# The Multidimensional Impacts of Global Vehicular Congestion: Economy, Living Quality, Environment, and Adaptation Strategies

**Muhammed Salim Anappattath***

Associate Professor of Economics, MES Ponnani College, Malappuram, Keralam, India, 679586

**Corresponding Author Email: salimkodalipoyil@gmail.com*

**Abstract:** *This study analysed the impact of traffic congestion on 363 cities worldwide, focusing on adaptation strategies such as metro systems and airport expansion. While congestion modestly affects environmental quality, living standards, and economic outcomes, it significantly prompts investment in faster transport modes, especially in cities with longer travel times. However, not all congested cities have adopted such measures. Developing countries face more severe congestion challenges than developed countries, which manage them better.Interestingly, the quality of urban governance has little global influence on traffic management. Overall, congestion increases the likelihood of adaptive responses, although it explains less than 10 per cent of urban outcome variation.*

**Keywords**: Traffic Congestion, Adaptation Strategies, Faster Transport

## INTRODUCTION

The cost of traffic congestion remains one of the most frequently cited examples of negative externalities in the modern economic literature. This has been a major obstacle in maintaining sustainable transport systems, particularly in large cities worldwide (Fattah et al., 2022). It affects multiple spheres of urban life, consuming time and money and imposing economic, emotional, and environmental costs (Xu et al., 2024; Thorne et al., 2024). Disruptions to economic activity can undermine productivity and deter investment, while personal time is constrained when roads are the primary mode of transport and traffic is slow. Slow-moving traffic and inadequate transportation infrastructure further diminish the quality of life and commuter well-being (Han et al., 2022). Congestion contributes significantly to both air and noise pollution, which can create health issues and deteriorate visibility.

### Causes of Urban Traffic Congestion in Developing Countries

Urban traffic congestion in developing countries arises from both infrastructural and behavioural factors. Excessive vehicles, narrow roads, ineffective public transport systems, and bus operators' attitudes significantly contribute to congestion (Fattah et al., 2022). These issues are exacerbated by poor road planning and inadequate traffic management, making commuting in major cities extremely difficult (Jain et al., 2012). Financial constraints further limit the capacity of developing nations to expand and modernise their transport networks. Ardila-Gomez and Ortegon-Sanchez (2016) describe this as an "under-funding trap," where insufficient resources prevent necessary infrastructure investment, perpetuating congestion. Consequently, urban transportation in developing countries remains highly vulnerable to financial and institutional bottlenecks.

### Economic, Environmental, and Health Consequences

Traffic congestion imposes heavy economic, environmental, and health-related costs. Economically, it reduces productivity by wasting time on non-productive travel, with the opportunity cost of delays determining the scale of loss (Sweet, 2011). Industries dependent on specialised labour and timely deliveries are particularly affected (Weisbrod et al., 2003). Beyond economic inefficiencies, congestion contributes to pollution, stress, and a diminished urban quality of life. Vehicular traffic is a major source of air and noise pollution (Chin, 1996), and frequent idling and stop-and-go movements increase the emissions of CO, NOx, PMx, and hydrocarbons (Anjum

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et al., 2019).

These pollutants have serious health impacts. Levy et al. (2010) estimated that traffic-related emissions caused around 3,000 premature deaths across 80 U.S. cities in 2005, costing about $24 billion. These findings highlight that traffic congestion extends beyond transportation inefficiency; it is a multidimensional urban challenge that affects the economy, environment, and public health.

### Diverging Experiences: Developed vs Developing Countries

Empirical evidence on the relationship between congestion and economic performance varies by context.In developed countries, slow-moving traffic does not necessarily hinder the economic growth. Marshall and Dumbaugh (2020), studying U.S. metropolitan areas, found no significant negative economic effects from slower traffic; infact, dense urban environments with slower speeds were sometimes linked to greater accessibility and commercial activity.

However, this experience contrasts sharply with that of developing economies. In Dhaka, Bangladesh, congestion severely restricts economic growth owing to inadequate planning and high population density (Chakraborty, 2010). Fattah et al. (2022) estimated daily economic losses of approximately $2.01 million in Chittagong due to congestion, while studies in Sri Lanka (Jayasooriya & Bhandara, 2017) and India (Samal et al., 2021) reported similar losses in productivity, fuel, and labour hours. Overall, congestion significantly hampers the performance of metropolitan areas in developing countries (Jain et al., 2012).

Developed nations manage urban congestion more effectively through technology and policies. The Advanced Traveller Information System (ATIS) provides real-time updates to commuters, enabling efficient travel decisions (Ackaah, 2019). Moreover, institutional mechanisms, such as congestion pricing, successfully implemented in London, Stockholm, and Singapore, regulate traffic volumes and promote public transport use (Metz, 2018). Consequently, developed countries experience lower vulnerability to traffic-related fatalities owing to preventive measures, efficient management, and sustained infrastructure investment (Berhanu et al., 2023).

In summary, traffic congestion in developing countries stems from inadequate infrastructure, poor planning, and financial constraints, resulting in severe economic, environmental, and health costs. In contrast, developed nations effectively mitigate congestion through technology, governance, and investment, underscoring the need for integrated and well-funded urban transport policies in the developing world.

**Rationale of the Study:** While many studies have explored the economic, health, and environmental effects of road traffic, fewer have analysed how cities with varying congestion levels adapt strategically. This study also considers how governance, population density, and national income moderate the impact of congestion, offering insights for urban policy. By comparing responses across developed and developing nations, this study highlights how infrastructure investments in rapid transit and aviation mitigate congestion while shaping urban vitality, living standards, and environmental health.

## DATA AND RESEARCH METHODS

This study employed a multidimensional, cross-sectional quantitative design to analyse how vehicular congestion influences five urban outcomes: economic performance, quality of life, environmental quality, airport-based adaptation, and metro-based transit adaptation.Unlike Fattah et al. (2022), who examined the impact of congestion in Chittagong's port and industrial zones, this study adopts a global perspective grounded in urban economics, transport studies, and environmental governance. It also explores the economic, demographic, and administrative determinants of traffic congestion.

Secondary data were collected and employed for the cross-sectional study. Vehicular congestion, measured as the average seconds required to drive 10 km, was sourced from the TomTom Traffic Index 2024 (TomTom, 2025) for 363 cities worldwide in 2024. Ranked data on economic performance, quality of life, and environmental quality in 2024 were drawn from the World Cities Database (2025) and regrouped into ten analytical categories. Data on airport-based adaptation (ordinal) and metro-based adaptation (dummy) were collected from web sources to assess cities' adoption of faster alternative transport modes under high congestion.

Ordinal and binary logistic regression models (PLUM) were used to examine the effects of congestion on these outcomes. Additionally, three determinants per capita income (World Bank, 2025), population density, and governance quality (World Cities Database, 2025) were analysed using bivariate correlations to identify key influences on congestion intensity.

The final sample comprised 363 cities (out of 500 in the TomTom Index) due to data availability, representing both developed and developing nations, including the U.S. (78 cities) and the U.K.(25), Germany (22), France (21), Spain (17), Italy (13), Canada (10), Japan (10), Poland (10), India (10), Turkey (10), Brazil (9), and Mexico (6) countries. Of the 363 sample cities, 264 are in "developed countries" (GDP per capita e" $30,000 in 2024; World Bank); however, the most congested cities are concentrated in developing nations. Among 99 cities from countries with a GDP per capita of less than $30,000, 75 face severe congestion, averaging over 1,300 seconds to travel 10 km. Notably, 30 developing-country cities fall into the slowest category (> 1,700 s per 10 km) compared to only 21 in developed nations. As travel time decreases, the share of developing country cities steadily declines only 24 appear in the fastest group (< 1,300 seconds), against 188 from developed countries. This pattern underscores a clear divide: cities in developing nations experience far greater congestion, reflecting a strong preliminary link between economic development and the average urban travel speed.

### Objectives

1. To analyse the impact of vehicular congestion in world cities on key urban outcomes, including economic performance, quality of life, and environmental quality.

2. To examine how world cities adapt to vehicular congestion through airport-based and metro-based faster

transport modes.

3. To identify how economic, demographic, and administrative factors are related to vehicular congestion.

## RESULT & DISCUSSION

### Urban Traffic Congestion: The Influence of Income, Population Density, and Governance

Vehicular congestion, measured as the average time to drive 10 km across 363 cities, shows a strong negative correlation with national income levels. Pearson's analysis reveals that congestion declines as per capita income rises ($r = –0.615$; Table 1), confirming that traffic congestion remains primarily an issue in developing countries (Jain et al., 2012). This reflects the greater capacity of high-income economies to manage traffic through the use of efficient infrastructure and alternative transit systems. Exceptions such as London, Kyoto, and Dublin, which are ranked among the world's ten slowest cities (TomTom, 2025), indicate that even advanced economies face congestion challenges (Jain et al., 2012; Fattah et al., 2022).

Population density also correlated positively with congestion ($r = 0.405$; Table 1), highlighting the pressure of dense urban settlements on transport systems. However, anomalies exist: Davao City (Philippines) and Tainan (Indonesia) record severe congestion despite low densities, whereas Middlesbrough (UK) remains one of the fastest cities despite its higher density (TomTom, 2025).

Governance quality shows a modest but significant negative correlation (Spearman's $r = –0.215$; Table 3), suggesting that good governance aids but does not ensure effective congestion management without supporting factors such as controlled density and robust economic development (Gaygisiz, 2010).

**Table 1: Parametric and non-parametric correlation results of the determinants of traffic congestion**

| Variables | Average time to travel 10 km | Sig. (2 tailed) | N | Type of correlation |
|---|---|---|---|---|
| City's density of population | 0.405* | 0.000 | 363 | Pearson correlation |
| Country's per capita income | -0.615* | 0.000 | 363 | Pearson correlation |
| City's governance | -0.215* | 0.000 | 363 | Spearman correlation |

### Vehicular Congestion and Its Multidimensional Impacts: Evidence from Ordinal Regression

The data presented in Table 1 show a significant relationship between traffic congestion and all the selected urban outcomes. As expected, congestion negatively affects economic performance, quality of life, and environmental quality, with all effects statistically significant at the 1% level (Table 2). This indicates that higher congestion levels are associated with economic inefficiency, environmental deterioration, and declining living standards.

However, the explanatory power of these models is modest.The effect on economic performance is weak ($B = –0.001$; Nagelkerke $R^2 = 0.065$), suggesting that congestion alone explains little variation across cities. Similar to Harriet et al. (2013), who found that congestion in Ghana's Kumasi Metropolis reduced mobility and productivity, the results highlight its adverse impact on developing economies. In contrast, Marshall and Dumbaugh (2020) observed a positive association between congestion and GDP in U.S. metropolitan areas, implying that in advanced economies, congestion may accompany, rather than constrain, economic growth. For instance, cities such as London and Dublin among the world's slowest (TomTom, 2025) continue to sustain strong economic activity, partly due to effective measures such as congestion charging (Metz, 2018).

Thus, while congestion often signals inefficiency in developing cities, it may reflect high demand and economic dynamism in mature urban economies. The appropriate policy response lies not in vehicle restrictions but in the expansion of multimodal and affordable transport systems. As Duranton and Turner (2011) note, road expansion attracts more traffic, but limiting access can undermine productivity and accessibility. Therefore, balanced investment in infrastructure and public transportation is crucial for maintaining mobility, safety, and sustainable urban growth.

Its impact on quality of life and environmental quality was relatively weak, with Nagelkerke $R^2$ values of 0.033 and 0.024, respectively (see Tables 2 and 3). These results suggest that factors other than traffic congestion also influence changes in living conditions and environmental quality. The exact nature of these influences remains uncertain, indicating a complex interplay of factors beyond traffic. Simultaneously, Anjum et al. (2019) found that emissions due to slow-moving traffic remain particularly intense during peak hours in urban areas.

Interestingly, the models revealed a positive and statistically significant relationship between vehicular congestion and adaptation through the development of alternative and faster modes of transportation, such as airports and metro transit systems. For airport-based adaptation, the positive coefficient ($B = 0.001$, $p < .01$) corresponded to a Nagelkerke $R^2$ of 0.057. Similarly, in the binary logistic regression model for metro-based transit adaptation, the coefficient is positive ($B = 0.002$, $p < .01$), with a relatively higher Nagelkerke $R^2$ of 0.105 ( Table 4). These findings suggest that higher levels of traffic congestion prompt cities to expand their transportation infrastructure, particularly through metro systems, followed by airports. However, owing to the low explanatory power, it is true that not every city with heavy traffic adopts airports and rapid transit metros. This implies that several of the world's slowest cities have yet to adopt airport and metro systems. Even among the top 10 slowest cities globally, four lack operational rapid-transit metros. Notably, three of these cities Barranquilla (Colombia), Davao City (Philippines), and Trujillo (Peru) are in developing countries. Interestingly, Dublin, the capital of Ireland, does not have an overground or underground metro system. This is despite Ireland now being financially capable, in contrast to the pre-1980s period, when its per-capita income was significantly lower than that of many other developed European nations (Pedro, 2020). The absence of a full metro system in Dublin is primarily attributed to deep-rooted political, institutional, and territorial governance challenges (Moore-Cherry &Tomaney, 2019). Hodson (2025) links delays to a

combination of planning setbacks, political centralisation, cost overruns, and opposition from local stakeholders. The current study finds that traffic congestion prompts cities to adapt faster transport modes, such as transit metro, provided the city's financial viability and cohesive transit planning. The statistical significance and over 10 percent explanatory power of the model indicate a strong likelihood that the world's slow cities will adapt by investing in metro systems. Although the explanatory power is lower (6 per cent), cities experiencing heavy traffic also tend to expand passenger airports within and on the outskirts of the city (see Table 2).

**Table 2: Summary of ordinal regression results across outcomes**

| Outcome Variable | B (Traffic) | Sig. | Direction | Nagelkerke $R^2$ |
|---|---|---|---|---|
| Economy | -0.001* | 0 | Negative | 0.065 |
| Quality of Life | -0.001* | 0.001 | Negative | 0.033 |
| Environment | -0.001* | 0.004 | Negative | 0.024 |
| Airport-based Adaptation | 0.001* | 0 | Positive | 0.057 |
| Metro-based Adaptation (Binary) | 0.002* | 0 | Positive | 0.105 |

*Source: Author's estimation*

*estimates are significant at 1per cent level

All five regression models (four multinomial and one binary logistic) are statistically significant at the 1 per cent level, with the metro-based adaptation model showing the highest explanatory power (Nagelkerke $R^2 = 0.105$), followed by the economy (0.065) and airport adaptation (0.057) models. The quality of life (0.033) and environmental quality (0.024) models, although significant, exhibited weaker predictive strengths, indicating the influence of additional factors. (see Table 3).

**Table 3: Model Fit Statistics for Ordinal and Binary Logistic Regression Models**

| Dependent Variable | −2 Log Likelihood (Final) | $\chi^2$ (Model) | Df | Sig. (p-value) | Nagelkerke $R^2$ |
|---|---|---|---|---|---|
| Economy | 1310.366 | 24.017 | 1 | 0 | 0.065 |
| Quality of Life | 1348.272 | 11.803 | 1 | 0.001 | 0.033 |
| Environmental Quality | 1417.997 | 8.517 | 1 | 0.004 | 0.024 |
| Airport-based Adaptation | 427.06 | 15.18 | 1 | 0 | 0.057 |
| Metro-based Adaptation (Binary) | 470.153 | 29.692 | 1 | 0 | 0.105 |

*Source: Author's estimation*

## CONCLUSION

Traffic congestion in cities worldwide is closely linked to the per capita income of their countries (Fattah et al., 2022; Jain et al., 2012), with developed economies better equipped to manage urban traffic, whereas developing nations bear heavier congestion burdens (Ardila-Gomez & Ortegon-Sanchez, 2015). As expected, cities with higher population densities face more severe congestion, although some exceptions exist. The study finds that urban governance quality has no significant effect on congestion levels, aligning with Gaygýsýz (2010), and suggesting that infrastructural and economic factors are more decisive than administrative performance. Cities with greater congestion are more likely to adopt faster transport modes, such as metro systems and improved airport connectivity (Metz, 2018; Ackaah, 2019); however, only approximately 10 per cent of metro and 6 per cent of airport expansion can be directly attributed to congestion, indicating financial and spatial constraints, particularly in developing countries (Ardila-Gomez & Ortegon-Sanchez, 2015). While congestion significantly reduces productivity and economic performance (Chakraborty al., 2013; Chakraborty, 2010), its effects on environmental quality and quality of life, although weaker, remain negative (Anjum et al., 2019; Han et al., 2022). Overall, traffic congestion exerts a statistically significant influence on all major urban outcomes, underscoring the urgent need for sustained congestion management to safeguard productivity, liveability, and environmental sustainability (Levy et al., 2010; Sweet 2011).

This study contributes to the literature in three ways.First, it integrates economic, environmental, and quality-of-life outcomes into a single analytical framework to examine the multidimensional impacts of traffic congestion in global cities. Second, unlike conventional narrative reviews, this study employs secondary quantitative data from international databases and applies statistical techniques, including correlation and logistic regression, to identify the determinants and responses to congestion. Third, this study provides comparative insights relevant to developing countries, including India, by highlighting how income levels, population density, and infrastructure influence congestion outcomes.

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