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Impact of environmental awareness and attitudes on micromobility use: Analysis of generation Z intentions using the Theory of Planned Behaviour

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Abstract

Motivation: Record temperatures and intensification of extreme weather events observed in recent years have contributed to the implementation of sustainable transport systems. One way to reduce CO2 emissions and thus improve the quality of life is through micromobility, which encompasses bicycles and electric scooters.
Aim: The aim of this study was to identify factors influencing the intentions of Generation Z representatives to use micromobility. In accordance with the assumptions of the Theory of Planned Behaviour (TPB), particular focus was placed on analysing the impact of attitudes, subjective norms, and perceived behavioural control.
Materials and methods: The study employed a survey conducted among 167 students from various academic programs. Survey results from the study conducted in May 2025 were subjected to statistical analysis using AMOS and SPSS tools. Correlations between TPB model variables and their impact on students' attitudes toward micromobility were analysed.
Results: Analysis results demonstrated positive attitudes toward micromobility and a significant impact of subjective norms and perceived behavioural control on students' attitudes toward using these modes of transport. Additionally, environmental awareness was found to be a key factor strengthening pro-environmental attitudes, suggesting the need for further environmental education of Generation Z.

Keywords: *micromobility; Theory of Planned Behaviour (TPB)*
JEL: *R41; Q56; D91*

1. Introduction

The record temperatures observed in recent years, along with the escalation of extreme weather phenomena, are attributed to climate change and pose a significant threat to social and economic development worldwide. These alarming trends indicated the need for immediate and decisive actions to limit greenhouse gas emissions (Ripple et al., 2023; Wang et al., 2024).

One way to mitigate the negative effects of CO2 emissions, particularly in urban areas, is the development of micromobility. Micromobility, encompassing bicycles, electric scooters, and mopeds, represents a breakthrough development in urban mobility. It enables reducing the use of private combustion vehicles over

short distances, which in turn leads to improved air quality and overall quality of life in urban areas (Sang et al., 2024; Abduljabbar et al., 2021).

Similar to other EU countries, Poland has experienced a significant increase in the number of shared electric scooters and city bicycles available, which not only improves residents' mobility but also contributes to reducing pollutant emissions (Jędrzejewski, 2021). In the case of the provincial city of Olsztyn, further development of infrastructure supporting micromobility development becomes a significant challenge (Electromobility Development Scenarios in Olsztyn, 2023).

Due to greater environmental awareness and openness to new technologies, Generation Z plays a dominant role in popularising micromobility.

Generation Z, due to their greater environmental awareness and openness to new technologies, more frequently chooses ecological means of transport such as electric scooters and bicycles. This factor plays a crucial role in popularising micromobility, and thus in achieving climate goals (Gupta & Sharma, 2023; Reck et al., 2021).

Given the growing importance of micromobility in balancing urban transport, the aim of this research is to identify factors related to micromobility use by students at the University of Warmia and Mazury in Olsztyn. The study utilised the Theory of Planned Behaviour (TPB) model, which enables analysis of students' intentions and behaviours regarding micromobility. Survey research was conducted among full-time students, and SPSS and AMOS software were used for results analysis.

2. Literature review

Bicycles and scooters, being the foundation of the ecological revolution, play a special role in reducing air pollution and CO2 emissions. This is particularly true for urban areas, where shorter distances favour the use of micromobility (Neves et al., 2023; Gebhardt et al., 2022). Through the possibility of replacing cars on short routes, micromobility contributes both to reducing exhaust emissions and improving air quality, as well as alleviating the effects of urban congestion (Comi & Polimeni, 2024).

Integrating micromobility with urban transportation further enhances its positive environmental impact (Ghaffar et al., 2023). By enabling quick and convenient access to transit stops, micromobility mobilises people to use public transport. As a result of more sustainable urban transport, CO2 emissions decrease and air quality improves (Peng et al., 2021).

Although the production and charging of electric bicycles and scooters also generate CO2 emissions, in the overall assessment of their environmental impact, micromobility has significant potential (Tsavachidis & Petit, 2022).

To fully exploit this potential and accelerate transformation toward more sustainable cities, the engagement of younger generations will be crucial. People from Generation Z will play a crucial role in popularising micromobility, as research shows, who are characterised by greater environmental awareness and openness to new technologies compared to earlier generations (Gupta & Sharma, 2023; Chen et al., 2023).

Additionally, growing up in the digital era naturally inclines them to use innovative solutions such as micromobility (Wawer et al., 2022).

Research indicates that many Generation Z individuals, often well-educated and residing in large cities, willingly utilise micromobility for their daily commutes to schools, universities, or workplaces. Such a change in transport habits has the chance to significantly contribute to reducing exhaust emissions in cities. Their conscious preferences regarding sustainable transport constitute an important element supporting the achievement of climate goals (Reck et al., 2021; Chen et al., 2023).

Understanding the motivations and factors influencing Generation Z's transport choices is therefore crucial for effectively

promoting micromobility. In this context, it is worthwhile to examine the Theory of Planned Behaviour (TPB), which provides a useful theoretical framework for analysing these decision-making processes. This theory, developed by Ajzen, posits that intentions to engage in specific behaviour are influenced by three primary factors: attitudes toward the behaviour, subjective norms, and perceived behavioural control (Ajzen, 1991).

Studies by Kan and Fabrigar (2017) and Elmashhara et al. (2023) indicate the usefulness of TPB in analysing transport behaviours of young adults, particularly in the context of micromobility. Meanwhile, Agyeman and his team (2024), as well as Fearnley (2020), have demonstrated that pro-environmental attitudes, social support, and a sense of control influence decisions regarding the choice of sustainable transportation means.

Newton and Meyer (2013) and Kalhoro and others (2021) proved that, through TPB, better prediction and promotion of more ecological transport behaviours among young adults is possible. This issue is crucial in the era of growing popularity of micromobility and the pursuit of sustainable urban development.

Finally, Ajzen (1991), Newton and Meyer (2013), and Alimo and his team (2023) indicated that understanding the mechanisms described in TPB allows for better shaping of policies that support the adoption of sustainable transport solutions adapted to the needs of the young generation.

Despite the potential of micromobility, its dissemination faces several barriers that have been identified and analysed in various studies. Zhang and his team (2023) indicate that inadequate infrastructure, including a lack of dedicated bicycle paths and micromobility lanes, forces users to use sidewalks or lanes designated for motor vehicles, which increases accident risk. Meanwhile, Shaheen and colleagues (2022) emphasise that current regulations and rules are often not adapted to the specifics of micromobility, leading to misunderstandings and difficulties in law enforcement. Additionally, Anke and others (2023) demonstrate that the limited availability of these services in less populated areas, combined with the lack of integration with other forms of transportation, further hampers micromobility development.

3. Materials and methods

To better understand the factors shaping Generation Z's intentions toward micromobility, this study adopted a methodological approach based on the Theory of Planned Behaviour (TPB). A detailed description of the theoretical model, research hypotheses, and research tools used in this study is provided below.

The Theory of Planned Behaviour (TPB) is an extension of the Theory of Reasoned Action (TRA). Ajzen (1985, 1991) expanded it with predictors such as attitude toward behaviour (AT), perceived behavioural control (PBC), and subjective norms (SN). These are key determinants of intentions and behaviours (Ajzen, 1985; Ajzen & Fishbein, 1980; Kaplan et al., 2015). TPB has a wide range of applications in research on various types of behaviours, including the pro-environmental context (Yazdanpanah & Forouzani, 2015; Yadav & Pathak, 2016). Its effectiveness in predicting behaviours related to environmental protection and sustainable mobility has been proven (Lois et al., 2015).

Attitude, the first of the mentioned predictors, refers to an individual's positive or negative perception of a problem or event. In the Theory of Planned Behaviour, attitude is recognised as one of the strongest factors influencing behavioural intentions, particularly in the context of pro-environmental behaviour and consumer choices (Xu et al., 2020; Newton & Meyer, 2013). Research indicates that an individual's attitude toward specific products or actions, such as ecological shopping, influences their purchase intentions. For example, the study by Newton and Meyer (2013) on resource consumption in households showed that attitudes toward environmental protection significantly influenced actual consumer behaviour. Similar results were obtained by Oestreich et al. (2024), who

found that students' attitudes toward sustainable transportation had a significant impact on their transportation choices.

Based on the literature review, the following hypothesis was proposed:

H1: Positive attitude toward micromobility (AT) will be strongly associated with greater intentions to support its development (INT).

Another key element of the TPB model is the subjective norm (SN), which refers to the social pressure that individuals feel in connection with a specific behaviour. This norm is shaped by the influence of peers and individuals of higher social status, such as family members, close acquaintances, relatives, coworkers, or business partners (Kan & Fabrigar, 2017; Xu et al., 2020; Paul et al., 2016). Research indicates a positive correlation between SN and intentions to engage in pro-environmental behaviours, such as recycling or using environmentally friendly forms of mobility (Lois et al., 2015; Bamberg, 2003). Rodríguez-Rad and others (2023) found that the greater support individuals felt from important social groups in the context of sustainable transport, the stronger their intentions to use such forms of mobility. Similarly, Newton and Meyer (2013) observed that perceived ethical and social standards influenced behaviours related to recycling, and SN was an effective predictor of intended actions (Kaplan et al., 2024).

Based on the above, the following hypothesis was proposed:

H2: Subjective norms (SN) will have a significant impact on the intentions to support micromobility development (INT).

The third element of the TPB model is perceived behavioural control. It refers to the subjective assessment of ease or difficulty associated with undertaking a specific action (Paul et al., 2016). PBC is strongly associated with previous experiences and anticipated difficulties. Ajzen (1991) emphasised that people who lack the necessary resources, opportunities, or skills are unlikely to take action (Kaplan et al., 2024). This is also confirmed by research on consumer intentions related to recycling, choosing ecological food, and purchasing ecological products (Paul et al., 2016; Xu et al., 2020). Research by Newton and Meyer (2013) indicates that financial accessibility is a key factor influencing perceived control and consumer purchasing decisions (Kaplan et al., 2015).

Based on this, the following hypothesis was proposed:

H3: There is a positive relationship between perceived behavioural control (PBC) and intentions (INT).

To enhance the Theory of Planned Behaviour's (TPB) predictive ability, research suggests incorporating additional variables that may better explain pro-environmental behaviours, including choices related to micromobility. Among these variables, environmental awareness appears particularly important (Xu et al., 2020; Müller et al., 2021). Therefore, in this study, environmental awareness was added as a new variable to the TPB model.

Environmental awareness refers to the understanding of the impact of human actions on the natural environment and the readiness to undertake actions aimed at its protection (Paul et al., 2016; Yadav & Pathak, 2016). Research consistently shows that environmental awareness is a key factor influencing pro-environmental behaviours, such as choosing ecological food products or using more sustainable means of transport, including micromobility. Higher environmental awareness translates into more conscious consumer decisions supporting sustainable development (Paul et al., 2016). Moreover, research by Guan et al. (2024) suggests that positive experiences with using ecological forms of transportation, such as micromobility, can also strengthen environmental awareness, creating a positive feedback loop between travel satisfaction, pro-environmental attitudes, and the choice of sustainable transportation modes. Research by Eccarius and Lu (2020) and Zhang and others (2023) provides additional evidence that attitudes toward micromobility and subjective norms can impact intentions regarding the use of micromobility, such as electric scooters. Based on the literature review, the following hypotheses were proposed:

H4: Environmental awareness (EA) positively affects attitudes (AT), subjective norms (SN), and perceived behavioural control (PBC).

A summary of the methodology used in this study is presented in Scheme 1.

In connection with the research objective and adopted research model, a questionnaire was developed consisting of two parts, aimed at examining the attitudes of students at the University of Warmia and Mazury. The first part of the questionnaire included demographic data, while the second part contained a set of questions consistent with the TPB model (Table 1). Each question corresponded to a specific research construct, and responses were evaluated on a five-point Likert scale, where 1 meant "Strongly disagree" and 5 "Strongly agree." The questionnaire was tested in pilot studies and subjected to verification by experts from the University of Warmia and Mazury, who recommended introducing corrections in formulations and question sequence.

4. Data analysis

This study involved a two-stage analysis of survey data using SPSS and AMOS programs. In the first stage, using SPSS, correlation analysis, Student's t-test, and multiple regression were employed to examine the relationships between the factors of the Theory of Planned Behaviour (TPB) model. In the second stage, using AMOS, structural equation modelling (SEM) analysis was conducted to assess the theoretical model's fit to empirical data and verify construct validity and reliability.

Based on correlation analysis between TPB model factors, it was found that significant relationships existed between individual variables. For example, attitudes toward micromobility (AT) showed a strong positive correlation with intentions (IN) regarding micromobility support (r=0.587, p<0.001), suggesting that a positive attitude toward ecological forms of transportation is a key predictor of actions promoting them. Subjective norms (SN) also had a significant, moderate impact on intentions (r=0.512, p<0.001), particularly in the context of social expectations regarding sustainable transport. Perceived behavioural control (PBC) showed moderate correlation with intentions (r=0.531, p<0.001), which emphasises the importance of sense of availability and ease of using micromobility in shaping pro-environmental behaviours (Table 2).

Student's t-test analysis showed that women demonstrate significantly higher engagement in pro-environmental activities and more positive attitudes toward micromobility compared to men. These differences are particularly evident in areas related to limiting the use of combustion vehicles (t(162.43)=–4.37, p<0.001) and making conscious purchasing decisions, such as choosing environmentally friendly products (t(158.42)=–3.98, p<0.001). Women also more frequently limited car travel to short distances, choosing to walk or cycle (t(162.91)=–3.98, p<0.001), and were more engaged in local community activities aimed at promoting sustainable development (t(162.60)=–2.57, p=0.006). Additionally, women show a greater inclination to support initiatives promoting micromobility development in Olsztyn (t(160.02)=–3.22, p=0.001) and are more interested in participating in educational programs regarding the benefits of micromobility (t(160.89)=–3.00, p=0.002). These results suggest that women may play a key role in promoting sustainable forms of transport.

Multiple regression analysis results confirmed that all TPB model factors (Attitudes, Subjective Norms, Perceived Behavioural Control, and Environmental Awareness) have a significant impact on intentions to use micromobility. The model explained 64.5% of the variance in intentions, indicating that these variables are strong predictors. Subjective norms had the greatest impact on intentions (β=0.347, p<0.001), emphasising the importance of social pressure in shaping pro-environmental behaviours (Table 3).

In the next stage, using the AMOS program, structural equation modelling (SEM) analysis was conducted to assess the consist-

ency of empirical results with theoretical assumptions. Before beginning the analysis, the skewness and kurtosis of the variables were checked, confirming that they meet the general linear model assumptions.

Confirmatory factor analysis (CFA) showed that the model demonstrated a good level of fit to data: chi-square per degree of freedom (χ^2/df) was 1.574, Comparative Fit Index (CFI) value reached 0.946, and Tucker-Lewis Index (TLI) was 0.931. The RMSEA value of 0.059 and the SRMR index at the 0.05 level also indicate a good model fit. Construct reliability was confirmed using Cronbach's alpha coefficient, which ranged from 0.708 to 0.868, indicating high measurement reliability (Table 4).

Path analysis in SEM confirmed the significant impact of attitudes (AT), subjective norms (SN), and perceived behavioural control (PBC) on intentions (IN) to support micromobility. Additionally, environmental awareness (EA) had a significant positive impact on all three variables: attitudes, subjective norms, and perceived behavioural control.

Based on analysis results, it should be stated that the proposed model explains 64.5% (R^2=0.645) of the variance in intentions regarding micromobility use. Verification of individual hypotheses showed that:

- Hypothesis H1: Attitude (AT) significantly affects intentions to support micromobility (β=0.289, p<0.01), confirming the assumption that positive attitudes toward micromobility translate into willingness to support it.
- Hypothesis H2: Subjective norms (SN) have a significant impact on intentions to support micromobility (β=0.513, p<0.001), emphasising the role of social pressure in shaping pro-environmental intentions.
- Hypothesis H3: Perceived behavioural control (PBC) significantly affects intentions to support micromobility development (β=0.365, p<0.001), suggesting that the higher the sense of control over the possibility of using micromobility, the greater the intentions to support its development.
- Hypothesis H4: Environmental awareness (EA) has a significant positive impact on attitudes (AT), subjective norms (SN), and perceived behavioural control (PBC). High environmental awareness promotes shaping positive attitudes toward micromobility, stronger subjective norms, and greater perceived behavioural control.

4. Discussion

Study results confirm the significance of key Theory of Planned Behaviour (TPB) variables in shaping intentions related to micromobility. As assumed, attitude toward micromobility (AT), subjective norms (SN), and perceived behavioural control (PBC) have a significant impact on intentions to support micromobility. These results are consistent with the literature, particularly with research by Hauslbauer et al. (2022), which also indicates a strong impact of subjective norms on transport decisions.

Research by Zhang et al. (2023) emphasises the importance of perceived behavioural control, which is reflected in this study's results. Moderate correlation was found between PBC and intentions (r=0.531), indicating that a sense of control over the possibility of using micromobility constitutes a key factor favouring the promotion of these forms of transport. Similar conclusions were presented by Newton and Meyer (2013), who demonstrated that PBC is a significant predictor of pro-environmental intentions.

The research has significant implications for urban planning and university policy, especially regarding the improvement of infrastructure and safety measures that can promote micromobility. Results emphasise the need to strengthen subjective norms through educational and promotional campaigns, highlighting the social and ecological benefits of choosing micromobility. City authorities and educational institutions should focus on developing infrastructure that enables the safe and convenient use of micromobility,

which can increase users' sense of behavioural control.

Research by Elmashhara et al. (2023) demonstrates that infrastructure and safety measures play a crucial role in promoting micromobility, and their presence significantly influences the increase in popularity of these forms of transportation among students and city residents.

Generation Z plays a significant role in shaping the future of sustainable urban transport. Study results indicate that young people are more inclined to support micromobility, aligning with findings by Wawer et al. (2022), which show a high level of environmental awareness in this age group. The values and preferences of Generation Z make them a significant driving force in promoting sustainable forms of transport, which is crucial for future urban strategies.

5. Conclusion

Research conducted on students at the University of Warmia and Mazury in Olsztyn confirms that micromobility, including electric scooters and bicycles, has significant potential as a sustainable mode of transportation in urban areas. Results indicate a strong connection between intentions to use micromobility and attitudes toward these means of transport, subjective norms, and perceived behavioural control. The application of the Theory of Planned Behaviour (TPB) proved to be an appropriate approach in analysing this phenomenon.

Actions aimed at promoting micromobility should focus on shaping positive attitudes, increasing social support, and strengthening a sense of control over using these means of transport. City authorities and educational institutions should develop infrastructure supporting micromobility and conduct educational campaigns promoting its benefits. Environmental awareness, a key factor influencing students' attitudes and behaviours, emphasises the need for further environmental education in the context of sustainable transport.

Future research could expand the scope of analyses to cover various social groups and regions, allowing for a better understanding of the barriers and motivations related to micromobility. The results of this study can serve as the basis for developing more targeted urban policies and strategies that promote sustainable urban development, with micromobility as a key element.

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Appendix

Table 1.
Questionnaire questions regarding attitudes, subjective norms, and perception of control toward micromobility

Construct	Description	Source
EA1	Environmental protection actions are important to me	(Lucarelli et al., 2020), (Lee and Kim, 2021)
EA2	I participate in recycling programs or other initiatives aimed at environmental protection	(Lucarelli et al., 2020), (Lee and Kim, 2021)
EA3	I make conscious purchasing decisions, choosing environmentally friendly products	(García-Salirrosas et al., 2023), (Lee and Kim, 2021)
EA4	I engage in local community activities aimed at promoting sustainable development, e.g., tree planting or organising ecological workshops	(García-Salirrosas et al., 2023), (Lee and Kim, 2021)
AT1	I believe that micromobility is a good solution for a city like Olsztyn	(Lang et al., 2022)
AT2	I prefer using bicycles or electric scooters instead of a car	(Lang et al., 2022)
AT3	I perceive micromobility as an effective way to reach downtown Olsztyn	(Lang et al., 2022)
AT4	I try to limit car travel on short distances, choosing walking or cycling	(Wang et al., 2022)
AT5	I try to limit my use of combustion vehicles	(Wang et al., 2022)
SN1	In my social environment, ecological forms of transport are promoted	(Al-Swidi et al., 2014), (Passafaro et al., 2019)
SN2	I am expected to use sustainable means of transport	(Leong at al., 2023), (Passafaro et al., 2019)
SN3	The influence of my environment changes my attitudes toward micromobility	(Al-Swidi et al., 2014), (Passafaro et al., 2019)
PBC1	I feel that I have easy access to micromobility means in Olsztyn	(Leong et al., 2023), (Hauslbauer, et al., 2022)
PBC2	I believe that using micromobility is convenient on campus	(Leong et al., 2023), (Hauslbauer, et al., 2022)
PBC3	I perceive the cost of using micromobility as affordable	(Hauslbauer, et al., 2022)
PBC4	Micromobility is, in my opinion, safe on the Kortowo campus	(Passafaro et al., 2019)
INT1	I plan to use micromobility more frequently in the future than currently	(Leong et al., 2023)
INT2	I am willing to support initiatives promoting micromobility development in Olsztyn	(Al-Swidi et al., 2014)
INT3	I would be interested in participating in educational programs about the benefits of micromobility	(Passafaro et al., 2019)
INT4	I would participate in public consultations regarding infrastructure development for micromobility in Olsztyn	(Hauslbauer, et al., 2022)

Source: Items adapted from cited literature and own development.

Table 2.
Correlations between TPB factors

Factors	Correlation coefficient (*r*)	*p*-value	Interpretation
Attitudes toward micromobility (AT) — Intentions (IN)	0.587	<0.001	significant correlation, strong relationship
Subjective norms (SN) — Intentions (IN)	0.512	<0.001	significant correlation, moderate relationship
Perceived behavioural control (PBC) — Intentions (IN)	0.531	<0.001	significant correlation, moderate relationship
Attitudes toward micromobility (AT) — Subjective norms (SN)	0.403	<0.001	significant correlation, moderate relationship
Subjective norms (SN) — Perceived behavioural control (PBC)	0.347	<0.001	significant correlation, weak relationship

Note: n=167.

Source: Own research.

Table 3.
Multiple regression analysis results

Variables	Coefficient B	Standard error	Beta coefficient	*t*	*p*-value
(Constant)	−3,224	0,929	–	−3,471	<0,001
Environmental Awareness (EA)	0,248	0,061	0,250	4,073	<0,001
Attitudes (AT)	0,188	0,056	0,218	3,368	<0,001
Subjective Norms (SN)	0,529	0,092	0,347	5,772	<0,001

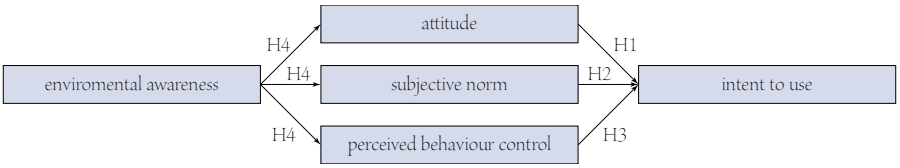
Source: Own calculations using SPSS software.

Table 4.
Structural model fit indices

Model fit indices	Result value	Recommended value
Chi-Square (χ^2)	231.34	>1 and <3
χ^2/df	1.57	>=0.90
CFI	0.946	>=0.90
TLI	0.931	>=0.90
RMSEA	0.059	<=0.08
SRMR	0.05	<=0.10

Source: Own research using AMOS software.

Scheme 1.
Proposed Research Framework



Source: Own elaboration using AMOS software.