Journal of Entrepreneurship, Business and Economics
ISSN 2345-4695
2025, 13(2), 118-153

PUBLIC ACCEPTANCE OF CONGESTION CHARGING: EVALUATING FEASIBILITY AS A POLICY RESPONSE TO URBAN TRAFFIC CONGESTION

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Received June 2025; accepted September 2025

Abstract
Traffic congestion represents a critical challenge in cities undergoing rapid urbanization. This study investigates the factors influencing public acceptability of congestion pricing in Penang, Malaysia, recognized as one of the most rapidly developing urban regions in the nation. Using purposive sampling, survey data were gathered from 397 respondents and analyzed with an ordered logit model to identify key determinants of acceptance. Variables examined include trust in government, awareness of congestion issues, perceived fairness, anticipated travel time savings, and socio-demographic characteristics. Contrary to findings from the majority of existing studies, trust in government, identified as the predominant factor, did not have a significant influence on the acceptability of congestion pricing in Penang, possibly due to the high trust levels of the populace in the current administration. The results reveal that most residents are inclined to accept a congestion charge, with the acceptable price range estimated at RM0.50 to RM0.60 per kilometer of travel. Notably, awareness, equitable pricing, travel time savings, and gender emerged as significant predictors of acceptance. These findings provide valuable insights for designing equitable and effective congestion pricing schemes and may guide policymakers in developing strategies that improve traffic flow, enhance public transport investment, and reduce the marginal social cost of congestion. This study contributes to the broader literature on sustainable urban mobility and pricing policies.

Research Paper

Keywords: Traffic Congestion; Congestion Charge; Trust; Fairness; Awareness; Marginal Cost

Reference to this paper should be made as follows: Tan, E.H., Hong., M.& Saleem, F. (2025). Public Acceptance of Congestion Charging: Evaluating Feasibility as a Policy Response to Urban Traffic Congestion. *Journal of Entrepreneurship, Business and Economics*, *13*(2), 118–153.

Introduction

Urbanization and rapid motorization have significantly increased traffic congestion in cities worldwide. Congestion occurs when vehicle demand exceeds road capacity, leading to longer travel times, higher fuel consumption, and increased air and noise pollution. These impacts, known as externalities, illustrate a market failure where road users do not consider the full social cost of their travel (Liu et al., 2016; Radovic-Markovic et al., 2022). An additional vehicle in a congested network adds time, environmental, and economic costs for all users. This gap between marginal private and marginal social costs indicates an inefficient allocation of public roadway resources.

In Malaysia, traffic congestion is a critical urban challenge, causing substantial economic losses. According to Prasarana Malaysia Bhd, congestion cost in the country is about RM 20 billion annually, while working-class Malaysians lose nearly 1 million hours daily in traffic, with fuel inefficiencies related to congestion contribute an estimated US$0.5 billion (Leong, 2020). These figures highlight the need for effective congestion management as a priority for infrastructure and a pressing environmental and social issue.

Congestion arises from both recurrent factors (e.g., inadequate road capacity relative to vehicle volume) and non-recurring factors (e.g., accidents, breakdowns, construction). Conversely, transport demand management (TDM) strategies, such as parking controls, carpooling incentives, and pricing mechanisms, aim to reduce demand rather than increase supply.

Among TDM strategies, congestion pricing (CP) is an efficient method to internalize externalities. CP assigns a fee to congested roads, discouraging overuse during peak hours and aligning private costs with social

costs (Litman, 2007; Lindsey & Verhoef, 2000). Successful implementations include Singapore's Electronic Road Pricing (ERP) system, which has reduced peak-hour traffic and influenced driver behavior through dynamic pricing (Ministry of Transport Singapore, 2022).

Despite the economic benefits of CP, political and public acceptability are significant barriers to implementation. In Malaysia, road pricing exists as highway tolls, but congestion-specific pricing policies have not been adopted. As the country experiences population growth, high private vehicle ownership, and aging infrastructure, a shift toward demand-based solutions is necessary. Penang, one of Malaysia's most urbanized states, exemplifies the increasing strain on transport systems. With 2.68 million registered vehicles and a population of 1.77 million as of 2024, Penang has more than two vehicles per person. George Town, its capital, ranks as the most congested city in Malaysia, with commuters losing 75 hours annually to rush-hour traffic (TomTom Traffic Index, 2024).

Hence, this study aims to evaluate the viability and public acceptability of congestion pricing (specifically, cordon pricing) in Penang. It examines how road users perceive different pricing levels and identifies factors influencing their willingness to pay. By providing empirical insights into congestion pricing acceptability and policy design in Malaysia, the research contributes to ongoing efforts to develop sustainable urban mobility systems. The findings will help policymakers create equitable pricing strategies that reduce traffic congestion, enhance transport efficiency, and improve overall urban livability.

Literature review

Congestion pricing

Congestion pricing is a policy tool designed to manage traffic congestion, supported by extensive analysis in transportation economics and urban planning. Newberry (1990) argues that road users in Britain should pay the marginal social cost (MSC) to ensure efficient transportation and location decisions. The MSC theory states that the optimal congestion price should equal the marginal social cost of driving, balancing it against the marginal social benefit while considering factors such as travel time, vehicle operating costs, and environmental externalities. Dewees (1979) calculated the marginal external social cost of an additional vehicle-mile. Li et al. (2017) applied MSC theory in a case study of Beijing, estimating the marginal external cost of traffic congestion (MECC) and determining optimal congestion charges based on traffic density and speed.

First-best pricing theory suggests the optimal congestion price should match the marginal social cost of congestion. However, achieving this ideal pricing is often difficult due to practical constraints. Verhoef (2002; 2007) explored second-best pricing mechanisms that aim to approximate the first-best solution in urban road pricing contexts. The value of time (VOT) theory highlights the importance individuals place on their time, indicating that congestion pricing should reflect the costs incurred by individuals due to congestion. Small and Verhoef (2007) studied the role of VOT in congestion pricing, considering income disparities and variations in travel time among individuals.

Deng et al. (2021) state that market volatility of critical materials, such as price spikes, stems from a disparity between demand and supply. Changes in supply or demand may be triggered by exogenous factors known as 'shifters.' Demand is linked to consumers' willingness and ability to purchase, while supply is affected by production costs, with supply shifters including input prices, taxes and subsidies, opportunity costs, and technological advancements.

Santos and Newberry (2001) argue that road taxes (CP) aim to reduce excessive road usage, but they often overcharge on less congested roads and undercharge in congested urban areas. Kaddoura and Nagel (2019) emphasize the need for a more adaptable pricing model that considers the behaviors of all travelers, as these significantly impact congestion levels.

Zheng et al. (2014) studied public acceptance of congestion charging schemes in Australia, noting its influence on policy implementation. They identified key factors affecting public attitudes toward congestion charges using a logit modeling approach with survey data from Melbourne and Brisbane. Factors such as democratic values, perceptions of justice, trust in government, awareness of the issue, perceived efficacy, complexity, and social demographics significantly shape public acceptance of congestion charge initiatives.

Raux et al. (2012) identified methodological challenges in their cost-benefit analysis (CBA) of congestion charge systems, using sensitivity tests and simulation models in London and Stockholm. They found that the most crucial components are time savings and fiscal implications for public funding, which are expected to increase substantially in the future.

Liu et al. (2016) discussed the establishment of toll charges, congestion pricing schemes, and factors influencing public approval of congestion charges. However, a gap remains in the academic literature in Malaysia, with no comprehensive methodology or survey conducted thus far. Zheng et al. (2014) noted that societal awareness of congestion may be a key determinant of public acceptance of congestion charges, although this hypothesis has yet to be empirically validated.

Proposed Research Framework

This study focuses on investigating the factors that affect the likelihood of accepting the congestion price. The research framework, as seen in the figure, is composed of trust in government, problem awareness, travel time savings, fairness (equity), social demographic factors, which will be the independent variables, and focus on the outcome effects on the independent variables, which is the likelihood to accept congestion pricing.

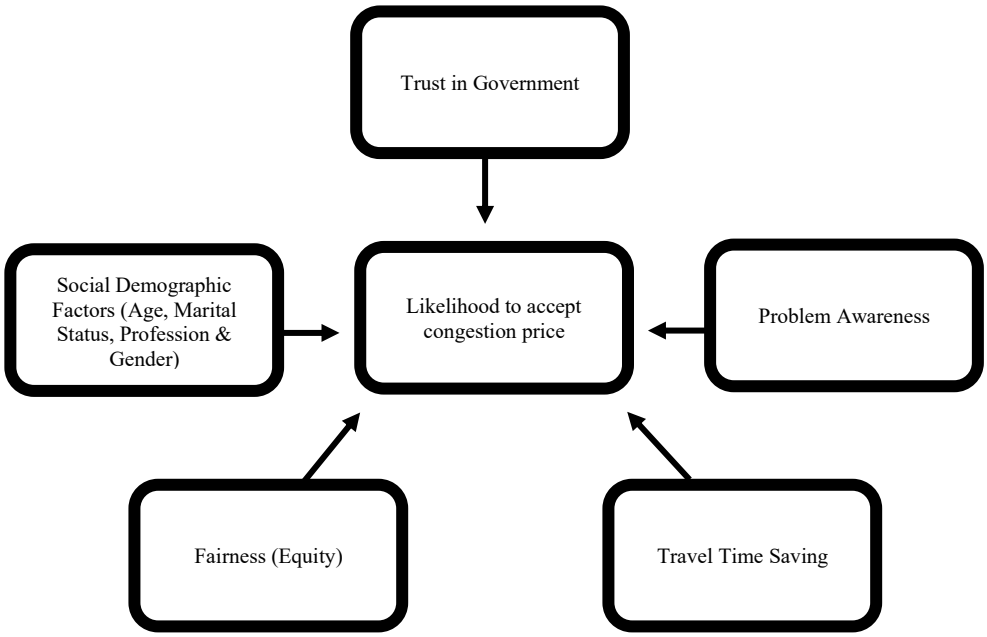

Figure 1. Research Framework

Hypothesis Development

It can be noted that significant progress has been made in understanding public acceptance of congestion charges from different perspectives. Trust in government, problem awareness, fairness, travel time savings, and sociodemographic background are important factors that were frequently mentioned in the literature. Thus, hypotheses are formed based on the theoretical framework of the study to represent the relationships portrayed in the theoretical framework, as follows:

The effect of Trust in the Government on the likelihood of accepting congestion charges.

Studies shows that the confidence of people in government affects the acceptability of congestion pricing (Abulibdeh, 2020; Kim et al., 2013; Marazi, et al., 2022; Schmöcker et al., 2011; Tanha et al., 2011). According to the OECD, trust in government represents the confidence of citizens and businesses in the actions of government to do what is right and perceived as fair. It is believing that the government is doing its job, which is to improve the general welfare of the people through the implementation of righteous and fair policies. Thus, government trust can be related to fairness (Zheng et al., 2014). Another study regarding the acceptability of low emission charging zones (LECZ) in Tehran, Iran, conducted by Mehdizadeh and Shariat (2021), reveals that distrust in the government concerning the allocation of LECZ revenues significantly affects the likelihood of public support for or opposition to the LECZ.

According to Liu et al. (2020), public acceptance of congestion charging in Beijing, China, is significantly influenced by deference to authority and social norms, stemming from a prevailing sense of trust in the government. Grisolia et al. (2015) on the acceptability of congestion pricing in Las Palmas de Gran Canaria, Spain, indicates prior resistance to any charging system, primarily due to a lack of trust in governmental institutions and concerns regarding the use of generated revenues. Perceptions of corruption among government officials and politicians are notably high in Spain. The findings suggest that public acceptability is contingent upon the characteristics of the congestion pricing scheme; specifically, more than one-third of the population

expressed a willingness to pay a daily fare of €2.22 (US$2.54) if the revenues were allocated to expanding green spaces, rather than being reinvested in the transportation system.

These studies suggest that citizens will likely evaluate the benefits and drawbacks of road pricing only if there is a foundational trust in government. Consequently, proposals from the government aimed at reducing traffic congestion may be dismissed outright. The issue of governmental trust is closely linked to public concerns regarding the use of collected revenues, particularly whether they will genuinely enhance societal welfare and contribute to environmental protection, rather than serving individual interests. Therefore, it is hypothesized that:

H1: Trust in the government positively influences the likelihood of accepting of congestion charges.

Problem Awareness

Wang et al. (2017) define problem awareness as the public's understanding of the government's sustainable transport planning policy initiatives. These policies should address issues such as traffic congestion, air pollution, parking difficulties, safety, and climate change (Schlag & Schade, 2003; Zheng et al., 2014; Anwar et al., 2025). Schlag and Schade (2003) assert that problem awareness entails a comprehensive recognition of mobility-related issues and the necessity and urgency for action. Schlag and Schade (2003) evaluated the acceptability of road pricing and identified factors influencing its acceptability, one of which is problem awareness. Their findings indicate that only those convinced that automobiles are significant pollutants support

the necessity of road pricing. Zhou and Dai (2017) argue that understanding public attitudes towards environmental issues arising from congestion reflects the level of awareness among individuals that can be improved through the implementation of congestion charges. Zhou and Dai (2017) further assert that public awareness regarding environmental issues, such as concerns over smog, influences individual acceptance levels for mitigating the problem through the payment of congestion pricing, often at the expense of personal interests. They express confidence in the government's efforts to address environmental challenges.

According to Dieplinger and Furst's (2014) case study of five European cities, clear and extensive communication regarding the charging scheme, specifying how concerns will be addressed, the benefits of the scheme, and its operational details, constitutes a critical component in enhancing acceptability. To ensure citizen acceptance of the system, it is essential that they recognise the tangible benefits of the charge, such as time savings in commuting and improved air quality resulting from reduced vehicle numbers on the roads.

Research conducted by Sugiarto et al. (2018) indicates that "awareness of the city's environment" and "awareness of the problems posed by cars in society" appear to be the most significant direct factors contributing to the recognition of a congestion pricing scheme's effects, as well as indirect factors influencing the policy's acceptability.

In contrast, Langit et al. (2025) study shows that even residents of the city are highly aware of and concerned about traffic problems, such awareness

alone does not guarantee public acceptance of congestion charging. Other factors, particularly the lack of information and perceived effectiveness, play a more dominant role in shaping acceptability.

Majority of these studies illustrate that citizens are more inclined to accept a policy if they are aware of the existing problems and their consequences, alongside the proposed governmental solutions to address these issues. An informed citizen is significantly more likely to seek a resolution to the problem, and an individual who understands that the proposed solution will alleviate these issues is considerably more inclined to support the implementation of such a policy and actively participate in its execution. Therefore, it is hypothesised that:

H2: Problem awareness positively influences the likelihood of accepting congestion charges.

Travel Time Saving

Marazi et al. (2022) designed a travel behaviour questionnaire survey aimed at eliciting users' perceptions of congestion pricing and its perceived benefits, employing a five-point Likert scale. The survey identified reduction in travel time and increased satisfaction with public transport as the two main perceived benefits and motivators associated with congestion pricing (Tajpour et al., 2021). Adurthi et al. (2022) developed a structured questionnaire for both revealed and stated preference data, providing each respondent with four pricing alternatives: Single Occupancy Vehicle (SOV), High Occupancy Toll (HOT), Dynamic Toll Pricing (DTP), and distance-based tolls. Among these four options, travel time savings emerged as the most significant factor,

alongside travel cost, influencing user acceptability. Selmoune et al. (2020) conducted a quantitative empirical analysis, revealing that other key benefits of congestion pricing that could enhance public acceptance include increased revenue, higher transit ridership, improved public health, environmental advantages, reduced travel times, and better transit services due to enhanced traffic conditions.

According to Raux et al. (2012), travel time savings are regarded as a conservative estimate of the surplus generated by congestion pricing schemes. The study highlights that, in cost-benefit analysis (CBA), travel time savings are monetised as the sum of two components. The first component equals the time gains of those who do not change their travel behaviour, multiplied by the marginal value of travel time (MVOTT). The second component is half the time gains of new users of the infrastructure (post-implementation, referred to as "induced traffic"), also multiplied by the MVOTT. This is commonly known as the "rule of half." However, in the context of congestion-charged traffic, this situation does not apply since traffic is actually reduced. The study addresses methodological issues in CBA concerning congestion charging schemes and employs a simplified fixed value of time to assess the CBA of the congestion pricing schemes in London and Stockholm, which may underestimate the surplus for drivers who remain on the road.

Milenković et al. (2019) found that respondents identified several significant positive effects of congestion pricing, including a reduction in the number of vehicles, decreased travel time, lower vehicle operating costs, reduced pollution, an increase in available parking spaces, improved traffic

safety, and enhanced travel speeds. Overall, the studies indicate that if a congestion pricing policy effectively reduces travel time, there is a high likelihood of public acceptance. Citizens are unlikely to endorse a policy that fails to address the issue of traffic congestion, which primarily manifests as increased travel time. Consequently, those affected are more likely to support policies aimed at reducing travel time. Therefore, the hypothesize is developed as follows:

H3: Total travel time savings have a positive influence on the likelihood of accepting congestion charges.

Fairness (Equity)

Fairness emerges as the most significant direct factor influencing the acceptability of congestion pricing (Hsieh, 2022; Wang et al., 2019; Sun et al., 2016; Kim et al., 2013). Equality suggests that all vehicle owners share the same obligation to pay for driving under congestion charge policies, whereas fairness and necessity indicate that these obligations may be reduced or waived (Martens & Golub, 2021).

Wang et al. (2019) use four different scenarios, and the results show that the public's perception of the fairness of congestion charging has a greater effect on their willingness to accept it. It further indicates that the transparency of charge collection and how revenue is allocated are the most significant factors influencing public uncertainty regarding the fairness of congestion charging. Gu et al. (2018) highlighted equity factors such as toll distribution, exemptions (e.g., for disabled drivers), and perceptions of who

benefits. Public support tends to rise when pricing is seen as broadly beneficial and when revenue redistribution and travel patterns are considered.

In the ride-hailing service industry, concerns have been raised over pricing equity. Studies show that dynamic pricing may disproportionately affect low-income and minority communities, who often rely on these services due to inadequate public transport. Hence, recent research has introduced fairness metrics and pricing strategies to address these disparities (Saxena et al., 2025). Consistent with Saxena et al. (2025), Selmoune et al. (2022) show that public acceptance of congestion pricing is influenced by fairness to the lower-income class and car drivers. The perception of fairness may lead to resentment among those who feel they are being forced to pay rather than choosing to do so, which could result in negative reactions from drivers.

Eliasson (2016) shows that citizens' perspectives on social matters like equity and procedural fairness do not significantly correlate with their income across groups. The study finds it difficult to argue that congestion pricing is inherently unfair, especially when its purpose is to correct market inefficiencies and allocate scarce resources.

According to Jakobsson et al. (2000), government strategies perceived to benefit the majority are more likely to be viewed as fair and accepted. Therefore, based on existing studies, fairness is a critical factor in the acceptance of congestion pricing policies. Thus, it is hypothesized that:

H4: Fairness has a positive effect on the likelihood of accepting congestion charges.

Social Demographic Background

Milenković et al. (2019) conducted a three-month online survey in October 2017 targeting the entire population of Belgrade, including residents of the central city zone and those from other areas. The questionnaire was disseminated to various companies, academic institutions, students, pensioners, and organisations representing the unemployed in Belgrade. Data analysis was performed using IBM SPSS 22 and R, employing standard methods of descriptive and analytic statistics, logistic regression, and structural equation modelling. The results from the logistic regression analysis demonstrate that certain socioeconomic characteristics, such as users' age, employment status, income, and mileage, significantly influence public acceptability of congestion pricing. Abulibdeh (2022) found that respondents aged 45 years or older exhibit a greater willingness to pay for tolls compared to their younger counterparts. Additionally, full-time and part-time employees demonstrated a higher willingness to pay (WTP) by 0.55 and 0.19 points, respectively, compared to unemployed respondents. Furthermore, the model results indicated that males exhibited a lower WTP than females by 0.011 points.

Using binary logit and ordered probit models, Marazi et al. (2022) identified the key attributes influencing commuters' acceptance of congestion pricing. Their findings suggest that higher income and education levels are associated with an increased likelihood of accepting congestion pricing. Moreover, age was also found to have a positive correlation with the acceptability of congestion pricing. Similarly, Zheng et al. (2014) assert that age, gender, and driving frequency significantly impact participants' responses to

road pricing systems. The study revealed that female drivers were more supportive of congestion charges than their male counterparts, and public transport users were more inclined to support congestion pricing than those using private transport. In contrast, the study by Kim et al. (2013) indicates that achieving acceptability for road pricing is more challenging among women compared to men. Based on existing studies, the sociodemographic backgrounds of residents appear to affect their decision-making regarding the acceptance of congestion pricing. Therefore, it is hypothesised that sociodemographic characteristics, including education, age, gender, income, and profession, positively influence the likelihood of accepting congestion charges.
H5: Sociodemographic characteristics has a positive effect on the likelihood of accepting congestion charges.

Method and Data

Sample and unit of analysis

In this study, the units of analysis consist of working adults aged 21 and above who commute to work. The terms defined here also serve as prerequisites for the questionnaire. Working adults over the age of 21 in Penang were selected as the sampling frame for this research, as they possess several key characteristics relevant to the unit of analysis. Firstly, this demographic is representative of the working population in Penang. Additionally, they are more likely to meet essential eligibility criteria for respondents, including adequate exposure to their vehicles and employment in full-time positions. Krejcie and Morgan's sampling estimate is alluded to in deciding the representable sample size for the study (Krejcie & Morgan, 1970). It is estimated

that the overall job rate in Penang is 830,000. Thus, the sample size needed for the analysis is 323 (Department of Statistics Malaysia, 2024). Using a purposive sampling method, a structured online questionnaire with targeted questions was developed and distributed to respondents, accompanied by a cover letter outlining the study's objectives and assuring the privacy and confidentiality of their answers. Total of 400 survey were collected, and 397 are usable.

Questionnaire and Measurement Items

In this study, the questionnaire is divided into multiple sections and begins with pre-requisite questions. Section A will capture the alternatives (choices) of the congestion pricing scheme from respondents. Section B includes questions capture the relationship between the independent and dependent variables. It is to investigate the determinants and the likelihood of the user paying for the congestion pricing scheme by using the conjoint technique and the multinomial logit model. Section C, the last section, is designed to profile the respondents by requesting their demographic backgrounds.

Table 1 shows the latent variables of the study and measurement items for independent variables (trust in the government, problem awareness, travel time saving, fairness, age, marital status and profession).

Table 1. Measurement items for latent variables

Independent Variables	*Measurement Items*	*Source*
Trust in Government	The government is able to effectively utilize the revenue collected. The government is doing its best to improve the welfare of society. The government is doing its best to protect the environment.	Zheng et al. (2014)
Problem Awareness	Congestion charges are able to mitigate congestion problems. Congestion charges are able to regulate environmental problems. Congestion charges can improve marginal social costs.	Zhou and Dai (2017)
Travel Time Saving	I have saved more time using roads that charge congestion prices. I am able to drive at higher speeds on roads that charge congestion prices. I am able to arrive punctually at my destination daily on roads that charge congestion prices.	Raux et al. (2012)
Fairness (Equity)	Prices are charged according to the allocation of costs and benefits. I am physically normal, and congestion prices are charged fairly. I have physical disabilities; the congestion prices are charged fairly.	Liu et al. (2018)
Abbreviations	Description	Types of data
Trust in Government (*tr2*)	Government trust may be linked to justice. It was stated that the confidence of people in government affects the acceptability of congestion fees (Zheng et al., 2014; Kim et al., 2013). 1. The government is able to effectively utilize the revenue collected. 2. The government is doing its best to improve the welfare of society. 3. The government is doing its best to protect the environment.	1 very unlikely 2 unlikely 3 slightly unlikely 4 slightly likely 5 likely 6 very likely

Independent Variables	*Measurement Items*	*Source*					
Problem awareness (*awl*)	Policy has changed from a one-way mode to a two-way contact mode, which stresses citizen engagement and involvement to raise public awareness of urban traffic challenges in a more systematic manner. Wang et al. (2017) also defined problem awareness as public understanding of the government's sustainable transport planning policy activities. Zhou and Dai (2017) stated that the understanding of the public towards environmental problems due to congestion indicates the level of awareness of individuals that can be mitigated by implementing congestion charges. The public is aware of the challenges that can be resolved by the introduction of such a framework, such as road congestion, air pollution, and climate change (Zhen et al., 2014). 1. Congestion charges are able to mitigate congestion problems. 2. Congestion charges are able to regulate environmental problems. 3. Congestion charges can improve marginal social costs.	1 very unlikely	2 unlikely	3 slightly unlikely	4 slightly likely	5 likely	6 very likely
Travel Time Saving (*t2*)	Savings on travel time are monetized as the sum of two elements. The first element is proportional to the time gains compounded by the marginal value of travel time for those that do not change travel (MVOT). The second is proportional to half the time gain of the new infrastructure users (after the introduction of the scheme, i.e., the "induced traffic") compounded by the MVOTT (Raux et al., 2012).	1	2	3	4	5	6

Independent Variables	*Measurement Items*	*Source*					
	1. I have saved more time using roads that charge congestion prices. 2. I am able to drive at higher speeds on roads that charge congestion prices. 3. I am able to arrive punctually at my destination daily on roads that charge congestion prices.	very unlikely	unlikely	slightly unlikely	slightly likely	likely	very likely
Fairness (Equity) (*fa2*)	As stated, fairness is normally viewed as equitable and gains stronger public interest as a result. Equity issues exist as regards the extent of access to alternative modes of transport and exist in terms of the additional expense (Liu et al., 2018).	1	2	3	4	5	6
	1. Prices are charged according to the allocation of costs and benefits. 2. I am physically normal, and congestion prices are charged fairly. 3. I have physical disabilities; the congestion prices are charged fairly.	very unlikely	unlikely	slightly unlikely	slightly likely	likely	very likely

The dependent variable in this study is the likelihood of paying the congestion price. Scenario was given in the questionnaire to facilitate respondent to answer questions, since congestion price had not been implemented in Penang[1]. Data for independent variables shall be obtained by means of a collection of Likert scale measurement products of six points, as shown in Table 1.

[1] Full questionnaire could be provided upon request.

Model Specification: Ordered Logit Model

The likelihood of an individual accepting the congestion charge and its relationship with its determinants is estimated using an ordered logit model. An ordered logit model allows the analysis of an ordinal dependent variable. The ordered logit model also allows the economic interpretation of utility maximization in a discrete choice situation.

This study takes the respondent's acceptance of the congestion charge as the dependent variable. It is an ordinal-dependent variable. The likelihood of consumers accepting or paying congestion is expressed as different likelihood categories on a six-point Likert scale, where 1 stands for "very unlikely" and 6 stands for "very likely." The ordered logit model can be derived from a latent variable model. Suppose the underlying process to be characterized is

$$y^* = X^T\beta + e$$

where y^* is the exact but unobserved dependent variable (perhaps the exact level of likelihood to pay by the consumer); X is the vector of independent variables; β is the vector of regression coefficients to estimate; and e is the error term. Since y^* cannot be observed; instead, we can only observe the categories of responses where the parameters μ_1 are "the externally imposed endpoints of the observable categories."

$$\gamma = \begin{cases} 0 \; if \; y^* \leq \mu_1 \\ 1 \; if \; \mu_1 < y^* \leq \mu_2 \\ 2 \; if \; \mu_2 < y^* \leq \mu_3 \\ \quad . \\ \quad . \\ \quad . \\ J \; if \; \mu_j < y^* \end{cases}$$

An ordered logit technique will use the observations on γ, which are a form of censored data on y^*, to fit the parameter vector, β, μ_1 is unknown cut-of values of the latent likelihood to accept the congestion charge. Likert scale data collected from the survey were converted to binary data format and estimated using Stata.

Results

Total survey collected was 410, and 397 were useable. Of these, 62% were male and 38% female. The majority (76%) were aged between 21 and 35 years, while 24% were above 35 years old. The mean age of respondents was 31 years. In terms of education, 65% had attained tertiary-level qualifications, whereas 35% reported secondary education or below. With respect to income, 28% earned less than RM1,000 per month, 33% earned between RM1,000 and RM3,000, 25% earned between RM3,001 and RM5,000, and 14% reported monthly earnings above RM5,000. Regarding profession, 36% were employed in the private sector, while the remaining 64% fell under other occupational categories (self-employed, government staff, etc). A notable 93% of respondents reported commuting to work by car, reveals the heavy reliance on private vehicles for daily travel.

Table 2. Respondent's profile

Respondent Profile	Categories	*Samples*	Percentage (%)
Gender	Male	246	62
	Female	151	38
Age	21- 35	99	76
	> 35	310	24
Education Level	Secondary or below	102	35
	Tertiary	259	65
Income	< RM1000	86	28
	RM1000 – RM3000	102	33
	RM3001 – RM5000	76	25
	> RM5000	46	14
Profession	Private Employee	142	36
	Others	255	64

The mean and standard deviation values for all variables are presented in Table 3. The lowest mean score was 3.71 (trust in government), while the highest was 4.24 (travel time savings). In terms of standard deviation, fairness (equity) exhibited the lowest variation (1.078), whereas trust in government showed the highest variation (1.40).

Table 3. Descriptive Statistics

Variable	*Mean*	*Std. Dev.*	*Min*	*Max*
tr	3.713235	1.398005	1	6
awl	4.058824	1.236811	1	6
fa2	4.229219	1.077948	1	6
t2	4.240196	1.208549	1	6

Table 4 presents the result of the ordered logit model. Based on data collected from 397 respondents. The ordered logistic regression model showed a good fit to the data. The log likelihood for the null model, which includes no predictors, was −612.22, while the log likelihood for the fitted

model, which incorporates all eight predictors, improved to −555.10. The likelihood ratio chi-square test produced a value of 114.24 with 8 degrees of freedom, which was statistically significant ($p < .001$). This indicates that the model provides a better fit overall than an intercept- only model. The ordered logistic regression model assessed the impact of eight predictor variables on respondents' likelihood ratings (*pa1_likelihood*). Among these predictors, several demonstrated statistically significant associations with the outcome. The variable *t2* had a notable positive effect (OR = 1.455, $p < .001$), indicating that for each unit increase in *t2*, the odds of reporting a higher likelihood rating increased by approximately 45.5%. Similarly, *fa2* was positively associated with the outcome (OR = 1.776, $p < .001$), suggesting that individuals with higher *fa2* values were 77.6% more likely to report elevated likelihood ratings.

Table 4. Ordered Logit Result

pa1_likelihood	Odds Ratio	Standard Errors
tr2	.8981144	.06804
aw1	1.200658**	.1175797
t2	1.455216***	.1393322
fa2	1.776211***	.1975888
a2	.9502838***	.0150773
g1	3.638291***	1.788887
m3	2.113229***	.5825634
p6	.7976658***	.637799
Observation	397	
log likelihood	−612.22	
chi-square	114.24	
prob. Chi-square	p < 0.001	

Notes:
1. **** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level*
2. *Tr2 = trust in government, aw1 = problem awareness, t2 = travel time savings, fa2 = equity, a2 = age, g = gender, m = marital status, p6 = profession*

Another strong positive predictor was *g1* (OR = 3.638, p = .009), meaning that respondents with *g1* coded as 1 were over three and a half times more likely to select a higher category of likelihood compared to the reference group. The variable *m3* also had a significant positive effect (OR = 2.113, p = .007), effectively doubling the odds of being in a higher likelihood category.

In contrast, *a2* exhibited a significant negative effect (OR = 0.950, p = .001), suggesting that as *a2* increased, the odds of selecting a higher likelihood category decreased by about 5%. Similarly, *p6* was linked to a reduction in likelihood ratings (OR = 0.798, p = .005), indicating a 20.2% decrease in the odds of a higher outcome with each unit increase in *p6*. The variable *aw1* displayed a marginally significant positive association with the outcome (OR = 1.201, p = .062), suggesting a weak tendency for higher values of *aw1* to increase the likelihood rating. Finally, *tr2* was not a statistically significant predictor (OR = 0.898, p = .156), indicating no meaningful effect on the outcome variable.

In socio-demographic categories, gender is highly significant at the 1% level. Being male increases the odds of being in a higher category of acceptance toward the congestion charge by approximately 263.8% compared to females. In other words, gender has a strong and statistically significant positive effect on the likelihood of accepting the congestion charge. In addition, the status of being unmarried significantly amplifies the probability of accepting the congestion charge, with an over twofold increase relative to individuals who are married or belong to alternative classifications, indicating a 111.3% increase in the likelihood. This phenomenon is statistically significant at the 1% threshold. Further, respondents working in the private sector

show a significantly lower likelihood of accepting the congestion charge, with a reduction in odds of approximately 20.2%. This negative association is also statistically significant at the 1% level.

This higher acceptance rate observed among unmarried males, particularly in Penang, Malaysia, is attributed to their career-focused nature, the prioritization of travel time savings and the likelihood that they have higher financial resources to allocate towards congestion price. The financial aspect plays a crucial role; It is expected that unmarried males possess lesser obligations, and they likely have additional financial assets, which they can allocate to enhance the efficiency and expediency of their travel.

Discussion and Implications

This section examines a detailed review of the study's results on how the public in Penang, Malaysia, feels about congestion charging. It seeks to explain the main factors found in the study, including trust in the government, awareness of the problem, savings in travel time, perceived fairness, and sociodemographic traits like gender, marital status, and occupation

Trust in government positively influences the likelihood of accepting congestion charges. The results indicate that trust in government has a partially significant positive effect on this likelihood. The findings of this study contrast with the majority of existing studies. The literature often highlights the importance of trust in government for public acceptance of congestion pricing. A survey conducted by Transparency International reveals that 71% of Malaysians perceive government corruption as a major issue, with 39% of respondents strongly believing that corruption in Malaysia is increasing.

Studies suggest that citizens evaluate the benefits and drawbacks of road pricing based on a foundational trust in government, and proposals may be dismissed if this trust is lacking. Research by Zheng et al. (2014), Kim et al. (2013), Fujii (2005), Grisolia et al. (2015), and Mehdizadeh and Shariat (2021) demonstrates that citizen trust in government affects the acceptability of congestion pricing. It is also noted that trust in government may be linked to perceptions of fairness (Zheng et al., 2014; Kim et al., 2013).

Nevertheless, the findings of our study indicate that respondents exhibit a continued support to congestion charges, acknowledging both the underlying problem and the proposed solution, as the congestion charge is designed to alleviate congestion-related challenges. This phenomenon may be ascribed to the observation that Malaysia ranks among the top 10 nations exhibiting high levels of trust to its government. The recently published 2024 Edelman Trust Barometer survey revealed that Malaysia is positioned within the top 10 most trusting nations out of the 28 evaluated, with its Trust Index score experiencing an increase of six points, reaching a score of 68 in comparison to the previous year, 2023 (Zalani, 2024). To quote, “The ascendance of trust in Malaysia highlights a favorable transformation in public perception regarding our governance and institutional frameworks,” said Edelman Malaysia Chief Operating Officer Christopher de Cruz.

This increase in trust may reflect a growing public confidence in the government's ability to manage congestion effectively and allocate resources appropriately. Trust is a valuable asset for all institutions, and ongoing trust-building activities should be one of the most important strategic priorities for every organisation.

Awareness of the problem positively influences the likelihood of accepting congestion charges. The study results confirm that problem awareness enhances the likelihood of acceptance. This finding aligns with the work of Schlag and Schade (2003), Dieplinger and Furst (2014), Zheng et al. (2014), Zhou and Dai (2017), and Wang et al. (2017), which suggest that public awareness of environmental problems stemming from congestion, and the potential for mitigation through congestion pricing, increases acceptance rates. Although descriptive statistics reveal a high level of awareness among respondents coupled with a lack of trust in the government, they still support the congestion charge.

Total travel time savings also positively impact the likelihood of accepting congestion charges. The results indicate that respondents are willing to pay for congestion pricing if it leads to significant time savings, corroborating the findings of Raux et al. (2012), Milenković et al. (2019), Selmoune et al. (2020), and Marazi et al. (2022), which demonstrate that congestion pricing policies that reduce travel time are more likely to be accepted.

Fairness positively affects the likelihood of accepting congestion charges. The results indicate that fairness is a highly significant variable in the ordered logit results and is closely correlated with awareness, according to the multi-collinearity analysis. This supports existing studies highlighting the positive effect of fairness on the acceptance of congestion pricing. Findings from Liu et al. (2018) also align with this, showing that vehicle owners who perceive congestion pricing as fair and beneficial to society are more likely to support it.

Sociodemographic characteristics, such as gender, marital status and profession, positively influence the likelihood of accepting congestion charges. Results demonstrate that, regarding gender, males exhibit a higher positive effect on the likelihood of accepting congestion pricing than females, with males having 3.64 times the odds compared to females. This may be attributed to the larger number of males in the working population in Penang, Malaysia, many of whom are career-focused and prioritise travel time savings, impacting their performance in terms of effectiveness and efficiency. The findings suggest significant relationship exists between profession and the likelihood of accepting congestion pricing. A private employee earning a higher monthly income does not necessarily imply a willingness to pay the congestion price or a higher road usage fee.

The study concludes that the most significant variables impacting the likelihood of accepting congestion pricing are travel time savings and fairness. Citizens are willing to accept a congestion price if it alleviates traffic congestion, reduces travel time, and is applied fairly among all residents. The government should consider the pricing structure aimed at alleviating traffic congestion, benefits, and exemptions for road users and residents within the charging zone, ultimately contributing to the overall welfare of society.

Conclusion

This study enhances the understanding of public acceptance of congestion pricing in Penang, Malaysia. It identifies key influencing factors such as trust in government, problem awareness, travel time savings, perceived

fairness, and socio-demographic characteristics. Notably, awareness, equitable pricing, travel time savings, and gender emerged as significant predictors of acceptance.

Overall, the study reveals that most residents are inclined to accept a congestion charge, with the identified price range estimated at RM0.5 to RM0.6 per km of travel. An estimation of RM 0.5 to RM 0.6 per kilometer is deemed to be a reasonable estimate, particularly in light of the findings by Minhans and Moghaddasi (2023), which indicate that the prevailing vehicle operating cost in Johor Bahru, Malaysia, is RM 2.05 per kilometer. An enhancement in the efficiency of travel time and a reduction in fuel consumption are likely to contribute to a decrease in the overall vehicle operating expenses, potentially offsetting the financial implications associated with congestion pricing.

The results suggest that public support may be enhanced through the implementation of transparent and equitable pricing scheme, along with the reinvestment of generated revenue into enhancements of public transportation systems. Consequently, this study recommends for the adoption of strategies designed to persuade the citizenry, thereby cultivating a collaborative relationship between policymakers and the citizen, achieved through the dissemination of transparent and comprehensive information regarding the proposed system, which would enhance both their trust and awareness. Policymakers must communicate the advantages and financial implications of the congestion charge, alongside the comprehensive strategy encompassing rate tables, covered geographical areas, and the timeline for implementation. Furthermore, policymakers must ensure the provision of alternatives or contingency

plans during the initial phase of execution. Finally, it is imperative for policymakers to engage in public consultation to facilitate citizen contributions regarding the project. These insights can guide other cities contemplating similar policies. It is essential to ensure that the benefits and costs are equitably distributed. Building trust through participatory and transparent policymaking is also crucial, as perceived fairness, particularly regarding the use of revenue, directly impacts public acceptance.

This study offers an initial exploration of congestion pricing in Penang, Malaysia, using primary data, but several limitations should be noted. The purposive sampling approach, while appropriate for engaging key stakeholders, may introduce selection bias and constrain the generalizability of findings beyond the sampled groups. Future research could employ probability-based or larger, more diverse samples to improve representativeness and external validity. Further work might also examine political factors such as corruption, governance, and revenue redistribution, as well as the distributional and welfare effects of alternative revenue recycling strategies.

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