Perceived safety and use of public transportation: Analysis of the role of safety in public transportation in the Rhine-Main area

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ABSTRACT

„Study of sense of security in public transport". Perceived safety significantly influences public transport usage. This study examines safety perceptions in public spaces and transit environments using a 6-point Likert scale. Results show overall high safety (M = 2.40, SD = 0.996), but lower perceptions at night reduce public transport use. Enhancing safety through lighting, surveillance, and staff presence can improve commuter confidence and increase usage.

KEYWORDS

perceived safety, public transport, mobility, security perception, transport behavior

1. Introduction

Safety is a central aspect of urban mobility and has a significant influence on the acceptance and use of public transportation. The subjective feeling of safety can be influenced by physical security measures such as surveillance cameras or increased police presence, as well as by individual experiences, sociodemographic factors and situational circumstances.[2] A low sense of security can cause people to avoid certain means of transportation or times of day, which in turn negatively impacts the frequency of use and satisfaction with the transportation system.[5]

1.1 Background

Safety is a central aspect of urban mobility and has a significant influence on the acceptance and use of public transportation. The subjective feeling of safety can be influenced by physical security measures such as surveillance cameras or increased police presence, as well as by individual experiences, sociodemographic factors and situational circumstances.[2] A low sense of security can cause people to avoid certain means of transportation or times of day, which in turn negatively impacts the frequency of use and satisfaction with the transportation system.[5]

1.2 Problem statement

Despite the well-known importance of security for the use of public transportation, there is a lack of systematic analyses that examine both the sense of security in public spaces and in public transportation together.

Particularly insufficiently researched are differences between these two security contexts, the influence of the time of day on the perception of security, and the connection between the sense of security and satisfaction with public transport. The present study addresses this research gap by systematically recording subjective perceptions of security and analyzing their influence on the use of public transport.

1.3 Research objectives

This study examines the role of subjective safety in public transportation in the Rhine-Main area based on- the following questions:

1. How does the subjective sense of safety in public space differ from that in public transport?
2. What factors influence the perception of safety in buses and trains?
3. To what extent does the perception of safety differ depending on the time of day (during the day vs. at night)?
4. How does the sense of security affect satisfaction with public transportation?

Based on these questions, the following hypotheses are tested for the area:

- H1: A higher subjective sense of security correlates positively with satisfaction with public transport.
- H2: The subjective sense of security is significantly lower at night than during the day.

The results should help to identify specific measures to increase the subjective sense of security in public transport and thus increase the attractiveness of public transport.

2. Materials and Methods

2.1 Study approach

This study is based on a quantitative, survey-based approach to investigating safety in public spaces and on public transportation in the Rhine-Main area. The study is based on a quantitative, survey-based methodology for capturing safety and security perceptions in public spaces and on public transport. Two safety and security contexts were considered: the general sense of safety and security in public spaces and the sense of safety and security on public transport, with a differentiation according to the time of day. The aim was to analyze differences between these contexts and their influence on mobility behavior.

2.2 Data collection

Data collection was carried out using a combination of telephone interviews and a supplementary online survey. The telephone survey was based on a random sample, stratified by demographic characteristics. It was conducted by trained interviewers using standardized questionnaires to ensure high data quality. The online survey was conducted via an online panel recruited offline to minimize distortions due to self-selection. The combination of both methods ensured that both older and younger population groups were adequately represented.

2.3 Measuring instruments

The sense of security was measured using a 6-point Likert scale. The following dimensions were considered:

- Sense of security in public spaces: "Even when I am out and about after dark, I feel safe."
- Sense of security on public transport: distinction between day and night times with a rating scale from 1 = 'Feel completely safe' to 6 = 'Do not feel safe at all'.

In addition, a 'don't know/no answer' option was offered to account for uncertainties in the assessment.

2.4 Sample

The final sample size after adjustment includes over 10,000 participants. The gender distribution is approximately balanced, with 55 percent of respondents being female and 45 percent male. The age structure ranges from 15 to over 80 years, with a slight overrepresentation of older participants. The sample was stratified according to settlement structures, so that large cities, medium-sized towns, small towns and rural areas were included in the analysis.

2.5 Data analysis

The analysis of the safety perception was conducted using a combination of descriptive and inferential statistical methods. Descriptive analyses included calculating means, standard deviations, and distributions, while inferential statistical procedures were used to test group differences. Comparative analyses were conducted to analyze differences between feelings of safety in public spaces and on public transit, and between daytime and nighttime hours.

In addition, multiple regression analyses were used to quantify the influence of safety perception on public transport frequency and satisfaction. Significance tests were conducted to identify differences between gender, age and mobility patterns.

2.6 Validity and methodological limitations

To ensure the internal consistency of the scale, Cronbach's Alpha was calculated, with values above 0.7 indicating a reliable measurement, while lower values may suggest measurement errors or insufficient item validity. Despite the careful methodological approach, several potential biases could influence the results. Self-selection bias may have occurred, as individuals with a particular interest in mobility and security might have been more likely to participate in the survey. Additionally, subjective perception bias could have played a role, as the sense of security is shaped by personal experiences, media coverage, and situational factors, potentially skewing the responses. Social desirability bias may also have influenced participants, leading them to either exaggerate or downplay their security concerns depending on perceived social norms. Furthermore, the time of day when respondents completed the survey could have affected their reported feelings of security, potentially leading to an over- or underestimation of insecurity perceptions. Lastly, while the sample was stratified based on settlement structures, a more detailed differentiation between urban and rural areas could enhance future analyses, allowing for a more nuanced understanding of regional variations in safety perceptions.

3. Results

3.1 Descriptive Statistics

The descriptive analysis of perceived safety (SGG Gesamt) indicates an overall positive safety perception among respondents. On a 6-point Likert scale (1 = very safe, 6 = very unsafe), the mean value is 2.40 (SD = 0.996), suggesting a general sense of safety in public spaces and public transport. However, a comparison between public spaces (SG1) and public transport (SG2) reveals a notable difference, particularly regarding nighttime travel.

3.2 Analytical Results

Time of day significantly influences safety perceptions in public transport ($p < 0.001$), with respondents reporting lower safety levels at night (SG2_2) compared to daytime (SG2_1).

Women feel significantly less safe than men in public transport, particularly at night ($p < 0.01$).

Urban vs. rural comparison: Respondents in urban areas report lower safety perceptions than those in suburban or rural regions ($p < 0.05$).

These findings confirm that perceived safety is influenced by time, location, and individual characteristics. The results provide insights into how security concerns affect public transport use and where improvements may be necessary.

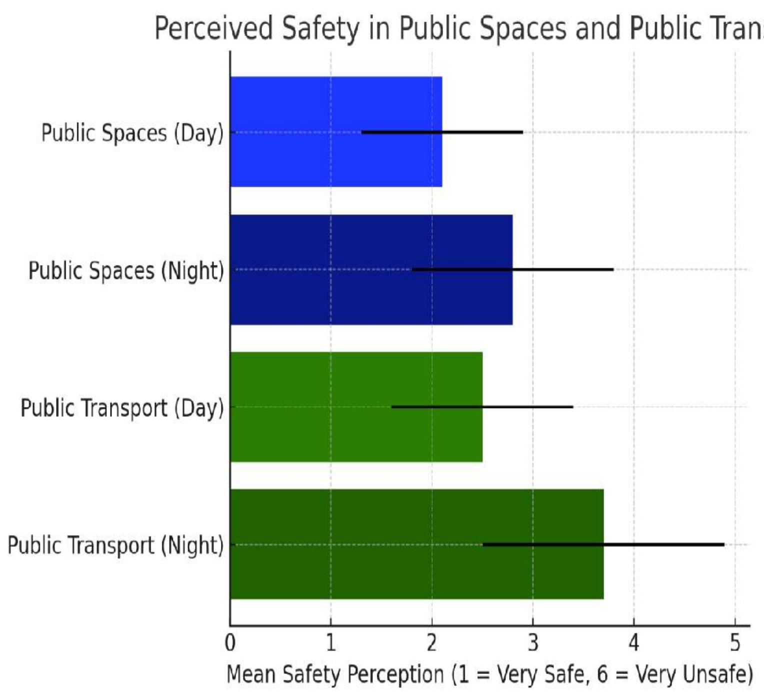

Figure 1: own representation of the feeling of security in the Rhine-Main area by day section

4. Discussion

4.1 Interpretation

The results indicate that perceived safety varies significantly between public spaces and public transport, particularly at night. The mean value of 2.40 (SD = 0.996) suggests an overall positive perception, yet the right-skewed distribution (skewness = 0.595) highlights that some individuals still experience notable insecurity. These findings align with previous research, which suggests that fear of crime and perceived vulnerability increase after dark.[4]

Furthermore, the significant gender differences ($p < 0.01$) confirm findings from Loukaitou-Sideris [3], where women reported avoiding certain transport modes at night due to safety concerns. Similarly, the urban-rural divide ($p < 0.05$) suggests that population density and anonymity contribute to heightened security concerns in cities.[6]

4.2 Implications

Given that perceived safety affects public transport usage, targeted interventions are necessary. Previous studies have shown that improved lighting, an increased security presence, and thoughtful infrastructure design can significantly enhance safety perceptions.[7] These findings emphasize the importance of developing gender-sensitive and time-sensitive security strategies, particularly for nighttime travelers, to address their specific concerns and encourage greater use of public transport.

Future research should investigate longitudinal trends in perceived safety to understand how security perceptions evolve over time. Additionally, assessing the effectiveness of security measures such as surveillance systems, emergency communication options, and increased patrol frequency could provide valuable insights into the most effective interventions. Furthermore, exploring individual coping strategies that influence transport mode choice would help identify how passengers adapt to perceived safety risks and what measures could further support a secure and comfortable transit experience.

5. Conclusions

5.1 Summary of Key Findings

This study confirms that perceived safety is a key determinant of public transport usage. While most respondents report a generally positive safety perception, significant differences emerge between daytime and nighttime travel, gender groups, and urban vs. rural areas. Women and urban residents report higher insecurity levels, particularly at night. These findings underscore the need for targeted interventions to enhance commuter confidence.

5.2 Future Research and Practical Implications

To improve safety perceptions in public transport, authorities should implement measures such as enhanced lighting and surveillance at stations and inside vehicles, as well as an increased presence of security personnel, particularly during late-night hours. Additionally, public awareness campaigns on safety measures and emergency protocols can help educate commuters and reduce anxiety. A participatory approach to urban planning, involving commuters in the design of safer transport environments, can also contribute to a greater sense of security.

Future research should explore longitudinal trends in safety perceptions to identify changes over time and assess the effectiveness of security interventions. Moreover, alternative methodologies, such as qualitative interviews, could provide deeper insights into subjective safety concerns. Strengthening both objective and perceived security is crucial to maintaining public transport as a viable and attractive mobility option, ensuring that passengers feel safe and confident in using transit services.

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