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Mehdizadeh, Milad; Kroesen, Maarten; Vos, Jonas De

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Perceived accessibility and life satisfaction: the mediating role of activity participation?

Milad Mehdizadeh [a,*], Maarten Kroesen [b], Jonas De Vos [c]

[a] Institute for Transport Studies, University of Leeds, Leeds, United Kingdom
[b] Delft University of Technology, Delft, the Netherlands
[c] Bartlett School of Planning, University College London, London, United Kingdom

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ABSTRACT

A lack of accessibility can lead to social exclusion and lower quality of life. While research has shown that objective accessibility measures influence well-being, few studies have examined the role of perceived accessibility. In this study, we test the notion that activity participation might play a mediating role in the relationship between perceived accessibility and well-being. In addition, we hypothesize that perceived accessibility may also directly influence well-being, assuming that a sense of residing in an accessible place has intrinsic value to people. Using data from the 2022 Netherlands Mobility Panel (n = 4,222), we test these chain relationships: perceived accessibility-activity participation-life satisfaction. The results of the structural equation modeling show that higher perceived accessibility by cars and bicycles directly enhances life satisfaction, while perceived accessibility by walking influences life satisfaction only indirectly, through increased activity participation. Accessibility by public transport, however, has no direct/indirect significant effect on well-being.

1. Introduction

Travel plays an important role in the economic and social development of our society. Studies have shown that restrictions on accessibility, i.e. the ease to reach destinations (e.g., Geurs & van Wee, 2004), can lead to social exclusion and lower quality of life (Banister and Bowling, 2004; Cass et al., 2005; Delbosc and Currie, 2018; Mokhtarian, 2019). The proposition that well-being is facilitated by accessibility is well-embedded in theoretical frameworks (Delbosc and Currie 2018; Shliselberg and Givoni 2018).

Over the past decades, accessibility has generally been measured using objective features of the built environment (e.g., population density, land use mix) and the transport system (e.g., travel speed). However, as accessibility refers to the ease of reaching destinations, this is also affected by people's perceptions (Lättman et al., 2016; Pot et al., 2021). Consequently, recent studies have focused on perceived accessibility, i.e., how easy people feel it is to reach destinations, in general or by using specific travel modes. This perceived accessibility may not only be affected by the built environment and transport systems, but also by personal travel options (e.g., car ownership), travel experience, and travel attitudes/preferences (e.g., Lättman et al., 2016; van der Vlugt et al., 2019).

While research has shown that objective accessibility measures indeed (positively) influence subjective well-being (Lionjanga & Venter, 2018), only a few studies have investigated the relationship between perceived accessibility and well-being. These studies have found that perceived accessibility is positively related to life satisfaction (Friman & Olsson, 2023) and self-rated health (Parga et al.,

* Corresponding author at: G.01, Institute for Transport Studies, University of Leeds, Leeds, United Kingdom.
E-mail address: M.Mehdizadeh@leeds.ac.uk (M. Mehdizadeh).

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2024) and negatively related with depressive symptoms (Vitman-Schorr et al., 2020). The study of Vitman-Schorr et al. (2020) additionally revealed that the relationship was mediated by physical activity and satisfaction with social contacts. The authors speculated that increased activity participation plays a relevant role in these mediating relationships, but did not explicitly test this hypothesis.

Against this background, the primary goal of this research is to provide new empirical insights on how perceived accessibility influences subjective well-being. Firstly, we follow-up on the work of Vitman-Schorr et al. (2020) and explicitly test whether activity participation mediates the relationship between perceived accessibility and subjective well-being. We assume that greater perceived access leads people to engage in more out-of-home activities, which in turn, positively influences people's well-being. Secondly, in addition to this indirect effect, we also hypothesize that perceived accessibility may directly influence subjective well-being. Subjective well-being is generally decomposed into an affective component, reflecting how people feel, and a cognitive component, reflecting the perceived realization of desires (Veenhoven, 2009). It may be hypothesized that residing in an accessible place may be cognitively evaluated by people as something that is desirable. By assessing the relative strength of these indirect and direct pathways, our goal is to shed more light on the mechanisms through which perceived accessibility affects subjective well-being. From a policy perspective, our study can inform policymakers by providing insights into whether measures such as limiting car accessibility, which may have positive effects on the transport system, also align with health-related outcomes and help maintain or improve overall well-being in society.

To explore and assess the links between perceived accessibility, activity participation, and subjective well-being, we use a rich dataset from the 2022 Mobility Panel Netherlands (N = 4,222 participants). Subjective well-being is operationalized using the Satisfaction with Life Scale (SWLS), which was specifically developed to tap into the cognitive component of subjective well-being, but which has also been shown to correlate strongly with (positive and negative) affect. As such, it represents a scale that aligns well with the goals of this study.

2. Background

2.1. Perceived accessibility and activity participation

Perceived accessibility reflects individuals' perceptions of how easily they can access desired destinations, services, or activities (Pot et al., 2021). In a recent theoretical study in the travel behavior domain, perceived accessibility is defined as "how easy it is to live a satisfactory life with the help of the transport system" (Lättman, 2018). Perceived accessibility can thus reflect a spectrum of perceptions, including convenience, ease of access, travel time, and flexibility, among others. This broader scope allows for a more comprehensive understanding compared to the limited behavioral outcomes associated with travel (e.g., mode choice, trip-making). Pot et al. (2021) also highlight that the concept of accessibility is not solely contingent upon the objective physical environment but is also intricately influenced by how individuals subjectively perceive that environment. In alignment with this understanding, the exploration of perceived accessibility, recognized as a pivotal determinant of travel behavior, has recently gained prominence within the research domain (Pot et al., 2021; Lättman et al., 2016, 2018; Curl, 2018; Van Wee et al., 2019). In a limited number of recent empirical studies, the role of perceived accessibility on travel satisfaction has been examined. However, these studies have focused solely on the direct relationship between these elements, without investigating how activity participation, which may be a more accurate predictor of life satisfaction, could mediate this relationship.

Individuals who perceive activities in their neighborhood to be easily accessible, might report more frequent visits to parks, community centers, and cultural venues, compared to those in less accessible areas. These activities might contribute to a richer, more fulfilling life experience, thereby enhancing life satisfaction. Consider a practical example: an urban resident with high perceived accessibility may easily walk to a local farmers' market, join a fitness class at a nearby gym, or attend social events at community hubs. These activities not only provide physical and mental health benefits but also foster social connections and a sense of community belonging. Conversely, a resident in an area with poor accessibility might struggle to engage in these beneficial activities, leading to lower levels of life satisfaction.

2.2. The effect of out-of-home activity participation on life satisfaction

Out-of-home activity participation encompasses the frequency and diversity of engaging in various activities, such as shopping, leisure activities, and social outings. These activities are essential components of daily life, contributing significantly to individuals' well-being. Theoretically, it can be hypothesized that accessibility facilitates participation in these activities (Levinson and King, 2020). As asserted by De Vos et al. (2013), engagement in out-of-home activities can, in turn, be expected to positively influence well-being or life satisfaction. Therefore, this connection suggests that the ability to easily reach desired destinations indirectly influences life satisfaction by enabling more frequent and diverse activity participation. From this theoretical perspective, activity participation might serve as a mediator in the relationship between perceived accessibility and life satisfaction. The concept of mediation in this context implies that perceived accessibility influences life satisfaction through its effect on the frequency and variety of activities individuals engage in. In this line, the Fundamental Model of Access developed by Levinson and King (2020) supports the notion that greater accessibility leads to increased activity participation. This activity participation might be subsequently linked to improved life satisfaction, as it may fulfil psychological needs for autonomy, competence, and relatedness (De Vos et al., 2013).

The importance of this mediating variable, activity participation, becomes evident when considering the multidimensional nature of well-being. Well-being is not solely determined by the ability to reach destinations but also by the quality and variety of experiences

gained through participation in various activities. Engaging in diverse activities enhances individuals' social networks, provides opportunities for skill development, and offers leisure and relaxation, all of which are critical for holistic well-being. Therefore, understanding the mediating role of activity participation has significant theory and policy applications. Incorporating activity participation as a mediating variable is important for a robust theoretical model. This approach addresses the conceptual gap between perceived accessibility and life satisfaction by providing a clear pathway through which accessibility influences well-being. Without an intermediary step, the direct link between accessibility and satisfaction might seem tenuous. Activity participation provides a tangible way through which accessibility translates into enhanced well-being. It can be expected that people with high levels of perceived accessibility will also be able to participate in out-of-home activities more often. Somewhat surprisingly, not a lot of studies have focused on this.

2.3. A direct relationship between perceived accessibility and life satisfaction

In addition to the mediating role of activity participation, it is also possible that perceived accessibility directly influences well-being. High levels of mobility or the capacity to be mobile may directly result in feelings of freedom, autonomy and independence (e.g., Flamm & Kaufmann, 2006; Nordbakke & Schwanen, 2014), which can positively influence life satisfaction. The augmentation of accessibility not only expands the range of available options but may also contribute to enhanced well-being, even if individuals do not actively utilize these options, as described by the concept of option value or motility (Geurs et al., 2006; Shliselberg and Givoni, 2018). A recent study conducted by Chaloux et al. (2019) included satisfaction in accessibility measures, conceptualizing that travel satisfaction as a main element of the psychology of travel can better capture the accessibility concept in transport. Chaloux et al. (2019) concluded that the inclusion of satisfaction in accessibility measures allows for a more nuanced interpretation of the ease of access. It can also be hypothesized that accessibility perceptions by certain travel modes might directly provide intrinsic values. In line with self-determination theory (Ryan, 2017), individuals may derive a sense of security, independence, and control simply from knowing they can access desired activities by a certain travel mode, even if they do not participate in these activities frequently. Therefore, such intrinsic values (accessibility perceptions) may directly enhance life satisfaction.

Life satisfaction is often understood to have two main components: an affective component, which reflects how people typically feel, and a cognitive component, which reflects how well people believe their desires have been fulfilled (Veenhoven, 2009). These two components are shaped by different mental processes. The affective component arises from a person's emotional experiences, which occur automatically without requiring conscious thought. The cognitive component, also called contentment, reflects the perceived gap between life circumstances and subjective standards (Veenhoven, 2009). Unlike affective experiences, this component requires conscious reflection. Veenhoven (2009) emphasizes that both components contribute to predicting overall happiness, or life satisfaction, which he defines as a distinct and comprehensive concept.

In this research, we hypothesize that the intrinsic value of accessibility primarily relates to the cognitive component of life satisfaction. We assume that people develop certain subjective standards with respect to their desired level of accessibility and can consciously evaluate one's perceived level of accessibility with these standards. In line with this line of reasoning we adopt a cognitive measurement scale to measure life satisfaction. Additionally, activity participation (possibly affected by perceived accessibility) may affect two other distinctions of well-being. Participation in activities may affect hedonic well-being as it may cause people to experience positive emotions. On the other hand, people may also perform out-of-home activities to realize goals and achieve personal growth, hence enhancing eudaimonic well-being (e.g., Ryan & Deci, 2001).

2.4. The conceptual model and research focus

The main contribution of this work is to investigate the empirical links between perceived accessibility, activity participation, and life satisfaction. The conceptual framework of the study is shown in Fig. 1. In the core of the model, the direct and indirect relationship between mode-specific perceived accessibility and life satisfaction are tested. Perceived accessibility by walking, cycling, public transport and cars is measured. For activity participation, the frequency of seven activities including grocery shopping, shopping, eating out, sports, visiting someone, a day trip, and other leisure activities is considered. Exogenous variables, such as the level of urbanity (the degree to which individuals live in urban or rural areas) and sociodemographic factors (e.g., age, gender, income), were included as controlling covariates for perceived accessibility, activity participation, and life satisfaction.

3. Method

3.1. The study area

This study focuses on the Netherlands as the context for examining the relationships between perceived accessibility across different travel modes, activity participation, and life satisfaction. With a population of over 17.5 million, the country displays one of the most advanced multimodal transportation systems in Europe. Around 27 % of all trips in the Netherlands are made by bicycle, reflecting the country's well-established cycling infrastructure (Martens, 2007). Cities like Amsterdam and Utrecht are renowned for

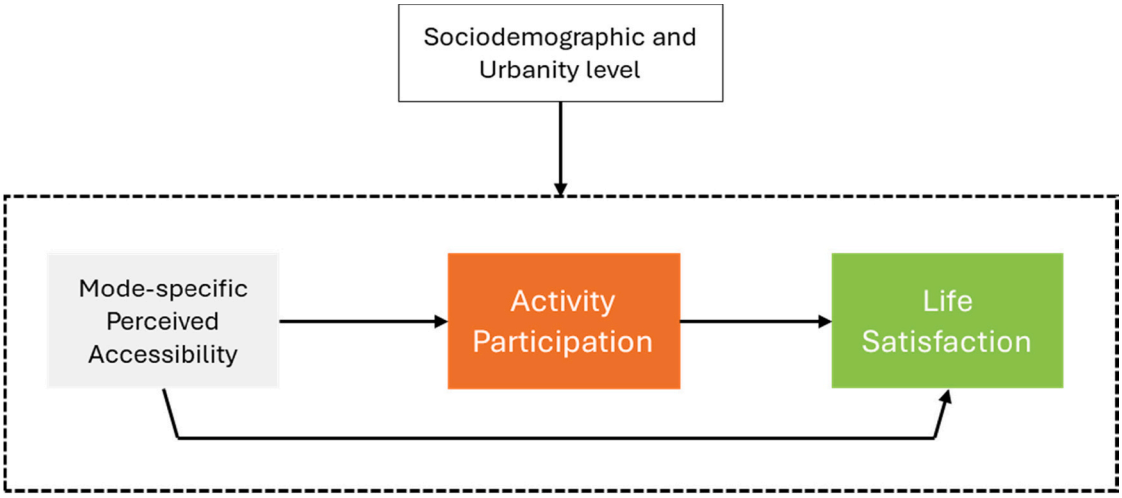

Fig. 1. The conceptual model.

their extensive bike lanes, with more than 35,000 km of dedicated cycling paths across the country (De Mulder et al., 2019). In 2021, the average Dutch citizen traveled approximately 0.6 km per weekday using urban public transit systems like buses, metros, and trams.[1] For intercity train passengers, this distance more than doubled. Statistics also show a steady increase in the degree of urbanization in the Netherlands from 2013 to 2023. By 2023, 93.18 % of the country's total population resided in cities,[2] enabling walking and cycling for many trips.

Additionally, studies show that Dutch residents generally rank high in life satisfaction, with the Netherlands consistently scoring above 7.5 out of 10 in international well-being surveys (Veenhoven, 2018). According to national travel surveys, participation in various travel activities, such as visiting people and doing shopping, is also relatively prevalent. Given this diverse transport infrastructure and levels of activity participation, the Netherlands offers a good opportunity to explore how residents' perceived accessibility can explain their engagement in daily activities, and, ultimately, their overall life satisfaction.

3.2. Sample

The data come from the latest wave of the Netherlands Mobility Panel (Mobiliteitspanel Nederland, MPN) in 2022. MPN is a monitoring program run by the KiM Netherlands Institute for Transport Policy Analysis (Hoogendoorn-Lanser et al., 2015). It gathers data on the travel behavior of a fixed group of individuals and households over multiple years. Since we aimed to test associations (correlations) between variables, we chose the most recent cross-sectional data from MPN. This dataset, from the post-COVID era, also provides up-to-date insights into various aspects of transport and perceived accessibility.

After refining the data by excluding respondents with too many missing values, and individuals younger than 12 years old, a total of 4,222 participants were included in the subsequent analyses. In our sample, 46.1 % of participants were man, 54.8 % were employed, and 34.2 % had college or university degrees. Approximately 20 % of the sample consisted of high-income residents, whose household gross income was at least twice the national benchmark (€73,000 to < €87,100 or higher). As shown in Table 1, the overall sample distribution closely aligns with the corresponding population distribution, although some deviations are present. In particular, young people are slightly underrepresented compared to the general population.

3.3. Measures

The following variables from the survey were used in this study. Age was measured for each respondent based on an interval answer scale ranging. Participants' gender (male/female), their educational attainments (whether they hold college/university degree or lower/other degrees), job status (employed versus unemployed), gross household income (relative income to the national benchmark income; € 29,500 – € 43,500) were also asked in the survey. The urbanity level (municipal level) was also measured by an interval scale ranging from (1) very strongly urban (2,500 or more area addresses per km2), (2) highly urban (1500 to 2500 area addresses per km2), (3) moderately urban (1000 to 1500 area addresses per km2), (4) sparsely urban (500 to 1000 area addresses per km2), and (5) non-urban (less than 500 area addresses per km2).

In the MPN survey, perceived accessibility by four different travel modes is measured by a single statement per mode stating, "my neighbourhood is easily accessible by car (PA_AUTO)/bicycle (PA_CYCLE)/public transport (PA_PT)/foot (PA_WALK)". A five-point

[1] https://www.statista.com/topics/11011/public-transportation-in-the-netherlands/#topicOverview.
[2] https://www.statista.com/statistics/276724/urbanization-in-the-netherlands/.

Table 1
The respondents' characteristics participated in the survey.

Variable	Category	Sample (%)	Population (%)[a]
Gender	Male	46.1	49.7
	Female	53.9	50.3
Age	12–17	1.9	7.5
	18–24	6.5	10.2
	25–29	5.5	7.4
	30–39	16.0	14.6
	40–49	15.9	13.6
	50–59	17.1	16.2
	60–69	18.4	14.1
	70–79	14.4	10.8
	80 and older	4.4	5.6
Job-status	Employed	54.8	59.1
	Other	45.2	40.9
Education	College or university degree	34.2	34.7
	Other	65.8	65.3

[a] Statistics Netherlands (2024).

Likert scale ranging from (1) strongly disagree to (5) strongly agree was used to evaluate the statements. Although this measure has been tested in past studies (e.g., Mehdizadeh and Kroesen, 2025), we do acknowledge that the statements have limitations as 1) we only have one statement per mode, and 2) the statements focus on the accessibility of the neighbourhood, rather than activities in the neighbourhood.

Frequency of participating in different activities including doing grocery shopping, shopping, eating out, sports, visiting someone, a day trip,[3] and leisure (other) activities, were asked from respondents. A six-point scale was employed to measure the frequency of activities ranging from (1) (almost) never, (2) 1 to 5 days per year, (3) 6 to 11 days per year, (4) 1 to 3 days per month, (5) 1 to 3 days per week, to (6) 4 or more days per week. Notably, the original answer scale was in reverse order, but for clearer interpretation of the results, we applied an ascending order in this study.

Life satisfaction was measured by an existing and validated instrument (Diener et al., 1985) that measures the cognitive component of subjective well-being, namely the Satisfaction with Life Scale (SWLS). The scale consists of five statements including "SWLS_S1 – In most cases, my life is almost perfect", "SWLS_S2 – My living conditions are excellent", "SWLS_S3 – I am satisfied with life", "SWLS_S4 – So far I have achieved the most important things in my life, and "SWLS_S5 – If I could start my life all over again, I would change almost nothing". These statements were assessed with a seven-point Likert scale ranging from (1) strongly disagree to (7) strongly agree.

3.4. Analysis approach

To test the conceptual model illustrated in Fig. 1, a structural equation model (SEM) was developed. The model consists of a structural part and a measurement part. In the measurement part, life satisfaction was measured as a latent variable including five indicators. Variance of error terms and covariances between error terms of endogenous variables were also considered in the model estimation. Before testing the model, the reliability of the latent variable scale (i.e., life satisfaction) was assessed using Cronbach's Alpha.

For the SEM, the maximum likelihood method was employed to estimate the model parameters. In SEM, several criteria are used to evaluate model fit, with specific thresholds indicating how well the model represents the data. The Chi-Square Test of Model Fit (χ^2) assesses the discrepancy between the observed and model-implied covariance matrices. However, due to its sensitivity to large sample sizes, it is often supplemented with other indices. The RMSEA (Root Mean Square Error of Approximation) measures the error of approximation and adjusts for model complexity, with values of RMSEA ≤ 0.05 indicating a close fit, $0.05 < \text{RMSEA} \leq 0.08$ reflecting a reasonable fit, and values above 0.08 indicating poor fit. The CFI (Comparative Fit Index) and TLI (Tucker-Lewis Index) compare the model to a baseline model, with CFI/TLI values ≥ 0.95 suggesting a good fit and values between 0.90 and 0.95 considered acceptable (Kline, 2023). Finally, the SRMR (Standardized Root Mean Square Residual) reflects the average discrepancy between observed and predicted correlations, where SRMR ≤ 0.08 denotes a good fit and SRMR ≤ 0.05 an excellent fit (Kline, 2023). Together, these indices provide a comprehensive assessment of model fit, with a good-fitting model typically meeting the thresholds for multiple indices. The model was tested both with Mplus and Stata.

[3] A day trip (in Dutch: een dagje uit) is better translated in English as "a day out." It refers to a recreational outing to an attraction, such as a theme park or museum.

4. Results

Descriptive statistics of the model variables are presented in Table 2.[4] Overall, respondents reported relatively high perceived accessibility across different travel modes. Notably, perceived accessibility by bicycle received the highest score (Mean = 4.55), while perceived accessibility by public transport had the lowest score (Mean = 3.63). Among the seven activity types, grocery shopping was reported as the most frequent activity (Mean = 4.71), whereas activities such as eating out (Mean = 2.98) and taking a day trip (Mean = 2.89) were the least frequent. Regarding life satisfaction, the third indicator, "I am satisfied with life" (SWLS_S3), had the highest mean score (5.26). Around 20 % of the respondents reported their household annual gross income is at least twice or more than the national benchmark income. The frequency analysis across various urbanity categories reveals that 22.8 % of respondents reside in very strongly urban areas, 32.5 % in highly urban areas, 15.7 % in moderately urban areas, 21.7 % in sparsely urban areas, and the remaining 7.2 % in non-urban areas.

Cronbach's Alpha indicates high reliability for the life satisfaction scale ($\alpha = 0.89$). The structural equation model, which includes all direct and indirect effects as shown in Fig. 1, produced satisfactory fit indices ($\chi2 = 932.335$, $p < 0.001$, CFI = 0.967, TLI = 0.902, RMSEA = 0.053, SRMR = 0.019). The model's overall R-squared is 37 %, while the R-squared for life satisfaction, the final outcome variable, is around 11 %. This suggests that the predictors account for only a modest portion of the variance in life satisfaction. This is reasonable, as life satisfaction is influenced by a wide range of factors beyond mobility-related aspects, and the variables in the model represent just one part of this broader context. However, the model reveals several statistically significant direct and indirect relationships between perceived accessibility, activity participation, other exogenous variables (such as sociodemographic characteristics and urbanity level) and life satisfaction. Overall, the direction of these relationships aligns with both common sense and existing literature.

The parameter estimation results for the structural part of the model, including standardized regression weights, are provided in Table 3. The results for the measurement model, along with the variances of error terms and the covariances between the error terms of endogenous variables, can be found in Table A in the appendix. The measurement model shows satisfactory results, with relatively high and statistically significant indicators.

To maintain parsimony and focus on the core relationships, those between perceived accessibility, activity participation, and life satisfaction, Fig. 2 highlights the standardized regression weights for the statistically significant links. The results indicate that perceived accessibility by car has a direct effect on grocery shopping ($\beta = -0.09$, $p < 0.001$) and on life satisfaction ($\beta = 0.07$, $p < 0.01$). Similarly, perceived accessibility by bicycle also has a direct (and positive) effect on grocery shopping ($\beta = 0.06$, $p < 0.01$) and life satisfaction ($\beta = 0.06$, $p < 0.01$). Perceived accessibility by foot positively impacts a few activity participations, including sports ($\beta = 0.05$, $p < 0.05$), visiting someone ($\beta = 0.09$, $p < 0.001$), and leisure trips ($\beta = 0.05$, $p < 0.05$). Perceived accessibility by public transport positively impacts participation in grocery shopping ($\beta = 0.04$, $p < 0.01$) and negatively impacts leisure activities ($\beta = -0.04$, $p < 0.05$). Regarding the relationship between activity participation and life satisfaction, engagement in sports ($\beta = 0.07$, $p < 0.001$), visiting someone ($\beta = 0.08$, $p < 0.001$), taking day trips ($\beta = 0.10$, $p < 0.001$), and leisure trips ($\beta = 0.03$, $p < 0.05$) all positively affect life satisfaction.

Regarding the associations of gender, age, job status, education, income, and urbanity level with perceived accessibility, activity participation, and life satisfaction, no gender differences were found in perceived accessibility across different modes of transport. Older individuals reported higher perceived accessibility by car, bicycle, and walking. Job status did not statistically influence perceived accessibility by any mode. Highly educated individuals were more likely to report higher perceived accessibility by bicycle, while income did not have a statistically significant impact on perceived accessibility. People living in non-urban areas were less likely to report higher perceived accessibility by public transport and walking, but were more likely to report higher perceived accessibility by car.

Women are more likely than men to participate in grocery shopping, general shopping, visiting others, and leisure trips. Older individuals are more likely to engage in doing groceries, while younger individuals are more active in other activities, such as shopping, eating out, sports, visiting others, and taking day trips. Employed individuals are more likely to participate in grocery shopping, eating out, and day trips, but are less likely to engage in leisure trips. Those with higher education levels tend to participate in activities like grocery shopping, eating out, sports, day trips, and leisure trips more frequently than those with lower education levels. Higher-income individuals are more likely to frequently engage in eating out, sports, and day trips compared to lower-income groups. Additionally, people living in urban areas are more likely to frequently participate in grocery shopping, general shopping, eating out, and day trips compared to those living in non-urban regions.

Men tend to report greater life satisfaction than women, and older individuals are generally happier compared to younger ones. Additionally, life satisfaction is higher among those who are employed, have higher household incomes, and live in non-urban areas. As shown in Fig. 3, further investigation into the direct and indirect effects of perceived accessibility on life satisfaction through activity participation reveals that perceived accessibility by car and bicycle has only direct, positive effects on life satisfaction, with no mediation by activity participation. In contrast, higher perceived accessibility by foot is associated with greater life satisfaction only indirectly, through its influence on activity participation. However, perceived accessibility by public transport does not explain life satisfaction either directly or indirectly.

[4] The descriptives of age, gender, education, and job status are reported in Table 1.

Table 2
Descriptive statistics of the variables (n = 4,222).

	Minimum	Maximum	Mean	Std. Deviation
Perceived accessibility				
PA_AUTO	1	5	4.41	0.792
PA_CYCLE	1	5	4.55	0.695
PA_PT	1	5	3.63	1.201
PA_WALK	1	5	4.41	0.810
Activity participation				
Grocery shop	1	6	4.71	1.111
Shopping	1	6	3.24	1.189
Eating out	1	6	2.98	1.188
Sports	1	6	3.00	1.944
Visit	1	6	3.97	0.980
Day trip	1	6	2.89	1.017
Leisure	1	6	3.00	1.708
Life satisfaction				
SWLS_S1	1	7	4.81	1.345
SWLS_S2	1	7	5.12	1.279
SWLS_S3	1	7	5.26	1.221
SWLS_S4	1	7	4.91	1.287
SWLS_S5	1	7	4.43	1.511
Being high income	0	1	0.20	0.401
*Urbanity (level)**	1	5	2.58	1.251

* (1) very strongly urban, and (5) non-urban.

5. Discussion

One of the key takeaways is that perceived accessibility by different travel modes influences well-being in distinct ways. Perceived accessibility by car and bicycle has a direct positive effect on life satisfaction, while perceived accessibility by walking improves well-being indirectly, through increased out-of-home activity participation. Meanwhile, public transport accessibility shows no links to life satisfaction, raising important questions about how people experience and value accessibility by different travel modes in their daily lives.

A notable finding is that simply perceiving good access by car or bicycle appears to enhance life satisfaction, even without necessarily frequently participating in various out-of-home activities reached by these modes (e.g., groceries, sports, eating out, visiting friends). This suggests that people may associate these modes with a sense of independence, convenience, or security, as also found by Singleton (2019), which directly contributes to their well-being. This might reflect the psychological comfort of knowing one has easy access to a car or bike, regardless of how often they actually use it to participate in activities. This might suggest that accessibility by certain travel modes can hold intrinsic psychological value. This aligns with self-determination theory (Ryan, 2017), which emphasizes autonomy as a fundamental human need. The ability to move freely, or the capacity to be mobile, may increase a sense of autonomy (Flamm & Kaufmann, 2006), reinforcing well-being regardless of actual travel behavior. This finding also aligns with research on the positive utility of travel, suggesting that people may derive value from certain aspects of travel and do not always seek to minimize travel time (e.g., De Vos et al., 2013; Redmond & Mokhtarian, 2001; De Vos, 2019b).

In general, the findings suggest that perceived accessibility by personally owned travel modes (car and bicycle) may serve as a psychological and social resource for enhancing life satisfaction. For example, regarding car ownership, in a relatively old study, Gärling et al. (2002) argued that since participating in activities contributes to well-being and many urban areas are built around car use, owing a car can be important for maintaining daily routines. A reduction in car access could therefore limit activity participation and negatively impact well-being, especially for those who rely on it the most. This finding partially supports Lättman's (2018) definition of perceived accessibility, particularly for personally owned travel modes, which describes it as "how easy it is to live a satisfactory life with the help of the transport system".

On the other hand, walking accessibility works differently as it encourages people to engage in social and recreational activities (sport, visits, leisure), which then results in greater life satisfaction. This highlights the value of walkable environments (De Vos et al., 2025), not just for mobility but for supporting meaningful daily activities that enhance quality of life. Public transport accessibility, however, tells a different story. Public transport does not seem to directly or indirectly influence life satisfaction, and higher perceived accessibility by public transport is associated with fewer leisure trips. This could mean that while public transport is useful for utilitarian travel, it may not provide non-use values. Factors like service reliability and access whenever needed at a moment's notice, could be playing a role in shaping how people experience accessibility by public transport beyond just proximity to a train station or bus stop.

As expected, people who participate more frequently in out-of-home activities, especially sports, social visits, and leisure trips, tend to report higher life satisfaction. Interestingly, day trips (e.g., routine outings) had the strongest link to well-being, which suggests that having frequent, everyday engagements might contribute to a sense of purpose and structure in life. This likely suggests that, for some people, regular activity participation can enhance their well-being regardless of how easy or difficult their accessibility is. Among different modes, perceived accessibility by foot was the only one that could have an indirect effect on life satisfaction through these

Table 3
Estimations of standardized regression weights for the structural model part.

	Dependent variable											
	PA_AUTO	PA_CYCLE	PA_PT	PA_WALK	Grocery shopping	Shopping	Eating out	Sports	Visit	Day trip	Leisure	Life satisfaction
Exogenous variables												
Gender (Male = 1)	0.01	−0.01	0.03	0.01	−0.15 ***	−0.15 ***	−0.02	−0.02	−0.10 ***	−0.02	−0.04 **	0.04 **
Age	0.09 ***	0.09 ***	0.01	0.11 ***	0.18 ***	−0.04 *	−0.16 ***	−0.16 ***	−0.13 ***	−0.15 ***	0.02	0.13 ***
Employed	0.02	0.01	−0.02	−0.02	0.04 *	0.02	0.08 ***	0.02	−0.01	0.12 ***	−0.05 **	0.12 ***
Highly educated	0.02	0.04 **	−0.01	−0.01	0.08 ***	−0.02	0.06 ***	0.11 ***	0.02	0.06 ***	0.05 **	0.02
High income	−0.01	0.02	−0.01	0.02	−0.03 *	0.02	0.10 ***	0.07 ***	0.01	0.06 ***	−0.01	0.10 ***
Urbanity	0.11 ***	0.04 **	−0.30 ***	−0.05 ***	−0.04 **	−0.05 ***	−0.08 ***	−0.02	0.03	−0.03 *	0.01	0.03 *
Perceived accessibility												
PA_AUTO	—	—	—	—	−0.09 ***	−0.03	−0.02	−0.01	0.01	−0.01	0.01	0.07 ***
PA_CYCLE	—	—	—	—	0.06 **	0.01	0.04	0.02	0.01	−0.04	0.01	0.06 *
PA_PT	—	—	—	—	0.04 **	0.03	0.03	−0.01	−0.03	0.03	−0.04 *	−0.01
PA_WALK	—	—	—	—	0.01	0.03	−0.02	0.05 *	0.09 ***	0.03	0.05 *	0.03
Activity participation												
Grocery shopping	—	—	—	—	—	—	—	—	—	—	—	−0.01
Shopping	—	—	—	—	—	—	—	—	—	—	—	0.03
Eating out	—	—	—	—	—	—	—	—	—	—	—	0.02
Sports	—	—	—	—	—	—	—	—	—	—	—	0.07 ***
Visit	—	—	—	—	—	—	—	—	—	—	—	0.08 ***
Day trip	—	—	—	—	—	—	—	—	—	—	—	0.10 ***
Leisure	—	—	—	—	—	—	—	—	—	—	—	0.03 *
_cons	5.01 ***	6.12 ***	3.62 ***	5.20 ***	3.70 ***	2.90 ***	2.92 ***	1.70 ***	3.98 ***	3.31 ***	1.52 ***	—

*p < 0.05 **p < 0.01 ***p < 0.001.

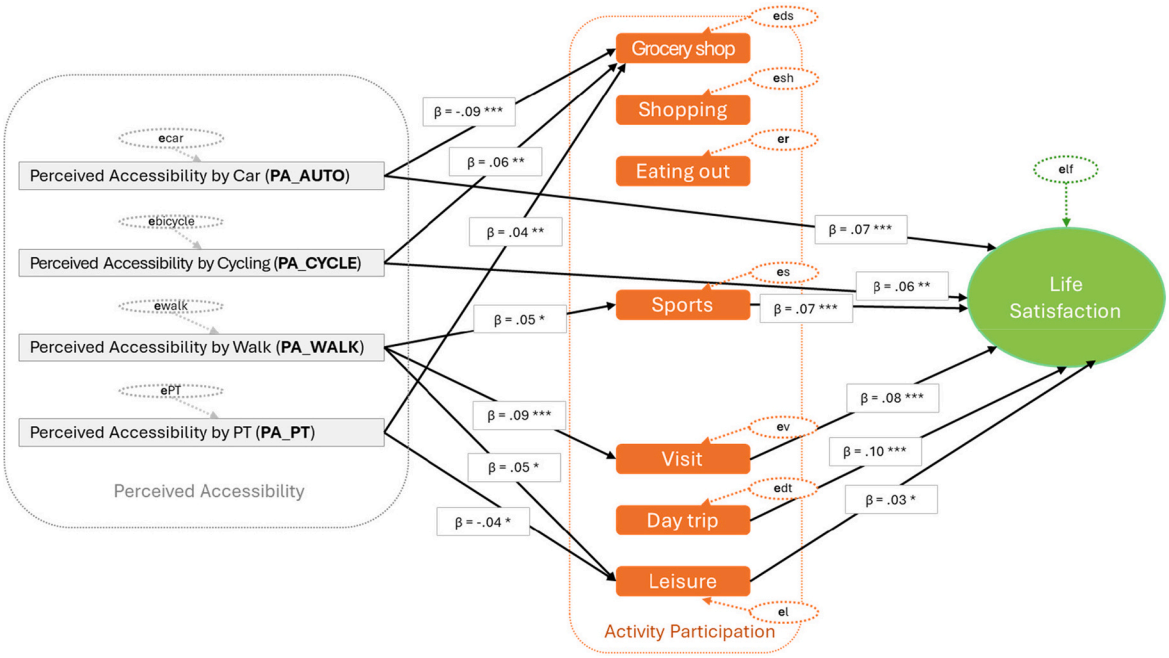

Fig. 2. Standardized regression weights (SEM results) for the core part of the model. *Note: Insignificant paths involving perceived accessibility, activity participation, and life satisfaction, as well as exogenous variable weights, are not shown. The full results can be found in* Table 3 *and Table A (measurement model and covariances).*

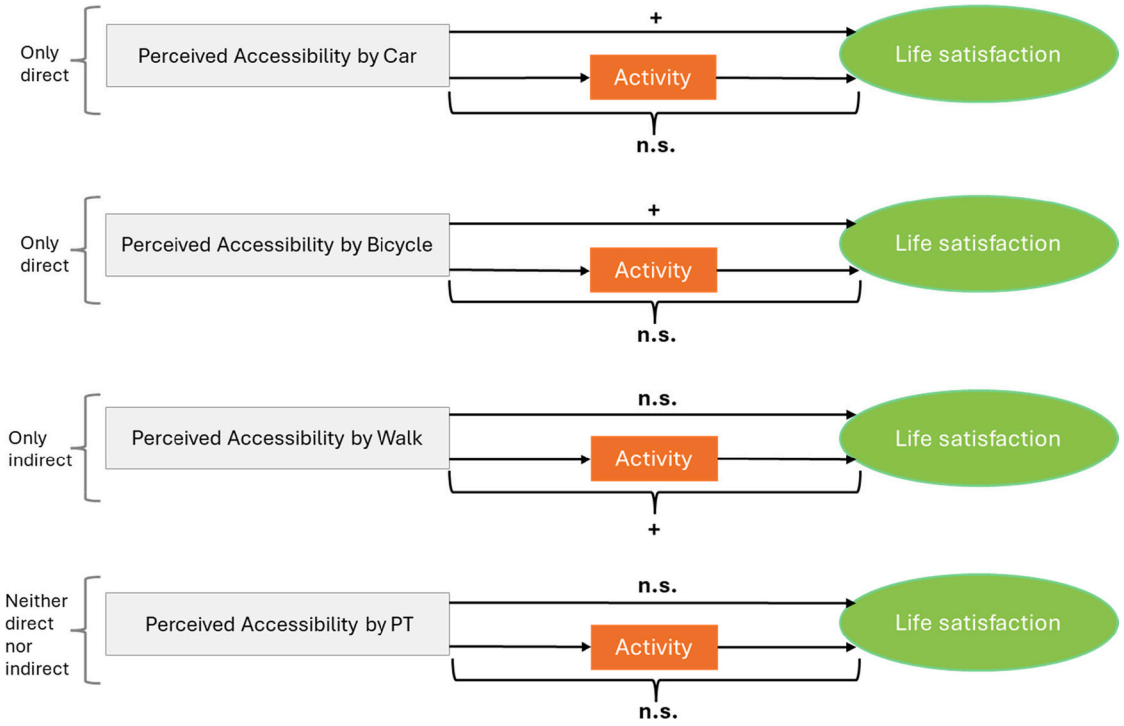

Fig. 3. Direct and indirect effects of perceived accessibility on life satisfaction (+ means a positive and statistically significant effect, n.s. means not significant effect).

activities. However, further insight shows that the unique contribution of perceived accessibility by foot to activity participation in this chain link is very small. To examine the extent to which these activities actually stem from perceived accessibility by foot, increases in explained variances (i.e., higher R-squared values compared to other predictors) are considered when the accessibility variable is added to their specific regressions in the SEM (as reported in Table 3). The increased R-squared values show that, compared to other sociodemographic variables, the unique contribution of perceived accessibility by foot to sports, social visits, and leisure trips is 0.3 %, 0.8 %, and 0.2 %, respectively. Notably, the total explained variances for sports, social visits, and leisure trips are 6.1 %, 3.2 %, and 1.0 %, respectively. This might challenge the mediating role of activity participation between perceived accessibility and life satisfaction. The findings also highlight how age, gender, and location shape both accessibility perceptions and travel behaviors. Older individuals report better accessibility by car, bicycle, and walking, possibly because of their longer familiarity with their surroundings. People in urban areas feel they have better access to public transport and walking routes but report lower car accessibility, pointing to the trade-offs of living in different environments. In terms of activity participation, women are more likely than men to participate in routine activities like shopping and social visits, while younger people engage more in social and recreational outings. Interestingly, men report higher life satisfaction than women, and older individuals tend to be happier than younger ones, patterns that align with broader research on well-being (De Vos, 2019a). Life satisfaction is also higher among those with jobs, higher incomes, and those living in non-urban areas, suggesting that economic stability and lifestyle factors play an important role in shaping happiness.

6. Conclusion

This study sheds light on how perceived accessibility, activity participation, and life satisfaction are connected. This study highlights that (perceived) accessibility influences well-being in different ways depending on the travel mode. Car and bicycle accessibility provide intrinsic values to people that directly enhances life satisfaction, while walking accessibility encourages more activity participation, which in turn improves well-being. Public transport accessibility, however, shows no effects, suggesting the need for deeper exploration into how people experience and perceive public transport systems. By understanding these dynamics, we can create transport environments that not only improve mobility but also support happier, healthier, and more engaged communities. In order to increase levels of out-of-home activity participation, and hence improve people's well-being, it is important that future studies analyze the determinants of perceived accessibility in detail. It would be particularly interesting to know which built environment characteristics, both macro scale (e.g., population density and land-use mixture) and micro scale (e.g., street design, street furniture), influence perceived accessibility. By doing so, policymakers and urban planners could stimulate activity participation by making adjustments to the characteristics and design of the built environment.

Our study has important takeaways for city planners and policymakers. Our finding regarding perceived car accessibility serves as an important counterweight to environmentally motivated policies that aim to discourage car use, such as taxation or driving restrictions. While such policies are often necessary to address sustainability goals, they may inadvertently reduce the well-being of individuals who depend on intrinsic values of car access. However, the situation differs for modes which cannot be privately owned. In the case of walking, improving neighborhood walkability can indirectly enhance well-being by promoting greater participation in out-of-home activities. The study reinforces the idea that walkability is ultimately about enabling people to live fuller, more engaged lives. Instead of just focusing on travel times or congestion, transport policies should aim to make walking easier for people to engage in activities that matter to them, whether that is running errands, socializing, or enjoying leisure time. The lack of link between public transport accessibility and life satisfaction suggests that improving public transport goes beyond just increasing coverage. Enhancing comfort, reliability, and flexibility might make public transport a more attractive and satisfying option.

The concept of perceived accessibility is relatively new and has attracted growing attention, particularly over the past two years. Consequently, researchers have employed slightly different measures to capture this construct. This variability raises an important question: do different types of perceived accessibility influence activity participation and overall life satisfaction in distinct ways? Future research could explore this by testing various measures of perceived accessibility within the current analytical framework. However, an ideal first step would be to establish a unified definition and standardized measurement of perceived accessibility, which could then be rigorously tested in studies like the present one. An ideal measure of accessibility should reflect the ease of access to activities or destinations, either in general or via specific modes of transport. However, the data used in our study measures the accessibility of the neighbourhood, rather than activities in the neighbourhood. That said, considering emerging planning concepts such as 15-minute cities, the measure available in the MPN dataset, despite its limitations, can still offer meaningful insights into accessibility to activities within neighborhoods. We believe that future planning policies would emphasize localized accessibility measures, especially with the rise of "x-minute cities," to ensure broader access to daily activities across different neighborhoods. In this context, we maintain that the current measure in this study remains valuable for exploring the relationship between accessibility, activity participation, and well-being. As asserted by relevant studies (e.g., Mogaji and Nguyen, 2021), we also acknowledge that future research should consider people with disabilities who are not able to access the available transport infrastructure, who are unable to cycle or even engage with the built environment in the modeling framework. We also emphasize the need for future research in diverse settings, both developed and developing countries, to evaluate the generalizability of the findings. In particular, studies should be extended to regions with lower population densities and potentially less-developed transport infrastructure.

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CRediT authorship contribution statement

Milad Mehdizadeh: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maarten Kroesen:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Jonas De Vos:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Conceptualization.

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.

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Appendix A. Supplementary data

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