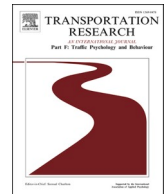




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Measuring commuting satisfaction: validation of the commuting satisfaction scale in the Australian context

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ABSTRACT

Commuting satisfaction is an important sub-domain of subjective well-being, with commuting dissatisfaction linked to lower well-being and negative spillovers into other life domains. Valid and comprehensive measures of commuting satisfaction are therefore imperative. The Commuting Satisfaction Scale (CSS) is designed to assess satisfaction across seven core aspects of commuting. It is intended for use in a variety of settings, including different travel modes, distances, and urban and rural environments. However, the CSS has only been validated once, in a selective sample of commuters in large cities worldwide during the pre-pandemic period. This limits the generalisability and transferability of the findings. Using data from 2107 workers from three waves of the Melbourne Institute–Roy Morgan Taking the Pulse of the Nation (TTPN) survey in Australia, this study validates the CSS for the first time in a general population survey from the post-pandemic period. We employ multiple validation tests, including internal consistency testing, exploratory factor analysis, and assessments of construct and criterion-related validity. Results indicate a one-factor structure with high internal consistency across travel modes and residential contexts. Commuters are most satisfied with safety from crime and least with crowding. Commuting satisfaction is higher among physically active (i.e., walking or cycling) and rural commuters. Longer commuting times are associated with lower commuting satisfaction. Higher commuting satisfaction correlates with lower mental distress and job leaving intentions, but higher life and job satisfaction. These findings provide supportive evidence that the CSS is a reliable and valid instrument in various commuting contexts.

1. Introduction

Commuting, which is characterised by routine journeys between the home and the workplace, represents a time-consuming activity

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that is an integral part of individuals' daily routines. Many commuters are unhappy with their commute (e.g., Ye et al., 2020), and commuting is seen as one of the least enjoyable parts of the day (Adam et al., 2018; Morris et al., 2020). The adverse impacts of commuting, including elevated health concerns and stress levels (e.g., Botha et al., 2026; Chen et al., 2024; Murphy et al., 2023), diminished worker productivity and elevated absenteeism rates (e.g., De Reuver and Biron, 2024; Ma and Ye, 2019), as well as environmental degradation (International Energy Agency, 2021), traffic congestion (Xu et al., 2024), and intricate infrastructure planning (Taillanter and Barthelemy, 2023), underscore the necessity of studying this issue comprehensively.

Commuting satisfaction is considered a sub-domain of overall subjective well-being (SWB) (e.g., Chatterjee et al., 2020). Research has shown that commuting satisfaction affects individuals' job satisfaction, health, and SWB (e.g., Li et al., 2024; Maheshwari et al., 2024a). Moreover, dissatisfaction with the commute may influence major life decisions, for example, contributing to subsequent workplace changes or residential relocation (Maheshwari et al., 2024b). Additionally, commuting satisfaction may shape individuals' commuting behaviours and patterns, such as the choice of transport modes. Consequently, research on this issue has garnered growing interest among scholars, policymakers, and traffic and infrastructure planners aiming to improve travel quality and commuting experiences.

To determine which aspects of commuting are more or less satisfactory and how this varies by transport mode, commuting satisfaction measures must capture individuals' satisfaction with key aspects of their commute across different travel modes. This was a major limitation of previous commuting satisfaction measures, such as the Satisfaction with Travel Scale (STS) (Ettema et al., 2011) and the McGill Commuter Survey (Fordham et al., 2018; Legrain et al., 2015; St-Louis et al., 2014). Whereas the STS does not assess satisfaction with specific aspects of commuting, the McGill Commuter Survey does not consistently assess satisfaction with various commuting aspects across transport modes.

The recently introduced Commuting Satisfaction Scale (CSS) (Rüger and Bischof, 2025) addresses these limitations. It covers seven key aspects of commuting satisfaction (duration, comfort, crowding/congestion, reliability, safety from crime, risk of accidents and the behaviour of others) using consistent item wording across all travel modes. The first validation of this new measure was conducted with a sample of German Foreign Service (GFS) employees working in various locations around the world (Rüger and Bischof, 2025). The results showed that the CSS had a one-factor structure and high reliability. The CSS was highly correlated with key predictors and outcomes of commuting satisfaction. Specifically, longer commute duration and length were associated with lower commuting satisfaction, whereas higher commuting satisfaction correlated with greater SWB, better health, and lower stress levels. These findings indicate high construct and criterion-related validity for the CSS. Notably, its strong validity holds across different transport modes (public transport, car, bike/foot) and continents, underscoring its broad applicability as a valid measure of commuting satisfaction.

Although the new CSS has demonstrated strong validity, several issues warrant further examination. To date, the CSS has been validated only once. Although this initial validation offered valuable insights and established the CSS as a valid and reliable measure of commuting satisfaction, questions remain about the generalisability and transferability of the scale. The sampled group was unique and selective, comprising GFS employees mainly working abroad and representing specific occupational groups, making it unrepresentative of broader or local working populations. Consequently, it is unclear whether the strong validity of the CSS extends to more heterogeneous and representative samples. Furthermore, the initial validation of the CSS was conducted in 2019, before the COVID-19 pandemic. However, the pandemic substantially altered individuals' commuting behaviour, including the use of various travel modes, and changes in commuting distances and frequency (e.g., Aaditya and Rahul, 2023; Chen et al., 2023; Wang et al., 2025), as well as their satisfaction with different aspects of travel (e.g., Sun et al., 2022). These changes may also have influenced how individuals assess their commuting satisfaction, raising questions about the continued applicability of pre-pandemic findings in a post-COVID-19 context.

Another key limitation of the initial validation of the CSS is that it relies on respondents primarily working in large cities worldwide, restricting its scope to commuting satisfaction in metropolitan contexts. However, commuting conditions and satisfaction can differ significantly between urban and rural areas (e.g., Maheshwari et al., 2022), which is particularly true for specific aspects of the commute. Consequently, the high validity demonstrated in metropolitan settings may not necessarily apply to non-metropolitan regions. This raises questions about the generalisability of the CSS to rural contexts.

These limitations highlight the need to validate the CSS in a broader setting. Key questions include: Does the CSS perform well in both rural and urban areas? Are there notable differences in overall commuting satisfaction and its individual aspects between these spatial areas and between transport modes? Finally, is the CSS still valid in the context of different commuting patterns following the COVID-19 pandemic?

We address these questions by validating the CSS using recent data from three waves of the Melbourne Institute–Roy Morgan Taking the Pulse of the Nation (TTPN) survey in Australia, conducted between April 2024 and March 2025. The TTPN survey is based on a general population sample of individuals living in Australia from both urban and rural areas, including workers from various occupational groups across the country. Consequently, this validation uses a more diverse sample of commuters, which supplements the results of Rüger and Bischof's (Rüger and Bischof, 2025) initial validation.

Australia is a particularly interesting case with regard to commuting, as it includes both metropolitan areas and sparsely populated rural regions. Commuting is a highly salient issue in Australia, where according to Household, Income and Labour Dynamics in Australia (HILDA) Survey data, the average worker spent 3.8 hours per week commuting in 2023 — equivalent to 52 minutes per working day (Laß et al., 2025). Compared to other industrialised countries (Eurostat, 2020), Australia's commuting times are notably long. They have also increased significantly over time, rising from 3.7 hours per week in 2002 to 4.6 hours in 2019 (Laß et al., 2025). The onset of the COVID-19 pandemic temporarily reduced commute times due to increased remote work, but these times rose again by 0.2 hours between 2021 and 2023. As more workplaces call employees back to the office (NSW Government, 2024), commuting times are expected to increase further.

2. Data and methods

2.1. Data and sample

The data came from the cross-sectional Melbourne Institute–Roy Morgan TTPN survey ([Melbourne Institute, 2025](#)). The TTPN began in April 2020 and surveyed Australians about how they were doing during the COVID-19 pandemic. It collected information on topics such as mental distress, financial distress, vaccine hesitancy, and attitudes towards public health measures. After the pandemic, the focus of the TTPN shifted more towards being a monthly survey of current social and economic policy issues.

The TTPN is based on a stratified sample of the general Australian population, with respondents sampled from 514 sampling areas of approximately equal size based on a selection probability proportional to age, gender, and residential location in order to achieve national representativeness.

Ethics approval for the survey was provided by the University of Melbourne Human Research Ethics Committee (approval ID: 2024-23376-61169-5). The TTPN was administered online, based on a managed online group of survey respondents who have given their

Table 1
Overview of the sample composition.

	N	Relative share (%) ^a
Sex		
Male	1063	50.45
Female	1027	48.74
Diverse	17	0.81
Age		
Below 35 years	754	35.79
35–49 years	743	35.26
50–64 years	523	24.82
65 years or older	87	4.13
Highest level of education		
Less than bachelor's degree	715	34.11
Bachelor's degree or higher	1381	65.89
Partnership status		
Not partnered	791	37.88
Partnered	1297	62.12
Children under 18 living in the household		
No children	1343	63.74
Children	764	36.26
Country of birth		
Not born in Australia	385	18.27
Born in Australia	1722	81.73
Occupational Group		
Professionals	548	28.38
Managers	169	8.75
Technicians and trades workers	153	7.92
Community and personal service workers	408	21.13
Clerical and administrative workers	311	16.11
Sales workers	149	7.72
Machinery operators and drivers	119	6.16
Labourers	74	3.83
State		
New South Wales	586	27.81
Australian Capital Territory	70	3.32
Northern Territory	15	0.71
Victoria	605	28.71
Queensland	395	18.75
South Australia	157	7.45
Western Australia	224	10.63
Tasmania	55	2.61
Residential area		
Urban	1486	70.53
Rural	621	29.47
Transport mode		
Public transport	474	22.50
Car	1505	71.43
Bike/foot	128	6.07
Wave		
April 2024	558	26.48
October 2024	1046	49.64
March 2025	503	23.87

Notes: N = 2107, except for highest level of education (N = 2096), partnership status (N = 2088), and occupational group (N = 1931). ^aDue to rounding effects, there may be some deviations.

consent to be contacted and answer surveys from Roy Morgan on a regular basis, including the TTPN survey. In addition, respondents had to provide their consent in each survey participated in. Participation was entirely voluntary; respondents could withdraw from the survey at any time and could also ask for any unprocessed data to be deleted. As part of the TTPN survey's approved Distress Protocol, all respondents were provided with the contact details of relevant well-being support structures, if required. Completely de-identified data were stored in the Melbourne Institute Data Lab (MIDL), a secure virtual environment housed within the Melbourne Institute. All collected anonymised data were transferred securely into MIDL by a pre-approved Roy Morgan representative.

The TTPN survey utilises a repeated cross-sectional design with a typical sample size of slightly more than 1000 respondents per monthly wave. We used three waves of the TTPN, conducted in April 2024, October 2024, and March 2025, as these waves included the relevant CSS questions. The October 2024 wave had a comparatively large sample size of about 2000 respondents, as it surveyed twice as many respondents as usual. Together, these waves yielded a pooled sample of more than 4000 respondents. Importantly, the CSS was only administered to individuals who were currently employed and did not work exclusively from home. From an original sample of 2569 employed respondents, we excluded 462 respondents who did not complete all questions on the CSS. Our final analytical sample consists of 2107 respondents pooled across the three survey waves.

The respondents represent a diverse range of occupational groups and come from all Australian states and territories (see Table 1). Most respondents commute by car (71.43%), followed by public transport (22.50%), while only a minority engages in physically active commuting by bike or on foot (6.07%). This reflects Australia's commuting landscape, which is characterised by extensive car use and low rates of physically active commuting (Australian Bureau of Statistics, 2022). Moreover, the sample includes individuals from both urban and rural areas, with most residing in urban areas (70.53%) and 29.47% residing in rural areas.

2.2. The commuting satisfaction scale (CSS)

The CSS comprises seven key aspects of commuting satisfaction: duration, comfort, crowding/congestion, reliability, safety from crime, risk of accidents, and the behaviour of others (for a detailed theoretical foundation and scale development, see Rüger and Bischof, 2025). Respondents rate their satisfaction with each aspect of their commute using their main transport mode on a five-point Likert scale, ranging from 1 'very bad', 2 'bad', 3 'neither bad nor good', 4 'good' to 5 'very good' (see Table 2).

Compared to the original version, the scale used in this paper has been slightly modified and simplified. Originally, each item was worded and measured separately across three transport modes (car, public transport, walking/cycling), but the revised version uses identical wording across all modes. This enhances comparability and facilitates survey implementation. Section B of the Supplementary Material provides full documentation of the CSS measurement instrument, including item wording, response scales, filter procedures, and detailed information on its implementation.

2.3. Other variables

The CSS's validity and applicability across different travel modes and geographical regions are assessed using respondents' transport mode and residential area. Respondents could report eleven different *transport modes*, which we summarised into three broader categories: public transport, car, and bike/foot. Travel by bus, tram/light rail, train, and ferry was combined into the category 'public transport'. The category 'car' consists of travel by car, truck, motorcycle/moped, and taxi/ride-share. This category includes mainly car drivers but also some motorcycle users. We grouped them together because both modes of commuting represent different types of motorised private transport. The third category 'bike/foot' consists of bicycle/e-bicycle, e-scooter, and walking.

We consider the *region of residence* by broadly differentiating between urban and rural regions. Urban areas cover respondents who live in the Australian Capital Territory, Sydney, Melbourne, Brisbane, Adelaide, Hobart, or Perth. Rural areas cover respondents who live in New South Wales excluding Sydney, Victoria excluding Melbourne, Queensland excluding Brisbane, South Australia excluding Adelaide, Tasmania excluding Hobart, Western Australia excluding Perth, or the Northern Territory. Table S1 in the Supplementary Material, Section A contains the exact question upon which this classification of urban and rural areas is based. The response options align with the Greater Capital City Statistical Areas (GCCSA) classification used by the Australian Bureau of Statistics (Australian Bureau of Statistics, 2025), except that the city of Darwin was not distinguished from the rest of the Northern Territory due to its relatively small population size compared to the other capital cities.

Additionally, key predictors (commute duration) and outcomes (mental distress, life satisfaction, job satisfaction, and job leave intention) of commuting satisfaction were used to assess the construct and criterion-related validity of the CSS. *Commute duration* refers to the typical total daily commute time in minutes. *Mental distress* was measured by asking how often respondents felt depressed or anxious during the past week. Response options on the five-point scale were 'none of the time', 'a little of the time', 'some of the time', 'most of the time', and 'all the time', with higher values indicating greater mental distress.⁵ *Life satisfaction* and *job satisfaction* were both assessed on an eleven-point scale ranging from 'completely dissatisfied' to 'completely satisfied', asking respondents how satisfied they are with their life and with their job, respectively, all things considered. *Job leave intention* was captured by asking respondents to estimate, in percent, the likelihood that they will voluntarily leave their job within the next 12 months, ranging from 0% ('no chance') to 100% ('absolute certainty'). The measures for commute duration, life satisfaction, job satisfaction, and job leave intention are based on the same or similar questions in the HILDA Survey.

⁵ See Botha et al. (Botha et al., 2022) for a more general description and validation of this measure against the Kessler-6 scale.

Table 2
Survey instrument CSS.

Thinking about your commute to work using your <u>main mode</u> of transport: How do you evaluate your commute to work regarding the following?
- The amount of time it takes to get to work.
- Comfort (e.g., amenities, joy, noise, air pollution).
- Congestion (e.g., the crowds at public transport stops or during the journey, crowded streets, or traffic jams).
- Reliability, predictability of travel time (e.g., affected by delays/cancellations/crowded streets).
- Safety (e.g., protection against crime).
- Risk of accidents.
- Behaviour of other passengers or road users.
Response codes:
1. Very bad
2. Bad
3. Neither bad nor good
4. Good
5. Very Good
8. Don't know
9. Refused

2.4. Analytical strategy

The validation of the CSS involves various methods and steps (e.g., Boateng et al., 2018). All statistical analyses were conducted using Stata, version 18. First, we analyse the *empirical distributions* (1) of the seven commuting satisfaction items to explore individuals' satisfaction levels with specific aspects of commuting. Subsequently, we employ an *exploratory factor analysis* (EFA) (2) to uncover the underlying factor structure of the CSS. We examine the intercorrelations among the seven items and assess the factor structure using the Kaiser criterion (Kaiser, 1960), Cattell's scree plot (Cattell, 1966), and Velicer's minimum average partial (MAP) test (Velicer, 1976). Because our goal is to identify the latent construct of commuting satisfaction rather than data reduction, we employ factor analysis rather than component analysis (Costello and Osborne, 2005; Fabrigar et al., 1999). In a third step, we assess *reliability* (3) using Cronbach's alpha to gauge overall internal consistency and additionally present descriptive statistics of the CSS.

Finally, we assess the quality of the measurement instrument based on several aspects of validity, in particular construct and criterion-related validity, by examining its relationship with theoretically linked constructs. For this purpose, we test the *construct validity* (4) of the CSS by analysing whether commute duration negatively correlates with commuting satisfaction. Longer commutes increase exposure to commuting-related stressors (Wener et al., 2003) and have been linked to higher stress levels (Evans and Wener, 2006), which could lead to lower satisfaction with the commute. Previous studies have shown that longer commute durations are associated with lower commuting satisfaction (e.g., De Vos et al., 2022; Higgins et al., 2018; Mouratidis et al., 2019; Shi et al., 2022; Zhu and Fan, 2018). Consequently, we assume that *longer commute duration is associated with lower CSS values*.

Additionally, we test the *criterion-related validity* (5) of the CSS by analysing how commuting satisfaction is associated with central outcomes. According to (commuting) stress models (e.g., Koslowsky, 1997; Novaco et al., 1979), workers' perceptions of commuting conditions (e.g., traffic congestion) may trigger strain reactions that affect individuals' well-being and health. In this context, low commuting satisfaction may act as a stressor, causing stress levels to increase and negatively affect overall well-being. Previous research suggests that long commutes negatively affect SWB (e.g., Chatterjee et al., 2020; Zijlstra and Verhetsel, 2021), for an overview) and that commuting satisfaction is positively linked to overall life satisfaction (Li et al., 2024; Maheshwari et al., 2024a). Based on these findings, we expect that *higher commuting satisfaction is linked to greater life satisfaction*.

Furthermore, previous research suggests that longer commuting durations are associated with poorer mental health (e.g., Botha et al., 2026; Garrido-Cumbrera et al., 2023; Liu et al., 2022) and that both extended commute times and commuting-related stress increase the risk of burnout (Amponsah-Tawiah et al., 2016; Chen et al., 2024). Consequently, we assume that *higher commuting satisfaction is associated with lower mental distress*.

(Dis)satisfaction with commuting may also spill over into other life domains, including work (Chatterjee et al., 2020), which may reduce job satisfaction (Calderwood and Mitropoulos, 2021). Empirical evidence confirms that longer commute durations are linked to lower job satisfaction (e.g., Clark et al., 2020; Liu and Ma, 2024; Ma et al., 2025), while higher commuting satisfaction correlates with greater job satisfaction (Li et al., 2024; Maheshwari et al., 2024a). Beyond job satisfaction, commuting stress and dissatisfaction with the commute may also increase employees' intention to quit. Research has shown that commuting stress is associated with higher turnover intentions (Amponsah-Tawiah et al., 2016; Demiral, 2018) and that longer commute times raise the likelihood of job changes (Ma et al., 2025). Moreover, Maheshwari et al. (Maheshwari et al., 2024b) found that low satisfaction with commuting time, combined with low job satisfaction, increases the probability of changing workplaces in subsequent years. Based on this evidence, we expect that *higher commuting satisfaction is associated with greater job satisfaction and lower intention to leave the job*.

As the CSS is intended to be applicable to and provide valid results across different travel modes and geographical regions, we replicate the previous validation methods with subsamples differentiating between travel modes (public transport, car, bike/foot) and residential areas (rural, urban).

3. Results

3.1. Descriptive statistics for the individual commuting satisfaction items

First, we examined the empirical distributions of the individual commuting satisfaction items (Table 3).

In the full sample, commuting satisfaction was highest for safety from crime and lowest for crowding and the behaviour of others. Safety from crime also had the highest satisfaction scores across the different commuting subgroups (transport mode, residential area), apart from physically active commuters (walking or cycling), who were most satisfied with reliability and duration of their commute. Interestingly, for public transport users, satisfaction with the behaviour of others appeared to be less of a concern, whereas relatively low satisfaction with the behaviour of others remained consistent across other commuting subgroups.

Comparisons across the commuting subgroups showed notable differences in satisfaction levels with certain aspects of commuting. For instance, physically active commuters reported substantially higher satisfaction with duration, crowding, and reliability compared to those using public transport or cars. However, their satisfaction with comfort was similar to car commuters, whereas their satisfaction with the behaviour of others aligned more closely with public transport users. Additionally, satisfaction with safety from crime was relatively consistent across travel modes, whereas satisfaction with the risk of accidents was substantially higher for public transport users compared to physically active commuters or those commuting by car. These findings suggest that the higher commuting satisfaction of physically active commuters does not extend uniformly across all aspects of the commute. Interestingly, rural residents reported higher satisfaction across all commuting aspects compared to urban residents. These differences were particularly pronounced for duration, comfort, crowding, and reliability but only marginal for safety from crime, risk of accidents, and behaviour of others.

3.2. Exploratory factor analysis

Before conducting the EFA, we examined the correlations between the seven items (Table 4). The matrix revealed that all items were at least moderately correlated, yet correlations varied in strength. Relatively strong correlations existed between 'reliability' and 'crowding' ($r = 0.69$), 'duration' and 'crowding' ($r = 0.64$), 'duration' and 'reliability' ($r = 0.62$) as well as 'risk of accidents' and 'behaviour of others' ($r = 0.62$). By contrast, correlations between 'safety from crime' and the other six aspects were weaker, ranging from 0.38 to 0.51. Specifically, the correlation between 'safety from crime' and 'risk of accidents' was only moderate ($r = 0.48$), indicating that they capture related but distinct aspects within the commuting experience. While 'safety from crime' refers to protection from criminal activities such as theft or assault during the commute, 'risk of accidents' reflects exposure to traffic-related dangers.

We also calculated the Bartlett's test for sphericity (Bartlett, 1954) and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1974) to test whether our data are appropriate to conduct an EFA. Results from Bartlett's test for sphericity confirmed that the correlation matrix was not random, $\chi^2 = 6663$, $p = .000$. Additionally, the KMO value of 0.87 is considered good (Kaiser, 1974), indicating that the correlation matrix is suitable and supporting the decision to proceed with the EFA.

Results from the Doornik-Hansen test (Doornik and Hansen, 2008) indicated that our variables did not follow a multivariate normal distribution, suggesting the use of a method that does not require multivariate normality (Costello and Osborne, 2005; Fabrigar et al., 1999). Because estimations with the standard principal factoring (PF) method failed to converge for some groups, we applied the iterated principal factoring (IPF) method, which re-estimates communalities iteratively and can provide estimates that are preferable to PF (Ramsey and Gibson, 2006).

The EFA using the IPF method followed the step-by-step procedure described in the literature (e.g., Costello and Osborne, 2005; Fabrigar et al., 1999; Ford et al., 1986). The factor structure was examined using the Kaiser-Criterion, scree plot, and the MAP test. This procedure was based on the unrotated matrix. The IPF results in Table 5 show that only the first factor had an Eigenvalue above the threshold of 1. This factor explained 77.32% of the common variance. Additionally, five further factors were identified, but each had

Table 3
Descriptive statistics of the seven aspects of commuting satisfaction.

Variable	Total sample	Transport mode			Residential area	
	Mean (SD)	Public transport	Car	Bike/foot	Urban	Rural
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Duration	3.50 (1.15)	3.27 (1.13)	3.51 (1.15)	4.30 (0.87)	3.39 (1.15)	3.79 (1.11)
Comfort	3.83 (0.97)	3.39 (0.96)	3.96 (0.93)	4.00 (0.91)	3.74 (0.97)	4.08 (0.91)
Crowding	3.22 (1.18)	3.09 (1.11)	3.20 (1.19)	3.96 (1.06)	3.06 (1.15)	3.67 (1.16)
Reliability	3.59 (1.10)	3.35 (1.15)	3.61 (1.07)	4.29 (0.91)	3.46 (1.09)	3.94 (1.05)
Safety from crime	4.07 (0.88)	4.00 (0.85)	4.09 (0.88)	4.10 (0.93)	4.04 (0.88)	4.15 (0.86)
Risk of accidents	3.52 (1.03)	4.00 (0.86)	3.35 (1.03)	3.65 (1.05)	3.50 (1.02)	3.57 (1.05)
Behaviour of others	3.26 (1.04)	3.57 (0.90)	3.13 (1.06)	3.54 (1.06)	3.22 (1.03)	3.36 (1.06)
N	2107	474	1505	128	1486	621

Notes: SD denotes standard deviation. Scales for commuting satisfaction items range from 1 to 5, with 1 indicating low satisfaction and 5 indicating high satisfaction.

Table 4
Correlations between the seven aspects of commuting satisfaction.

Variable	1	2	3	4	5	6
1. Duration						
2. Comfort	0.51					
3. Crowding	0.64	0.51				
4. Reliability	0.62	0.52	0.69			
5. Safety from crime	0.38	0.51	0.43	0.49		
6. Risk of accidents	0.40	0.32	0.44	0.42	0.48	
7. Behaviour of others	0.43	0.40	0.52	0.50	0.48	0.62

Notes: $N = 2107$. All correlations were highly significant ($p < .001$).

Eigenvalues significantly below the threshold of 1. According to the Kaiser-Criterion, these results suggested a one-factor solution. All loadings on the first factor were well above 0.50, which is considered strong (Costello and Osborne, 2005). Therefore, all items can be assigned to the first factor. The last column presents the communality, indicating how well each item is explained by the factors, with values closer to 1 reflecting better explanatory power. All communalities significantly exceeded 0.40, a commonly accepted minimum benchmark in the social sciences (Costello and Osborne, 2005).

We also performed a scree plot and the MAP test to further investigate the factor structure (see Figs. S1 and S2 in Supplementary Material, Section A). The scree plot revealed that the first factor had a substantially higher Eigenvalue compared to the subsequent factors, with a pronounced 'elbow' after the first factor, indicating a clear dominance of the first factor. The MAP test showed that the average partial correlation of the variables was at a minimum for one factor (0.055), suggesting that one factor should be retained. All these findings clearly suggested a one-factor structure.

In addition to the overall sample, we analysed the factor structure separately for the various commuting subgroups. Table 6 presents results of the IPF for the total sample and the different travel mode and residential area subgroups. Across the travel modes and residential areas, the results were similar to those of the total sample, with the first factor in each case explaining a high proportion of the common variance and all seven items loading strongly onto it. The one-factor solution is further supported by the scree plots and MAP tests across all subgroups (see Figs. S3 to S8 for travel modes and Figs. S9 to S12 for residential areas).

Congruence coefficients were used to assess factor similarity (Tucker, 1951). The congruence coefficients comparing loadings for each travel mode (CC public transport, car = 0.989; CC public transport, bike/foot = 0.998; CC car, bike/foot = 0.996) and residential area (CC = 0.999) were all very high, indicating strong similarity in loadings structure across modes and residential areas (Lorenzo-Seva and ten Berge, 2006). In sum, we conclude that the CSS works similarly and effectively for different travel modes and types of regions.

3.3. Reliability and descriptive statistics of the CSS

As a next step, we assessed the reliability of the CSS for the total sample as well as different travel modes and residential areas using Cronbach's alpha (Table 7). We found the overall internal consistency to be highly reliable for the total sample ($\alpha = 0.87$), the different travel modes (public transport: $\alpha = 0.85$; car: $\alpha = 0.89$; bike/foot: $\alpha = 0.86$), and type of regions (urban: $\alpha = 0.86$; rural: $\alpha = 0.89$). Given the high reliability and the one-factor structure of the CSS, we combined the seven individual aspects of commuting satisfaction into a single scale.

The CSS represents individuals' overall commuting satisfaction, calculated as the average of the seven single items (summarised index). Satisfaction levels varied by travel mode and residential area. Specifically, physically active commuters reported substantially higher satisfaction (3.98) compared to those using public transport (3.52) or commuting by car (3.55). Additionally, rural commuters (3.79) tended to be more satisfied than those in urban areas (3.49).

We also explored whether these group differences in the CSS were significant using comparison of means analyses. When comparing the travel mode groups individually (Table S2 in Supplementary Material, Section A), we found that public transport

Table 5
Results of Exploratory Factor Analysis (EFA), Iterated Principal Factors (unrotated).

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Communality
Duration	0.73	-0.28	-0.13	0.19	0.09	-0.03	0.67
Comfort	0.67	-0.17	0.12	0.12	-0.11	0.00	0.61
Crowding	0.79	-0.22	-0.07	-0.07	-0.04	0.08	0.72
Reliability	0.79	-0.22	-0.17	-0.17	0.05	-0.06	0.72
Safety from crime	0.67	0.18	-0.09	-0.09	0.10	0.01	0.63
Risk of accidents	0.66	0.46	0.08	0.08	0.10	0.02	0.68
Behaviour of others	0.72	0.33	-0.02	-0.02	-0.18	-0.03	0.67
Eigenvalue	3.64	0.54	0.32	0.10	0.08	0.01	–
% of explained common variance	77.32%	11.84%	6.87%	2.11%	1.61%	0.26%	–

Notes: $N = 2107$. Values above 0.50 are highlighted in bold.

Table 6

Factor loadings on factor 1 based on IPF (unrotated), by different travel modes and residential areas.

Item	Total sample	Transport mode			Residential area	
		Public transport	Car	Bike/foot	Urban	Rural
Duration	0.73	0.64	0.75	0.66	0.73	0.72
Comfort	0.67	0.78	0.66	0.76	0.64	0.71
Crowding	0.79	0.68	0.82	0.75	0.77	0.81
Reliability	0.79	0.75	0.81	0.82	0.77	0.83
Safety from crime	0.67	0.74	0.65	0.69	0.64	0.73
Risk of accidents	0.66	0.56	0.73	0.62	0.66	0.68
Behaviour of others	0.72	0.68	0.74	0.69	0.70	0.76
Eigenvalue	3.64	3.69	3.84	3.58	3.46	3.95
% of explained common variance	77.32%	79.76%	81.26%	70.99%	76.16%	78.77%
N	2107	474	1505	128	1486	621

Notes: Values above 0.50 are highlighted in bold.

Table 7

Reliability and descriptive statistics of the CSS for the total sample, different travel modes and residential areas.

	Total sample	Transport mode			Residential area	
		Public transport	Car	Bike/foot	Urban	Rural
Mean	3.57	3.52	3.55	3.98	3.49	3.79
SD	0.79	0.73	0.81	0.72	0.77	0.80
Cronbach's α	0.87	0.85	0.89	0.86	0.86	0.89
N	2107	474	1505	128	1486	621

Notes: SD denotes standard deviation. The CSS theoretically ranges from 1 to 5.

commuters were significantly less satisfied than those who commute by bike or on foot, with a medium effect size of -0.57 . Similarly, car commuters reported significantly lower satisfaction than the bike/foot group, with a small to medium effect size of -0.49 . However, the difference in satisfaction between public transport users and car commuters was not significant, with a small effect size of -0.04 .

Additionally, we conducted a regression analysis controlling for commute duration, commute frequency, and survey waves (Table S3) to see to what extent differences in commuting satisfaction between travel modes were driven by these factors. When accounting for these factors, public transport users and active commuters (walking or cycling) reported significantly higher commuting satisfaction than car users. Therefore, differences in commuting satisfaction between public transport and car users only become apparent when the commuting context is held constant.

Comparing residential areas (Table S4), we found that urban commuters were significantly less satisfied with their commute than rural commuters, with a small to moderate effect size of -0.39 .

3.4. Validation

Table 8 presents the bivariate correlations of the CSS with key predictors and outcomes of commuting satisfaction.

As expected (see section 2.4 Analytical strategy), longer commuting times were significantly associated with lower commuting satisfaction. Moreover, higher commuting satisfaction was significantly associated with lower mental distress and lower job leave intention, but higher life satisfaction and job satisfaction. These findings demonstrate that the CSS is statistically significantly correlated with key predictors and outcomes of commuting satisfaction, supporting theoretical assumptions and aligning with previous research. This indicates strong construct and criterion-related validity of the CSS.

We further examined these relationships using regression models that account for relevant confounding factors, including

Table 8

Bivariate correlations with the CSS.

Variable	Mean	SD	Correlations with CSS
Commuting context			
Commute duration (min.)	68.01	(53.42)	-0.38^{***}
Mental health, well-being, and job			
Mental distress (1–5)	2.39	(1.07)	-0.23^{***}
Life satisfaction (0–10)	6.06	(2.41)	0.19^{***}
Job satisfaction (0–10)	6.63	(2.12)	0.25^{***}
Job leave intention (0–100)	26.15	(31.94)	-0.13^{***}

Notes: SD denotes standard deviation. $N_{\min.} = 1442$, $N_{\max.} = 2107$. Job satisfaction and job leave intention were only collected in the October 2024 and March 2025 waves. *** indicates $p < .001$, ** indicates $p < .01$, * indicates $p < .05$.

sociodemographic characteristics (gender, age, highest level of education, partnership status, children under 18 living in the household, and country of birth), occupational differences (occupational group), regional context (residential area), and additional factors (travel mode and survey wave) (see Table 1 for details on these variables). The results show that the negative association between commute duration and the CSS (see Table S5 in Supplementary Material, Section A), as well as the associations between the CSS and each outcome (see Table S6), remain statistically significant and robust. These findings reinforce the results from the bivariate analyses and provide further empirical support for the construct and criterion-related validity of the CSS.

In addition to analysing the overall sample, we also examined the bivariate correlations between the key determinant, the outcomes, and the CSS for subsamples of travel modes and residential areas. The results for different travel modes aligned closely with those of the overall sample, as all the correlations were in the expected direction (see Table S7 in Supplementary Material, Section A). Interestingly, the association between the CSS and mental distress was somewhat stronger in the bike/foot sample. Correlations were also mostly comparable across residential areas (see Table S8). However, job leave intention was not significantly associated with the CSS in rural areas. Overall, we conclude that our findings support the high construct and criterion-related validity of the CSS across travel modes and residential areas. Additionally, beyond the aggregated CSS, we examined the bivariate correlations between the key determinant, the outcomes, and the seven individual commuting satisfaction items. The results were similar to those for the overall CSS (see Table S9). A longer commute duration was significantly and negatively correlated with all aspects of commuting satisfaction. However, the strength of the associations varied. As expected, commute duration was particularly highly correlated with satisfaction with commute duration (-0.51). The correlations of the single aspects of commuting satisfaction with mental distress, life satisfaction and job leave intention were all very similar, with only slight differences. These correlations ranged from -0.15 to -0.19 , from 0.12 to 0.16 and from -0.08 to -0.11 , respectively. This provides supportive evidence that the seven individual CSS items also demonstrate strong construct and criterion-related validity.

4. Discussion and conclusions

This paper validated the recently introduced Commuting Satisfaction Scale (CSS; see Rüger and Bischof, 2025), a comprehensive measure capturing seven key aspects of commuting satisfaction. We used data from three waves of the Australian TTPN survey (April 2024, October 2024, March 2025), which is based on a stratified sample that is representative of individuals living in Australia in terms of age, gender, and location. This study is the first to validate the CSS using a general population sample, and the first to do so in the post-pandemic period. As such, it strengthens the generalisability of the CSS's validity across diverse populations, commuting subgroups and evolving post-pandemic commuting patterns.

We applied a range of validation procedures to assess the CSS. Results indicate varying satisfaction levels across commuting aspects, with the highest satisfaction for safety from crime and the lowest for crowding and the behaviour of others. Despite this variation, all items are clearly interrelated. A one-factor structure emerged, with all seven items loading strongly on a single factor, explaining over 77% of the common variance. The scale also demonstrates high internal consistency, indicating strong reliability. In line with theoretical expectations and prior research, the CSS is significantly associated with key predictors and outcomes: longer commuting times are linked to lower commuting satisfaction, whereas higher commuting satisfaction is associated with lower mental distress and job-leave intention, as well as greater life satisfaction and job satisfaction. These findings support the CSS's high construct and criterion-related validity. Overall, the results suggest that the CSS is a reliable and valid measure of commuting satisfaction.

We additionally validated the CSS across different travel modes (public transport, car, bike/foot) and residential areas (urban and rural). Results show that commuting satisfaction varies by travel mode and region of residence. Consistent with previous research, bicycle or foot commuters report significantly higher satisfaction than both public transport and car users (Handy and Thigpen, 2019; Mouratidis et al., 2019; Zhu and Fan, 2018), while public transport users report higher commuting satisfaction levels when commute times are comparable (Mouratidis et al., 2019; Runa and Singleton, 2021). Furthermore, urban commuters report significantly lower satisfaction compared to rural commuters, particularly with regard to crowding, reliability, and duration; potentially due to higher traffic congestion, overcrowding, and less pleasant commuting environments in urban areas (Taylor and Mitra, 2021). Despite these slight differences, the CSS performs consistently across groups, exhibiting a one-factor structure, high reliability, and strong validity. Further validation of the seven individual items of the CSS also indicates high item-level validity, suggesting that each aspect of commuting satisfaction is both meaningful on its own and part of a cohesive unidimensional construct. These findings indicate that the CSS represents a reliable and valid instrument across travel modes and residential areas.

Overall, this study provides supportive evidence for the findings from the initial validation of the CSS with a sample of German Foreign Service (GFS) employees primarily working in metropolitan areas around the world (Rüger and Bischof, 2025). Consistent with that initial validation, we observed similar patterns. In both studies, respondents reported the highest satisfaction with safety from crime and the lowest satisfaction with crowding and other people's behaviour. Likewise, both studies found high internal consistency of the items and a one-factor structure of the CSS in the overall sample and across subgroups. In addition, both studies provide evidence of strong construct and criterion-related validity, with the CSS showing expected associations with key determinants, such as commute duration, and outcomes, including well-being, stress, health, and job-related measures. Interestingly, commuting satisfaction is broadly similar among public transport users and physically active commuters in both studies. However, car users in the current study reported higher satisfaction levels than those in the predominantly metropolitan context of the GFS study. This likely reflects the distinct commuting conditions experienced by car users in large cities and suggests that even large cities in Australia are more car-friendly than in many other countries (Fooks et al., 2024). Our findings highlight the scale's strong validity in contexts beyond metropolitan commuting and in the face of altered commuting patterns in the post-pandemic era. Taken together, these two studies provide supportive evidence that the CSS is a reliable and valid instrument for assessing commuting satisfaction across transport

modes, world regions, and both urban and rural settings, thus supporting its broad applicability.

Nevertheless, our study has some limitations that should be acknowledged. Although we successfully validated the CSS across different regions in Australia, covering both urban and rural areas, this captures only the place of residence. As the dataset lacks information on respondents' workplaces, we cannot precisely determine commuting routes, such as whether individuals commute within a city or between rural and urban areas. Moreover, the urban–rural classification only distinguishes respondents living in metropolitan areas from those in other areas and therefore cannot fully account for variation in the degree of urbanisation. Furthermore, although the CSS has now been successfully validated in both the Australian context and among German GFS employees working worldwide, it may still be limited in scope to the perspective of Western commuters. Therefore, for future research it would be valuable to test the CSS on samples of non-Western commuters from different cultural backgrounds. Moreover, though we find strong correlations between the CSS and key outcomes of commuting satisfaction, these associations may in part be affected by reverse causality. For instance, individuals with higher commuting satisfaction may be less prone to mental distress, but conversely, those experiencing greater mental distress might be more susceptible to commuting-related stressors and thus experience lower commuting satisfaction. Implementing the CSS in longitudinal studies could help address this issue. Finally, the surveys were conducted during different times of the year, raising the likelihood of seasonal effects in survey responses. However, apart from controlling for survey wave in regression models, we cannot fully account for potential weather effects on responses given the large variation in weather across Australia during the same periods.

The CSS offers numerous opportunities for future research. First, it allows for a deeper exploration of the factors influencing commuting satisfaction. Future studies could examine how socio-demographic characteristics, occupational factors, commuting arrangements and commuting environment shape commuting satisfaction. Additionally, future research could investigate seasonal variations in commuting satisfaction and their implications, such as whether (dis)satisfaction with seasonal circumstances (e.g., temperature, rain, icy roads) causes commuters to switch travel modes.

A key strength of the CSS is its ability to assess satisfaction with specific aspects of commuting alongside the aggregated scale. In this respect, the CSS goes beyond conventional scales, such as the Satisfaction with Travel Scale (STS) (Ettema et al., 2011), which measures travel-related SWB by capturing cognitive evaluations and affective responses to daily travel, but does not assess satisfaction with specific aspects of commuting. Comparing these aspects across different transport modes enables researchers to identify which aspects are more or less relevant to commuter (dis)satisfaction and how these vary by transport mode. Furthermore, the CSS allows for analyses of how commuter satisfaction affects key outcomes such as work behaviour (e.g., absenteeism, job turnover, remote work patterns), health (e.g., mental strain, exhaustion), and well-being (e.g., life satisfaction, job satisfaction, work-life balance). These insights could inform policymakers on ways to enhance commuting experiences such as improving public transport and pedestrian infrastructure, thereby mitigating potentially negative consequences of commuting dissatisfaction.

Commuting is a dynamic process shaped by life transitions (e.g., job changes, relocation), external factors (e.g., infrastructure developments), and evolving work arrangements (e.g., flexible hours, remote work). These changes may influence both commuting satisfaction over time and its implications for commuters. To better capture the long-term determinants and consequences of commuting satisfaction, as well as commuters' adaptive strategies, the validated CSS should be incorporated into national longitudinal studies. Using the CSS in a longitudinal design would provide deeper insights into how commuting satisfaction evolves, revealing causal relationships and long-term trends. This would allow researchers to examine how shifts in commuting modes, job transitions, or relocations affect commuting satisfaction, and whether dissatisfied commuters adapt their commuting patterns or persist despite dissatisfaction. Furthermore, this could inform the evaluation of policy changes relating to traffic planning and infrastructure projects.

CRedit authorship contribution statement

Stephan Bischof: Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization. **Ferdi Botha:** Writing – review & editing, Writing – original draft, Funding acquisition, Formal analysis, Data curation. **Inga Laß:** Writing – review & editing, Writing – original draft, Funding acquisition. **Heiko Rüger:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Conceptualization.

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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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.trf.2026.103767>.

Data availability

The authors do not have permission to share data.

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