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Public Transport Use Among Workers in Bali: Behavioral Evidence for Green Economy-Oriented Mobility Policy

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ABSTRACT

Public transport is a strategic instrument for reducing congestion, lowering transport-related emissions, and supporting a green economy. However, workers in Bali still rely heavily on private vehicles for commuting, even after the development of Sarbagita and Teman Bus services. This study aims to examine the socioeconomic, demographic, and employment-related factors associated with workers' decisions to use public transport in the Sarbagita area of Bali and to derive worker-oriented policy implications for sustainable mobility. A quantitative survey was conducted among workers in Denpasar, Badung, Gianyar, and Tabanan, and the data were analyzed using a probit model and marginal effects. Model diagnostics and robustness checks were also conducted using Variance Inflation Factor (VIF), Log-Likelihood, McFadden Pseudo R-squared, and re-estimation after excluding high-income observations. The probit results show that gender, income, working hours, employment status, and location significantly affect the probability of using public transport. Income, working hours, and formal employment status reduce the likelihood of using public transport, while residence in Denpasar and Badung increases it. The marginal-effect results indicate that living in better-served areas increases the probability of public transport use by 27.77 % points. In contrast, higher income, formal employment, and longer working hours decrease it. The robustness check confirms that the main findings remain stable after excluding high-income observations. These findings suggest that public transport policy in Bali should move beyond infrastructure provision by aligning service hours, accessibility, reliability, and information systems with workers' commuting patterns.

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■ INTRODUCTION

Air pollution, congestion, and the increasing use of private motor vehicles have become important issues in urban and regional development. In Indonesia, growth in private vehicle ownership has intensified pressure on road infrastructure and contributed to declining environmental quality. This issue is particularly relevant in Bali, where mobility pressure is shaped by the concentration of residential, tourism, education, trade, and service-sector activities in relatively limited urban and peri-urban corridors. Official transport statistics show that Bali recorded 4,756,197 motorcycles and 569,311 passenger cars in 2025, indicating the strong dominance of private motorized mobility in the provincial transport system (Badan Pusat Statistik Provinsi Bali, 2026; Badan Pusat Statistik, 2026). Public transport is therefore increasingly positioned as a policy instrument to reduce congestion, improve mobility efficiency, and support a green economy. In this context, shifting workers from private vehicles to public transport is particularly important because commuting is a routine and repeated form of daily mobility. Evidence from vehicle-restriction policy also shows that reducing private vehicle use can contribute to air-quality improvement (Zhang et al., 2017).

Bali provides an important case for examining worker mobility because daily travel demand is generated not only by residents but also by interactions among tourism activities, administrative centers, education, trade, and service-sector employment. The Sarbagita area, comprising Denpasar, Badung, Gianyar, and Tabanan, is the main urban and peri-urban

mobility corridor in southern Bali. Denpasar and Badung function as major centers for employment, administration, education, and tourism services, while Gianyar and Tabanan include more dispersed residential, agricultural, and peri-urban areas. This spatial configuration creates differences in route density, access to bus stops, travel time, and first-mile and last-mile connectivity. Therefore, workers' decisions to use public transport should be understood not only as a response to fare levels but also to spatial accessibility and the compatibility of public transport services with daily work routines.

The benefits of public transport are multidimensional. From an environmental perspective, public transport can reduce per-capita energy consumption and emissions by carrying more passengers with fewer vehicles. Economically, it can reduce individual travel expenditure, lower dependence on fuel subsidies, and improve the efficiency of urban and regional mobility. Socially, inclusive public transport can improve access to employment and public services while reducing inequality in mobility. These benefits are consistent with the sustainable transport paradigm, which emphasizes reducing unnecessary travel, shifting travel modes, shortening trips, and improving system efficiency (Banister, 2008; Miller et al., 2016).

Bali has pursued public transport development through Sarbagita and the later digital-based Teman Bus service. These initiatives indicate the provincial government's intention to provide sustainable and accessible public transport. Nevertheless, the use of public transport among workers remains low. This claim is supported by official performance data from the Bali Provincial Transportation Agency. The 2023 performance report shows that Trans Sarbagita corridors I and II recorded a load factor of only 23.85%. This figure indicates that available bus capacity has not been fully absorbed by passengers and that public transport utilization remains limited relative to the capacity provided (Dinas Perhubungan Provinsi Bali, 2024). The same report also shows that Trans Sarbagita carried an average of 4,301 passengers per day in 2023, comprising 3,254 on Corridor I and 1,047 on Corridor II. These data suggest that the central issue is not only the existence of public transport services, but also the extent to which those services are attractive, accessible, and compatible with the mobility needs of potential users, especially workers.

The problem is not only the availability of transport infrastructure but also the behavioral and socioeconomic factors that shape commuting decisions. Workers may prefer private vehicles because they offer flexibility, punctuality, perceived safety, and compatibility with work schedules. Such decisions are consistent with behavioral economics, which recognizes that individuals respond not only to monetary costs but also to bounded rationality, habits, social norms, perceived risk, and convenience (Simon, 1986; Cartwright, 2018). In this study, bounded rationality is used as an interpretive framework rather than as a directly measured psychological construct. The empirical model does not include a separate perception-risk variable because the survey instrument was designed to capture factual socioeconomic, employment-related, and spatial constraints. Therefore, bounded rationality is operationalized indirectly through observable variables that represent practical constraints in workers' commuting decisions, including income, working hours, employment status, location, and gender. The choice between private vehicles and public transport can also be understood as a social dilemma in which individual convenience may conflict with collective environmental benefits (Van Vugt et al., 1995).

This framework was translated into measurable indicators that are aligned with the variables tested in the probit model. Income was used to capture purchasing power and access to private vehicles. Working hours represented time pressure and compatibility between work schedules and public transport operating hours. Employment status reflected differences in punctuality requirements and workplace discipline. Location captured unequal access to public transport services between Denpasar–Badung and Gianyar–Tabanan. Gender was included because perceived safety, comfort, and mobility constraints may differ between male and female workers. Recent studies also show that women's use of public transport is strongly affected by perceptions of safety, comfort, and gendered mobility constraints (Sil et al., 2023; Hermaputi et al., 2024; Yossa et al., 2024; Agrawal et al., 2025). Thus, the study does not test bounded rationality as a latent construct, but uses it to interpret how observable constraints shape workers' public transport choices.

Previous studies show that mode choice is associated with demographic factors, income, work schedule, travel time, service quality, and accessibility to public transport (Chakrabarti, 2017; Arslannur & Tortum, 2023; Babapour et al., 2025; Zarabi et al., 2024). For workers, employment-related constraints are crucial

because formal work schedules often require punctual arrival and predictable travel time. In Bali, where many economic activities are linked to tourism and services, working hours can be longer or less aligned with the limited operating hours of public transport. Consequently, the same public transport service may be evaluated differently by workers depending on income, gender, employment sector, and residential location. Previous studies also show that travel behavior is shaped by built-environment characteristics such as density, diversity, design, accessibility, and proximity to transport services (Cervero & Kockelman, 1997; Ewing & Cervero, 2010; Handy et al., 2005). Evidence from Indonesian cities also shows that built-environment conditions are associated with mobility and physical activity patterns, reinforcing the relevance of accessibility and walkability in transport behavior (Muzayanah et al., 2022).

The literature on sustainable mobility emphasizes that increasing public transport use requires more than physical infrastructure. Banister (2008) argues that sustainable mobility involves reducing car dependence, improving accessibility, and reshaping travel behavior. Miller et al. (2016) further show that public transportation contributes to sustainability when services are reliable, efficient, and socially inclusive. In commuter mode-choice analysis, Hensher and Rose (2007) demonstrate that travel time, service reliability, and the perceived usefulness of transport alternatives are important determinants of travel decisions. Studies in Indonesia also confirm that income, employment characteristics, accessibility, and travel behavior influence commuter mode choice (Adwiluvito, 2019; Irjayanti et al., 2021; Setyodhono, 2017). However, most Indonesian commuter studies have focused on large metropolitan regions such as Jabodetabek, while worker-specific evidence from Bali remains limited. This limitation is important because Bali has a distinctive mobility structure, characterized by tourism-oriented employment, dispersed residential patterns, and strong dependence on motorcycles and private vehicles.

Several public transport studies in developing-country contexts also highlight the role of service quality, accessibility, and user perception. Ngoc et al. (2017) show that users evaluate public transport through comfort, reliability, safety, travel time, and information availability. Nurlaela and Curtis (2012) emphasize that public transport accessibility around residential locations affects travel behavior. Ouali et al. (2020) demonstrate that gender differences in perceived safety are relevant in public transport use. These studies indicate that workers' public transport behavior should be examined through a combination of socioeconomic characteristics, employment constraints, spatial accessibility, and behavioral considerations. For Bali, this perspective is especially relevant because many workers face irregular schedules, tourism-related shifts, long working hours, and uneven access to public transport routes.

The research gap addressed in this article is the limited empirical analysis of worker-specific public transport behavior in Bali, particularly in the Sarbagita area. Existing public transport policies often focus on infrastructure provision, while workers, as a target group, receive less attention. In addition, previous discussions on public transport in Bali have not sufficiently connected low utilization indicators, such as load factor, with worker-level socioeconomic and employment characteristics. This creates a policy gap: public transport services may be available, but they may not align with workers' daily constraints and behavioral preferences. Understanding this gap is essential for designing green economy-oriented mobility policy because the environmental benefits of public transport can only be achieved if potential users are willing and able to shift from private vehicles to public transport. From an operational perspective, effective public transport also depends on service availability, accessibility, reliability, comfort, and network integration (Vuchic, 2005).

Given this gap, this study examines three related issues. First, it identifies the socioeconomic, demographic, employment-related, and spatial factors that influence workers' decisions to use public transport in the Sarbagita area of Bali. Second, it estimates the magnitude of each factor's marginal effect on the probability of using public transport. Third, it translates the empirical findings into operational policy implications for worker-oriented public transport services that support green economy-oriented mobility in Bali. By addressing these issues, the study connects worker-level commuting behavior to practical transport policy interventions, including service-hour adjustments, reliability improvements, first-mile and last-mile connectivity, safety enhancements, and digital travel information.

Referring to the literature on mode choice, sustainable mobility, and bounded rationality, this study proposes the following hypotheses. Age is expected to have a non-linear relationship with workers' probability of

using public transport. Gender is expected to be associated with differences in public transport use because safety, comfort, and mobility constraints may differ between male and female workers. Marital status is expected to affect public transport use because household and family mobility responsibilities may influence commuting decisions. Income is expected to reduce public transport use because higher purchasing power increases access to private vehicles and shifts preferences toward more flexible mobility. Working hours are expected to reduce public transport use because time constraints and schedule incompatibility make public transport less attractive. Formal employment status is expected to negatively affect public transport use because formal workers tend to face stronger punctuality and reliability requirements. Location is expected to affect public transport use, with workers living in Denpasar and Badung more likely to use public transport than those living in Gianyar and Tabanan due to higher route density and service accessibility. Activity-travel behavior studies indicate that public transport use is closely related to how individuals allocate time and activities during travel (Zhang & Timmermans, 2010).

This study therefore aims to analyze the socioeconomic, demographic, and employment-related factors influencing workers' decisions to use public transport in Bali and to identify priority factors to improve public transport policy as part of implementing the green economy. The contribution of this study is twofold. First, it provides empirical evidence on worker-specific public transport behavior in Bali using measurable socioeconomic, demographic, employment-related, and spatial variables. Second, it connects probit estimates and marginal effects to practical policy interventions, allowing the findings to inform operational improvements such as service-hour adjustments, feeder-service strengthening, reliability improvements, safety enhancements, real-time information provision, and institutional coordination for worker-oriented public transport services.

■ METHOD

Participants and Sample

This study used primary data collected through a questionnaire distributed to workers. The target population is workers aged 15 years and above who are actively employed and receive wages, salaries, or income from work or business activities. The study treated Sarbagita as one integrated mobility area rather than as four separate comparative regions. The survey covered workers in Denpasar, Badung, Gianyar, and Tabanan because these areas form the Sarbagita public transport service corridor and represent the main urban mobility area in Bali. Respondents were selected using purposive sampling based on the study's inclusion criteria: workers aged 15 years and above, actively employed during the survey period, and engaged in work-related commuting within the Sarbagita area. The four administrative areas served as the geographic coverage for data collection. At the same time, location was included in the empirical model as a dummy variable to capture differences in public transport accessibility among Denpasar, Badung, Gianyar, and Tabanan.

The minimum sample size was calculated using the Slovin formula with a 5 percent margin of error. The working-age population in the Sarbagita area was 1,404,788 persons (Badan Pusat Statistik Provinsi Bali, 2025a), resulting in a minimum sample requirement of approximately 400 respondents. Because the study focused specifically on workers as the target group of public transport policy, purposive sampling was considered appropriate to ensure that respondents had relevant commuting experience and could provide information on transport mode choice, employment status, income, working hours, and residential location. However, the actual field survey produced a substantially larger dataset. After data checking and cleaning, 3,610 worker observations were retained for the final analysis. Therefore, 400 is reported as the minimum sample requirement, while 3,610 represents the final analytical sample used in the descriptive statistics and probit estimation.

This definition follows the employment concept used by Statistics Indonesia, in which workers are individuals who actively work in an economic activity and receive income, either in cash or in kind. The inclusion criteria were: (1) being at least 15 years old, (2) being actively employed during the survey period, (3) residing or working in one of the four Sarbagita areas, and (4) being able to provide information on commuting mode, employment status, income, and working hours. Respondents who were not actively employed or did not provide complete information on the dependent variable were excluded from the analysis. To reduce field-selection bias, data collection was conducted across Denpasar, Badung, Gianyar, and Tabanan, encompassing diverse workplace settings, residential areas, and commuting contexts. The questionnaire used standardized questions and fixed response categories, and the data were checked for completeness, coding consistency, and plausibility before analysis.

The sampling procedure combined area-

based stratification and purposive respondent selection. First, the study area was stratified into four administrative locations: Denpasar, Badung, Gianyar, and Tabanan. Second, respondents within each location were purposively selected based on the inclusion criteria: being workers aged 15 years and above and having work-related commuting experience. This approach was used because the study focused specifically on workers as the target group for public transport policy rather than the general population. The procedure also enabled the study to capture variation in residential and workplace locations, employment status, income, working hours, and commuting mode.

Before answering the questionnaire, respondents were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. Informed consent was obtained from each respondent before data collection. Respondents were not asked to provide sensitive personal identifiers in the analysis, and the data were processed only in aggregate form for academic purposes. The study was conducted as part of an institutional research project funded by DIPA PNBP Universitas Udayana in 2023 under the Research Assignment Agreement No. B/1.393/ UN14.4.A/PT.01.03/2023, dated 2 May 2023. Before data collection, respondents were informed about the purpose of the study, the voluntary nature of participation, and the confidentiality of their responses. Informed consent was obtained from all respondents. The questionnaire did not collect sensitive personal identifiers, and all data were analyzed and reported only in aggregate form for academic purposes.

Research Design

This study uses a quantitative approach to examine workers' decisions to use public transport for commuting. The research area covers the Sarbagita region of Bali, consisting of Denpasar, Badung, Gianyar, and Tabanan. These areas were selected because they are connected to the main public transport development areas in Bali and represent locations where public transport access is available but unevenly distributed.

The study employed an explanatory cross-sectional survey design, which is appropriate for examining relationships among variables using data collected from respondents at a single point in time (Creswell & Creswell, 2018). The explanatory design was used because the study aims to identify the socioeconomic, demographic, employment-related, and spatial factors associated with workers' decisions to use public transport. The cross-sectional design was considered appropriate because the data were collected from workers at a single point in time and were used to estimate the relationship between respondent characteristics and commuting mode choice.

Sarbagita was treated as one integrated mobility corridor rather than as four separate comparative regions. Denpasar, Badung, Gianyar, and Tabanan were included in the survey's geographical coverage because they constitute the main public transport service area and worker mobility corridor in southern Bali. Within this design, location was included as an explanatory variable to capture differences in public transport accessibility between areas with denser service access and areas with less dense access.

The research design also follows a behavioral mobility perspective. Workers' decisions to use public transport were assumed to be influenced not only by economic factors but also by employment constraints, time availability, service accessibility, and perceived commuting convenience. Therefore, the empirical model includes variables such as income, working hours, employment status, location, gender, marital status, and age. This design allows the study to connect the behavioral framework discussed in the Introduction with measurable variables used in the quantitative analysis.

The analysis was designed to estimate workers' probability of using public transport through a discrete choice framework. Because the dependent variable is binary, namely whether a worker uses public transport or not, the design is consistent with a probit model (Train, 2009). After the probit estimation, average marginal effects were calculated to assess the magnitude of changes in probability associated with each explanatory variable. Additional diagnostic and robustness procedures were conducted, including multicollinearity checks using Variance Inflation Factors (VIFs), model fit reporting using Log-Likelihood and McFadden Pseudo-R-squared, and a robustness check excluding the top 1 percent of income observations. Policy implications were then synthesized from the probit results, marginal effects, robustness check, and concept map.

Instruments

The dependent variable is the decision to use public transport for commuting to work. It is coded as a dummy variable, with 1 indicating that the worker uses public transport and 0

otherwise. The independent variables include age, squared age, gender, marital status, income, weekly working hours, employment status, and location. Gender, marital status, employment status, and location are measured as dummy variables. Location is coded as 1 for Denpasar and Badung, which have denser, more strategic public transport access, and as 0 for Gianyar and Tabanan, where access exists but is less dense. The selection of transport-related indicators was also informed by international studies showing that service quality, reliability, accessibility, comfort, information, and travel time influence public transport evaluation and use (Eboli & Mazzulla, 2007, 2011; Dell'Olio et al., 2011; de Oña & de Oña, 2015).

The data were collected using a structured questionnaire developed from employment concepts used by Statistics Indonesia and previous studies on commuter mode choice and public transport behavior. The questionnaire was not designed as a psychological perception scale but as a factual, categorical instrument to obtain the measurable information required for the probit model. The main indicators covered in the questionnaire included demographic characteristics, socioeconomic characteristics, employment characteristics, residential and workplace location, and commuting mode.

The questionnaire consisted of two main sections. The first section recorded respondents' personal and spatial characteristics, including age, gender, education level, district of residence, district of workplace, occupation, and marital status. The second section recorded transport and employment information, including the main mode of transport used to get to work, employment status, monthly net income or wage, and total working hours during the last week. Examples of questionnaire items include: "What is the main mode of transport you use to go to work?" "What is your employment status?", "How much net income/wage/salary did you receive during the last month?", and "During the last week, how many working hours did you have per day, excluding rest time?"

The response categories were structured and fixed. For the commuting mode question, the response categories included private/official vehicle, public transport, online transport, and walking or no vehicle. For employment status, the response categories followed labor-force classifications, including own-account worker, employer assisted by temporary or unpaid workers, employer assisted by permanent

Table 1. Operational variables used in the model

Variable	Measurement	Expected relationship
Public transport use	Dummy: 1 = use public transport; 0 = otherwise	Dependent variable
Age	Years	Non-linear effect expected
Age squared	Squared age	Controls for non-linear age effect
Gender	Dummy: 1 = female; 0 = male	May reflect differences in safety and mobility constraints
Marital status	Dummy: 1 = unmarried/not married; 0 = otherwise/married or previously married.	May reduce public transport use due to family mobility needs
Income	Monthly net income/wage/salary received during the last month, reported as an absolute value in Indonesian rupiah.	Higher income may reduce public transport use.
Working hours	Hours per week	Longer hours may reduce public transport use
Employment status	Dummy: formal sector = 1; informal sector = 0	Formal workers include employees and employers assisted by permanent workers; informal workers include own-account workers, employers assisted by temporary/unpaid workers, casual workers, and unpaid family workers. Formal workers may require more flexible and punctual mobility.
Location	Dummy: Denpasar/Badung = 1; Gianyar/Tabanan = 0	Better access may increase public transport use

workers, employee, casual worker in agriculture, casual worker in non-agriculture, and unpaid family worker. These categories were then recoded into the variables required for the empirical model. For example, the dependent variable was coded 1 if the respondent used public transport for commuting and 0 otherwise. Employment status was recoded into formal sector = 1 and informal sector = 0. Location was recoded into Denpasar/Badung = 1 and Gianyar/Tabanan = 0.

Instrument validity was addressed through content validity. Each questionnaire item was aligned with the operational variables used in the empirical model and with indicators identified in previous mode-choice studies, such as demographic factors, income, employment characteristics, working hours, and spatial accessibility (Hensher & Rose, 2007; de Oña & de Oña, 2015). The questionnaire items were also checked to ensure they corresponded directly to the variables required by the probit model. Because the instrument consisted mainly of factual and categorical items rather than multiple Likert-scale items measuring a latent perception construct, internal consistency reliability, as assessed with Cronbach's alpha, was not calculated. Reliability was instead maintained through standardized questions, fixed response categories, consistent coding procedures, and data checking before analysis.

Data Analysis

The main analytical method was a probit regression model because the dependent variable is binary. The model estimated the probability that a worker uses public transport as a function of socioeconomic, demographic, and employment-related characteristics. Binary choice models are appropriate when the dependent variable represents two possible outcomes, such as using or not using public transport (Train, 2009). The general model is written as $\text{Probit}[\pi(x)] = \alpha + \beta X + \mu$, where $\pi(x)$ is the probability of using public transport, α is the intercept, β is the vector of parameters, X is the vector of independent variables, and μ is the error term.

After estimating the probit model, marginal effects were calculated to interpret the change in the probability of public transport use associated with a change in each explanatory variable. Marginal effects were used because probit coefficients indicate the direction and statistical significance of the relationship, but they do not directly indicate the magnitude of changes in probability. Therefore, marginal effects provide a clearer interpretation of how each variable affects the probability that workers use public transport (Williams, 2012).

Before regression estimation, the data were examined for completeness, coding consistency, and plausibility. Extreme values in income and working hours were not automatically deleted. The maximum weekly working hours and the maximum monthly income were reviewed as potential outliers. These values were retained in the baseline model because they remained substantively plausible in the context of long shifts, multiple jobs, tourism-related work schedules, and income variation in Bali. Therefore, the baseline probit model used the original data as-is. To assess whether extreme income values influenced the results, a robustness check was conducted by excluding the top 1 percent of the income distribution and re-estimating the probit model.

Multicollinearity among explanatory variables was examined using the Variance Inflation Factor (VIF). Model fit was reported using the Log-Likelihood and McFadden Pseudo-R-squared. The final analysis therefore consisted of descriptive statistics, probit estimation, marginal effect calculation, multicollinearity testing, model fit reporting, and robustness checks. Operational policy implications were synthesized from the empirical results and visualized through a concept map linking worker-related barriers with specific public transport interventions.

■ RESULT AND DISCUSSION

Respondent Characteristics

The descriptive statistics indicate that the final analytical sample consisted of 3,610 workers. Workers in the sample are, on average, 39.70 years old. The average monthly income is IDR 3,579,273, while the average weekly working time is 46.79 hours. The maximum monthly income reaches IDR 30,000,000, and the maximum working time reaches 84 hours per week. These values were treated as potential outliers during data checking but were retained in the baseline analysis because they remained substantively plausible in the context of income variation, multiple jobs, long shifts, and extended working schedules in Bali's service and tourism-related economy. The baseline model, therefore, used the original data as-is. At the same time, the influence of extreme income values was further assessed by conducting a robustness check that excluded the top 1 percent of income observations. The descriptive results also show variation by gender, marital status, and formal employment status, enabling

Table 2. Descriptive statistics of respondents

Variable	N	Mean	Std. Dev.	Min	Max
Age	3,610	39.69751	11.57047	17	64
Gender	3,610	0.3595568	0.479937	0	1
Marital status	3,610	0.0382271	0.1917707	0	1
Income	3,610	3,579,273	2,491,284	1,540,000	30,000,000
Working hours	3,610	46.78781	10.72017	20	84
Employment status	3,610	0.6357341	0.4812904	0	1

the model to assess how worker characteristics are associated with transport choice.

To complement the descriptive statistics in Table 2, Figure 1 presents the boxplot of monthly income by gender. Income is presented in million Indonesian rupiah. The boxplot displays the median, interquartile range, dispersion, and extreme values by gender. Figure 2 presents the violin plot of weekly working hours by gender. These visualizations allow readers to observe the median, dispersion, distributional density, and extreme values more clearly. The violin plot is used for working hours because it provides a more detailed view of the density distribution of long working-hour patterns among workers.

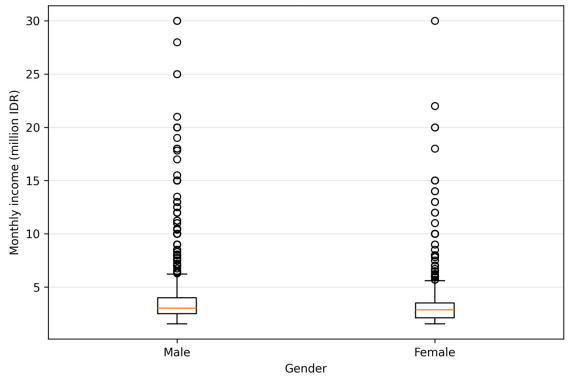

Figure 1. Boxplot of Monthly Income by Gender

Determinants of Workers' Public Transport Use

The probit estimation examines the socioeconomic, demographic, employment-related, and spatial determinants of workers' decisions to use public transport. The results are presented in Table 3. This section directly addresses the first research question by identifying the factors that significantly influence workers' use of public transport in the Sarbagita area.

Before estimating the probit model, multicollinearity among the explanatory variables was examined using the Variance Inflation Factor (VIF). Because the model includes both age and age squared, age was mean-centered before generating the squared term for the VIF diagnosis to avoid artificial collinearity between polynomial terms. As shown in Table 3, all explanatory variables have VIF values far below the commonly used threshold of 10. The highest VIF is 1.1598 for employment status, while the mean VIF is 1.0825. This indicates that multicollinearity is not a serious problem in the model, including the relationship between income and employment status.

Table 3. Variance Inflation Factor Test

Variable	VIF
Age (centered)	1.1502
Age squared (centered)	1.0145
Gender	1.0437
Marital status	1.0399
Income (ln)	1.0882
Working hours	1.0148
Employment status	1.1598
Location	1.1493
Mean VIF	1.0825

The probit estimation results and average marginal effects are presented in Table 4. The table combines coefficient estimates, standard errors, z-values, p-values, and average marginal effects to provide a more concise presentation of the determinants of workers' use of public transport. The model has a Log-Likelihood of -1060.8784 and a McFadden Pseudo R-squared of 0.3641, indicating that the explanatory variables provide meaningful improvement over the null model.

The results in Table 4 show that gender, income, working hours, employment status, and location significantly affect workers' probability of using public transport. Age, age squared, and marital status are not statistically significant. Income has a negative and significant coefficient, indicating that higher-income workers are less likely to use public transport. Since income is entered in logarithmic form, this result suggests that income increases reduce the probability of public transport use by strengthening access to private mobility options. The average marginal effect of income is -0.0947.

Working hours are also negatively and significantly associated with public transport use. The average marginal effect shows that each additional weekly working hour reduces the probability of using public transport by

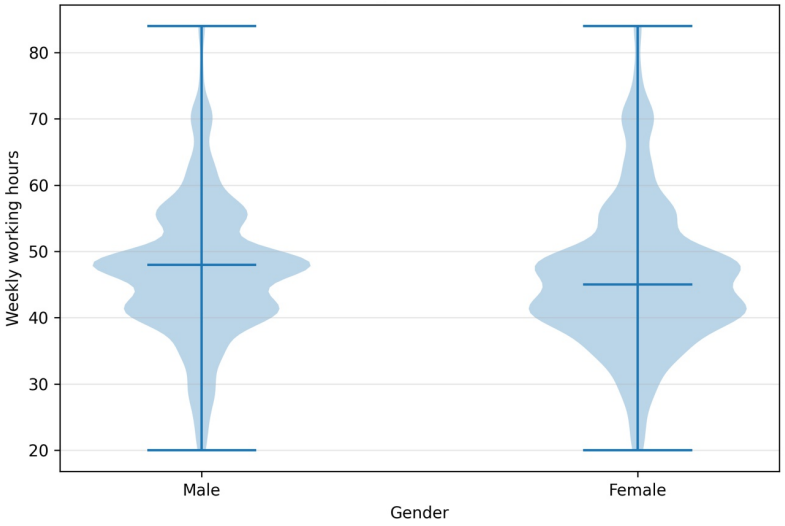

Figure 2. Violin Plot of Weekly Working Hours by Gender

approximately 0.28 percentage points. Although the per-hour effect is small, it becomes meaningful for workers with long or irregular work schedules, especially in Bali's service- and tourism-related economy.

Employment status has a significant negative effect. Formal-sector workers have a 5.82 percentage point lower probability of using public transport than informal-sector workers, holding other variables constant. This suggests that formal workers may have stronger punctuality requirements and lower tolerance for uncertain arrival times.

Location has the largest substantive effect. Workers living in Denpasar or Badung have a 27.77 percentage point higher probability of using public transport than those living in Gianyar or Tabanan. This indicates that spatial accessibility remains the strongest determinant of public transport use in the model.

Gender is also statistically significant. Female workers have a 2.65 percentage point lower probability of using public transport than male workers, holding other variables constant. This result should be interpreted in relation to differences in perceived safety, comfort, mobility constraints, and travel responsibilities. Overall, the results indicate that workers' use of public transport is shaped most strongly by spatial accessibility, followed by economic capacity, employment-related constraints, working hours, and gender-related mobility considerations.

Marginal Effects and Magnitude of Probability Changes

Despite the average marginal effects being reported in Table 4, Figure 3 is retained to provide a clearer visual comparison of the direction and magnitude of each variable's effect on workers' probability of using public

Table 4. Probit Regression Results and Average Marginal Effects

Variable	Coefficient	Std. Error	z-value	p-value	Average marginal effect
Age	0.003954	0.019037	0.208	0.835	0.000709
Age squared	-0.000110	0.000231	-0.475	0.634	-0.000020
Gender (1 = female)	-0.147855	0.063060	-2.345	0.019	-0.026498
Marital status (1 = unmarried)	-0.208850	0.141351	-1.478	0.140	-0.037430
Income (ln)	-0.528235	0.064825	-8.149	0.000	-0.094670
Working hours	-0.015853	0.002552	-6.212	0.000	-0.002841
Employment status (1 = formal)	-0.324706	0.073916	-4.393	0.000	-0.058193
Location (1 = Denpasar/ Badung)	1.549481	0.061065	25.374	0.000	0.277696
Constant	8.524217	0.971388	8.775	0.000	—

Note. Number of observations = 3,610. Log-Likelihood = -1060.8784. McFadden Pseudo R-squared = 0.3641. Marginal effects are average marginal effects.

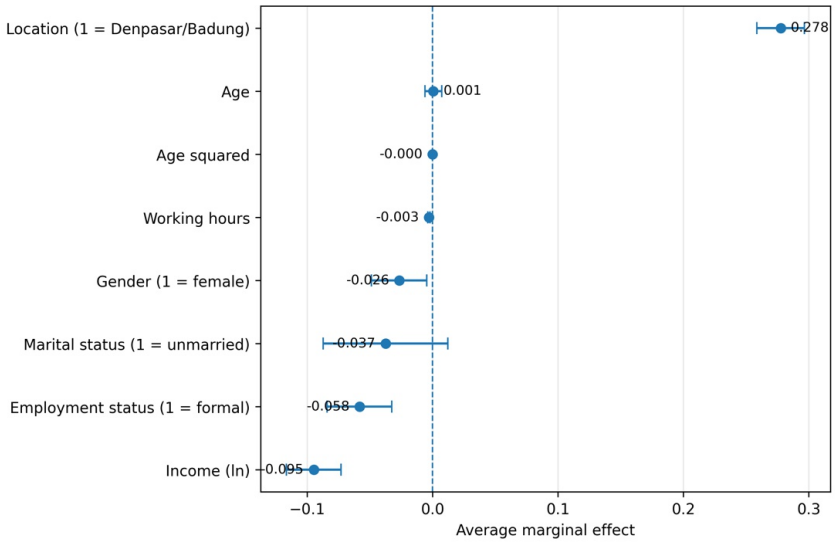

Figure 3. Coefficient plot of marginal effects on public transport use

transport. The figure displays average marginal effects with 95 percent confidence intervals, numerical data labels, and a vertical reference line at X = 0 to distinguish positive and negative effects.

As shown in Figure 3, location has the largest positive marginal effect, while income, employment status, working hours, and gender have negative marginal effects. This visual pattern confirms that spatial accessibility is the strongest factor increasing public transport use. In contrast, higher income, formal employment, longer working hours, and gender-related mobility constraints reduce the probability of using public transport. Age, age squared, and marital status have confidence intervals that include zero, indicating that their effects are not statistically significant.

Figure 3 visually confirms the pattern reported in Table 4. Points represent average marginal effects, while horizontal lines indicate 95% confidence intervals. The vertical dashed line at X = 0 separates positive and negative effects. Numerical labels indicate the estimated marginal effect for each variable. Location has the largest positive marginal effect, indicating that workers living in Denpasar or Badung are more likely to use public transport than those living in Gianyar or Tabanan. In contrast, income, employment status, working hours, and gender show negative marginal effects. The confidence intervals for age, age squared, and marital status cross the zero line, confirming that these variables are not statistically significant. Overall, the figure reinforces that public transport use among workers is shaped mainly by spatial accessibility, economic capacity, employment-related constraints, and gender-related mobility considerations.

Robustness Check: Excluding High-Income Observations

To assess whether the negative relationship between income and public transport use was driven by extreme income values, a robustness check was conducted by excluding observations above the 99th percentile of the income distribution. The 99th-percentile cutoff was IDR 15,000,000. After excluding observations above this cutoff, the robustness model used 3,584 worker observations.

The robustness results are presented in Table 5. Overall, the direction and statistical significance of the main variables remain consistent with the baseline model. Income remains negative and significant, indicating that higher-income workers are still less likely to use public transport, even after excluding high-income observations. Working hours and formal employment status also remain negative and significant, while location remains positive and significant. Gender continues to have a significant negative effect. Age, age squared, and marital status remain statistically insignificant.

These findings indicate that the main conclusions are not driven by high-income outliers. The determinants of workers' public transport use remain stable once high-income observations are excluded, confirming the robustness of the baseline probit results. Building upon this robust framework, the broader analysis reveals that workers' use of public transport in the Sarbagita area is shaped by socioeconomic, employment-related, spatial, and gender-related constraints. Among these determinants, income has a significant negative effect, suggesting that higher-income workers

Table 5. Robustness Check Excluding High-Income Observations

Variable	Baseline AME	Robustness AME	Robustness p-value
Age	0.0007	0.0006	0.859
Age squared	-0.0000	-0.0000	0.648
Gender (1 = female)	-0.0265	-0.0283	0.011
Marital status (1 = unmarried)	-0.0374	-0.0347	0.162
Income (ln)	-0.0947	-0.0819	0.000
Working hours	-0.0028	-0.0024	0.000
Employment status (1 = formal)	-0.0582	-0.0595	0.000
Location (1 = Denpasar/Badung)	0.2777	0.2885	0.000

Note. AME = Average Marginal Effect. Baseline model: N = 3,610. Robustness model: N = 3,584. The robustness model excludes observations above the 99th percentile of the income distribution. Robustness model Log-Likelihood = -1006.7910; McFadden Pseudo R-squared = 0.3895.

are less likely to use public transport. This finding implies that rising incomes may expand access to private mobility options, particularly motorcycles and cars, which are often perceived as more flexible, faster, and better suited to individual commuting needs. In Bali, where daily mobility remains highly dependent on private vehicles, income can reduce workers' reliance on public transport rather than encourage a modal shift.

Working hours also reduce the probability of using public transport. This finding shows that public transport use is influenced not only by transport costs but also by time compatibility. Workers with longer or less predictable schedules may find fixed-route and fixed-schedule services less suitable for their commuting needs. This is especially relevant in Bali's service- and tourism-related economy, where workers may face early, late, or split shifts, weekend work, and irregular working hours. Under such conditions, public transport becomes less attractive when service frequency, operating hours, and travel-time reliability do not match workers' actual work schedules.

Employment status has a significant negative effect, indicating that formal-sector workers are less likely to use public transport than informal-sector workers. This may reflect stricter punctuality requirements, workplace discipline, and lower tolerance for uncertain arrival times among formal workers. In Bali, many formal jobs are connected to tourism, hospitality, retail, administration, and other service activities that require time discipline and customer-facing readiness. The accommodation and food service sector is also one of the largest contributors to Bali's economy (Badan Pusat Statistik Provinsi Bali, 2025b), which strengthens the relevance of work-schedule compatibility in explaining workers' commuting behavior. Therefore, the lower likelihood of using public transport among formal workers may reflect a rational response to the perceived risks of delays, unreliable headways, and limited flexibility in existing public transport services.

Gender also has a significant negative effect. Female workers have a lower probability of using public transport than male workers, holding other factors constant. This finding should not be interpreted only as a difference in preference, but also as an indication that safety, comfort, travel-chain complexity, and household-related mobility responsibilities may affect transport decisions. Public transport services that are not perceived as safe, reliable, accessible, and comfortable may unintentionally discourage female workers from using them. Therefore, gender-sensitive improvements are important for making public transport more inclusive.

Location is the strongest determinant of workers' use of public transport. Workers in Denpasar and Badung have a substantially higher probability of using public transport than those in Gianyar and Tabanan. This result confirms that public transport use is highly dependent on spatial accessibility. However, the location variable should be interpreted carefully. In this study, location is measured using a broad administrative proxy that distinguishes Denpasar/Badung from Gianyar/ Tabanan. It does not measure individual residential proximity to bus stops because the dataset does not contain respondent-level residential coordinates or detailed address points. Therefore, the positive location effect should be read as capturing broad inter-regional accessibility differences rather than uniform access within each district.

This distinction is important because not all parts of Denpasar and Badung have equal access to public transport. In particular, the northern parts of Badung may have more rural characteristics and weaker bus access than the main urban and tourism corridors. Therefore, the Denpasar/Badung category should not be interpreted as implying that all workers in these areas have equally strong access to public

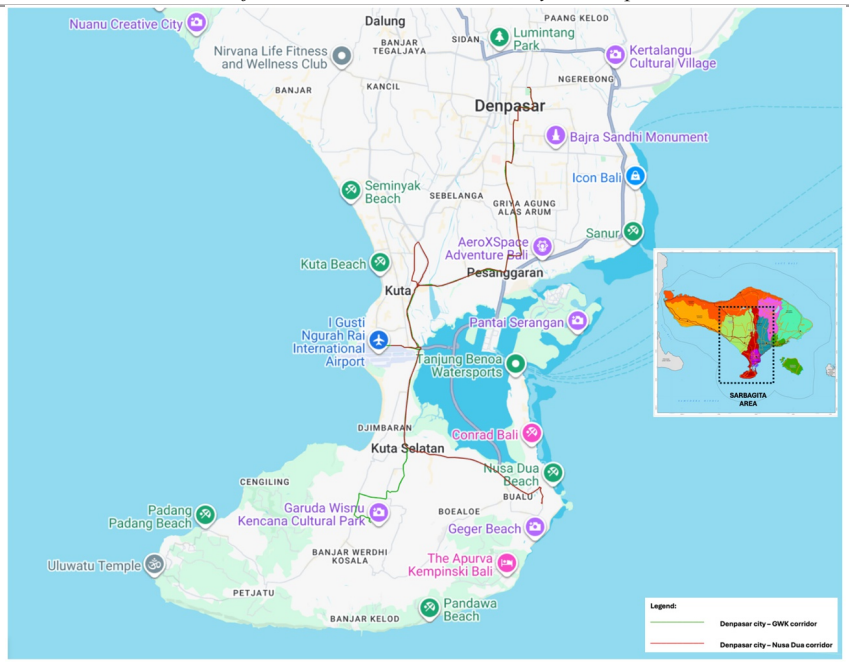

Figure 4. Active Trans Sarbagita corridors in the Southern Bali mobility area

transport. Instead, the result suggests that public transport services are generally more concentrated around the main activity corridors in Denpasar and southern Badung. This interpretation is consistent with available route information indicating that active Trans Sarbagita corridors are concentrated around GOR Ngurah Rai, GWK, and Nusa Dua/ITDC (Dinas Perhubungan Provinsi Bali, 2026), while wider Sarbagita route expansion remains uneven across the metropolitan area.

Figure 4 presents the active Trans Sarbagita corridors in the southern Bali mobility area. The figure shows that the currently displayed active corridors are concentrated around the Denpasar City–southern Badung corridor, particularly toward GWK and Nusa Dua. The green line represents the Denpasar City–GWK corridor, while the red line represents the Denpasar City–Nusa Dua corridor. The inset map shows the broader Sarbagita area, consisting of Denpasar, Badung, Gianyar, and Tabanan. The figure visualizes the current concentration of active Trans Sarbagita corridors in the southern Denpasar–Badung mobility corridor. Planned or inactive Trans Sarbagita routes toward Gianyar and Tabanan are not displayed. Individual respondent residential points are also not shown because the survey did not collect household coordinates or detailed residential addresses.

This visualization supports the interpretation that the location variable in the model captures broad differences in public transport accessibility across the Sarbagita area. However, the figure should not be interpreted as a respondent-level GIS overlay because the survey did not collect household coordinates or detailed residential addresses. Routes to Gianyar and Tabanan are not displayed in the figure because they are not among the currently active Trans Sarbagita corridors shown in this visualization. Therefore, the map is used to clarify the spatial concentration of active routes. At the same time, the regression location variable remains a broad administrative proxy rather than an individual distance-based accessibility measure.

The robustness check strengthens the interpretation of the baseline results. After excluding observations above the 99th percentile of income, the direction and significance of the main variables remain stable. Income, working hours, employment status, gender, and location continue to show consistent effects. This indicates that the main findings are not driven by high-income outliers but rather reflect broader socioeconomic, employment-related, and spatial constraints affecting workers' use of public transport.

The findings have several policy implications for green-economy-oriented mobility in Bali. First, improvements to public transport should be designed around workers' schedules. Since longer working hours reduce the likelihood of using public transport, service-hour adjustments are needed, particularly during early-morning and late-evening commuting windows. Second,

reliability should be treated as a central policy target. Formal-sector workers are less likely to use public transport, suggesting that uncertain arrival times may discourage workers with strict attendance requirements. Public transport policy should therefore prioritize punctuality, predictable headways, real-time information, and route reliability.

Third, spatial integration must be strengthened. The strong positive effect of location indicates that workers in areas with better general access are more likely to use public transport. Public transport planning should therefore improve route coverage, feeder services, and first-mile and last-mile connectivity between residential areas, employment centers, and main corridors. Denpasar and southern Badung can serve as core service areas. However, stronger integration with Gianyar and Tabanan, and with less-served parts of Badung, is needed for Sarbagita to function as a genuinely integrated metropolitan transport system.

Fourth, public transport must be made more inclusive for female workers. The negative gender effect indicates the need for improvements in safety, comfort, and accessibility. These may include better lighting at stops, safer waiting areas, clearer route information, reliable service frequency, and complaint-response mechanisms. Such measures are important not only for increasing ridership but also for ensuring that green mobility policy does not exclude workers with different safety and mobility needs. Overall, the results suggest that green economy-oriented transport policy in Bali should move beyond general encouragement of public transport use. The policy focus should shift toward operational improvements that directly address workers' commuting constraints: reliable schedules, extended service hours, route integration, feeder connectivity, safety, comfort, and real-time travel information. Recommendations related to worker communities or peer effects are not retained because the empirical model does not directly test social influence mechanisms.

■ CONCLUSION

This study concludes that workers' decisions to use public transport in Bali are shaped by socioeconomic, demographic, employment-related, and spatial factors. Gender, income, working hours, and formal employment status significantly reduce the probability of using public transport, while residence in Denpasar and Badung significantly increases it. The strongest marginal effect is location, indicating that accessibility remains central to public transport adoption. The robustness check further confirms that the main findings remain stable after excluding high-income observations, suggesting that the results are not driven by income outliers. These findings suggest that green-economy-oriented public transport policy in Bali should move beyond infrastructure provision and incorporate workers' specific commuting behavior. Practical policy directions include extending operating hours through shift-based systems, strengthening feeder services to reach dense residential and employment areas, improving service reliability and travel information, and enhancing safety and comfort for women workers. Because the location variable is measured at an aggregated administrative level, the results should be interpreted as broad inter-regional accessibility differences rather than precise respondent-level access to bus stops. Future research should collect more detailed spatial data, including residential coordinates, workplace locations, distance to bus stops, and route accessibility measures.

From an institutional perspective, the operational recommendation to adjust or extend evening service hours should primarily be led by the Bali Provincial Transportation Agency, particularly through UPTD Trans Bali/Trans Sarbagita, as the unit responsible for service provision, operational planning, implementation, monitoring, and evaluation of Trans Bali/Trans Sarbagita services. This policy should be coordinated with district/city transportation agencies in Denpasar, Badung, Gianyar, and Tabanan, and with the Bali Provincial Tourism Office, especially when service adjustments target tourism and service-sector workers whose schedules often extend beyond standard working hours. Therefore, the institutional implication of this study is that worker-oriented public transport policy requires cross-agency coordination between transport authorities, tourism authorities, and local governments in the Sarbagita area. Such coordination should focus on measurable operational improvements, including route coverage, feeder connectivity, first-mile and last-mile access, predictable headways, punctual arrivals, real-time travel information, extended service hours, and gender-sensitive service quality.

■ DECLARATION OF GENERATIVE AI USAGE IN THE WRITING PROCESS

During the revision and refinement of this manuscript, the author(s) used ChatGPT from OpenAI to support language editing, improve sentence clarity, and assist in organizing several

explanatory sections. The tool was not used to generate or alter the research data, statistical analysis, results, or substantive interpretation of the findings. Following the use of this tool, the author(s) carefully reviewed, verified, and revised the content to ensure accuracy, coherence, and alignment with the study objectives. The author(s) accept full responsibility for the final content of the article.

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