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Effect of Traffic Congestion on Productivity in Ghana: Evidence from Atwimah-Nwabiagya Municipality, Ashanti Region-Ghana

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Abstract Implementation of decentralization policies by successive governments in Ghana has contributed to an upsurge in economic activities in all district capitals and major cities leading to increased productivity, standard of living and social life. Undoubtedly, positive economic growth is directly related to road traffic congestion, a menace in district capitals and metropolitan areas in Ghana. To this end, the study examined the effects of traffic congestion on productivity and its related impacts on inhabitants of Atwima Nwabiagya municipality in the Ashanti Region. Data collected from an online structured questionnaire sourced and completed by 160 respondents were obtained through cluster and systemic random sampling from the municipality and was analysed in SPSS v. 26 and R v. 4.0.4. The study found that the people of Atwima Nwabiagya are tolerant with congestion and that on-going construction, faulty traffic signals, poor driver attitude, unauthorized parking, vehicle breakdown, volume of traffic, and poor road design are significantly contributing factors affecting productivity in the Atwima Nwabiagya municipality rather than the poor pedestrian attitude and provision of inadequate routes. The authors recommend the provision of adequate parking facilities with dedicated designated bus-stops as a measure to ease the congestion menace and suggests for further study, an investigation into why traffic congestion must be tolerated.

Keywords Traffic, Congestion, Atwima Nwabiagya municipality, Roadside Friction, Probit model

1. Introduction

Recent improvement in the Ghanaian standard of living has resulted in urbanization and increased private vehicle ownership thereby putting pressure on prevailing limited road infrastructural network. The inability of road networks to cope with the increasing vehicle numbers especially during peak periods has led to road traffic congestion in major towns and cities the country over. Road traffic congestion can potentially reverse economic gains in a country and must thus be dealt with to sustain economic growth [1].

Transportation in Kumasi Metropolis is constrained by traffic congestion and has instigated long travel delays at peak hours that adversely affect productivity (Harriet & Poku, 2013). The vehicular mix in the Central Business District (CBD) of Kumasi is about 77% cars and taxis and yet accounts for not more than 30% of all person-trips within the metropolitan area. Thus, traffic congestion is more severe in/around market centres and the CBD [2]. Yet, the basic challenge of traffic congestion is not limited to metropolitan areas but is an emerging trend in municipalities and districts characterised by slow vehicular movement, long travel time, and driver and passenger fatigue [2].

The dangers of traffic congestion make it imperative to tackle the menace in existing and emerging cities alike as well as urban areas particularly in developing countries like Ghana. Hence, the paper aims to investigate causes of congestion in municipalities and districts in Ashanti region using Atwima Nwabiagya municipality as a case study. The expectation is for the findings to be used by city authorities and planners in curbing inherent congestion.

1.1. Urban Transportation

Urban transportation consists of systems and infrastructure to facilitate accessibility and mobility for people, goods and services within towns and cities. An

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effective urban transportation system is fundamental to the sustenance of socio-economic activities and standard of living [3]. Simply put, transportation is a life process aimed at providing satisfactory mobility needed by mankind [4]. Effective urban transportation fulfils the wish for easy access within cities and further affirms transportation sector infrastructure an essential feature that directly determine capability and effectiveness of urban transportation systems within metropolitan areas [4,3].

Transportation infrastructure necessary for eased mobility include the provision of bus terminals, roads, and parking lots. Additionally, an effective urban traffic management system is vital to guide and control vehicular and human movement [5].

1.2. Traffic Congestion

Road traffic congestion may be attributed to lack of adequate road transport infrastructure resulting in low speeds, extended trip hours and long vehicle queues. [3] opined that road traffic congestion is the inevitable outcome of limited road transport facilities. Urban traffic congestion can be classified into passenger and freight core areas of circulation and is as a result of passengers and freight sharing the same road space beyond its capacity and characterised by slow vehicle movement, increased queuing and long trips [3]. The emergence of road traffic congestion is because demand for vehicle space has exceeded available road capacity [6]. According to [7], when large populations occupying small land areas can also lead to increased demand for space in road networks thus the demand for vehicles required for optimum transportation increases thereby reducing load capacity at a given point or over a certain length.

1.3. Traffic Congestion as a Global Problem

Traffic congestion has increased for both advanced and emerging countries and will continue to worsen posing a threat to the quality of city life and can be seen as a global problem [8,9]. The Chinese province of Hubei and the Brazilian city of Sao Paulo experienced traffic congestion that stretched over 100 km and commuters getting stuck for over two hours respectively [10,11].

The USA has seen a substantial increase in congestion for years with multiple repercussions on socio-economic activities [12]. Increased in city population among developing countries has caused a proliferation in automobile thereby increasing congestion [13].

1.4. The Impact of Transportation on Productivity

Economic growth sustenance requires an effective transportation system that links different parts of the country and other neighbouring countries to support local and international trade. Thus, workers need an effective road transport system to commute, deliver products, supply logistics while engaging in international trade [14]. A well-established transportation system is vital to a nation's growth, a catalyst to economic development and crucial to growth sustainability [15,4,14]. The input of a country's productivity is its investment in transportation infrastructure and Gross Domestic Product (GDP) as its output [16]. An efficient transportation system can significantly influence monetary cost of doing business by cutting down travel time and improving the comfort and safety of road users [14]. Hence, a good and efficient transportation system can be used as a measure to assess the reliability and business friendliness of cities.

Where perishable products are involved, reliable transportation system is crucial [14]. Thus a good transportation system is an avenue to increase productivity, create jobs and reduce cost of operating businesses while improving business output, and expanding access to markets as economic competitiveness [17]. An effective transportation system give improved access to health services and education, reduces vehicle maintenance costs and emission of harmful gases into the environment thus raising the standard of living [17].

1.5. Factors Contributing to Traffic Congestion

Contributory factors to traffic congestion are at the micro and macro levels. Micro-level factors include number of people using road space at the same time and extra number of vehicles on inadequate road space while macro-level factors comprise car ownership trends, land usage patterns and geographic economic advancement [18].

Congestion can be attributed to limited road transportation infrastructure such as road and parking space, road signals, and effective traffic management systems [3]. Other factors include poorly planned/inadequate road networks and traffic management systems, unplanned cities, road user disorderliness, and poor lane management systems [9]. Additionally, bad driver, trader and pedestrian attitude was found to be the major cause of congestion in Accra [19].

[6], however, suggests that economic growth is the cause of congestion since economic advancement increases vehicular use and overwhelms the existing road infrastructure. Further, parking, urban mobility, high population density, road incidents, and broken-down vehicles also contribute to the congestion menace [6].

Public transportation system inefficiencies lead to heavy dependence on private vehicle usage which puts pressure on the transportation infrastructure [20]. Traffic congestion in Accra is caused by inadequate road capacity, lack of adequate parking space, dysfunctional road signals, poor driver behaviour, vehicle breakdown and increased vehicle population [21]. Regardless, governance decentralization in Ghana has caused massive infrastructure development leading to rapid urbanisation and its related emergence of road traffic congestion.

1.6. Effect of Traffic Congestion

The effect of road traffic congestion are categorised into economic, environmental, health and social [22] [23]. These may differ from city to city depending on severity and nature of vastness of city, road network capacity, spatial distribution of land use, how public and private transport systems operate, and travel pattern [24].

The economic impact is directly related to fuel consumption and cost though economically active cities will definitely experience some congestion [25]. Yet, some believe that traffic congestion puts restrictions on free movement and disrupts commercial activities in cities and decreases productivity [1], inflicts costs on commuters, diminishes product output, and affects commercial operations involving product distributions [26]. Unreliable transportation systems, time lost due to extended travel time, extra fuel spent, and environmental pollution constitute the economic cost of congestion and is linked to cost of human health [14].

The environmental effects are seen in the emission of high volumes of harmful carbon monoxide into the environment as vehicles queue end-on-end in congestion. In addition to contributing to global warming, these harmful gases emitted into the environment could result in long-term smog in communities. The health impacts could manifest in mental stress, tiredness, fatigue, spinal cord injuries and respiratory diseases [13].

According to [26], the social impacts are measured by a decline in one’s life value as a result of dwindling personal revenue, and time for social activities. Drivers who spend long hours in traffic may be stressed, irritated, lose concentration and are likely to drive violently which may endanger the lives of other road users.

1.7. Managing Traffic Congestion

[3] asserts that traffic congestion in urban areas cannot be eliminated but can be reduced to satisfactory levels provided that a multi-faceted approach is adopted in tackling the menace. Such approaches include use of transportation systems management (TSM) schemes like congestion pricing, signal synchronization, incident management, and road lane management [3]. Reduction in congestion is possible by road capacity expansion, new route construction, reduction in traffic volume, and enhanced TSM schemes [2].

TSM strategies to reduce demand may include congestion pricing, parking restriction, park and ride, road space rationing, use of traffic warden/police, provision of dedicated stops and parking areas, enticements to use the public transportation system, and variable speed limits [27].

The issue of technology in identifying traffic congestion maps is being applied to some extent in this contemporary times. [28] utilized the digital camera concept in generating JPEG images to finding roads with traffic congestion, and therefore, developed a congestion traffic map to ameliorate the situation. [29] contended that due to the use of Waze or Google Traffic applications to improve systems bothering on traffic congestion detection, am emerging research in this area is on the rise. 3000 traffic cameras installed to monitor traffic offenders [30] can be used in the future to provide information on traffic congestion in Ghana.

Autonomous vehicles have recently been tested and deployed in some countries to, among other things, curb traffic congestion. [31] noted in their study that, notwithstanding the giant strides achieved in the last few years relative to autonomous technology, it was quite early to implement same commercially, especially for the AV above Level 3 Automation. They, however, opined that should more efforts be made to improve its robustness at all levels of automation, the automated vehicles would run efficiently and safely on the roads in not-too-distant future.

2. Materials and Method

2.1. Study Area

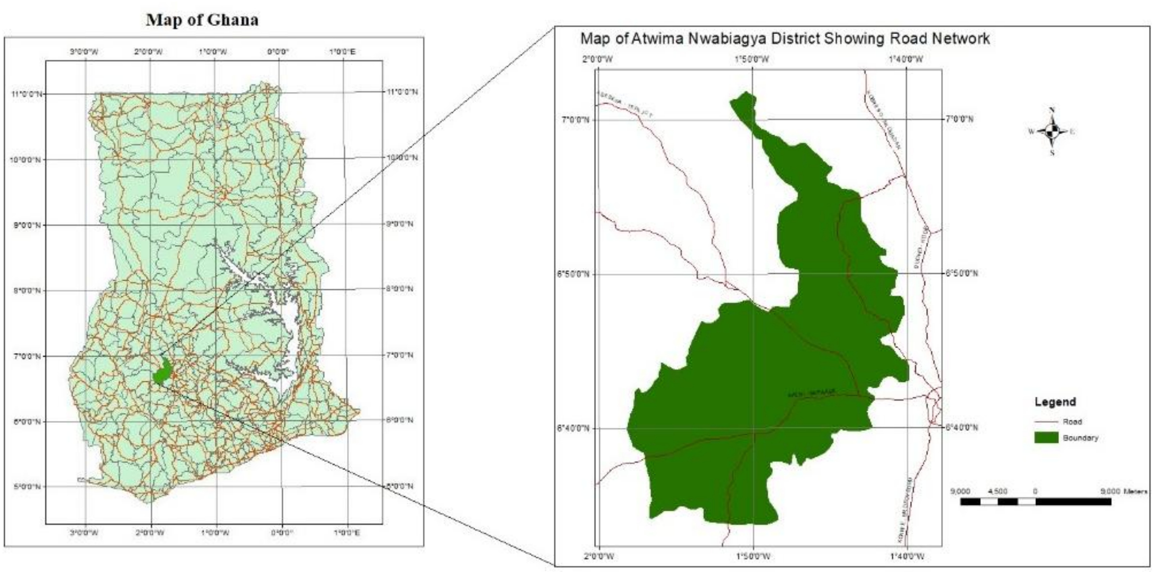

Figure 1. Study Area

The Atwima Nwabiagya municipality is one of the 261 Metropolitan, Municipal and District Assemblies (MMDAs) in Ghana, and forms part of the 43 MMDAs in the Ashanti Region with its administrative capital located in Nkawie. It covers an estimated land area of 294.84 km^2 and is one of the largest municipality in the western part of Ashanti Region. The municipality lies approximately on latitude $6°\,75'N$ and between longitude $1°\,45'\,W$ and $2°\,00'W$. It shares common boundaries with Ahafo Ano South and Atwima Mponua districts, Offinso municipality, Amansie West and Atwima Kwanwoma districts, and Kumasi Metropolis and Kwabre East municipality to the west, north, south, and east respectively. The population is essentially made up of female (52.3%) and male (47.7%) represented as 149,025 persons [32].

2.2. Data Collection

The study adopted a quantitative research approach facilitated by a set of structured questionnaires which were administered online. In all, a total of one hundred and sixty (160) respondents completed the survey. Data collected were categorized into socio-demographic (age, sex, occupation etc) and traffic (volumes) characteristics. The target population comprised inhabitants and commuters in and around the Atwima Nwabigya municipality.

Cluster sampling was first utilized to group the respondents, after which a systemic random sampling approach to collect responses and it satisfied all demographic variables and targeted relevant individuals, groups, and all stakeholders.

2.3. Model Specification and Tests

2.3.1. Model Specification

The conventional simple probit model with binary response variable is generally given as

$$Y_i^* = X_i^T\beta + u_i = \beta_0 + \sum_{a=1}^{k}\beta_a X_{ia} + u_i \tag{1}$$

where

Y_i^* defines a continuous real-valued index variable (i.e. productivity) for observations i that is unobserved

$X_i^T = (1\ X_{i1}\ X_{i2} \ldots X_{ik})$, a $1 \times k$ row vector of regressor values for observation i

$\beta = (\beta_0\ \beta_1\ \beta_2\ \beta_3 \ldots \beta_k)^T$, defines a vector of regression coefficients of size $k \times 1$ column

$X_i^T\beta =$ defines a 1×1 scaler called the index function for observation i

$u_i =$ an independent and identically distributed $(0, \sigma^2)$ random error term for observation i

The observation outcomes of the binary choice problem, such as this study, are represented by a binary indicator variable Y_i that is related to the unobserved response variable (productivity) Y_i^* as follows:

$$Y_i = 1 \text{ if } Y_i^* > 0 \tag{2}$$

$$Y_i = 0 \text{ if } Y_i^* \leq 0 \tag{3}$$

The random indicator variable Y_i represents the observed realizations of a binomial process with the following probabilities:

$$Pr(Y_i = 1) = Pr(Y_i^* > 0) = Pr(X_i^T\beta + u_i > 0) \tag{4}$$

$$Pr(Y_i = 0) = Pr(Y_i^* \leq 0) = Pr(X_i^T\beta + u_i \leq 0) \tag{5}$$

Thus, probit models analytically represent the binomial probabilities in Equations (4) and (5) in terms of the standard normal c.d.f $\Phi(Z)$ as follows:

$$Pr(Y_i = 1) = Pr(Y_i^* > 0) = \Phi(X_i^T\beta) \tag{6}$$

$$Pr(Y_i = 0) = Pr(Y_i^* \leq 0) = 1 - \Phi(X_i^T\beta) \tag{7}$$

Where Pr represents probability and Φ defines the cumulative standard normal distribution function. Under the zero conditional mean error assumption, equation (1) implies that

$$E(Y_i^* / X_i^T) = E(X_i^T\beta / X_i^T) + E(u_i / X_i^T) = X_i^T\beta \tag{8}$$

since $E(u_i / X_i^T) = 0$

The partial derivatives of the regression function in equation (8), if all the explanatory variables are continuous and enter the index function linearly, would be obtained as follows:

$$\frac{\partial E(Y_i^* / X_i^T)}{\partial X_{ij}} = \frac{\partial X_i^T\beta}{\partial X_{ij}} = \frac{\partial(\beta_0 + \sum_{a=1}^{k}\beta_a X_{ia})}{\partial X_{ij}} = \beta_j \tag{9}$$

But if the explanatory variables are binary or enter the index function nonlinearly, then its partial derivative of the regression function in Equation (5) are not so simply interpreted. Thus, it requires the marginal effect approach, which is obtained as follows:

$$X_j = X_{1i}^T\beta - X_{0i}^T\beta \tag{10}$$

Equation (10) is usually difficult to interpret, if not impossible. Thus, the concept of marginal probability effect approach, as was utilized in this study, was adopted. This is given as follows:

Marginal probability effect of

$$X_j = \Phi(X_{1i}^T\beta) - \Phi(X_{0i}^T\beta) \tag{11}$$

Where Φ defines the cumulative standard normal distribution function.

2.3.2. Goodness-of-fit Test

The goodness-of-fit of the model and the comparison of the estimated model with a model which only contains an intercept as the right-hand variable are given as follows:

$$In\hat{L}(M_{Full}) \geq In\hat{L}(M_{Intercept}) \tag{12}$$

The Pseudo R^2 is defined as

$$R_{McF}^2 = 1 - \frac{In\hat{L}(M_{Full})}{In\hat{L}(M_{Intercept})} \tag{13}$$

For $0 \leq R_{McF}^2 \leq 1$

Where M_{Full} and $M_{Intercept}$ defines model with full complement of the independent variables and model with intercept only respectively.

When there are additional explanatory variables in the right-hand side of Equation (13), then an adjusted measure as shown in Equation (14) is appropriate.

For purposes of testing the relevance of variables, the following Likelihood ration test was utilized:

$$LR = -2In\lambda = -2(InL_R - InL_U) \sim \chi^2(K) \quad (14)$$

Where $\lambda = \frac{L_R}{L_U}$ and $0 \leq \lambda \leq 1$

For purposes of this study, the hypothesis tested under this test is as follows:

H_0: all the coefficients except the intercept are equal to zero

H_1: all the coefficients except the intercept are not equal to zero

3. Results

3.1. Descriptive Analysis of Socio-Demographic Characteristics of Respondents

Table 1. Socio-demographic Characteristics of Respondents

Socio-demographic characteristics		Total	
		F	%
Gender	Male	115	71.9
	Female	45	28.1
Age group	<25	20	12.5
	25-40	75	46.9
	41-60	48	30.0
	>60	17	10.6
Educational level	Basic	12	7.5
	Secondary	52	32.5
	University	96	60.0
Marital Status	Single	45	28.1
	Married	107	66.9
	Widowed	8	5.0
Employment status	Government Workers	40	25.0
	Private Sector Workers	30	18.8
	Drivers	70	43.8
	Business/Traders	20	12.5

The socio-demographic characteristics of respondents were considered for age, occupation, marital status, and educational level and the results are presented in Table 1.

The results from Table 1 indicate that about 46.9% of the respondents fell within the 25-40 age bracket and are therefore mostly young folks in the district. The respondence rate was evidenced by a preponderance of males (71.9%) with the females being in the minority. Respondents are also highly educated with 60.0% of them having university degrees and only a small percentage (7.5%) having basic education. It is interesting to note that about 66.9% of respondents are married with a widowed rate of 5.0%. 43.8% of the respondents are in the driving profession, 25.0% work in the government sector and 12.5% engaged in business and other trading activities.

3.2. Impact of Congestion on Inhabitants of Atwima Nwabiagya Municipality

The impact of congestion on the people of Atwima Nwabiagya is presented in Table 2. The table compares the statistics of similar impacts on government workers, private sector workers and drivers.

The results indicate that only the frequency of congestion has a positive significant relationship on drivers with all other relationships remaining insignificant for the rest of the parameters for government and private sector workers as well as drivers in the Atwima Nwabiagya municipality.

3.3. Causes and Impact of Congestion on

3.3.1. Socio-Economic Livelihood

The causes and impact of congestion on the socio-economic livelihood of the people living in and around the Atwima Nwabiagya municipality are presented in Table 3. The causes and impacts are compared for government workers, private sector workers and drivers.

The results show that the effect of congestion on the health of inhabitants is highly significant as it has very sharp p-values for both government and private sector workers as well as drivers in the municipality.

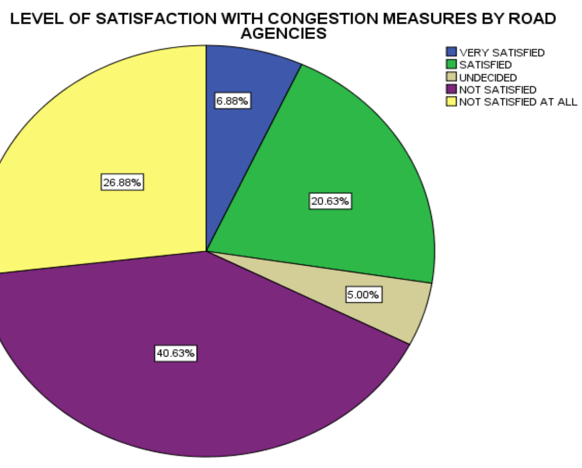

Figure 2. Level of Respondents Satisfaction

Table 2. Period and Types of Congestion of Road Users

				Government Workers		Private Sector Workers		Drivers	
Description	**Details**	**F**	**%**	**p-value**	**Crude OR (95% CI)**	**p-value**	**Crude OR (95% CI)**	**p-value**	**Crude OR (95% CI)**
Time to leave for work	Before 6:00am	41	25.6	0.246	2.768 (0.495-15.490)	0.063	1.048 (0.148-7.399)	0.068	4.565 (0.892-23.777)
	6:00am to 8:00am	60	37.5	0.048	0.990 (0.263-3.720)	0.017	0.808 (0.196-3.321)	0.043	1.636 (0.478-5.606)
	After 8:00am	59	36.9	.	.	.	.	.	.
Time to arrive at work	Before 6:00am	30	18.8	0.177	6.149 (0.441-85.738)	0.348	3.864 (0.229-65.129)	0.068	11.220 (0.837-150.326)
	6:00am to 8:00am	113	70.6	0.015	0.637 (0.110-3.687)	0.046	0.686 (0.103-4.561)	0.040	1.714 (0.306-9.598)
	After 8:00am	17	10.6	.	.	.	.	.	.
Type of congestion	Recurrent	126	78.8	0.026	3.871 (0.355-42.193)	0.029	6838268.221 (0.000-)	0.011	1.479 (0.187-11.730)
	Occasional	24	15.0	0.315	4.342 (0.247-76.351)	0.091	13667055.101 (0.000-)	0.463	2.570 (0.207-31.871)
	Recurrent/Occasional	10	6.3	.	.	.	.	.	.
Period of congestion	Holiday/Festive	65	40.6	0.023	0.219 (0.018-2.615)	0.027	0.225 (0.015-3.296)	0.041	0.396 (0.036-4.396)
	Weekday	80	50.0	0.032	0.278 (0.022-3.533)	0.003	0.593 (0.040-8.727)	0.021	0.884 (0.076-10.300)
	Weekend	15	9.4	.	.	.	.	.	.
Morning Peak	Before 6:00am	45	28.1	0.892	0.868 (0.114-6.620)	0.154	0.194 (0.020-1.851)	0.166	0.267 (0.41-1.732)
	6:00am to 8:00am	86	53.8	0.010	0.525 (0.077-3.577)	0.034	0.712 (0.101-5.034)	0.018	0.316 (0.057-1.764)
	After 8:00am	29	18.1	.	.	.	.	.	.
Afternoon/ evening peak	12noon to 3:00pm	18	11.3	0.097	0.216 (0.035-1.321)	0.081	0.115 (0.010-1.304)	0.083	0.271 (0.062-1.187)
	3:00pm to 5:00pm	28	17.5	0.027	4.031 (0.421-38.632)	0.007	8.606 (0.860-86.145)	0.046	1.840 (0.193-17.563)
	After 5:00pm	114	71.3	.	.	.	.	.	.
Congestion frequency	Very Often	89	55.6	0.090	1.007 (0.000-)	0.070	2.154 (0.000-)	0.060	1.970E-7 (1.807E-8-2.149E-6)
	Often	55	34.4	0.031	1.307 (0.000-)	0.020	0.881 (0.000-)	0.022	1.638E-7 (1.372E-8-1.956E-6)
	Not Often	15	9.4	0.089	1.983 (0.000-)	0.072	2.218 (0.000-)	.	3.481E-7 (3.481E-7-3.481E-7)
Congestion delay	Below 30 minutes	47	29.4	0.034	2.366 (0.327-17.111)	0.048	0.487 (0.061-3.907)	0.047	0.941 (0.170-5.220)
	30 to 60 minutes	88	55.0	0.020	1.245 (0.188-8.222)	0.016	0.747 (0.114-4.898)	0.041	0.705 (0.139-3.589)
	Above 60 minutes	25	15.6	.	.	.	.	.	.

3.4. Respondents' Satisfaction

Respondents' satisfaction levels on stakeholder response to and in managing congestion was tested using a five-point Likert Scale and results shown in Figure 2.

The chart in Figure 2 shows a 27.51% satisfaction, 5.0% indifference and 67.51% non-satisfaction levels among the Atwima Nwabiagya respondents.

From Table 4, the marginal effects concept was used to assess the required effects of the explanatory variables on the response variable (productivity) as the causal factor were deemed dummy in nature. Thus, for every change from zero to one in the dummy variable *volume of traffic*, the likelihood of productivity taking value one increases by 22.0%. Also, a change in inadequate routes from zero to one would change the probability that productivity takes the value one by 29.8%. The mean predicted likelihood or chance of low productivity was 99.8% should dummy variable *unauthorized parking* changes from zero to one. Again, the mean predicted probability of productivity was reduced by 13.2% owing to on-*going construction* when it changes from zero to one. The probability of low productivity because of vehicle breakdown changing from zero to one was 29.9%. Moreover, faulty traffic signals when it changes from zero to one, have 19.9% probability of reducing productivity. For a change in the dummy variable, driver attitude, from zero to one, the probability of productivity taking value one decreases by 17.8% for the dummy variable pedestrian attitude. When it changes from zero to one, the likelihood of productivity taking value one reduces by 35.4%.

Having examined the extent of marginal effect of the individual explanatory variables, it was imperative to test the significance or otherwise of each explanatory variable in the model relative to its contribution. Form Table 4, it observable that seven (7) out of the nine (9) predictor variables were statistically significant in terms their contribution to productivity. These predictors were volume of traffic ($p < 0.001$), inadequate routes ($p < 0.01$), unauthorized parking ($p < 0.01$), on-going construction ($p < 0.05$), vehicle breakdown ($p < 0.01$), faulty traffic signals ($p < 0.001$), driver attitude ($p < 0.05$), and poor rood design ($p < 0.01$). However, two (2) of the predictor variables contribution to the response variable, productivity, was statistically not significant. These were inadequate routes ($p > 0.05$) and pedestrian attitude ($p > 0.05$).

Meanwhile, under the model indices in Table 4, the $Pr > |\chi^2|$ (0.001) is smaller than the significance level ($\alpha = 0.01$). This indicates that there was sufficient reason to reject the null hypothesis in favour of the alternative hypothesis. Thus, the decision was that all coefficients were each different from zero (or not equal to zero) in the probit model at 99% confidence interval. Also, Mc Fadden Pseudo-R^2 showed that the explanatory variables accounted for 70.13% of the variance in productivity (response variable).

Table 3. Causes and Impact of Congestion

				Government Workers		**Private Sector Workers**		**Drivers**	
Description	Details	F	%	p-value	Crude OR (95% CI)	p-value	Crude OR (95% CI)	p-value	Crude OR (95% CI)
Cause of Congestion	Too many vehicles	17	10.6	0.039	0.198 (0.013-2.929)	0.041	0.454 (0.016-12.550)	0.020	0.185 (0.013-2.565)
	Inadequate Routes	6	3.8	0.436	0.232 (0.006-9.168)	0.050	1.694 (0.038-74.540)	0.046	0.351 (0.012-10.524)
	Unauthorized Parking	43	26.9	0.076	0.819 (0.066-10.194)	0.048	1.532 (0.072-32.450)	0.023	0.884 (0.073-10.650)
	On-going Construction	10	6.3	0.005	0.968 (0.037-25.627)	0.018	1.030 (0.019-55.921)	0.017	1.544 (0.062-38.275)
	Vehicle Breakdown/ Accident	19	11.9	0.045	0.751 (0.042-13.291)	0.046	1.409 (0.044-44.729)	0.025	1.988 (0.127-31.157)
	Faulty Traffic Signals	13	8.1	0.019	0.844 (0.032-22.207)	0.043	4.295 (0.114-161.704)	0.039	1.088 (0.045-26.028)
	Poor Driver Attitude	28	17.5	0.938	0.895 (0.053-15.031)	0.471	3.307 (0.128-85.418)	0.076	1.525 (0.098-23.833)
	Poor Pedestrian Attitude	15	9.4	0.982	1.039 (0.041-26.166)	0.421	4.362 (0.121-157.629)	0.073	1.790 (0.080-40.032)
	Poor Road Design	9	5.6	.	.	.	.	.	.
Effect of Congestion	Loss of Revenue	37	23.1	0.034	0.437 (0.077-2.470)	0.049	0.489 (0.064-3.765)	0.048	0.553 (0.107-2.868)
	Low Productivity	43	26.9	0.027	0.386 (0.069-2.153)	0.029	0.881 (0.131-5.901)	0.012	0.269 (0.051-1.424)
	Health Implications	5	3.1	0.000	23041071.639 (1921581.369-276278169.046)	0.000	73163967.031 (5253576.399-1018918478.559)	.	47381856.708 (47381856.708-47381856.708)
	Excessive Fuel Usage	21	13.1	0.074	.838 (0.093-7.527)	0.068	1.599 (0.149-17.127)	0.013	1.285 (0.161-10.276)
	Stress	24	15.0	0.039	1.012 (0.075-13.744)	0.031	3.827 (0.273-53.697)	0.057	2.009 (0.172-23.529)
	Time Wastage	30	18.8	.	.	.	.	.	.

Table 4. Probit model

Variable	Coefficient	Std. error	Z-statistic	P-value	Marginal effect	95 Conf. Interval	
						Lower	Upper
intercept	1.932	0.213	4.5682	0.001**	-	1.2012	2.1562
Volume of traffic	0.4576	0.335	5.1432	0.000***	0.1420	0.2200	0.6423
Inadequate routes	0.8971	0.422	6.0014	0.651	0.2214	0.2981	0.9897
Unauthorized parking	0.3211	0.303	5.7621	0.011**	0.9983	0.1554	0.4215
On-going construction	-0.8772	0.198	-7.0014	0.041*	-01324	-0.9209	-0.6652
Vehicle breakdown	0.9123	0.267	5.9821	0.001**	0.2998	0.7824	1.1063
Faulty traffic signals	-0.4459	0.1019	-5.7742	0.000***	-0.1985	-0.5417	-0.2873
Driver attitude	0.6632	0.2201	4.8896	0.029*	0.1776	0.4905	0.8013
Pedestrian attitude	-0.5578	0.1240	-6.6230	0.214	-0.3542	-0.6702	-0.3890
Poor Road Design	0.7439	0.1102	4.8123	0.004**	0.4044	0.5912	0.9766

Model indices

Index	Value	Index	Value
Null deviance	257.254 $(df = 160)$	Predicted percentage correction	92.01%
Residual deviance	221.892 $(df = 153)$	Akaike I.C.	452
Mc Fadden Pseudo-R^2	0.7013	Likelihood ratio	43.432
$\chi^2(df = 9)$	408.953	Number of iterations	6
$Pr > \lvert\chi^2\rvert$	0.001		

NB: *** $(p < 0.001)$, ** $(p < 0.05)$ and * $(p < 0.1)$

4. Discussions

The survey response rate which favoured males (71.9%) is in contrast with studies by [33,34,35], which suggest that females are more likely to respond to surveys than their male counterparts. The reason the reverse is so in this study could be because, the females did not find traffic congestion interesting enough to participate in as did the males after all, [36] concluded that relevance of study does influence response rates. However, more highly educated people (60%) completing the survey agrees very well with the general idea that more educated people usually participate in surveys [33,37,35].

The study suggests that the frequency of traffic congestion is of paramount importance to respondents rather than the recurrence or otherwise of congestion, the times the morning/afternoon/evening peak is occurring, the seasonality of the congestion, or the delay experienced during congested periods. Inference can therefore be made that the people of Atwima Nwabiagya are tolerant of the traffic congestion situation given that it is infrequent irrespective of which forms it takes. But why would anyone tolerate traffic congestion? According to [38], traffic congestion is irritating since it throws personal schedules into shreds, yet some use it as an excuse to be habitually late for appointments. That notwithstanding, trip staggering and alternate work schedules could minimize the frequent congestion since it has been established that COVID-19 and its related lockdowns contributed to decreased traffic demand leading to reduced delays and emissions especially for congested urban areas [39,40].

On-going construction, poor pedestrian attitude, faulty traffic signals, poor driver attitude, unauthorized parking, vehicle breakdown/accident, are conditions likely to cause congestion in the Atwima Nwabiagya municipality rather than the volume of traffic and provision of inadequate routes as can be seen in Table 3. Parking and vehicle breakdown/accidents along the road contribute to congestion by reducing the effective road width (side frictional effects) and eventual traffic flow as experienced by motorists on most road segments [41] thus the higher likelihoods as presented in Table 3. Nonetheless, lack of adequate parking space is the reason for the indiscriminate parking at unauthorized locations. Provision of adequate parking spaces, adopting park and ride services, and institution of parking restraints and parking charges may be beneficial to help fight congestion.

Poor driver/pedestrian attitude which manifests in unplanned and uncontrolled stops also affects congestion. A study on travel time variability confirms that multiple indiscriminate stops and unplanned trips contribute significantly to congestion and variations in travel time [41]. Trip planning models could serve as a solution to curbing the congestion situation in the municipality.

The impact of health on inhabitants of Atwima Nwabiagya municipality is highly significant as evident in the p-value of 0.000, however, stress and excessive fuel usage are more likely to impact on respondents than loss of revenue and low productivity. It is proven that congestion is directly proportional to productivity which leads to revenue losses, impedes growth and quality of life [15,42], yet the inhabitants in Atwima Nwabiagya municipality do not place much importance on it.

The general expectation is for responsible agencies (Motor Traffic and Transport Department (MTTD), Department of Urban Roads (DUR), Ghana Police Service

(GPS), National Road Safety Authority (NRSA) to propose and implement strategies to help control congestion. Satisfaction levels from respondents reflect a lackadaisical attitude. This could be because, the inhabitants do not want to live with expectations that may take forever to be met since about three-quarters (72.5%) are indifferent, not satisfied or not satisfied at all. Enforcement of specific agency strategies such as applying traffic byelaws, imposing fines on offending road users, road space rationing, and effective/functional TSM strategies, are essential to boost respondent attitude and discipline.

5. Conclusions

Rapid urbanisation in the Atwima Nwabiagya municipality in Ashanti Region, Ghana, has brought huge pressure on the limited infrastructure leading to substantial increase in daily vehicular movements and subsequent road traffic congestion. On-going construction, faulty traffic signals, poor driver attitude, unauthorized parking, vehicle breakdown, volume of traffic, and poor road design are significant contributing factors affecting productivity in the Atwima Nwabiagya municipality rather than the poor pedestrian attitude and provision of inadequate routes. Also, the most significant impact of congestion on inhabitants of Atwima Nwabiagya municipality is health, however, stress and excessive fuel usage are more likely to impact on respondents than loss of revenue. The paper suggests that city authorities provide adequate parking alongside designated bus stops particularly for commercial drivers while adopting and enforcing various TSM strategies to ease traffic congestion. Additionally, authorities must provide effective road maintenance and repair strategies to immediately repair damaged road portions to ensure full road capacity for smooth traffic flow. Use of traffic wardens/police could also be adopted to direct and control vehicle and pedestrian movements.

Although cameras have been installed on some highways in Ghana, its purpose has only been to curb crime and monitor over speeding. It is recommended that the police and government use the traffic camera system to generate a traffic congestion information for drivers. Moreover, the government is encouraged to adopt the use of autonomous vehicles to ease traffic congestion as it will boost productivity.

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