The Cradle of Knowledge: African Journal of Educational and Social Science Research Volume 10, No.3 ISSN 2304-2885-p, 2617-7315-e
https://dx.doi.org/10.4314/ajessr.v10i3.5

The Cradle of Knowledge: African Journal of Educational and Social Science Research
AJESSR - ISSN 2304-2885-p, 2617-7315-e
Volume 10, Issue 3, 2022
P.O. Box 555 (00202) Nairobi. Kenya
editor@serek.or.ke

SOCIETY OF EDUCATIONAL RESEARCH AND EVALUATION IN KENYA

Supply creating its own Demand in Ghana's Urban Transportation: Economic Analysis of Motor Tricycle Transport System in Kumasi

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Abstract
The booming motor tricycle transportation system in urban areas in Ghana offers far reaching insights for policy reform. The freedom to choose one's means of transportation had for a long time been partly hindered through state regulation. Given the option, many urban dwellers in Ghana have chosen to switch from the traditional means of urban transport to motor tricycles. This paper assesses the economic incentives responsible for the booming motor tricycle transportation in urban Ghana. It employs a quantitative approach to analyse a survey of owners, drivers and passengers of the tricycles, to ascertain the role of supply in the creation of the current demand. A probit regression technique was used to model and analyse the likelihood of owners supplying additional tricycles and to also assess factors that determine the choice between motor tricycles and traditional modes of urban transport in Ghana. The study found that owners of tricycles who had reliable riders were 96% more likely to acquire additional tricycles than invest in some composite commodity. Also, commuters chose the tricycle above the traditional modes of urban transport because it significantly reduced their travel time. In addition, riders of the tricycles obtained gainful employment, with monetary rewards worth more than 300% of what minimum wage earners receive in Ghana. Thus, the study validates Say's Law at the microeconomic level. Therefore, the government of Ghana would need to formally legalize the use of the tricycles for urban transportation, and institute favourable regulations, which will sustain the demand for their services.
Keywords: *Demand; Ghana; Probit Model; Supply; Tricycles; Urban transportation*

1. Introduction

The introduction of motor tricycles in Ghana in 2013 has brought to the fore a new dimension of the issue of supply creating its own demand. These tricycles never gained prominence after their introduction, until the Micro Finance and Small Loans Centre (MASLOC) of Ghana in 2015 distributed some to the youth in the country. Since then, their acceptance and patronage have courted some agitations between their drivers and drivers of the traditional inner city transportation systems, especially taxi drivers who see them as keen competitors (Allotey, 2018).

However, tricycles serving as commercial means of urban transport has been be an illegality, based on Ghana's Legislative Instrument (LI) 2180 of 2012, which bans the use of motorbikes for commercial transportation of human passengers. The booming tricycle sector appears to have secured some favourable attention from the government of Ghana, which intends to introduce some regulatory policy regarding commercial use of motor tricycles, thereby indirectly lifting the ban on their illegality as commercial urban vehicles. Thus the supply of these tricycles appear to have created their own demand to the extent of wielding the potential to cause a major change in transportation policy in Ghana, a microeconomic level validation of Say's Law of Markets.

This study generally aims at analysing the factors accounting for the surge in the number of motor tricycles in urban Ghana. Specifically, it sought to ascertain the economic importance of the motor tricycle for urban transport and to analyse the preferences of commuters, riders and owners of the motor tricycles as against the traditional inner city

means of transport. Findings of the study have a strong potential to inform Ghana's urban transportation policy, in a period when the state is contemplating legalizing the use of motor tricycles for human transport in urban areas.

1.1 Say's Law of Markets

Various perspectives of supply creating its own demand, also known as Say's Law of Markets, have emerged in economic literature since the Keynesian critique of the concept. These views explain why and how supply should or should not create its own demand in an economy at the macroeconomic level. Mill (1808) argued that the means of payment for a flow of more goods and services will be obtained from the goods and services themselves. Thus there exists purchasing power provided by the very goods and services which are offered for sale. He stated that commodities produced create markets for themselves (Mill, 1808). For goods supplied to create their own demand, such goods must be the goods that other sellers demand (Ricardo, 1962; Malthus, 1814; Torrens, 1821).

Modern expressions of Say's Law which have been subjected to as much acceptance as criticisms are attributed to Becker and Baumol (1952) and Lange (1942). Based on real output only, the proposition of Lange for a formal statement of the idea that supply creates its own demand was captured by the identity in equation (1):

$$\Sigma_j p_j x_j = 0, \text{ for } (j = 1, \ldots, n), \quad (1)$$

Where price of the good j is p_j and excess demand for the good is x_j. The statement expressed in equation (1) upholds the identical equality between the sum of the monetary value of quantities of goods and services demanded at any time and the monetary value of the quantities of the goods and services offered for sale by suppliers.

In line with the theory, it is worth examining whether the supply of motor tricycles match what Ghanaian urban commuters are willing and able to pay for, thereby creating a seeming boom in the sector since 2015. Such demand can be modelled and analysed using discrete choice models, with the ultimate aim of informing policy. De Witte et al. (2013) proposed three major ways of determining discrete choice models; these are the rationalist, socio-geographic and socio-psychological approaches. Commuters just like consumers being rational, tend to choose transport modes that would most likely offer them maximum satisfaction. Thus if the supply of motor tricycles offers consumers maximum satisfaction, it could have the tendency to create its own demand, thereby validating Say's Law of Markets.

1.2 Empirical Literature

There is substantial empirical literature on the use of tricycles and bicycles for human transportation in some continents. However, Africa has had very little coverage when it comes to empirical studies on tricycle and bicycle transportation. This study is thus one of the very few empirical studies on tricycle use in Africa.

Li et al. (2019), Zhang et al. (2019), Campbell et al. (2016) and Guo et al. (2017) investigated the determinants of bicycle use in various parts of China, while Balaria (2016) studied the use of tricycles in the Philippines. Shahikhaneh et al. (2020) and Elsokkary et al. (2019) modelled the choice between motorcycles and other means of transportation while Ashrafi and Neumann (2017), Sheikh Abdul Kadir (2006) and Nissen et al. (2020) examined general conditions that influenced choice of modes of transportation by commuters. Through the use of various statistical techniques, these empirical investigations were quite convergent around the outcomes that unemployment, commuter demand, traffic congestion, travel distance, travel time, travel cost, sex, age and income were among the most significant determinants of tricycle, motorcycle or bicycle use.

1.3 Ghana's Urban Transportation Sector

Since the privatization of Ghana's Omnibus Services Authority in the 1970s, private informal sector operators have become the major providers of city transport services (Kwakye & Fouracre, 1998). These informal sector operators mainly provide services through minibuses locally known as "tro-tro". These tro-tros usually convey about 20 passengers between two well defined destinations within urban settlements. Private taxi services are also available through saloon cars on a limited basis along some popular routes in cities. Currently, even though some formal large buses operate in some Ghanaian cities, urban transportation is mostly dominated by informal sector operators (Arroyo-Arroyo, 2021).

Over the past three decades, there has been a 60% increase in ownership of vehicles in Ghana. Also, due to urbanization, distances travelled have increased by up to 10 times in some urban areas of the country. Thus the

increasing demand for transportation has created opportunity for vehicles which can render the needed services in the informal sector. In the capital city, Accra, and Kumasi the second largest city, about 60% and 40% respectively of urban commuters go to their work places by means of these minibuses (Arroyo-Arroyo, 2021).

The minibus operators ensure they are filled to capacity before departing to their various destinations. This creates congestion mainly at the terminals and popular stops where passengers get off. Also, passengers seeking transportation services within the first two kilometers along the minibuses' routes usually find it difficult getting places on the minibuses except they go to the terminals to board (Arroyo-Arroyo, 2021). This creates the need for some other means of public transport to take care of those not well served by the minibuses.

Ghana has for many years suffered loss of productivity as a result of urban transport congestion. In Kumasi, minibus operators lose about 22% of their incomes through traffic congestion. Formal sector operators also encounter a loss of hours of productivity of about 9% daily (Takyi et al., 2013).

The reliance on urban transport for job access has been poor in Ghana's cities. In Accra, about 50% of the population are not able to reach their work places within one hour from home by means of public transport, while in Kumasi this affects about 60% of residents. There are also significant transportation challenges for access to health facilities faced by about 26% of city dwellers generally on any day and worsening to about 78% of residents in the mornings. With respect to the poor, the poorest 20% of urban dwellers spend about 60% of their daily incomes on two trips of urban transport in Accra, while in Kumasi the two trips would require 111% of the daily incomes of the poorest 20% (Arroyo-Arroyo, 2021).

The discussion above, on the state of Ghana's urban transportation sector brings to light how inefficient, economically and socially costly the existing structures have been. The current state of affairs has created gaps for efficient means of transport that will reduce travel time and also serve the underserved commuting populations of Ghana's urban areas.

The following section provides a brief methodology for the study, followed by a presentation and analysis of the results of the study. A discussion of the major findings then follows, after which the paper concludes with some recommendations for policy.

2. Methodology

The design of the study is quantitative, mainly based on a market survey. Data for the study was collected from the Ashanti region of Ghana, which is the most populous region in Ghana, using a three-part questionnaire. The first part elicited demographic and socio-economic characteristics of riders of the tricycles. The second part dwelt on tricycle owners' characteristics and factors accounting for the influx of the motor tricycles. The final part captured characteristics of commuters and the factors responsible for their choice of the motor tricycles as prime sources of intra-city transportation. Questionnaire administration was conducted through face-to-face contacts with sampled respondents. The total sample for the study, computed through the Yamane (1967) formulation was 558 respondents. This comprised of 202 commuters, 150 riders and 206 owners of motor tricycles.

The discrete choice between motor tricycle and the traditional mode of transportation (taxi/tro-tro) was modelled as a binary decision, with an individual choosing between the tricycle and the traditional mode of transportation. Thus the dependent variable was a discrete dummy variable where the choice to own motor tricycle equals 1 while the choice to own a different mode of transport equals 0. The formulation of the probit model is captured by equations (2) and (3) as:

$$M_i = W(D_i) \quad (2)$$

$$D_i = (b_0 + \Sigma_{nj=1}\, b_j\, Q_{ji}) \quad (3)$$

Where M_i is the response observed (1 or 0) for the *ith* individual such that,

$$M_i = \begin{cases} 1, & if\ additional\ motor\ tricycle \\ 0, & if\ composite\ commodity \end{cases} \quad \text{.....Model 1}$$

$$M_i = \begin{cases} 1, \ if\ commuter\ chooses\ motor\ tricycle \\ 0, \ if\ commuter\ chooses\ traditional\ mode \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots \textbf{Model 2}$$

D_i is the stimulus for likelihood of owning the tricycle or choosing motor tricycle;
W is the function relating the observed response (M_i) and index of the stimulus (D_i);
D = 1, 2, …, k, represents the number of observations, with k being the size of the sample;
Q_{ji} is the *jth* independent variable for the *ith* observed response; b_0 is a constant; b_j are parameters not known; and j = 0, 1, 2, …, n, where n is the number of all independent variables.

Therefore, the cumulative logistic distribution function, which becomes the probit model $W(*)$ can be written as equation (4) below.

$$Pr(M_i = 1 / Q_{ji}) = W(D_i) = W(b_0 + \Sigma_{nj=1} b_j Q_{ji}) = Pr(Z =< z) \quad (4)$$

Where $z = b_0 + \Sigma_{nj=1} b_j Q_{ji}$

Model 1 and Model 2 thus represent the supply and demand sides of the motor tricycle market respectively. The supply side specifically modeled the likelihood of owners acquiring additional motor tricycles. The probit regression equation is thus presented as equation (5):

$$Y_i = Pr(Y_i=1/Gender, Age, Years\ of\ Education, Marital\ status, Reliability, Cost, Returns)$$
$$= \Phi(\beta_0 + \beta_1 Gender + \beta_2 Age + \beta_3 Years\ of\ Education + \beta_4 Marital\ status + Reliability + \beta_6 Cost + \beta_7 Returns) + \varepsilon_i \quad (5)$$

The demand side modelled the factors that determine the discrete mode choice between motor tricycle and traditional mode of transport. The probit regression equation is thus modelled as equation (6):

$$Yi = Pr(1/ Explanatory\ variables)$$
$$= \Phi(\beta_0 + \beta_1 Gender + \beta_2 Age + \beta_3 Years\ of\ Education + \beta_4 Marital\ status + \beta_5 Safety + \beta_6 Rainfall + \beta_7 Comfort + \beta_8 Distance + \beta_9 Affordability + \beta_{10} Delay) + \varepsilon_i \quad (6)$$

3. Analysis of Data and Discussion of Results

Analysis of the data was done by means of probit regression. The following sub-sections present and discuss the results obtained based on the category of respondents.

3.1 Owners' choice and tricycle supply

The choice tricycle owners had to make was between purchasing an additional tricycle and investing their money in some composite commodity. This choice was modelled using a binomial probit function to analyse the likelihood of owners supplying another motor tricycle or investing in a composite commodity. The regression results of the probit model (model 1) representing the supply side are presented in Table 3:

Table 3: Probit results for the likelihood of supplying another tricycle by owners

Explanatory variables	Coefficients	Standard errors	P > | z |
Constant	−2.171586*	0.800211	0.007
Gender (Reference: female)			
Male	−0.0702382	0.4103765	0.864
Age (Reference: Modal Age 29 – 39 years)			
18 – 28 years	0.7400204	0.7259425	0.308
40 – 50 years	−1.281766*	0.5901114	0.030
51 & above years	−1.843631*	0.7277387	0.011
Edu (Reference: no formal education)			
Primary	0.9024578	0.6564729	0.169
Secondary	0.6729399	0.5157591	0.192
Tertiary	−0.1261752	0.5361011	0.814

Marital status (Reference: single)			
Married	−0.4833447	0.5836623	0.408
Reliability of drivers	4.211814*	0.6168669	0.000
Direct cost	−0.000123*	0.0000389	0.028
Total returns	0.0001034*	0.0000438	0.016
Pseudo R^2 = 0.7448	Prob > Chi^2 = 0.0000	*Values significant at an alpha level of 0.05	

From Table 3, the probit regression results showed that, the reliability of riders and total returns were positive and statistically significant determinants of the probability of owners choosing to have an additional tricycle. Also, direct cost and owners aged above 40 years had negative coefficients and were statistically significant determinants of the likelihood of owners supplying another tricycle. This implies that as long as returns to the tricycle investment was positive, owners of tricycles were most likely to purchase more tricycles for business.

Also, owners of tricycles were very likely to purchase additional tricycles as long as they had reliable riders to ride their tricycles. In addition, increasing direct cost borne by owners of tricycles had the probability of discouraging investment in the tricycles, holding all other factors constant. Also, owners of tricycles aged above 40 years were less likely to purchase more tricycles compared to younger owners of tricycles. These results are consistent with the theory of supply.

Table 4: Marginal effects for probit results

dy/dx	Coefficients	Standard errors	P > | z |
Gender (Reference: Female)			
Male	−0.0210091	0.12139	0.863
Age (Reference: Modal Age 29 – 39 years)			
18 – 28 years	−0.259811	0.27625	0.347
40 – 50 years	−0.417496*	0.17866	0.019
51 & above years	−0.6422462*	0.18154	0.000
Educational level (Reference: no formal education)			
Primary	0.2083923*	0.10768	0.053
Secondary	0.1894788	0.13188	0.151
Tertiary	−0.03898021	0.16843	0.817
Marital status (Reference: single)			
Married	−0.137224	0.15148	0.365
Reliability of drivers	0.9647037*	0.0269	0.000
Direct cost	−0.0000371*	0.00002	0.021
Total returns	0.0000318*	0.00001	0.010
Y = Pr (Tricycle) (predict) = 0.7721	*Values significant at an alpha level of 0.05		

Table 4 shows that the marginal effect on owners of tricycles in the age group 40 – 50 years is a 41% less likelihood to acquire additional tricycles than those in the modal age group 29 – 39 years. Also, owners of tricycles aged 51 years and above were about 64% less likely to acquire additional motor tricycles compared to those in the modal age group 29 – 39 years. The marginal effects of the probability of owners acquiring additional tricycles as a result of the direct cost and total returns respectively were not strong enough (0.003%) compared to the other variables, though significant.

With regard to the level of education, owners of tricycles with primary education only, were about 20% more likely to acquire additional motor tricycles than those with no formal education. Also, owners of tricycles who had reliable riders were about 96% more likely to acquire additional tricycles than invest in some composite commodity. This variable has the most significant marginal effect and represented 70% of the owners. The results thus show that owners of tricycles desire and are able to add to the existing fleet of tricycles in Ghana.

3.2 Commuters' Choice

Table 5 shows the characteristics of users of the tricycles. The modal age group of commuters who patronized the tricycle was 40-50 years. People with tertiary education were the least users of the tricycle as compared with those with lower levels of education. Both males and females as well as those married and single used the tricycle almost equally. Also, the tricycle was patronized mostly by low income earners, that is those who earned about GHS200 (US$40) and below in a week.

Table 5: Characteristics of Commuters

Category	Attributes	Frequency	Percentage (%)
Gender	Male	97	48
	Female	105	52
Age group	Less than 18	24	11.9
	18 – 28	59	29.2
	29 – 39	29	14.4
	40 – 50	79	39.1
	Above 50	11	5.4
Level of education	No formal education	44	21.8
	Primary level	53	26.2
	Secondary level	80	39.6
	Tertiary level	25	12.4
Marital status	Married	105	52
	Single	97	48
Average weekly income	Less than GHC100	92	45.5
	GHC100 – GHC300	68	33.7
	Above GHC300	42	20.8

The specific factors that made motor tricycle a primary choice of intra-city transportation compared to the traditional mode of transport were ascertained through the data collection process. These factors were found to be safety, comfort, waiting time, trip distance, rainfall, affordability and less delay in traffic as depicted in Figure 1.

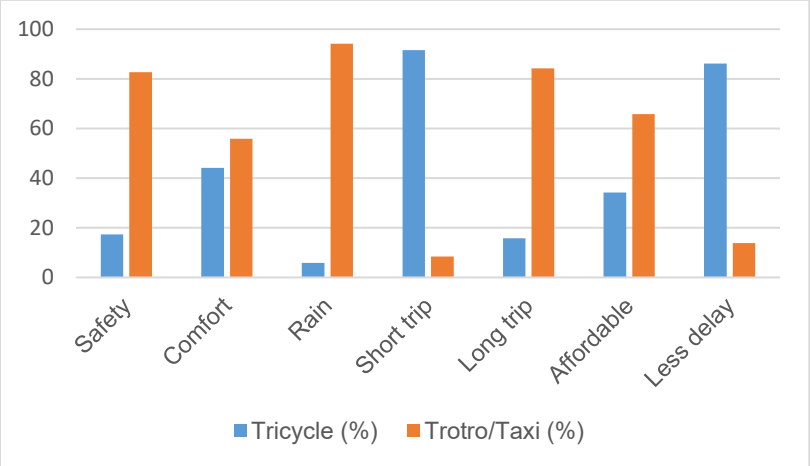

Figure 1: Factors accounting for choice between tricycles and trotro/taxis

The main motivation for the utilization of motor tricycle by 86.1% of the commuters was its ability to decrease travel time during traffic congestion. About 65.8% of commuters however, found the traditional mode of transport to be more affordable than the motor tricycle.

The regression results of the probit model (model 2) for commuters' choice between tricycles and the traditional means of transport (tro-tro or taxi) are presented in table 6:

Table 6: Probit regression results for commuters' choice

Explanatory variables	**Coefficients**	**Standard errors**	**P > | z |**
Constant	0.0155555	0.6154236	0.980
Gender (Reference variable: Female)			
Male	-0.0488227	0.2182195	0.823
Age in years (Reference age: less than 18)			
18-28	-0.005967	0.3267116	0.985
29-39	0.1925972	0.492489	0.696
40-50	0.5247721	0.5109435	0.304
51 and above	0.421833	0.6267476	0.501
Education (Reference level: No formal education)			
Primary	-0.4944268	0.2947204	0.093
Secondary	0.3292698	0.4031127	0.414
Tertiary	0.1964896	0.3662878	0.645
Income in Ghana cedis (GHS) (Reference level:<GHS100)			
100-300	0.3594137	0.2443023	0.141
Above 300	0.3573366	0.3022621	0.237
Other factors referenced on traditional means of transportation			
Safety	-0.3407447	0.2626203	0.194
Comfort	-0.0055417	0.2188417	0.980
Rainfall	-0.2462527	0.3885522	0.526
Short trip distance	-0.2652515	0.3602371	0.462
Long trip distance	-0.2115364	0.2748448	0.442
Affordability	-0.1229301	0.2145301	0.567
Less delay in traffic	0.4840937	0.2800468	0.084

From Table 6, none of the factors had a significant effect on the probability of commuters to use the tricycle at 5% level of significance. However, less delay in traffic had a positive significant effect on the probability of commuters to choose the tricycle at the 10% level of significance. Thus generally the probability of avoiding long delays in traffic was the main reason for which most commuters opted to travel in tricycles. Figure 1 shows that about 86% of commuters used tricycles because of their ability to ensure less delay in traffic as against the traditional modes of city transport.

This finding is confirmed by Arroyo-Arroyo (2021), who found that time spent travelling and how unpredictable this can be is a major source of discontent among commuters who use the traditional modes of urban transport in Ghana. Commercial mini-buses (tro-tros) for instance have to wait to fill up all seats before departing their terminals, while on their way, they typically have to stop several times, dropping off passengers and picking passengers to replace those who disembark before the final destination. Therefore, the tricycles are resorted to, since they can usually weave their way through congested traffic and will not need to fill up all their seats before departing, making their travel times far shorter than tro-tros.

This finding about commuters indicates that tricycles will remain a vehicle of choice among many commuters if they can continue to fulfil the expectation of reducing travel time. Currently, non-designated and unmarked middle lanes of most roads are used by the tricycles to avoid traffic congestion in cities. This is how they are able to reduce travel times. However, since the middle lanes are not legally designated lanes, traffic rules could easily disallow

tricycles from using them, meaning that they will have to follow normal traffic lanes. If this happens, their capacity to reduce travel times could be lost, thus depriving them of the patronage they have.

3.3 Tricycle Riders

Table 7 shows that all riders of the tricycles were males. Mukhtar et al. (2015) also found that riders of commercial motor tricycles were all males in Nigeria. These riders were mostly young people with 78% of them being between 18 and 39 years old. This suggests that the motor tricycle transportation system had provided employment for the youth in Ghana. Balaria (2016) also noted that one reason for the dominance of motor tricycle transportation in the Philippines was its ability to provide a large number of people with jobs.

About 70% of the riders earned on average 350 Ghana cedis per week, which was about US$9.30 per day. This earning is far higher than Ghana's minimum wage of US$2.07 per day. Thus compared to earners of minimum wage, the riders were better off in terms of wages than several formal sector workers earning the minimum wage in Ghana. Thus for riders of the tricycles, gainful employment has been provided by the introduction of the tricycles for urban transportation in Ghana.

Table 7: Socio-economic characteristics of Riders

Category	Attributes	Frequency	Percentage (%)
Gender	Male	150	100
	Female	0	0
Age group	Less than 18	13	8.7
	18 – 28	78	52
	29 – 39	39	26
	40 – 50	12	8
	Above 50	8	5.3
Level of education	No formal education	14	9.3
	Primary level	43	28.7
	Secondary level	79	52.7
	Tertiary level	14	9.3
Marital status	Married	106	70.7
	Single	44	29.3
Average weekly income	Less than GHC200	34	22.7
	GHC200 – GHC500	106	70.7
	Above GHC500	10	6.6

4. Conclusion and Policy Recommendations

The study sought to assess the economic incentives responsible for the booming motor tricycle transportation system in urban Ghana. It employed a quantitative approach to analyse a survey of owners, drivers and passengers of the tricycles, to ascertain the role of supply in the creation of the current demand. A probit regression technique was used to model and analyse the likelihood of owners supplying additional tricycles and to also assess factors that determine the choice between motor tricycles and traditional modes of urban transport in Ghana.

The study found that motor tricycles were chosen by commuters because they aided them to reduce their travel time. In addition, the supply of additional tricycles was sustained by the significant returns to owners on their investments and the reliability of riders of the tricycles. The results indicate that the availability of the tricycles made them desirable for commuters to avoid delays in traffic. This shows that supply of the tricycles in Kumasi had created demand for them, validating Say's Law of Markets at the microeconomic level.

If a previously unsolicited good (the motor tricycle) can enjoy the existing boom in patronage, merely by its availability in Ghana, then it seeks to suggest that supply indeed creates its own demand for the good in Ghana. In addition, the supply of tricycles has created employment opportunities and significant incomes for riders and owners of the tricycles.

The study recommends that, the government of Ghana should formally legalize the use of the tricycle for urban transportation and begin to tax the incomes earned through their use, to increase national revenue for economic growth. In addition, the policy legalizing the use of tricycles for city transport will have to designate and mark out the middle lanes of city roads for the use of these tricycles, to maintain their capacity to reduce travel time to sustain their patronage.

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