behaviour apply specifically to small cities in Norway (Hagen et al., 2019; Næss et al., 2019). While research indicates that large-scale factors like land use and distances play a crucial role in walking behaviour (Saelens and Handy, 2008; Knapskog et al., 2019), the influence of micro-scale characteristics such as street design, pedestrian environments, adjacent land uses, green spaces, vegetation, and perceived qualities of the built environment requires more detailed examination, particularly in the context of small cities where distances are typically shorter.

An important aspect to consider when exploring walkability and the characteristics of the built environments is that people tend to experience their surroundings as spaces rather than as a series of singular elements (Ewing and Handy, 2009; Stefansdottir, 2018). The sum of impressions and experiences during a journey can significantly influence the overall travel experience (Böcker et al., 2015; Hillnhütter, 2016), which, in turn, can affect whether people choose to walk or not (De Vos et al., 2018). Providing positive walking experiences is therefore crucial to encourage walking (D'Arcy, 2013; Rynning, 2018). Consequently, to develop knowledge on designing and developing walkable and pedestrian-friendly cities, neighbourhoods, and streets, a holistic approach is likely more appropriate. This approach explores the collective influence of various built environment elements rather than viewing them as isolated indicators that may function differently depending on their context. This perspective shift is advocated by several scholars (Krizek et al., 2009a; Stefansdottir, 2018; Saelens and Handy, 2008; Rynning, 2018; Stefansdottir et al., 2019).

Based on the above items, the aim of this paper is to address the following main research question:

What characterizes walkability in the context of a small city in Norway?

This main research question has been divided into the following sub-research questions:

1. What are the location patterns of places residents perceive as attractive for walking, which areas need improvement and what walkability indicators contribute to these patterns?
2. How does perceived walkability influence pedestrians' experiences and subsequent daily walking behaviour in small cities?

To address these questions, we conducted a systematic investigation of pedestrian experiences related to walking environments in three small cities in Norway: Narvik, Steinkjer, and Kongsvinger. The data collection included survey responses featuring map-based questions using Public Participation Geographic Information Systems (PPGIS), which were distributed to residents in these cities. Additionally, we conducted follow-up focus group interviews with families. In addition to examining traditional walkability indicators, we categorized them based on their characteristics and scale to adopt a more comprehensive approach. This approach allowed us to map pedestrians' perceptions of specific locations and identify barriers to walking.

The structure of the paper is as follows: in Section 2, we provide an overview of the literature on walkability and walking behaviour relevant to the approach of this study. Section 3 explains the research design and methodology. Section 4 presents the results from the survey and qualitative interviews. In Section 5, we discuss the findings in terms of what characterizes walkability in the context of small Norwegian cities. Finally, Section 6 concludes the paper with brief closing remarks.

2. Literature study

Walkability indicators have been conceptualized and categorized in various ways (Alfonzo, 2005; Krizek et al., 2009b; Pikora et al., 2003). In this study, we draw upon frameworks by Knapskog et al. (2019) as well as Hagen and Rynning, 2021, which categorize built environment characteristics influencing walkability and walking behaviour into four categories: (WI-1) Natural and built environment preconditions, (WI-2) Urban structure and urbanity, (WI-3) Infrastructure and traffic, and (WI-4) Surroundings and activities.

These categories provide a framework for presenting an overview of existing knowledge on walkability and walking behaviour relevant to the context of small cities. The indicators chosen within each category (italicized in the sections) guide the interpretation of the results (see Table 1).

2.1. Natural and built environment preconditions

Natural and built environment preconditions encompass characteristics that establish whether a trip can realistically be undertaken on foot from a city-scale perspective.

The geographical location of a city imposes certain natural and location-specific preconditions for walking conditions. For instance, the *latitudinal position* influences *weather and daylight conditions*. Factors such as darkness, precipitation, and wind can negatively impact the choice of walking as a mode of travel (Böcker et al., 2019; Krogstad et al., 2015), particularly affecting vulnerable groups such as older adults (Hjorthol, 2013).

Low temperatures and precipitation are associated with reduced walkability and lower rates of walking, especially in areas that are less pedestrian-friendly (Delclòs-Alió et al., 2020; de Montigny et al., 2012). Walkability tends to decrease significantly during snow conditions in areas where car dependency is high, characterized by low street connectivity and limited amenities (Clarke et al., 2017). Consequently, walking activity declines during snowy conditions (de Montigny et al., 2012). Moreover, the risk of pedestrians falling increases substantially in winter (Elvik and Bjørnskau, 2019; Öberg, 2011).

Harsh weather conditions and long, dark winters are common in North European cities, particularly in Scandinavian countries. Compared to larger cities in Northern Europe, smaller cities often lack in terms of walking infrastructure. Additionally, these cities encounter mobility challenges like those found in rural and remote areas (Shibayama and Emberger, 2023). These challenges include low concentrations of amenities, absence of car restrictions, and limited public transport services, all of which collectively promote car usage, especially during winter months.

Another natural characteristic that puts natural prerequisites to walking is *topography*. Flat terrains generally encourage more walking, whereas elevated and hilly terrains can deter walking for many individuals (Wang et al., 2016; Krizek et al., 2009a).

The spatial arrangement of residences and workplaces relative to the city or metropolitan center structure is a built environment characteristic that strongly shapes travel behaviour and, consequently, influences the choice of walking (Næss, 2012; Knapskog et al., 2019). This influence is likely relevant in smaller cities as well. Research conducted in small Norwegian cities on the built environment and driving distances suggests that proximity of residences to the city center and to larger cities in

Table 1
Categories and list of walkability indicators (WI), used in this study.

(WI-1) **Natural and built environment preconditions**
• The spatial arrangement of residences and workplaces relative to the city or metropolitan center structure
• Latitudinal position (daylight and weather)
• Topography
(WI-2) **Urban structure and urbanity**
• Density
• Proximity
• Type of urban form
• Urban structure
• Permeability, shortcuts
(WI-3) **Infrastructure and traffic**
• Functionality of walking infrastructure (incl. Maintenance and operations, ploughing, lighting, universal design, signage)
• Traffic safety, traffic volumes and speed levels
• Accessibility
(WI-4) **Surroundings and activities**
• Diversity and vitality
• Design and aesthetics (incl. Natural elements, vegetation, beautiful buildings, pleasant smells and sounds)
• Perceived social safety
• Social interactions, street life, urban atmosphere

the region may reduce car use, increase public transport usage, and potentially promote more walking (Wolday, 2018). In small cities, shorter distances between locations and destinations present a potential for increased utilitarian walking. However, small cities in Northern Europe often exhibit a dependence on cars (Tennøy et al., 2022a), highlighting a discrepancy between the potential for walking and actual everyday travel behaviors.

2.2. Urban structure and urbanity

Urban structure and urbanity encompass characteristics affecting the feasibility of walking from a neighborhood and street-scale perspective. This category includes *density, proximity, permeability,* and type of *urban form,* which refers to the size, shape, and configuration of an urban area. High-density land use promotes proximity to daily amenities, making it conducive to walking (Næss, 2012; Giles-Corti et al., 2005; Krizek et al., 2009b; Newman and Kenworthy, 2015; Saelens and Handy, 2008; Tennøy et al., 2017). Short and direct routes play a crucial role in enabling and promoting walking as a mode of transportation (Næss, 2012; Giles-Corti et al., 2005; Krizek et al., 2009a; Newman and Kenworthy, 2015; Saelens and Handy, 2008; Tennøy et al., 2017). This is due to the effort required for walking and its relatively slower speed compared to other modes of transport. Short blocks or *shortcuts* and high permeability further enhance accessibility for pedestrians (Melia, 2015). Walking rates tend to decline as distances increase, yet there is limited understanding of what people consider too far to walk (Krizek et al., 2009a). Recent studies in the U.S. suggest that people often overestimate walking distances in areas designed primarily for cars, with numerous turns or barriers along routes (Ralph et al., 2020). A recent study in Norway suggests that walking distances to local public transport stops tend to increase with city size, which in turn influences the likelihood of using public transport for daily commutes (Tennøy et al., 2022b). This finding underscores the importance of understanding how perceptions of walking distance vary across different contexts, including city size and the specific location of cities or neighbourhoods. Further research is clearly needed to delve deeper into these dynamics and their implications for urban mobility and transport planning.

The term *urbanity* has been employed to describe the overall character of streets or public spaces within compact urban structures, emphasizing how buildings, as well as public and private spaces, are arranged along streets (Montgomery, 1998). Conversely, a lack of urbanity refers to disjointed and non-compact *urban structures* characterized by large "empty areas," such as parking lots (Carmona, 2021). Urbanity, particularly in the form of narrow streets with intricate details close to eye level, has been found to enhance the walking experience positively, as the surroundings are more visually engaging (Hillnhütter, 2016).

2.3. Infrastructure and traffic

Infrastructure and traffic encompass characteristics influencing the instrumental aspects of walking at the street design level, emphasizing the *functionality of infrastructure* to ensure convenient, comfortable and safe pedestrian movement. Key elements include pedestrian infrastructure, street types, pedestrian crossings, *accessibility, traffic volumes, speed levels, traffic safety measures, universal design*, *maintenance and operations*, and public transport infrastructure. Research indicates that interventions aimed at improving walking and public transport infrastructure can significantly promote walking activity (Aasvik and Bjørnskau, 2020; Barnett et al., 2017; Hagen et al., 2019; Kärmeniemi et al., 2018; Lo, 2009). Such interventions may involve adding or expanding sidewalks, enhancing pedestrian crossings, improving *lighting* and *signage*, installing or upgrading stairs, and ensuring snow clearance and salting during winter conditions. Measures to reduce vehicle speeds and traffic volumes also play a crucial role. A study from Norway highlighted that maintenance and operational practices strongly influence people's decision to walk, their route choices, and their walking experiences. Inadequate maintenance, particularly in winter, poses a significant barrier to walking, especially among women and the elderly (Aasvik and Bjørnskau, 2020). Therefore, enhancing maintenance and operational efforts could encourage more people to walk during winter months. In small U.S. cities, utilitarian walking has been linked to the presence of pedestrian infrastructure, such as crosswalks and pedestrian signals reported by residents (Doescher et al., 2014). Further research is needed to comprehensively understand the role of infrastructure and traffic conditions in promoting walkability and walking behaviors in smaller cities across diverse geographical contexts.

2.4. Surroundings and activities

Surroundings and activities influence the walking experience in terms of pleasure and social interaction, covering a different set of characteristics. These factors may not directly relate to functionality but significantly impact the well-being and pleasantness of walking. "Pleasant" in this context refers to the extent to which the *design* of surroundings stimulates *aesthetic* experiences (Stefansdottir, 2018). Research indicates that this can be supported by elements that contribute to the beautification of the surroundings, such as the proximity of *natural elements, vegetation*, and *well-maintained buildings* (Handy et al., 2006; Liu et al., 2020). Calm and vegetated surroundings away from heavy traffic also lead to positive environmental *sounds* and the pleasant *smells* of vegetation.The presence of other people is also crucial for *social safety* in public spaces, often attributed to social control mechanisms (Loukaitou-Sideris, 2006). *Social interaction* has been positively linked to higher levels of walking activity within neighbourhoods (Mouratidis, 2019). Both the aesthetic quality and social dynamics of *street life* contribute to creating diverse *urban atmospheres* in surrounding areas (Stefansdottir, 2018).

Surroundings that support physical activity through amenities like bike routes, sidewalks, parks, and accessible public transit, along with fostering *urban vitality* through *diverse* neighbourhoods and social interaction, contribute to a pleasant walking experience (Handy et al., 2006; Liu et al., 2020). Areas with large public open spaces have also been associated with higher levels of walking (Giles-Corti et al., 2005). A pleasant walking experience has been shown to positively influence walking activity itself (De Vos, 2019; Panter et al., 2011). In small cities, these characteristics are highly context-dependent, varying between compact and vibrant small cities versus peaceful, greener, and low-density small cities. Furthermore, differences between small and larger cities in terms of land use and transportation systems contribute to these variations (Hu et al., 2018). Individual characteristics and attitudes also play a role in shaping walking experiences in small cities and warrant further exploration. Understanding these factors can inform efforts to enhance walkability and promote active lifestyles in diverse urban settings.

3. Research design and methodology

3.1. Methodological approach

This study employs a mixed-method approach, combining both quantitative and qualitative data through case studies. The three cities selected as case studies are described in Section 3.2. The research questions are outlined in the introductory section. To address the first sub-question, survey data supplemented with map-based Public Participation Geographic Information Systems (PPGIS) questions were collected. The web survey gathered data on residents' walking behaviour and their perceptions of the walking environment, while the map-based questions enabled the geographical recording of these perceptions. The methodology and the data collected through the survey are explained in Section 3.4. To answer the second sub-question, qualitative data were obtained from focus group interviews conducted in the three cities. This qualitative investigation allowed us to further explore findings from the survey, as well as topics for which a survey is less adequate. The methodology and this data collection process are further explained in Section 3.3.

3.2. The cases under study

The three municipalities serve as the main cities in their respective regions and offer most of the amenities needed by their residents (see Fig. 1 for the location of the cities in Norway). Most of the workforce lives and works within their municipality. The climate in these cities ranges from cool to warm summers, while all three experience cold winters with a considerable chance of snowfall. Key figures for the three cities are summarized in Table 2.

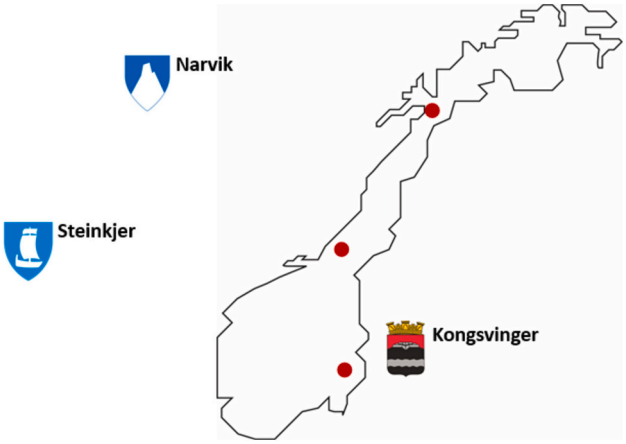

Fig. 1. Location of the three cities in Norway that serves as cases in this study.

The three cities share many features in layout and design (see Fig. 2). We therefore jointly present their main built environment characteristics and walking conditions based on an overall walkability analysis following the four categories presented in Section 2.

The cities are characterized by low-density, car-oriented urban forms. They mainly comprise detached houses with gardens, with a few apartment buildings located primarily in the centres. The city centres are relatively small and surrounded by residential areas in a continuous built-up urban structure, making the distinction between city and suburbs less evident. The centres of Steinkjer and Kongsvinger are flat, with a somewhat rising topography towards the surrounding residential areas, which can discourage walking to and from the city centres. Narvik's centre is more distinctly marked by its topography, featuring a rapid incline between parallel streets and towards the residential areas on the east side, at the slopes of the mountain. This steep terrain can strongly discourage walking to and from the city centre.

All three cities have significant barriers for pedestrians within the city centres in the form of major infrastructure, such as railways and major roads or highways. Additionally, Kongsvinger and Steinkjer are divided by a river. Both Steinkjer and Narvik are located by fjords, which helps limit sprawling development and can be beneficial for walking in the long run. However, in Narvik, the heavily trafficked main street, which also serves as a major regional and national road, is troubled by significant noise, pollution, and dust.

During working and opening hours, the city centres are relatively

Table 2
Key figures for the case cities (data for 2020, from Statistics Norway, retrieved June 2021).

	Steinkjer	Narvik	Kongsvinger
Population in municipality	24,357	21,845	17,829
Population in densely populated area* (the city)	16,259	18,333	13,078
Number of jobs in the municipality	11,165	10,053	8295
Proportion of workforce working in own municipality	77 %	90 %	71 %
Proportion of jobs occupied by people living in the municipality	77 %	92 %	66 %
Proportion of population living in densely populated areas	67 %	84 %	73 %
Distance to closest larger city**	120 km to Trondheim	230 km to Tromsø	93 km to Oslo

* 'Densely populated' area, as defined by Statistics Norway[i] **Oslo is Norway's capital, Trondheim is the third largest city and Tromsø is the 16th largest city.

Fig. 2. Maps and photos of the case cities. The top row: Narvik, the middle row Steinkjer and the bottom row Kongsvinger. To the left: The maps. In the middle: the city centers. To the right: long distance view.

lively. The compact parts of the city centres are mixed-use, with multiple activities and facilities, especially along the main streets. However, in all three cities, shopping centres located in the centre compete with the main streets for shops and visitors. While there are several distinct buildings and open first-floor facades in the city centres, many side streets have numerous empty locales.

There is ample parking in the city centres, both curb side and in larger parking lots, which occupy significant space and create detours for pedestrians, contributing to car-oriented surroundings. The infrastructure for pedestrians varies in some areas, it is inadequate and poorly maintained (especially in Narvik, which has a challenging climate), while in other areas, it is very good and relatively well-connected within the city centre. In the residential areas and on routes leading to them, there is often a lack of sidewalks, although speed limits are usually set at 30 km/h. In many locations, pedestrians share paths with cyclists.

There is a continuous urban structure from the city centres to the residential areas. These residential areas are semi-dense and relatively permeable, offering shortcuts and alternative routes for pedestrians away from car traffic.

The centres and residential areas feature abundant greenery. Along with their proximity to fjords and/or rivers, this creates pleasant surroundings for walking. The topography and the presence of fjords or rivers further aid in wayfinding, making navigation easier and more enjoyable for pedestrians.

3.3. PPGis survey and method for quantitative data collection and interpretation

Inhabitants over 18 years old in each city's main continuous built-up area were invited to participate in an online survey. Our goal was to maximize responses from the adult population in each city. To achieve this, we distributed the survey invitation with a link through various digital channels, such as Facebook groups specific to each municipality, municipal webpages, and emails to larger workplaces. Since the survey was intended to be completed on a computer, we utilized digital sources as much as possible to minimize drop-off (e.g., reducing the potential for drop-off if a letter required respondents to switch to a computer). Information about the survey was also disseminated through local newspapers and other local channels (e.g., interest groups, councils, etc.) to encourage participation. Specific groups, such as elderly individuals and people with disabilities, were offered computer assistance to complete the survey. The sociodemographic characteristics of the sample are shown in Table 3.

The survey was conducted using an online questionnaire that included both traditional multiple-choice questions and PPGIS mapping questions. The software used for the questionnaire was Survey Design, while the map solution utilized a Google Maps plug-in. The street registration map solution was developed by QuenchTec AS for the research project "Safety and mobility throughout the day" (Ingebrigtsen et al., 2018) and has been further developed in subsequent projects (Meyer et al., 2019).

The traditional survey part included questions about the amount of

Table 3
Sociodemographic characteristics of the sample.

	Narvik		Kongsvinger		Steinkjer	
Sociodemographic variables	N	Mean	N	Mean	N	Mean
Age (years)	605	41.46	481	48.00	502	43.74
Female (male or other = 0, female = 1)	603	60 %	481	65 %	500	65 %
Higher education (No = 0, Yes = 1)	598	62 %	472	64 %	493	68 %
Adult cohabitant (No = 0, Yes = 1)	605	64 %	481	68 %	502	66 %
Children under 7 years (No = 0, Yes = 1)	605	18 %	481	17 %	502	17 %
Children between 7 and 17 years (No = 0, Yes = 1)	605	21 %	481	30 %	502	28 %
Lives in [name of city] for more than 10 years (No = 0, Yes = 1)	605	66 %	481	69 %	502	64 %
Driving license for car (No = 0, Yes = 1)	605	90 %	481	93 %	502	95 %
Access to car (No = 0, Yes = 1)	605	92 %	481	95 %	502	94 %
Number of cars in the household	605	1.37	481	1.50	502	1.45
Household income (NOK 1000s)	565	825.31	451	815.74	465	776.13

walking during the week (both total and for utilitarian purposes), transport mode choices to typical utilitarian destinations, and acceptable travel time on foot for these destinations. It also explored the motivations for walking to these destinations. Additionally, participants were asked whether walking is a realistic option for their daily trips and what improvements could be made to enhance walking within the city centre. The information collected relates to the characteristics listed in Table 1.

PPGIS, or Public Participation Geographic Information Systems, is an interactive mapping methodology that integrates qualitative survey responses ('soft' subjective data) with quantitative GIS data ('hard' spatial data) (Brown and Kyttä, 2014; Czepkiewicz et al., 2017; Ingebrigtsen et al., 2018; Meyer et al., 2019). In our study, PPGIS questions involved a walkability assessment where respondents were asked to pinpoint locations that enhance positive walking experiences for daily purposes, as well as locations that need improvements to become more attractive for walking in their city. Each point marked by respondents allowed them to specify reasons from a predefined list of characteristics, with an option for open-ended responses. Respondents had the opportunity to answer these PPGIS questions up to three times, providing valuable insights into local perceptions and spatial preferences related to walkability.

For each point, respondents could specify reasons from a list of predefined characteristics, including an open-ended option. They had the opportunity to answer each of these PPGIS questions up to three times.

The predefined characteristics primarily belonged to categories W-III and W-IV, as these were considered more tangible and accessible for respondents to relate to than categories such as categories W-I and W-II with indicators such as "lattitudinal position," "the spatial arrangement of residences and workplaces relative to the city or metropolitan center structure," "proximity" and "permeability" (see Table 1).

3.4. Focus group interviews and method for qualitative data interpretation

Informants in the focus group interviews were recruited among survey respondents who had indicated interest in participating. We specifically targeted families for the group interviews, considering the complexities of daily routines involving children, which often prioritize efficiency (Næss, 2012), leading to a preference for car use despite short distances that could be walked. In each city, informants were selected if they had one or more children under 18 years old in their household and expressed the belief that walking to work, or school was feasible. We also aimed to include informants from different neighborhood zones.

In Steinkjer and Kongsvinger, the interviews took place in early summer in closed meeting rooms at public libraries. Steinkjer had 5 participants (3 men and 2 women), while Kongsvinger had 6 participants (4 women and 2 men). In Narvik, due to challenges in finding participants during early summer events, the interview was conducted online in early autumn using Zoom, with 4 participants (3 women and 1 man). For further details about the interviews and the participating informants, see Appendix A.

The interviews primarily focused on three main topics. Firstly, exploring the relationships between physical environments and the choice between walking and driving for short distances. This aimed to uncover opportunities for planning more pedestrian-friendly environments that encourage people to walk for their daily tasks. Secondly, examining people's attitudes and motivations for using the city centre as a destination for daily activities on foot. This included gathering opinions on physical measures that could enhance the attractiveness of the city centre for such purposes. Thirdly, investigating the factors that would encourage people to choose walking from their residence to downtown areas. This aimed to understand the incentives needed to promote walking for commuting and daily trips within the city.

The interviews lasted for about 1.5 h and were transcribed in their entirety. We developed an interpretation scheme to organize and analyze the qualitative information. The scheme consisted of questions aligned with the three main interview topics and included several subquestions to guide researchers in identifying relevant detailed information.

4. Results

4.1. Quantitative and PPGIS results

4.1.1. Travel behaviour

The initial part of the quantitative analysis presents findings concerning travel behaviour in the three cities under study. Fig. 3 illustrates that 68 % of survey participants from Narvik consider it feasible to walk from their homes to their workplaces or educational institutions during both summer and winter. In Kongsvinger and Steinkjer, this percentage drops to 52 % and 53 % respectively. These results confirm that due to the small size of these cities, walking for commuting is a viable option for most residents, even during the typically severe winter conditions in Norway.

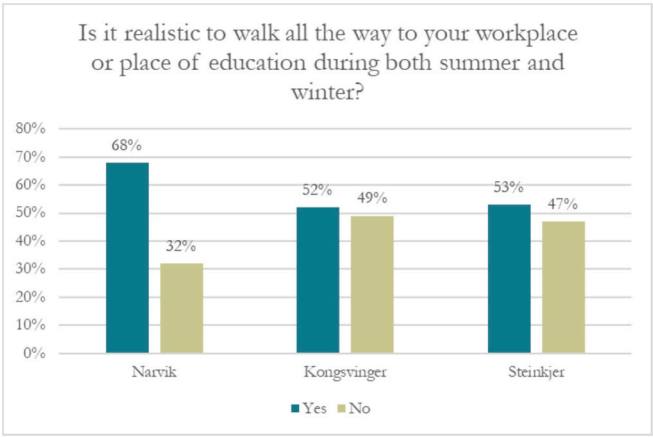

Fig. 3. Analysis of responses regarding the feasibility of walking to workplaces or places of education during both summer and winter. Note: This question applied exclusively to participants who were employed or enrolled in education.

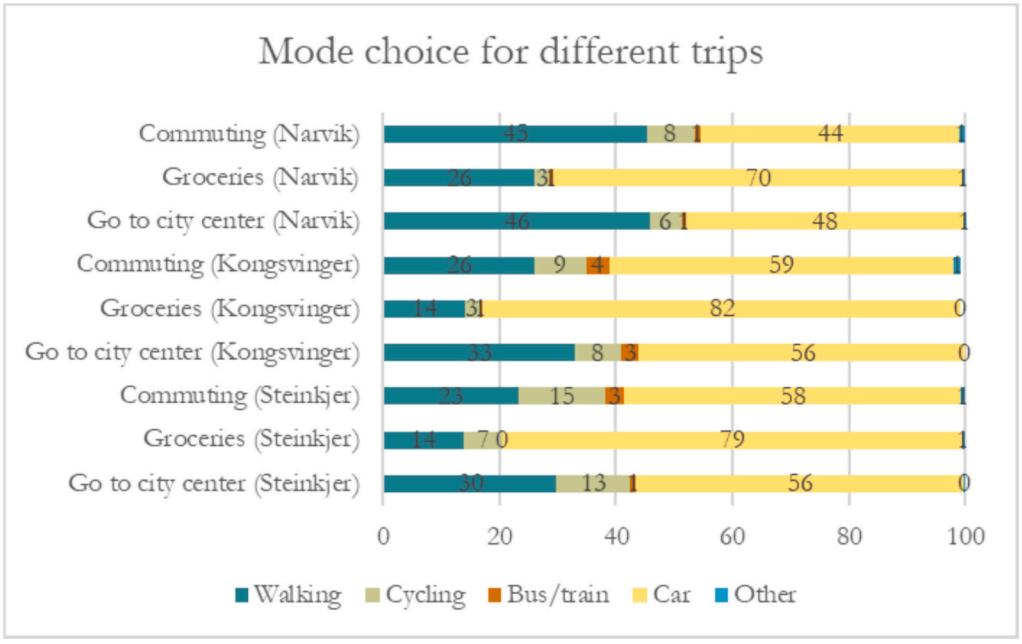

Fig. 4. Mode choice for different types of trips.

However, as shown in Fig. 4, a considerably smaller proportion of residents actually choose to walk for commuting purposes: 45 % in Narvik, 26 % in Kongsvinger, and 23 % in Steinkjer. This finding underscores the notion that these cities have not fully capitalized on their potential for walking trips. Previous research suggests that improvements in walkability could help unlock this potential.

We also observe in Fig. 4 how these cities are heavily reliant on cars; the car is the most used mode of travel for most respondents across various trip purposes (with some exceptions for Narvik). Public transport use is almost negligible, which is unsurprising given the limited availability and relatively low competitiveness of public transport compared to private cars in all three cities.

Walking, however, represents the second most common mode of transport for all trip purposes across the cities, except for commuting in Narvik. This could be attributed partly to shorter commuting distances in Narvik compared to the other cities, as well as Narvik's somewhat more compact urban structure being a half island. Notably, Narvik exhibits the lowest car modal share among the three cities.

The share of people who walk for commuting and for going to the city center in Narvik is similar to the share of people who use a car for these purposes. In Kongsvinger and Steinkjer, the car is by far the most commonly used travel mode for all types of trips. Finally, we observe that, when comparing different types of trips, the share of those who use a car to do their groceries is substantially larger than the share of car users for commuting or going to the city center.

Next, we examine the primary motivations for walking in the three

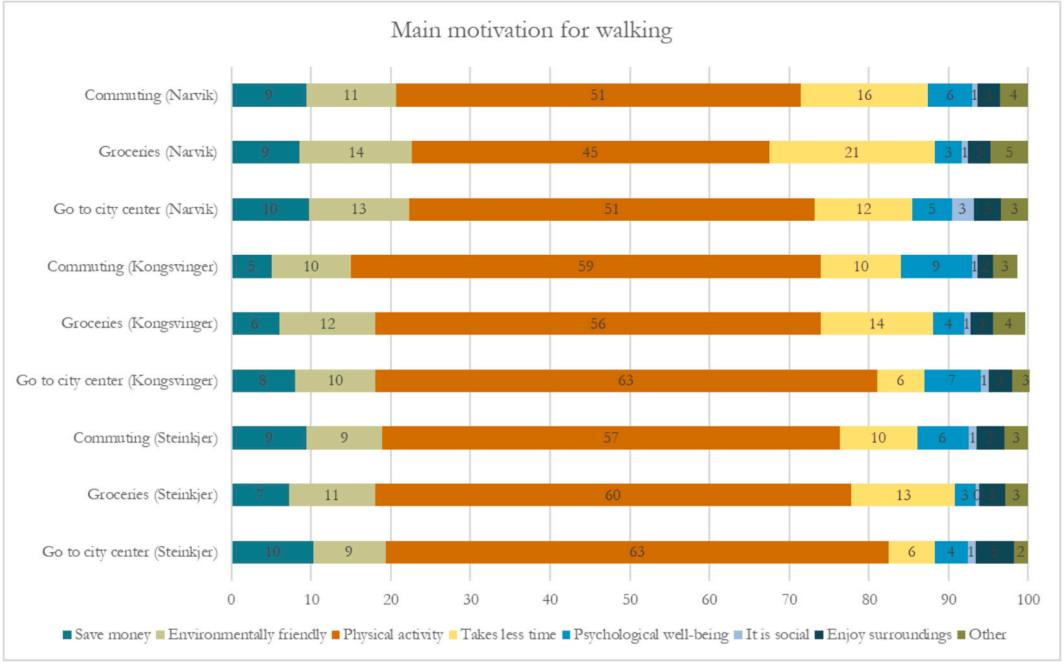

Fig. 5. Main motivation for choosing to walk for different types of trips.

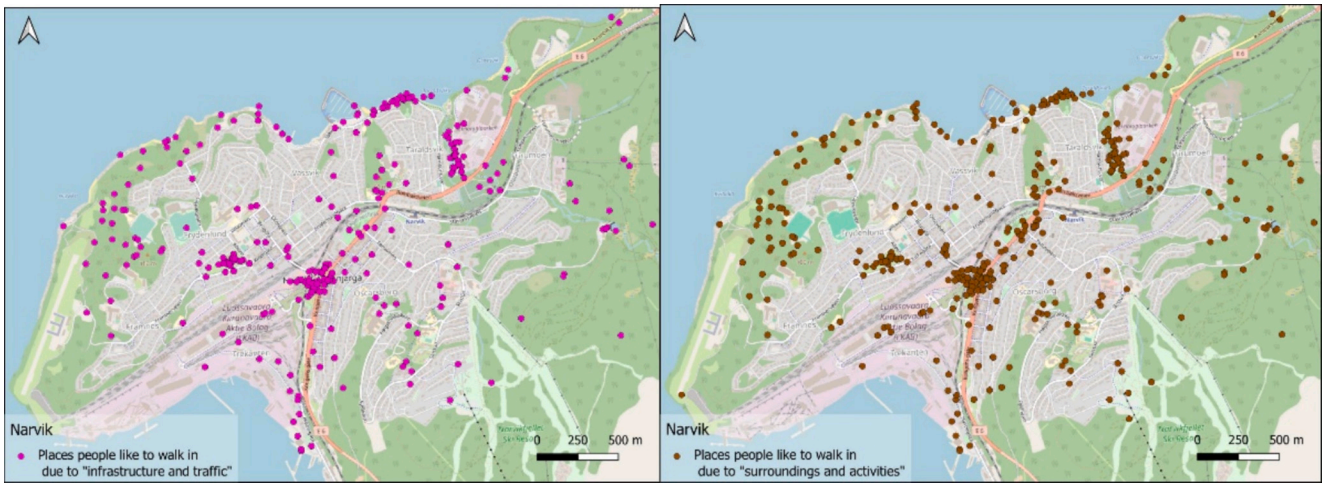

Fig. 6. Narvik: places people like to walk in due to "infrastructure and traffic" (left – purple) and "surroundings and activities" (right – brown). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

cities. Fig. 5 clearly indicates that the most common reason for walking is physical exercise. Other motivations, although less prevalent, include saving time, environmental considerations, and cost savings.

4.1.2. Walkability assessment with public participation geographic information systems (PPGIS)

Next, we assessed walkability using PPGIS. Participants were provided with an online map where they could select up to three points representing: i) Places they enjoy walking in for daily or weekly purposes, and ii) Areas where walkability could be enhanced for daily or weekly purposes. For each selected walking area, participants chose from a predefined list of characteristics known to contribute to positive walking experiences. Similarly, for areas needing improvement, they selected characteristics that could enhance walkability. All data points and associated information were analyzed using GIS software, and maps were generated accordingly. Since respondents could choose multiple options for each point, some points are linked to both WI-3 and WI-4 characteristics.

Figs. 6 to 11 display maps with points categorized separately into two groups. Points linked to both categories appear on both maps within the figure. Points linked to only one of the two categories appear solely on the corresponding map in the figure.

Figs. 6, 8, and 10 illustrate that participants in all three cities express a preference for walking in green spaces (such as parks, gardens, and forests), near blue spaces (like the sea or river), and in city centers. This highlights that a variety of walkability features, including both urban and natural elements ('green' and 'blue' characteristics), contribute to positive walking experiences.

Figs. 7, 9, and 11 indicate that participants' recommendations for improving walkability are primarily focused on the city center and to some extent in surrounding residential areas. This pattern is consistent across all three cities. Areas identified for walkability improvements often include streets with high car traffic and urban highways. In residential neighbourhoods, the points identified for improvement are more closely associated with WI-3, "infrastructure and traffic", rather than WI-4.

When comparing the patterns of places where people enjoy walking and areas needing walkability improvements, we notice that city centers are commonly highlighted in both categories. This dual evaluation is understandable since city centers typically serve as focal points for walking activities, particularly utilitarian walking, in these small cities.

4.1.3. Walkability improvements in neighbourhoods and city centers

Next, we analyzed respondents' answers regarding potential

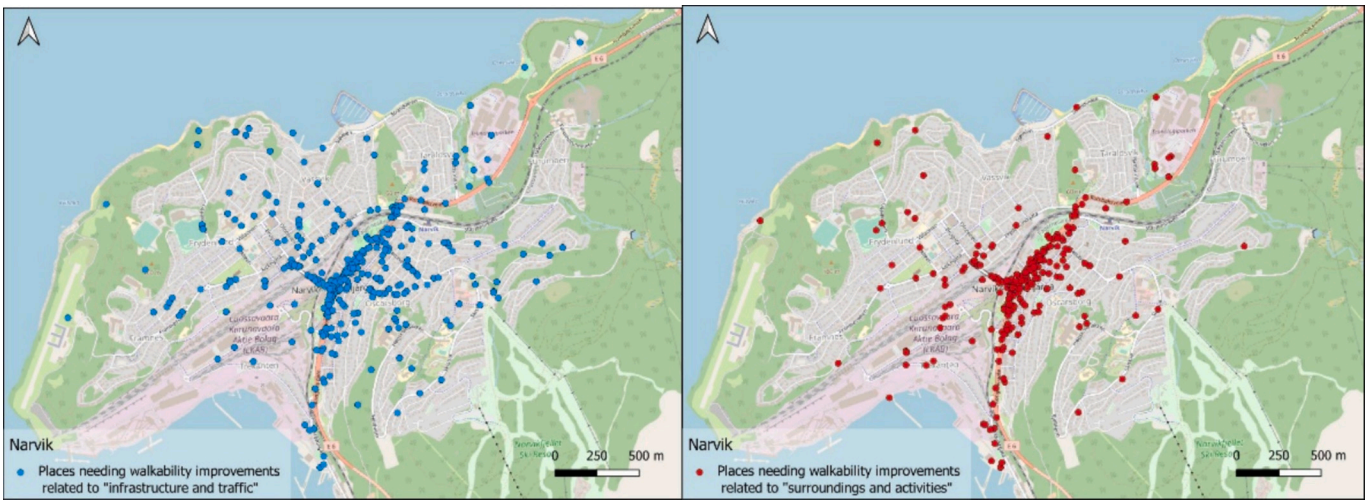

Fig. 7. Narvik: places needing walkability improvements related to "infrastructure and traffic" (left – blue) and "surroundings and activities" (right – red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

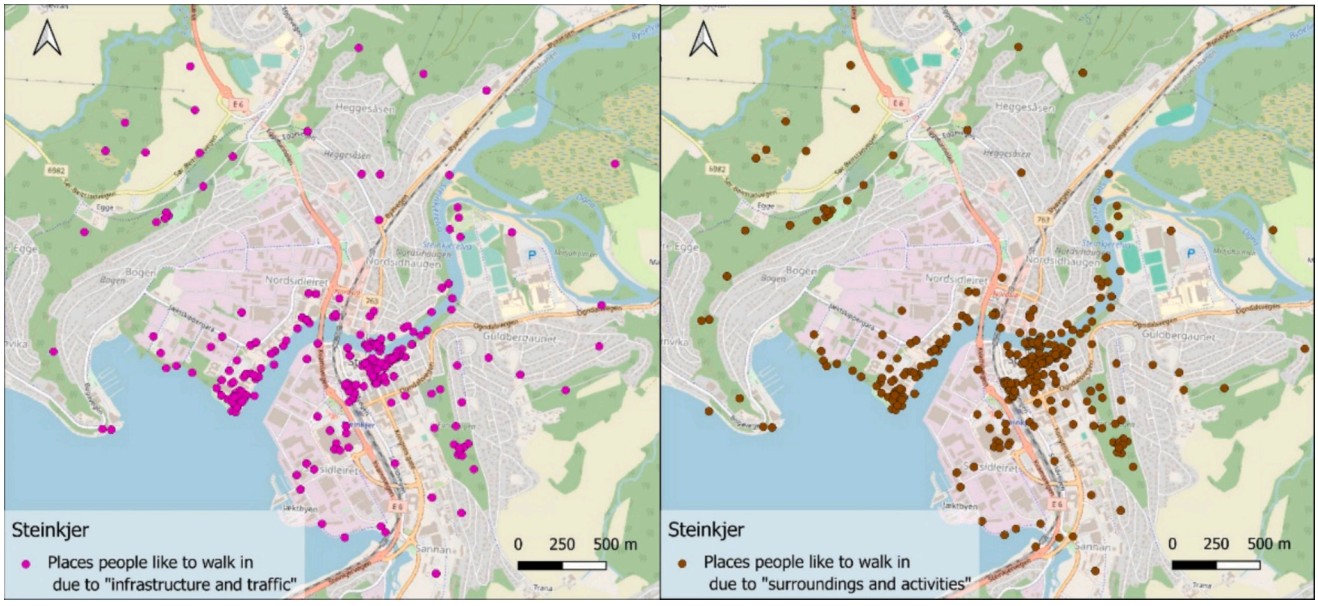

Fig. 8. Steinkjer: places people like to walk in due to "infrastructure and traffic" (left – purple) and "surroundings and activities" (right – brown). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

walkability improvements in their respective residential neighbourhoods and in the city centers. As a reminder, respondents were presented with separate lists of options to choose from for each question. Fig. 11 illustrates suggested improvements in residential neighbourhoods. The most commonly cited suggestions for improvement in all three cities are "better snow removal in winter" and "better lighting". These recommendations fall under WI-3 (*Infrastructure and Traffic*) of the walkability assessment framework outlined in Section 2 (Table 1). Additionally, we observe variations in the frequency of certain improvement suggestions across cities. Specifically, residents of Narvik more frequently selected improvements such as "sidewalks", "more trees and greenery", "better cleaning and maintenance", "less car traffic", " even surface or lower sidewalks", and "improvements for steep terrain" compared to residents of Kongsvinger and Steinkjer.

Fig. 12 depicts suggested walkability improvements in the city centers of the three cities. The most frequently selected suggestions pertain to winter conditions: "more frequent gritting of sidewalks during icy weather" and "better snow removal". Other commonly mentioned improvements include "more greenery" and establishing "pedestrian streets". Notably, "pedestrian streets" and "reducing car traffic" garnered significantly higher percentages of responses in Narvik compared to Kongsvinger and Steinkjer.

Results from both Fig. 12 and Fig. 13 indicate that the majority of suggested improvements in residential neighbourhoods and city centres fall under the category WI-3 (cf. Table 1). Among the most frequently suggested improvements, only "more greenery" corresponds to category *WI-4*.

4.2. Qualitative results from focus group interviews

The aim of this section is to address sub-question 2 (as outlined in the introductory section): how perceived walkability influences pedestrians' experiences and their subsequent daily walking behaviour, using qualitative insights from focus group interviews. The following sections will explore the relationship between perceived walkability and walking behaviour for the four categories outlined in section 2, Table 1. Additionally, the focus was on assessing perceived walkability along routes to downtown areas and identifying potential improvements. Winter conditions were considered in all three topics, alongside factors specific to the small city context.

4.2.1. Natural and built environment preconditions

Results from the survey indicate that winter conditions significantly influence perceived walkability in both neighbourhoods and city centres (refer to Fig. 5–6). Interviewees from all cities mention harsh weather conditions such as snow, heavy rain, and slippery surfaces as factors that encourage the use of cars. They also observe a consequential effect: the prevalence of car traffic dominating the surroundings. For instance, one respondent remarked, "*It's so windy here that you can almost blow away by the river at its worst.*" " … *it's really tough.*" (S-M28). Another interviewee mentioned, "*Then it takes longer, because there is often a lot of snow and such.*" (S-F57). In Narvik, steep and slippery hills often lead to the preference for driving in winter, and sometimes necessitate walking with spiked shoes. "*It's only uphill.* (…) *Then I'll take the car*…."(N-F43).

In addition to harsh weather conditions prevalent in northern areas, the low sun altitude also significantly impacts the utilization of public spaces in city centres. In Narvik, for a considerable part of the year, the sun remains low in the sky, resulting in long shadows cast by buildings and lower temperatures in shaded areas. Sunny conditions are highlighted as crucial for engaging in outdoor activities in public spaces, underscoring the importance of positioning amenities on the sunny side. Visual connections with nature from public spaces, such as sightlines to the sea or mountains, are also deemed essential for enhancing their appeal. One interviewee articulated this viewpoint: "*If you were to create a pedestrian street (…), which would be shaded almost all the time anyway, it might not encourage much street life. But if you had a pedestrian street where you get a lot of sunshine, with a better view, that could potentially make it more attractive.*" (N-F39).

4.2.2. Urban structure and urbanity

The survey results suggest that most respondents consider it feasible to walk to their workplace or educational institution (see Fig. 3), yet many still opt to drive (see Fig. 4). Insights from interviews highlight an important factor influencing this decision: the intricate time management of family schedules. Interviewees discuss how the complexity of daily family routines often leads to choosing the car for its convenience and efficiency.

For example, one interviewee noted that the car is sometimes chosen as an "*express solution*", particularly when managing teenagers' schedules for activities like training, due to time constraints. Another interviewee, S-M33, mentioned walking for most activities due to her central

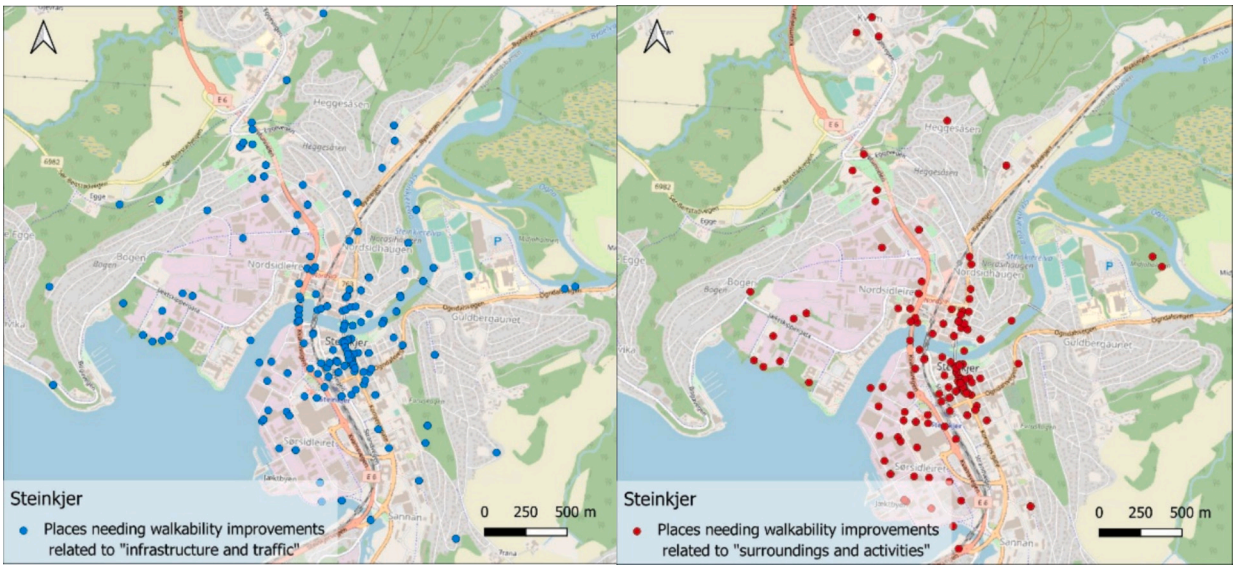

Fig. 9. Steinkjer: places needing walkability improvements related to "infrastructure and traffic" (left – blue) and "surroundings and activities" (right – red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

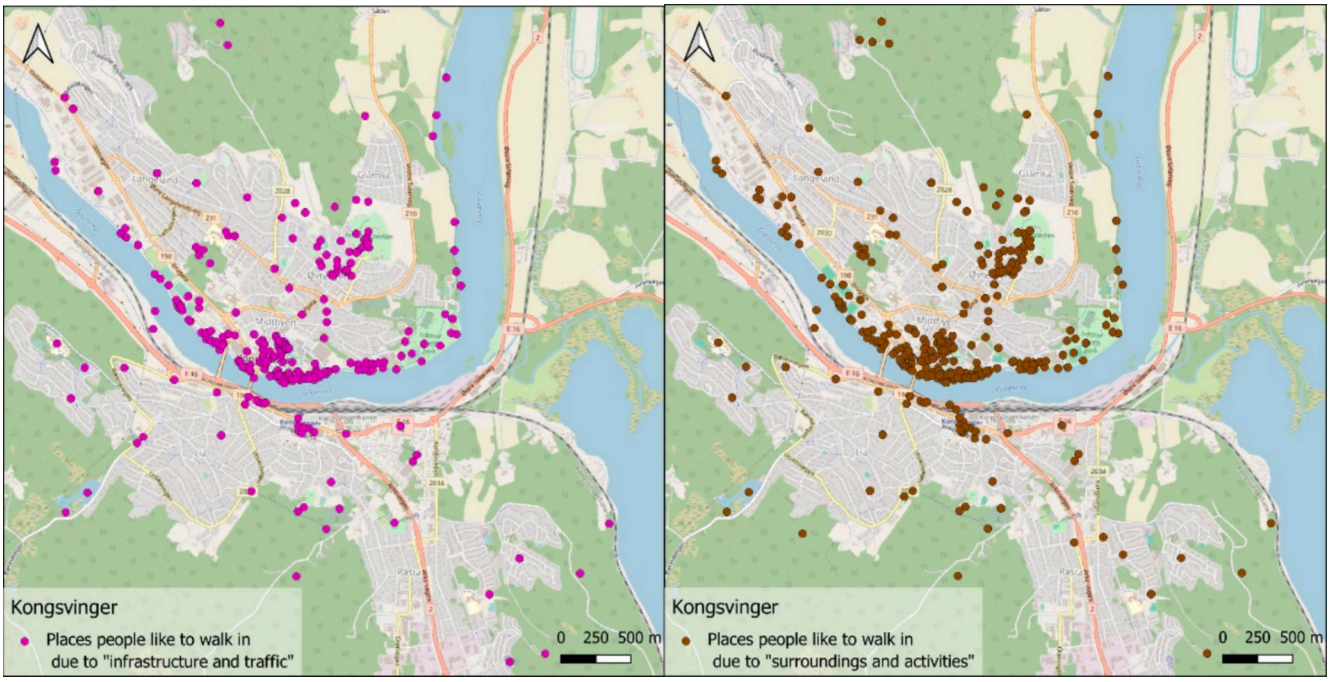

Fig. 10. Kongsvinger: places people like to walk in due to "infrastructure and traffic" (left – purple) and "surroundings and activities" (right – brown). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

location but occasionally opting for the car during busy periods: "*Lately it's been a bit busy, so I've taken the car, yes.*" She further elaborated, The car *"is a means of slightly increasing efficiency outside the city centre area… (…) So, it's mostly if the children are going to something (…) if I want the day's schedule to be somehow kept, then we take the car."* (S-M33).

The daily travel chain and its connection to managing daily schedules also influence decision-making regarding driving. For instance, S-M28 mentioned occasionally driving to a nearby kindergarten despite acknowledging that walking would be faster and more convenient. The reason for driving was to expedite subsequent travel to her workplace: "*It's more for such express use, 10 minutes instead of 30.*"

One potential strategy to improve walking travel times could be to provide more shortcuts for pedestrians. However, interviewees point out that shortcuts may have limited effectiveness during autumn and winter due to issues such as poor lighting and snow conditions. For instance, S-M46 mentioned, "… *I often have to take a detour in winter because the shortcuts get covered with snow.*" Similarly, S-M28 highlighted "… *every sidewalk and park become a snow dumping ground*".

Proximity is identified as a challenge contributing to the use of cars, particularly in Kongsvinger. Interviewees highlight that daily destinations are often spread across the entire city, resulting in longer total distances. For example, K-F34 mentioned, "*Yes, it's not far to work. But the kindergarten is at Holt. So that's what complicates things… If I have to drop off at the kindergarten, then I'll take the car.*" Similarly, K-F38 remarked, "…*the city is just spread over too large an area. You have friends across the city, a school on one side, a kindergarten on the other, and*

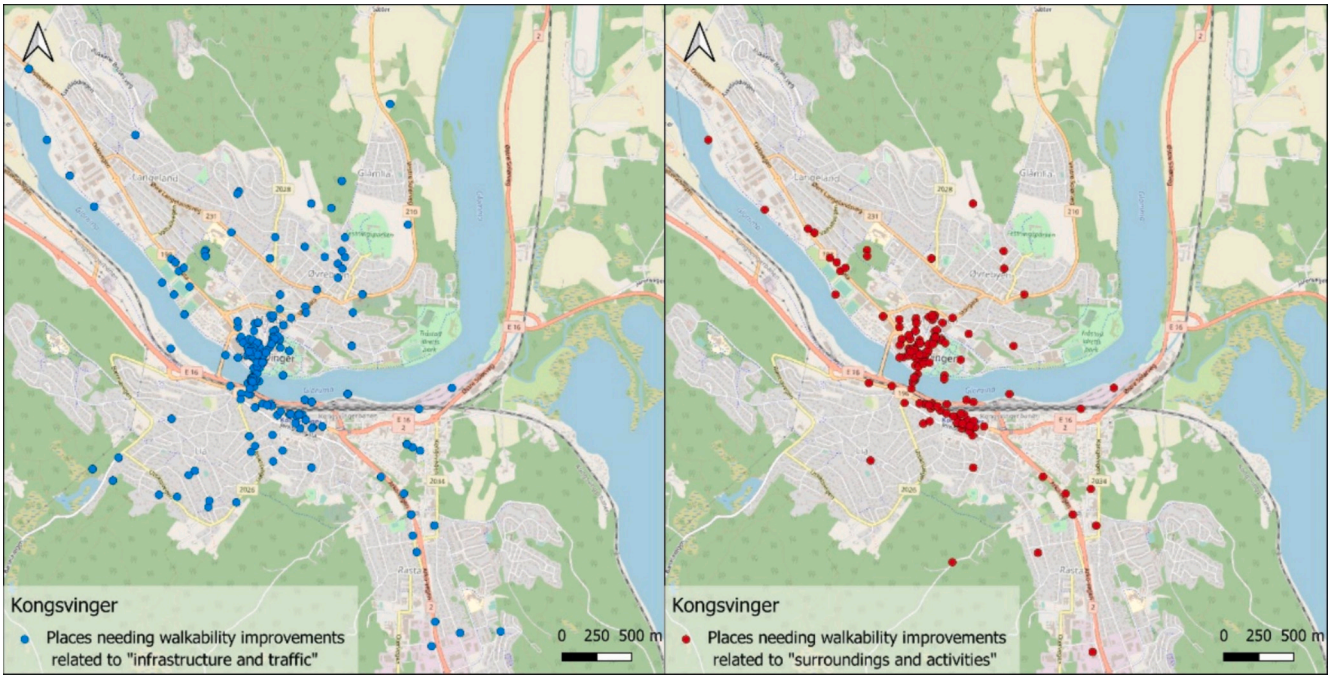

Fig. 11. Kongsvinger: places needing walkability improvements related to "WI-3" (left – blue) and "surroundings and activities" (right – red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

activities in a third place."

Despite short distances, inadequate lighting during the dark autumn and winter months can sometimes create feelings of insecurity, particularly in areas with open spaces and few people around. This lack of perceived social safety was highlighted by S-F57, who mentioned, "*When I go home in the evening, it can be quite dark and uncomfortable. There's little light, so I can feel a bit apprehensive… It's deserted out there… Because sometimes there are some fewer desirable people in that area.*"

4.2.3. Infrastructure and traffic

The survey results indicate that the functionality of walking infrastructure needs improvement in many locations to make walking more attractive. Interviews reveal that incoherent or inadequate pedestrian infrastructure contributes to a lack of perceived safety and discourages walking across all cities. Parents express concerns about their children's safety and distrust the traffic system, leading to increased reliance on cars. For example, K-F38 mentioned driving the youngest child to kindergarten, where the schoolchild begins their walk to school, due to the absence of pavements: "*…there is no pavement…we walk along the motorways*." Similarly, S-M46 shared a story about his former residence in Steinkjer: "*There is no footpath. And there is a stretch along the E6 where it is dangerous to walk, so you kind of have to drive anyway…then you have to drive to a safe place to go for a walk.*" S-M33 pointed out that the lack of continuous pedestrian infrastructure makes walking less efficient, as pedestrians must plan their routes carefully to ensure safety: "*Lack of continuous infrastructure for pedestrians wide over makes walking less efficient, as the pedestrian has to think more about where it is possible to walk and where it is safe.*"

An example of a route with inadequate pedestrian infrastructure is the one leading to downtown Kongsvinger. This route runs alongside busy roads where cars have priority, resulting in a less attractive walking experience. As K-F38 explained, "*The road itself is not part of the trip. It's just to get from A to B.*" Additionally, N-M41 in Narvik noted the lack of logical shortcuts for pedestrians: "*There are no logical shortcuts to take. You just have to follow the roads.*"

Good access to parking at the workplace contributes to the efficiency of driving. Conversely, limited parking access at destinations can reduce the efficiency of driving and encourage walking, as explained by K-F50: "*I think the fact that there is so much available parking everywhere makes people drive a lot more.*" Similarly, K-F34 noted, "*Yes, it is very easy to use a car. And it's also very nice as parents of small children.*" S-F57 illustrated the impact of parking fees: "*I've stopped driving completely because there is a parking fee at the nursing home now.*" The emphasis on car access in the transport system over pedestrians also promotes driving. For instance, S-F57 said, "*I think you drive to Amfi* (shopping mall). *It's not that easy to walk and cycle there because of the E6… for me, it becomes like mental… I drive there.*" K-F50 echoed this sentiment, noting that the mall has "*a large car park and it is easy to drive. And that makes people not walk.*" Informants in Steinkjer emphasized the necessity of establishing alternative travel options to cars, a need that likely applies to the other cities as well. Both buses and bicycles were mentioned as potential alternatives. S-M28 remarked, "*There is no alternative.*"

4.2.4. Surroundings and activities

The survey results indicate that creating pedestrian streets in city centres is important across all the cities studied. The city centre is considered a key location for social interaction and family activities, such as skating in winter, visiting playgrounds, and having picnics in parks. Informants agreed that city centres need improvements to encourage strolling and spontaneous activities in the streets, which would help create vibrant street life. They expressed a desire for more greenery and a reduction in asphalt and car traffic. The impact of heavy traffic noise and fumes is a significant issue, influencing the overall experience of the surroundings. As N-F39 explained, "*I have lived in the centre of Narvik for many years, I have also lived in the centre of Madrid… there is a lot of dust from the E6 and a lot of noise, but we are at the same time far, far away from any other noise.*" N-M41 noted that expectations regarding noise and traffic differ between larger and smaller cities: "*If you live in a big city… then you expect a lot of noise, you expect a lot of traffic… the smaller the city, there should be areas where you can be and where it feels a bit like… a large village, with a lively centre.*"

Still, "*the city is made for road users*," says S-M33. Informants in Kongsvinger mentioned that the city centre is a place to carry out specific tasks without staying longer than necessary, resulting in limited

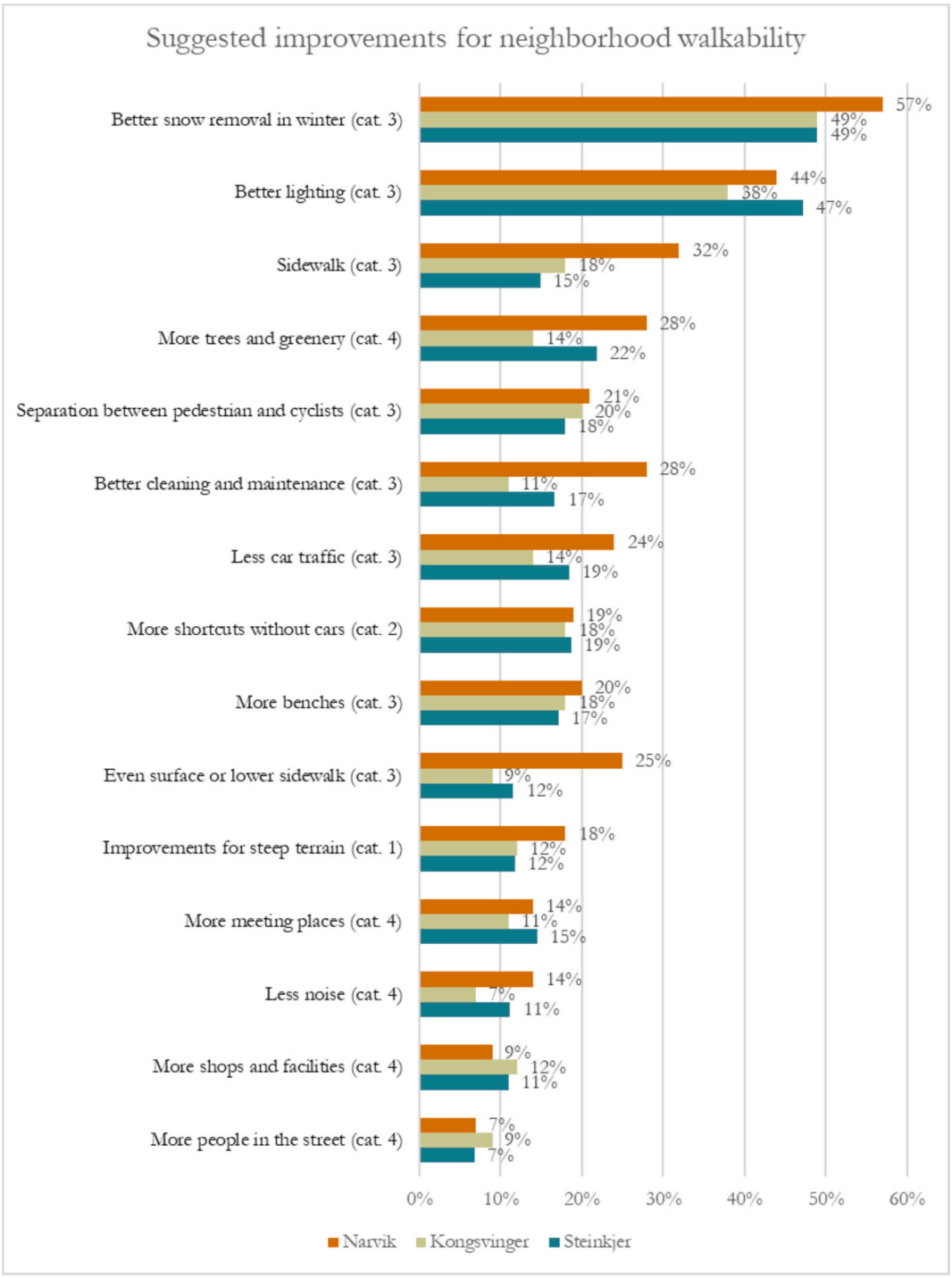

Fig. 12. Share of answers to the question: "What does it take to improve walking in your neighborhood zone ?". Note: Cat. refers to the categories shown in Table 1. A list of predefined choices was given. Choosing multiple options was possible.

street life. As K-F50 expressed, "*There must also be some areas reserved for people, not just cars, because I think there are cars, cars, cars, cars, parking, parking, parking everywhere. So, it won't be pleasant then.*" S-F57 added, "*I like to go where there is some life. Shops and people.*" Similarly, N-M41 noted, "*The only thing I really feel we use Narvik centre for is when you go shopping… I can't think of anything where we go downtown just to be there because it's nice or something like that. Nothing.*"

S-M33 emphasized the need for aesthetic improvements: "*The aesthetic should have been more in place, yes. Beautify the city a little spruce, for those who walk. Yes. Not for those passing through.*" Traffic volumes, fumes, and noise significantly impact the well-being of pedestrians and the overall quality of being downtown, especially in Narvik, where the E6 runs through the city centre. N-M41 highlighted this issue: "*There are nice areas that could be very pleasant to be in. Which could be alive, and you could have outdoor cafes… But it's not possible to use it today as you wish… there is too much noise downtown for it to be pleasant to go for a walk there.*"

Recreational areas in the cities, particularly those along rivers or on the outskirts, are more frequently used for strolling compared to the city

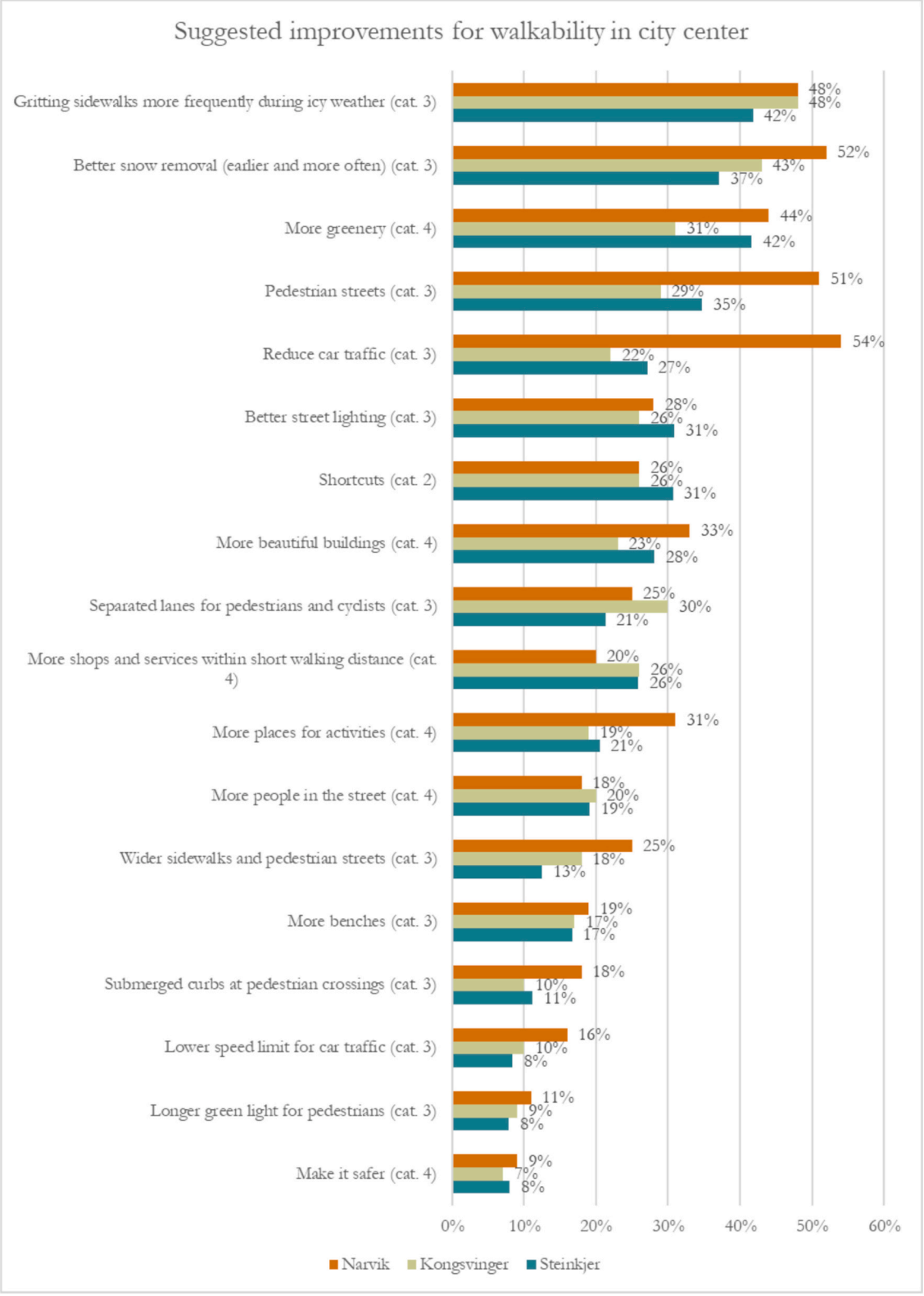

Fig. 13. Share of answers to the question: "How can it get better to walk in the center of [name of city]?". Note: Cat. refers to the categories shown in Table 1. A list of predefined choices was given. Choosing multiple options was also possible.

centres. As S-F57 explained, "*We go for walks in the recreational areas, but we don't go for walks in the city centre that much.*" Similarly, S-M33 highlighted the practical rather than leisurely use of the city centre: "*No, it's only practical, so it only has one use.*"

5. Discussion

5.1. Discussion of results

This study aimed to answer *what characterizes walkability in the*

context of a small city in Norway. The investigation is based on a mixed methodological approach consisting of a survey including map-based PPGIS questions and focus group interviews with families. The study was conducted in three small cities in Norway: Narvik, Kongsvinger, and Steinkjer. To structure our study, we employed a framework grouping walkability indicators (WIs) into four categories as explained in Section 2: (WI-1) Natural and built environment preconditions, (WI-2) Urban structure and urbanity, (WI-3) Infrastructure and traffic, and (WI-4) Surroundings and activities. We defined two sub-questions to further our analysis: 1) What are the location patterns of places residents perceive as attractive for walking and the places that can be improved, and which walkability indicators contribute to this pattern? 2) How does perceived walkability contribute to pedestrians' experiences and subsequent daily walking behaviour in small cities?

The location pattern of places residents perceive as attractive for walking lies primarily in the city centre, as well as near green and blue structures such as the fjord, the river, and larger green areas (Figs. 6–11). The interviewees similarly point to the city centres as attractive places for meeting people and enjoying activities. However, we also observe that the location pattern of suggestions for walkability improvements similarly lies primarily in the city centre, often on streets with heavy car traffic. Overall, the survey respondents seem to request a higher priority for pedestrians through better winter maintenance of sidewalks, reducing traffic, better street lighting, etc. (Figs. 12 and 13). The interviewees similarly experience a tendency to prioritize the needs of cars over pedestrians in the traffic system. Walking is often facilitated along heavy traffic streets or roads, sacrificing the pleasantness of the walking experience (cf. K-F38). Instead, interviewees call for facilitating strolling and unplanned stays in the downtown streets to create street life and invite more walking (WI-4). Points for walkability improvements in the residential neighbourhoods are primarily linked to traffic safety (WI-3) (Figs. 7, 9 and 11). In the interviews, this was in some cases linked to children's safety, e.g., for walking to school.

Exploring how perceived walkability contributes to daily walking behaviour, facilitation of car use (WI-2 and WI-3), travel distances (WI-1 and WI-2), as well as winter maintenance (WI-3) stand out as negative for walking. Survey results suggest that walking for commuting purposes is considered a realistic option by more than half of the residents in Kongsvinger and Steinkjer, and most residents in Narvik (Fig. 3), yet the car is the most frequently used travel mode for the majority of trip purposes (Fig. 4). This indicates a gap between inhabitants' perceived potential for walking and their actual walking activity and is an aspect that warrants further investigation. Reported high car shares are in line with previous findings (Tennøy et al., 2022a; Wolday, 2018), and with our initial expectations. Looking to the interviews, we find possible expla1nations for this finding.

We expected distances to be generally short due to the small city scale. Although they might be compared to larger cities, perceptions of walkability – and thus walking possibility – are, as previously explained, context-dependent. In the interviews, it emerged that for some (cf. K-F34), the total daily travel chain distance is considered too long for walking as daily destinations are spread out across the cities. And with inadequate public transport options, the car is the better alternative. This shows how assuming short travel distances because of city size may be an erroneous simplification, but also how the perception of distance is context dependent. If the total travel chain is perceived as too long, people will not walk. This is something municipalities must take into consideration in their planning if they wish to encourage daily walking.

Facilitation of car use, both in neighbourhoods and city centres, includes relatively good access for cars (e.g., parking at workplaces), and incoherent or inadequate walking infrastructure that contributes to a lack of perceived safety (or parents' fear about their children walking on their own, influencing them to shuttle by car). This shows a prioritisation of the car in the cities and contributes to a spin-off effect, i.e., many people drive, creating surroundings dominated by car traffic and asphalted areas, which, in turn, further discourages walking.

In addition to a higher priority of pedestrian infrastructure (WI-3), pedestrian streets and pleasant surroundings for walking (WI-4), informants call for better facilitation of alternative travel modes to the car. This is supported by previous research, showing how increased bus and bike use in the cities can improve walking attractiveness by making cars traffic and their infrastructure less dominant (Stefansdottir et al., 2024). We think this finding underlines the need to reverse the spin-off effect by limiting car traffic, for example, by reducing its accessibility in ways similar to those in bigger cities like Oslo, such as implementing parking policies (Marsden, 2006; Hagen and Tennøy, 2021).

Lacking or inadequate winter maintenance can be a barrier to walking (Aasvik and Bjørnskau, 2020; Elvik and Bjørnskau, 2019; Hjorthol, 2013; Öberg, 2011). The cities' Nordic location means long, dark, and often snow-rich winters. Hence, it is not surprising that the most frequent suggestions for walkability improvements are related to winter conditions in all three cities: better snow removal and gritting of sidewalks, and better street lighting. The findings are unfortunate, however, as adequate winter maintenance and operations (MO) are known to promote winter walking (Aasvik and Bjørnskau, 2020; Svorstøl et al., 2017). Ensuring this could be assumed a 'low-hanging fruit' for the municipalities to promote all-year walking, at least for the relatively able-bodied. Experiences from Scandinavian cities that have taken measures to improve winter MO for cycling show an increase in winter bike use and improved user experiences of winter bikeability (Øksenholt et al., 2020). This includes a clear priority of cyclists by clearing bike paths for snow before roads for cars, and strong requirements for operators regarding the quality of winter MO. It is not unlikely that this could be transferable to increasing winter walking. We have not explored whether the municipalities already do this or plan to, but survey results indicate that currently the experienced winter MO is insufficient. There might still be a limit to how many people can be encouraged to walk in winter, but according to survey respondents (Fig. 3), there is an unrealised potential to build upon.

The trends found in our study of perceived walkability in small Norwegian cities present several similarities with previous studies but also some distinct elements. Our finding that green and blue spaces positively contribute to perceived walkability is in line with studies from the US (Jensen et al., 2017; Root et al., 2017) and a recent study from a medium sized city in Northern Europe (Stefansdottir et al., 2024). Findings from small US cities (Doescher et al., 2014) also point in a similar direction as the findings in our study: walking infrastructure, green space, and recreational spaces improve walkability.

Our findings indicate that a variety of walking indicators influence walking attractiveness. Moreover, built environment characteristics that influence walking constantly interact, and it is the sum of these characteristics that creates the environments people walk through and that, in turn, shapes and influences walking experiences (Stefansdottir, 2018; Rynning, 2018).

Alfonzo (2005) presents a hierarchical model of walking needs that defines feasibility, followed by accessibility and then safety, as the most basic needs (WI-1, WI-2, WI-3 of the framework), whereas pleasure (WI-4) represents higher-order needs. However, Alfonzo also suggests that walking may be motivated by different needs simultaneously and that certain levels of needs may become necessary depending on the type of walk or purpose, such as a destination walk, strolling, or a combination of the two. The level of needs is also influenced by people's life cycle circumstances (ibid). For example, it is logical that safety for children is a fundamental issue in neighbourhoods, as our results suggest. While for the city centres, inviting more walking might require more emphasis on fulfilling needs for pleasant surroundings. Currently, it is the recreational areas in the cities, along rivers or on the fringe, that are used for strolling rather than the city centres. Moreover, they seem to best meet the survey respondents' main motivation for walking: physical exercise (Fig. 4). This indicates a potential to increase walking in the city centres, which might be achieved by offering characteristics such as calmness (e.g., less traffic) and greenery. As pointed out by Stefansdottir (2018), it is

important to plan for a peaceful and calm atmosphere in public spaces, which might be more obtainable in small city centres.

Interview results further suggest that, in addition to harsh weather conditions which make walking harder and take longer, the low sun altitude also affects the use of public space in the city centre. Sunny conditions are mentioned as important for outdoor activities because of the lower temperature in the shade. Gehl and Svarre (2013) have emphasized this feature to attract people to public spaces in northern areas.

Our study also includes findings that are unique compared to other perceived walkability literature. First, we find that suggestions for improving walkability in neighbourhoods and city centres of small cities may differ. Basic walking infrastructure, such as the presence of sidewalks and street lighting, is insufficient in residential neighbourhoods but not as much in the city centres, as pointed out by the respondents in our survey. Second, our study offers some findings that are unique to the Nordic context and generally to geographical areas with harsh winter conditions. We specifically found that the most frequently chosen suggestions for improving walkability in our cases were related to improving walking conditions during snow (removing snow and gritting the sidewalks). These findings show the importance of the local climate for perceived walkability and potentially walking behaviour. Third, a special feature of the small Norwegian cities examined in the study is that although these cities are compact in size and distances are short, they are characterized by low density. This results in a low concentration of destinations and a lack of urban vitality, both of which may contribute to lower walkability. Fourth, we observe some differences between findings from small and larger cities within Norway. In larger cities such as Oslo, people's views on perceived walkability are more focused on street life and feelings of social safety. These aspects are considered important and positive in Oslo city center (Meyer et al., 2019), whereas they seem to be less relevant in the three small cities in the present study. Moreover, although larger Norwegian cities such as Oslo, Trondheim, and Bergen are characterized by challenging weather conditions, they have higher rates of walking compared to the small cities examined in the study. This can be attributed to better walking infrastructure, proximity to multiple destinations due to higher density and mixed land uses, public transport services, car restrictions, and possibly more effective snow removal during winter.

5.2. Strengths and limitations

Through our study, we have identified several advantages of using a methodology combining PPGIS, traditional survey, and focus group interviews to assess perceived walkability. The advantages of PPGIS include the ability to reach multiple respondents simultaneously and perform geographical analyses with detailed user-provided information. PPGIS offers accuracy in measuring walkability based on exact locations. This type of measurement can be used for visualization (as done in this study) as well as spatial analysis. PPGIS, when combined with surveys and interviews, offers both enhanced visualization and the potential for geographical, statistical, and qualitative analyses. We believe this approach provides more nuanced findings than research designs that rely solely on objective spatial indicators of walkability.

However, there are also drawbacks associated with the methodology used in the study. These include recruitment challenges, selection bias, and issues with data quality. Technical proficiency requirements can exclude certain demographic groups, and many individuals may encounter difficulties when using and interpreting maps. Additionally, respondents' familiarity with different areas can introduce geographical bias.

To address the research questions of the study, we employed a descriptive approach which combines maps displaying patterns of places, descriptive statistics and indicators, and insights from qualitative interviews. The data can be further analyzed using more advanced statistical and spatial analytical approaches to address other types of research questions.

6. Conclusion

The mixed methodological approach of this study, with PPGIS map-based surveys and qualitative focus group interviews with families in Narvik, Kongsvinger, and Steinkjer, has strengthened existing knowledge on walkability and provided new insights into what characterizes walkability in the context of small cities in Norway. We found a significant gap between the potential for walking and actual walking activity, with several incentives in the cities promoting car use at the expense of making walking less attractive. For a positive walking experience, a range of walkability indicators were important, as they also interact. Access by car was shown to be very good and stimulated its use despite short distances. Its dominance in the traffic system caused a spinof effect that reduced walkability.

Sustainable mobility challenges faced by small Norwegian cities resemble those of rural and remote areas. In all these contexts, inadequate pedestrian infrastructure, low concentrations of amenities, abundant car parking without restrictions, and insufficient public transport services collectively have a negative influence on walkability and walking while promoting car use, especially during winter. To improve walkability in small cities in Northern Europe and other cities with similar characteristics, emphasis should be placed on facilitating a functional, continuous, and safe infrastructure network adapted for all seasons, better year-round maintenance and operations, as well as providing walking infrastructure and downtown pedestrian streets in calm surroundings with elements of nature and access to sunlight to create vibrant "rural town" street life.

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Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtrangeo.2024.104014.

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