Original Article

ISSN: 2788-8517 (online)
2788-9963 (Print)

Journal of Urban Development Studies
Vol. 3, Issue 1 (2023)

Challenging the Supply Side Approach: The Example of Road Traffic Congestion in Addis Ababa: the case of *Torhayloch – Mexico* Street Corridor

Matewos Guta Alebe[1] Dr. Berhanu Woldetensae Hussen (Dipl -Ing)[2] Dr. Abenezer Wakuma Kitila[3*]

1 Lecturer, Department of Urban Planning and Design, Ambo University Hachalu Hundessa Campus, Institute of Technology, Ambo, Ethiopia. ORCID: 0000-0001-6751-440X
2 Associate Professor, Chair holder of Urban and Regional Planning, Addis Ababa University – EiABC, Ethiopia. ORCID: 0000-0003-4569-5144
3 Associate Professor of Urban and Regional Development Planning, School of Geography and Environmental Studies, Haramaya University, Ethiopia. ORCID: 0000-0001-8553-1625
**Corresponding author: arsemawitgod@yahoo.com*

Received: 19 April 2023, revised:16 May 2023, accepted: 25 May 2023

Abstract
Addressing road traffic congestion in developing countries continues to be a pressing challenge for urban planners and policymakers. Effectively managing traffic congestion is essential for enhancing travel efficiency and reducing delays in public transportation systems. Implementing strategies such as improved traffic flow management, infrastructure development, and promoting the use of public transport are crucial steps in mitigating the adverse impacts of traffic jams. This study aims at investigating whether the recurrent congestion in Addis Ababa along the *Torhayloch – Mexico Street* corridor is caused by traffic volume exceeding road capacity. The study questions the belief that traffic congestion could be reduced by merely increasing road capacity by relating the nature of congestion along the corridor and challenges the policy direction of the Addis Ababa City Administration. To this end, the study employed a descriptive research design with a quantitative research approach. Both primary and secondary data sources were used to solicit the required data. Primary data were collected in the form of annual average daily traffic. With many parameters available to measure road traffic congestion, volume to capacity ratio was used since it can dictate transportation demand and supply relationship. Findings revealed that the volume-to-capacity ratio of the *Torhayloch – Mexico Street* corridor was between $0.5 \leq v/c \leq 0.8$, which indicates that the street corridor is serving below capacity despite being congested for the most part daily. This is suggestive of the other causes of congestion along the *Torhayloch – Mexico Street* corridor and corresponding measures of intervention to reduce congestion other than building more roads.

Keywords – Congestion, Design Capacity, Daily Traffic Volume, Corridor, Supply – Side

1. Introduction

The interdependence between shipping activity and the level of economic development has long been dominant. Obviously, early civilizations that could take advantage of nature, such as waterways in Egypt, China, Greece, and the Roman Empire, developed economically (Nistor & Popa, 2014). Transportation and mobility are recognized as the centers of sustainable development for promoting economic growth, improving accessibility, and achieving better economic integration while considering the environment (Rathour et al., 2018). Mobility is very important to the functioning of a city because it affects the socio-economic activity of the city (Olagunju, 2015).

The demand for transport, especially in the cities of developing countries, has been on the increase following rapid socioeconomic growth and urbanization. In contrast, the management of traffic is very ineffective in several third-world countries, regardless of the progress in transportation demand and supply. To that end, in the case of many global south countries, road traffic congestion is at a much lower per-capita ownership of cars (Gwilliam, 2003). As a result, cities in Africa such as Lagos, Dar es Salaam, Kampala, Gaborone, Lusaka, Khartoum, Nairobi, Johannesburg, Cairo, Egypt, Addis Ababa, Kinshasa, and Luanda have high congestion costs (Olagunju, 2015).

With respect to road coverage, he insisted that the 10–12% of land space devoted to all forms of road rights of way in the major cities in Asia falls far short of the 20–30% common in US cities. However, it is not, in fact, possible to escape congestion through the construction of new streets. Thus, it is not simply the dedicated space amount to roads but the more complex considerations of the overall structure of the system in urban transport that matter (Gwilliam, 2003).

Traffic congestion has become a serious mobility problem for Addis Ababa residents; it is frequent and everywhere across the city along major roads. It poses the challenges of longer trip times and the loss of working hours and is detrimental to Addis Ababa's economic development. In Ethiopia, Gorham (2014) argued that the Addis Ababa City Administration was making a demanding effort for the improvement of urban transportation, fundamentally via huge investments in different infrastructure: adding roads, constructing a brand-new light rail transit system (LRT), and developing strategies for launching a bus rapid transit (BRT) system. Also, from the City Administration side, there was an effort to increase the road coverage of the built area from 11.3% in 2014 to 20% by the year 2020" (Transport Policy of Addis Ababa, 2011). On the other hand, Gordon (2014) claimed that investments made in the road network seem to be providing less economic and mobility value for residents than intenders. Olagunju (2015) insisted that it is evident that the supply-side approach (the introduction of bus rapid transit) did not solve the congestion problem in Lagos, Nigeria, and that there was a transition to the management aspect of transportation.

Traffic congestion is common in Addis Ababa City Administration. However, it is not recognized as problematic enough. The policy document of Addis Ababa stated that, so as to speed up the development of the city, providing safe, efficient, and equitable transport service for the city is very important. Accordingly, eleven key policy issues and implementation strategies were outlined (transport policy of Addis Ababa, 2011, p. 17). It is good, except for the fact that solving the congestion problem is not one of them. In this regard, a few studies have been conducted so far, for instance, Wondwossen (2011) and Yared (2010). Even these two researchers did not look at the big picture and anomaly of the congestion, which is to say that according to Gorham (2014), there is a low motorization index but severe congestion in the city administration. Although it is acknowledged that there are different views and recommended solutions to solve the problem of traffic congestion, the researcher especially doubts the efficiency of solving traffic congestion by only increasing road coverage. So, the purpose of this study was to verify otherwise that traffic congestion is not due to supply-side constraints only as perceived by the City Administration's transport policy by investigating the nature of traffic congestion and seeing how the existing road infrastructure is serving in terms of capacity before adding more roads. The study was based on the supposition that the frequent and ubiquitous road traffic congestion along the Torhayloch-Mexico Street corridor is not due to capacity constraints.

2. Literature review

Traffic congestion is a complex concept, and it is unlikely to find a universally accepted definition for it (Downs, 2004; OECD/ECMT, 2007). However, broadly, congestion is categorized as recurrent congestion and non-recurrent congestion (OECD/ECMT, 2007; Toan, 2019).

2.1. Measuring Traffic Congestion

Measuring traffic congestion is necessary to understand the nature, severity, and control of congestion growth. Such measures provide the basis for identifying problems and deciding the effectiveness of mitigation strategies for transport engineers and policymakers. In addition, a consistent and uniform measure will allow comparison of traffic conditions at distinct locations and for longer periods at one locality so as to develop a priority for enhancements. This in turn helps the general public's understanding of the traffic situation empirically (Hamad & Kikuchi, 2002). Traffic congestion measures can be categorized into four broad groups: (i) basic measures; (ii) ratio measures; (ii) level of service; and (iv) indices (Aftabuzzaman, 2007). However, unlike the abovementioned measures, the volume/capacity ratio is the most appropriate measure to achieve the objective of this research, which was to figure out how the selected corridor was performing in terms of capacity.

The volume-to-capacity (v/c) ratio is the ratio of the current flow rate to capacity and an indicator of the quality of traffic operations on a road section. It also indicates how close a roadway is to its capacity. The roadway volume-to-capacity ratio can measure traffic congestion. A volume capacity ratio value, in general, can be categorized into three categories: (1) $0 \ v/c \leq 0.5$, (2) $0.5 \leq v/c \leq 0.8$, and (3) $0.8 \leq v/c \leq 1$. A volume capacity ratio less than 0.85 shows below capacity; 0.85–0.95 can be taken as close capacity; 0.95–1.0 is at capacity; and greater than 1.0 shows overcapacity (Federal Highway Administration, 2018). Congestion is an erratic function; when the road is close to full capacity, minor fluctuations in traffic flow can cause proportionally higher fluctuations in congestion delays (Victoria Transport Policy Institute, 2013). Knowing the four components of congestion, such as duration, extent, intensity, and reliability, is important in measuring congestion (Jenks et al., 2008).

Other parameters of road traffic congestion may include average travel speed, road saturation degree, travel efficiency, and low-speed proportion, whereas volume-to-capacity ratio (road saturation degree) was used intentionally as it can dictate transportation demand and transportation supply relationships (Wan et al. 2018), which fits the objective of this study.

2.2. Congestion alleviating strategies

There is no absolute solution to fully eradicate traffic congestion (OECD/ECMT, 2007), and congestion has become a serious problem and a challenge that is not easy to manage (Koźlak & Wach, 2018). Singapore, despite having fast economic growth, a large population number, and a high mobility rate, successfully managed a sophisticated and complex traffic system and, by doing so, reduced the impacts of traffic congestion (Toan, 2019).

In the following, the approaches to dealing with road traffic congestion are broadly classified as supply-side and demand-side approaches. The supply-side strategies consist of the construction of additional highways or streets or else expanding already prevailing streets so as to increase the carrying capacity of the system, refining the effectiveness of mass transport and non-motorized transportation systems, and using innovative traffic management and control of the traffic itself (OECD/ECMT, 2007; Talukdar, 2013; Toan, 2019).

The demand-side schemes basically regulate travel demand using procedures, for example, instruments of planning, monetary actions, and regulation. Examples of economic means comprise high oil tax imposition, increasing automobile or car registration charges, or congestion pricing (OECD/ECMT, 2007; Talukdar, 2013; Toan, 2019). Particularly, Talukdar (2013) has diagrammatically represented the supply-side and demand-side strategies of congestion mitigation as shown in Figs. 1 and 2, respectively.

In other terms, the transportation supply and demand models can be described as below by Derek Turner Consulting cited in (Broaddus et.al, 2009).

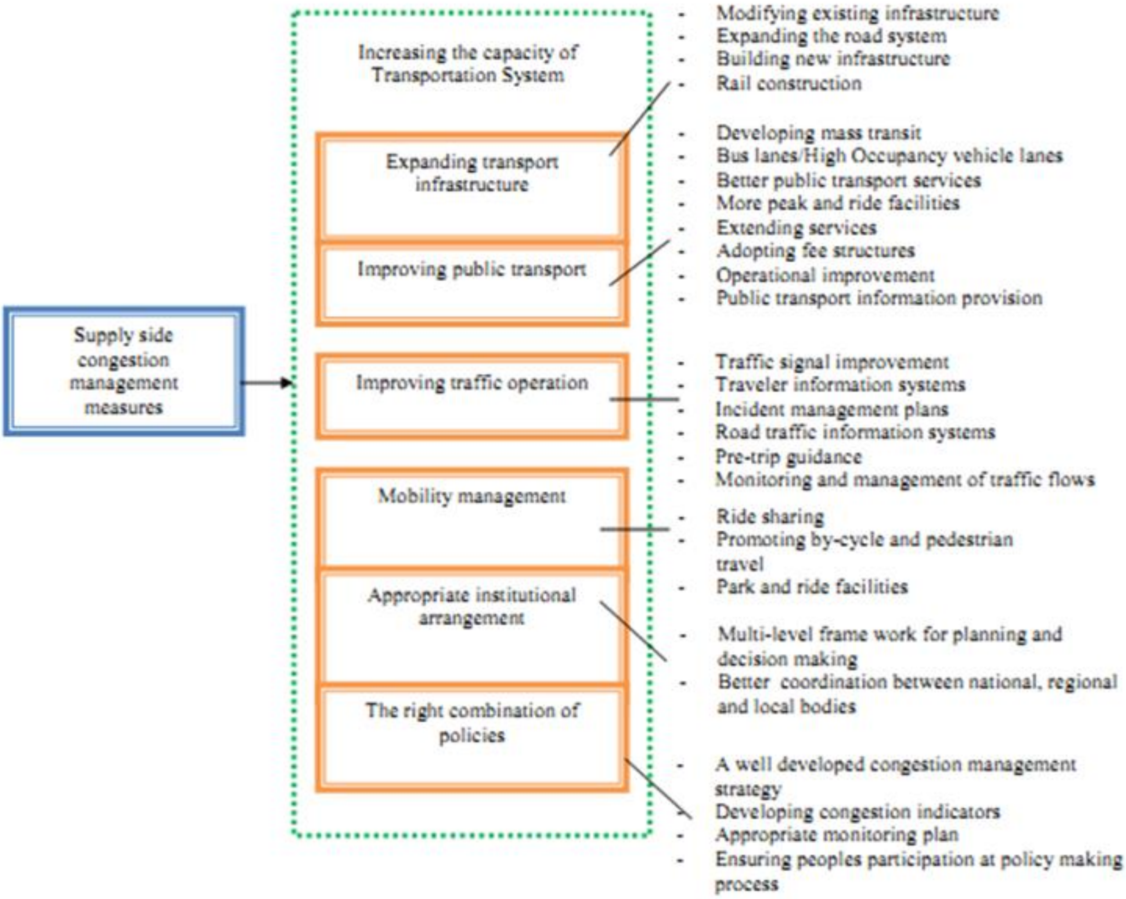

Figure 1. Supply-Side Congestion management measure framework (Source: Talukdar, 2013)

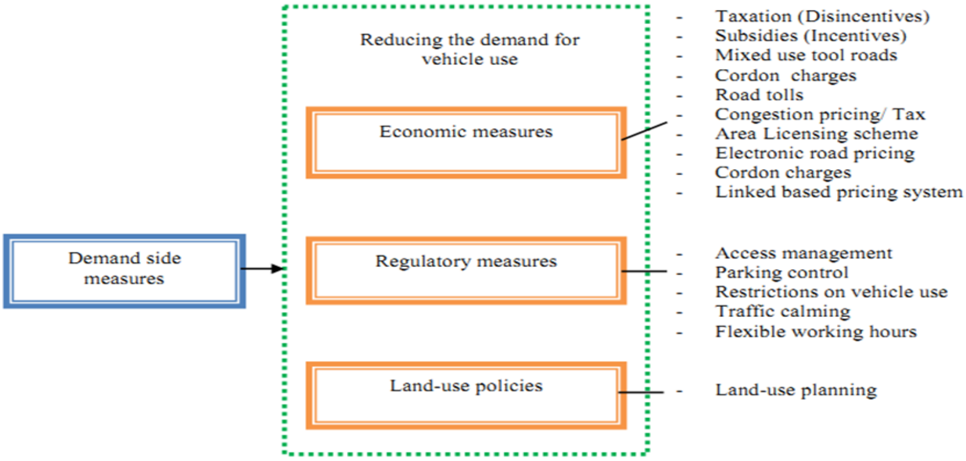

Figure 2. Demand side congestion management measure framework (Source: Talukdar, 2013)

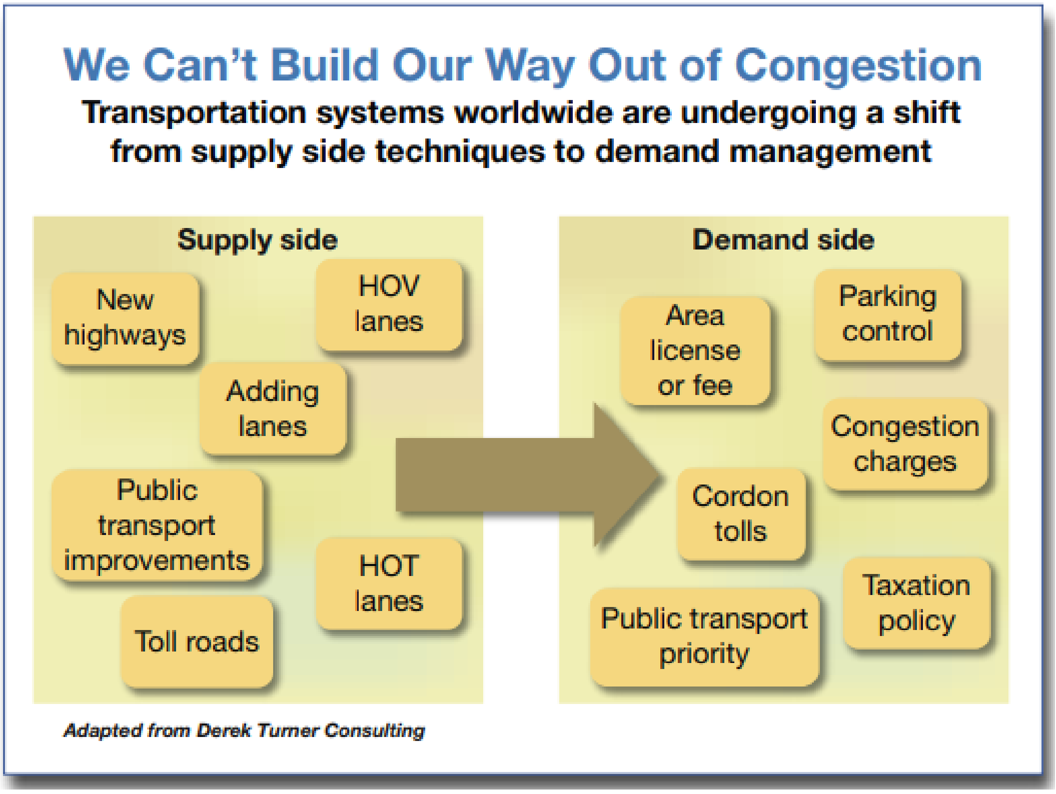

Figure 3. Paradigm shift from supply side measures to Demand Management (Source: Derek Turner Consulting, cited in Broaddus et.al, 2009).

3. Research Methodology

3.1.Description of the Study Area

In its earliest phase of origin and development, Addis Ababa developed spontaneously from its original nucleus around the Finfinnee hot springs. Addis Ababa, a chartered city with special status in the ethnically structured federal system of Ethiopia, is the overlapping capital city of the country and the Oromia Regional Government, the seat of the United Nations Economic Commission for Africa, the capital city of the African Union, and home to many international organizations. Addis Ababa city is the hub of the road networks in the country and has five main gates. Currently, the city also has three tiers of government. These are the city, Sub City at the intermediate level, and Wreda at the lowest level. There are 10 sub cities, and they are further subdivided into Addis Ababa accounts for about 80% of the vehicles in the country, according to Samson et al. (2006), with a yearly growth rate of 5%. As a result, there is frequent congestion of traffic observed at different locations throughout the day in Addis Abba, and the intensity of the average traffic congestion in the city expressed in vehicle minutes or person minutes is reported to be very high (Wondwossen, 2011).

Torhayloch-Mexico Street Corridor, which connects three sub-cities (Kolfe Kelaniya, Lideta, and Kirkos), is 2.5 km in length and one of the most highly congested streets in the city. Conversely, this corridor has improved capacity and been upgraded to multilane, six-lane, since the introduction of LRT in Addis Ababa. It is a type of street corridor found in Addis Ababa (see Fig. 3). The researcher chose the corridor after making regular observations, and it was always an area of high traffic congestion. The availability of the required secondary data to conduct the study was also one main factor in choosing Torhayloch-Mexico Street Corridor over the other streets in the city. Importantly, Torhayloch-Mexico Street Corridor was selected since the traffic volume count starts as early as 6:00 a.m. and continues until 6:00 p.m., and it was necessary to select the nearest site in order to avoid congestion delays.

3.2. Research Design, Data Collection, and Analysis Methods

The research method selected for this study was the quantitative research method. It involves quantitative data collection, a case study in strategy, and employs both statistical and text analysis. The methodology in this study included manual traffic counting and analysis of secondary data, as well as different methods and techniques that can be applied for data collection.

As to primary data, a manual traffic volume count was conducted for 12 solid hours starting from 6:00 a.m. to 6:00 p.m. at 5-minute intervals for two weeks. The Torhayloch-Mexico street corridor has two directional movements (Torhayloch-Mexico and Mexico-Torhayloch directions). These two directional movements were further broken into three mid-blocks each, as follows, for the purpose of determining important traffic count locations. Accordingly, the Torhayloch-Mexico direction was divided as Torhayloch-Coca midblock, Coca-Lideta midblock, and Lideta-Mexico. Similarly, the Mexico-Torhayloch direction was categorized as Mexico-Lideta, Lideta-Coca, and Coca-Torhayloch midblock. Accordingly, there are six counting locations along the two directional movements of the street corridor at which the traffic count was made.

The secondary data, the design capacity of the Torhayloch-Mexico Street corridor, was obtained in two forms. For passenger vehicles (small buses, medium buses, and large buses) as well as freight vehicles (medium trucks, heavy trucks, and trucks and trailers), the 2012 average annual daily traffic (AADT) was calculated between the three mid-blocks. The data was obtained from the Addis Ababa City Roads Authority's (AACRA) office in hard copy form. But for smaller vehicles (cars, two-wheelers, Land Rovers, and small trucks), the 2012 AADT was calculated from traffic count raw data between midblock, where the data was obtained from Core Consulting Engineers (CCEs) in soft copy form. This is because the surveyed traffic volume was not for the purpose of traffic management or study. It was done to compute the equivalent axle load for the pavement design of the Torhayloch-Megenagna corridor during the construction of Light Rail Transit (LRT) back in 2012. To get the design capacity of the Corridor, the 2012 AADT was taken as a base year and projected according to each vehicle growth rate. The vehicle’s growth rate was classified into two, i.e., 2011–2015 and 2016–2020. So, the projections were made for 2016 first, and then from the projected 2016 AADT, the 2020 AADT was projected.

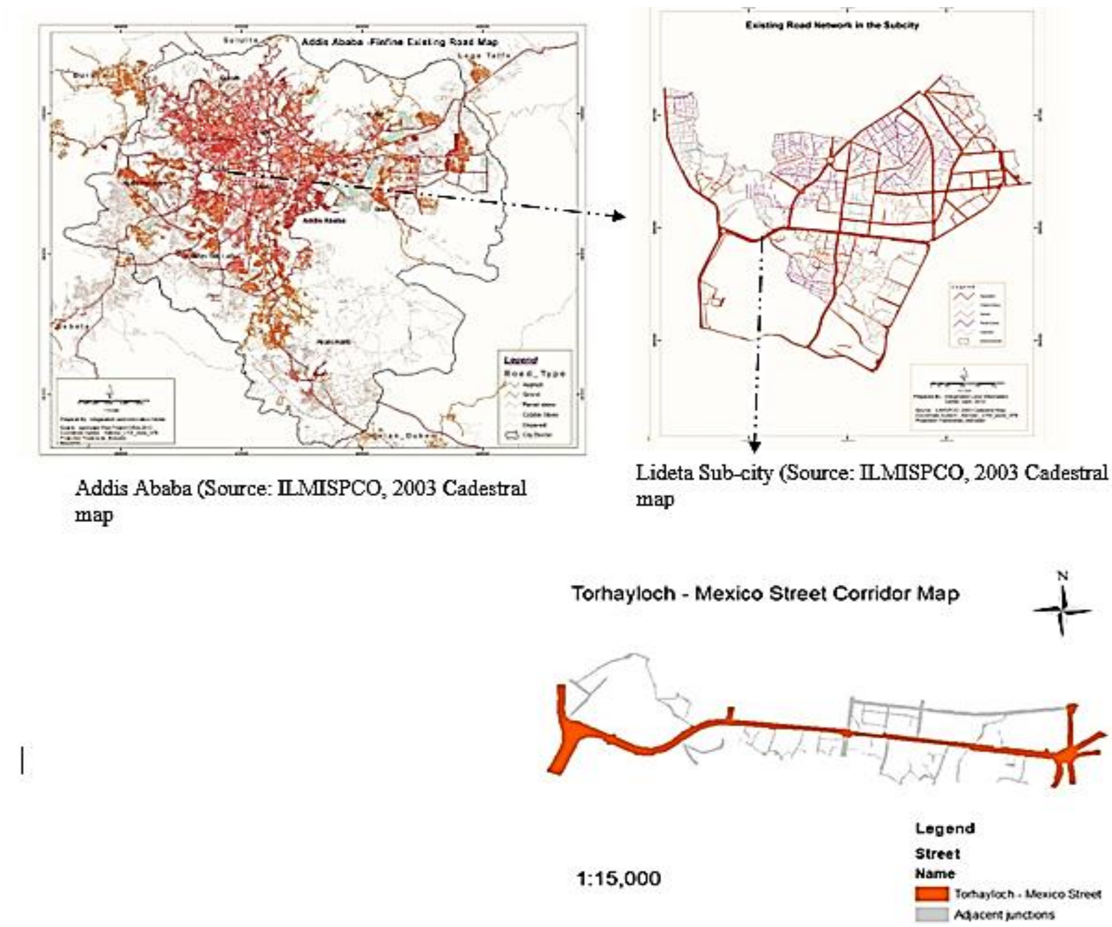

Figure 3. Location map of Torhayloch – Mexico Street Corridor
Source: Survey, 2019

4. Results

The average daily traffic volumes of the two directional movements and the design capacities of the respective midblock are presented below in a table to compute v/c ratios.

Table 1. Computed Volume Capacity Ratios along Torhayloch – Mexico Street Corridor

Directional Movements	Midblock	Daily Traffic Volume	Design Capacity	V/C Ratio Values
Torhayloch - Mexico	Torhayloch - Coca	23,948	33,230	0.72
	Coca- Lideta	11371	22305	0.50
	Lideta - Mexico	13377	26810	0.49
Mexico - Torhayloch	Mexico - Lideta	13275	26470	0.50
	Lideta - Coca	10329	20201	0.51
	Coca - Torhayloch	23015	31390	0.73

Source: Survey, 2020

Clearly, the computed values of volume to capacity ratio along the two directional movements within each midblock fall within the category of 0.5 v/c 0.8 as indicated in Table 1. These values are supposed to represent uncongested traffic flows along transport facilities. But this is not the case for the Torhayloch–Mexico Street corridor, as it is extremely congested. The volume-to capacity ratio must be greater than 1.0 to indicate an excess of demand over capacity (H. C., 2000). However, according to Wan et al. (2018) the traffic congestion index by saturation has a big deviation to reflect the field traffic status and is prone to errors of judgment because two different traffic statuses probably have the same saturation degree. On the other hand, the road saturation degree, which is the ratio of the survey traffic volume to road capacity, reflects the relationship between transportation demand and transportation supply.

5. Discussion

Based on the computed v/c ratio values, which are found to be within a range of $0.5 \leq v/c \leq 0.8$, it can be inferred that the traffic congestion along the Torhayloch-Mexico Street corridor is best defined as congestion without reaching capacity. However, it should be noted that the corridor was extremely congested in both directional movements. Specifically, from 9:00 a.m. to 12:00 p.m. along the Torhayloch-Mexico direction and from 3:00 p.m. to 6:00 p.m. along the reverse direction, the congestion was at its peak. It is imperative to address the congestion issue along this corridor to ensure smooth traffic flow and reduce travel time for commuters. This pattern of congestion was observed for the two weeks of manual traffic counting. However, these computed v/c ratios do not show the effect of recurrent congestion during peak hours. As a result, it was necessary to analyze traffic volume and design capacity on an hourly basis. To do that, the daily traffic volume and design capacity were converted to an hourly basis and displayed graphically. The average values of both daily traffic volume and the design capacity of all midblock along the direction are used along the two directional movements. In this case, the design capacity is the constant horizontal line where the collected hourly traffic volume changes over time.

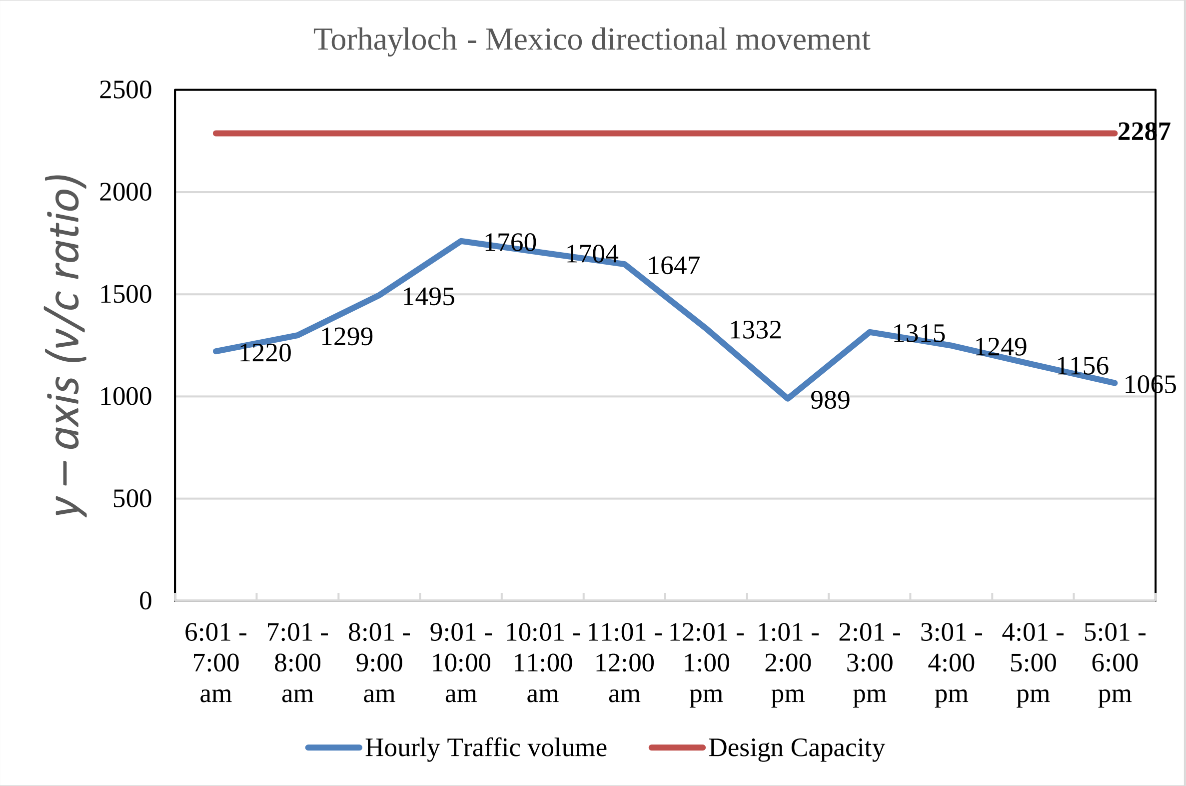

Figure 4. Design capacity vs. hourly traffic volume along Torhayloch – Mexico directional movement, Source: Survey, 2020

For the reverse directional movement, the same procedure is applied (see fig. 6) on the next page.

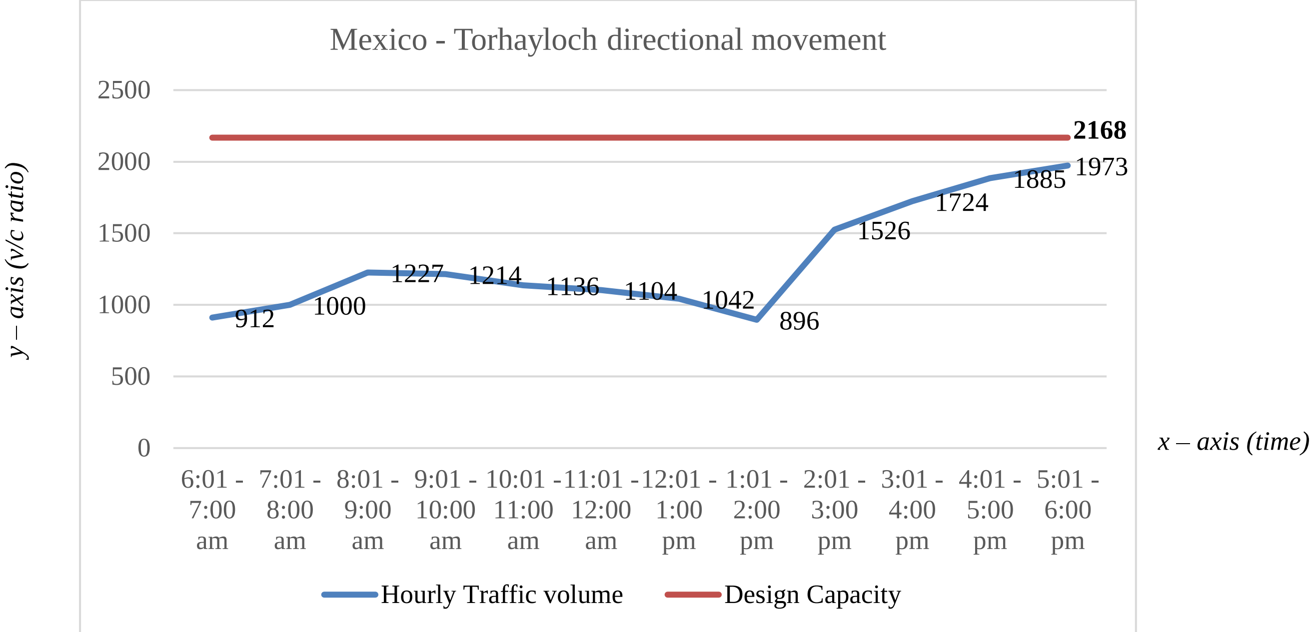

Figure 5. Design capacity vs. hourly Traffic volume along Mexico – Torhayloch directional movement
Source: Survey, 2020

It was understood that, from the collected traffic volume data, congestion occurs at various times of the day along the street corridor. In the direction of Torhayloch-Mexico, peak hours happen in the morning as traffic volumes were observed to be high. On the other hand, in the reverse direction, traffic congestion occurs in the afternoon, again attributed to traffic volumes during these hours. This is related to the unbalanced distribution of working places (employment zones) and living places in Addis Ababa. Commuters move to the city center during the morning hours, even though there are longer trips and a loss of working hours and delays, and return home to the periphery in the afternoon. This is a challenge that the monocentricity of Addis Ababa City has brought to the transportation system of the city administration. This kind of finding further challenges the solution that is being adopted currently: building more roads, which would solve congestion and improve the transport system of the city administration.

Generally, the congestion along the street corridor was commonly recurrent, as photos taken at the exact same location (see Fig. 7) indicate (right, morning peak hour, and left, afternoon non-peak hour).

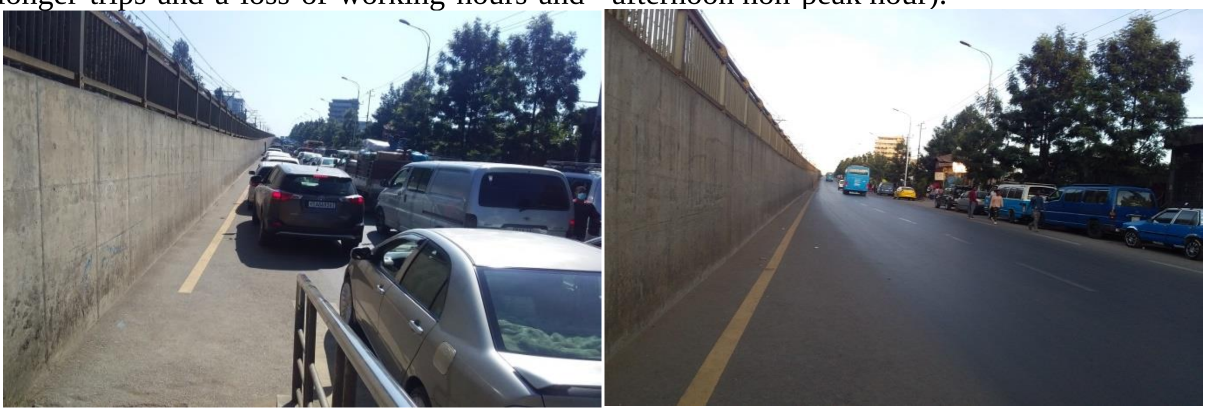

Fig. 6. Recurrent Congestion: peak hour (left) vs. non-peak hour (right) at Coca LRT station
Source: Survey, 2020.

Therefore, further analysis of vehicular composition and percentage revealed very important points about traffic congestion along the corridor during peak hours and can offer the best mitigation measures (see Tables 2 and 3) other than the supply-side approach strategy that the city administration assumed was the ultimate solution (Broaddus et al., 2009).

Table 2. Vehicular Percentage Composition during Peak Hours along Torhayloch – Mexico Directional Movement

Average Vehicles Percentage During Peak Hours				
Time		9:00 – 10:00 am	10:01 – 11:00 am	11:01 – 12:00 am
Vehicle Type	Motorcycle	5.18 %	5.3 %	4.5 %
	Car	15.3 %	15.6 %	16.7 %
	Van / Pickup	21.5 %	21.5 %	23.9 %
	Bus	4.7 %	4.45 %	3.46 %
	Minibus	5.28 %	4.41 %	3.52 %
	Higer Bus	0.69 %	0.78 %	0.57 %
	Taxi	24.05 %	24.3 %	22.5 %
	4WD	17.9 %	18.6 %	19.5 %
	Trucks	5.4 %	5.06 %	5.35 %
Total		100 %	100 %	100 %

Source: Survey, 2020

It is clear to understand that low-occupancy vehicles, such as motorcycles, cars, vans, pickups, and 4WD, have the highest proportion and averagely account for 61.8%; trucks account for 5.27%; and high-occupancy vehicles (Bus, Minibus, Higer Bus, and Taxi) only account for 32.9% on average along Torhayloch-Mexico Directional Movement. Hence, the most important argument in relation to these findings is that the demand-side strategy is a more favorable solution than the supply-side approach adopted by Addis Ababa's City Administration. The same analysis is done for the reverse directional movement (Mexico-Torhayloch directional movement), and the findings are almost similar (table 3 on the next page).

Table 3. Vehicular Percentage Composition during Peak Hours along Mexico –Torhayloch directional Movement

Average Vehicles Percentage During Peak Hours				
Time		3:00 – 4:00 pm	4:01 – 5:00 pm	5:01 – 6:00 pm
Vehicle Type	Motorcycle	4 %	5 %	10 %
	Car	16 %	18.5 %	15.3 %
	Van / Pickup	23.5%	22.3 %	22 %
	Bus	4 %	4 %	4.3 %
	Minibus	6 %	7 %	6.15 %
	Higer Bus	1.5 %	1 %	0.79 %
	Taxi	22.2 %	21 %	20 %
	4WD	17%	16 %	16.7 %
	Trucks	6 %	5.2 %	4.76 %
Total		100 %	100 %	100 %

Source: Survey, 2020

Similarly, along Mexico-Torhayloch directional movement, it is 62.1% for low-occupancy vehicles (motorcycles, cars, vans, pickups, and 4WD), 32.64% for high-occupancy vehicles (buses, minibuses, *higer* buses, and taxis), and 5.32% for trucks.

6. Conclusions

The study presents a compelling argument for a mismatch between the observed congestion patterns along the Torhayloch-Mexico street corridor and the strategies implemented by the Addis Ababa City Administration to alleviate traffic congestion. The discrepancy between the computed volume-to-capacity ratio values and the actual congestion levels along the corridor is evident, with lower volume-to-capacity ratio values coexisting with highly congested traffic flow. This incongruity suggests that the current approach to addressing traffic congestion may not be effectively targeting the underlying issues. As such, further investigation and potential adjustments to the existing traffic management strategies may be necessary to better align with the observed congestion characteristics. Besides, there is extended congestion hour, which occurs at different hours of the day along the two-directional movements of the street corridor, and it is a recurrent congestion type. The low occupancy vehicle proportion during peak hours is almost double the percentage of high occupancy vehicles along the Torhayloch-Mexico Street Corridor in both directional movements. The truck is also high enough to affect the traffic flow stream along the corridor during peak hours. Evidently, these above-mentioned facts are further evidence that the attempt made by the Addis Ababa city administration, which was to increase road network and coverage, could not solve traffic congestion effectively. As we look to address traffic congestion in Addis Ababa, it is crucial to consider a comprehensive approach that goes beyond simply building more roads. While increasing road capacity may provide temporary relief, it is important to investigate other contributing factors that lead to underutilization of existing street capacity. By understanding and addressing these underlying issues, we can develop more sustainable and effective solutions for managing traffic congestion. This may include exploring alternative transportation options, improving public transit infrastructure, implementing traffic management strategies, and promoting urban planning that prioritizes pedestrian and cyclist safety. By taking a holistic approach to addressing traffic congestion, we can create a more efficient and livable city for all residents.

Availability of Data and Materials

The data sets used and analyzed during the study are available from the corresponding author upon a reasonable request to reviewers.

Competing Interests:

The authors hereby declare that they have no competing interests. We also would like to ensure that the manuscript has not been published anywhere previously.

Authors' Contribution:

The authors hereby declare that the individual contributions were equally divided among the authors. All authors read and approved the final manuscript for submission.

References

Aftabuzzaman, Md. (2007). Measuring traffic congestion-a critical review. In *30th Australasian Transport Research Forum* (pp.1-16).

Broaddus, A., Litman, T., & Menon, G. (2009). Transportation demand management: Training

document. *Bonn, Germany: Federal Ministry for Economic Cooperation and Development*.

Downs, A. (2005). *Still stuck in traffic: coping with peak-hour traffic congestion.* Brookings Institution Press.

Federal Highway Administration (2018). U.S. Department of Transportation. Office of Highway Policy Information 1200 New Jersey Ave., SE, Washington, D.C. 20590. at https://www.fhwa.dot.gov/policyinformation

Gorham, R. (2014). Ethiopia - Addis Ababa Urban and Metropolitan Transport and Land Use

Linkages Strategy Review: *note on urban and metropolitan transport and land-use for*

inclusive green growth in Addis Ababa (English).
Gwilliam, K. (2003). Urban transport in developing countries. *Transport Reviews*, *23*(2), 197-216.
Hamad, K., & Kikuchi, S. (2002). Developing a measure of traffic congestion: Fuzzy inference
approach. *Transportation research record*, *1802*(1), 77-85.
Hussen, B.W. (2016). Sustaining Sustainable Mobility: The Integration of Multimodal Public Transportation in Addis Ababa.
Koźlak, A., & Wach, D. (2018). Causes of traffic congestion in urban areas. Case of Poland.
In SHS Web of Conferences (Vol. 57, p. 01019). EDP Sciences.
Jenks, W., Jenks, F., Sundstorm, L., Delanely, P., & B. Hagood (2008). NCHRP Report 618:
Cost Effective Performance Measures for Travel Time Delay, Variation and Reliability. *Transportation Research Board. Washington DC: National Academy.* Manual, Highway capacity manual. *Washington, DC*, *2*, 1.
OECD/ECMT (2007), Managing Urban Traffic Congestion, Economic Co-operation and Development (OECD) and European Conference of Transport Ministers (ECMT); at
www.internationaltransportforum.org/Pub/pdf/07Congestion.pdf

Olagunju, K. (2015). Evaluating traffic congestion in developing countries–a case study of Nigeria.
Nistor, F., & Popa, C. C. (2014). The role of transport in economic development.
Rathour, Y. S., Gupte, S., & Juremalani, J. (2018). Literature Review on Public Transport System and Its Impact on Mobility. Transportation, 5(02).
Samson, F. (2006). Analysis of Traffic Accident in Addis Ababa: Traffic Simulation. Addis Ababa University, Ethiopia.
Talukdar, M. H. (2013). Framework for Traffic Congestion Management. *Economia. Seria Management*, *16*(1), 54-64.
Toan Trinh Dinh (2019). Managing traffic congestion in a city: A study of Singapore's experiences. *ThuyLoi University, 175 TaySon, DongDa, Hanoi*; Summary at https://www.researchgate.net/publication/330776732.
Transport Policy of Addis Ababa, (2011).
Victoria Transport Policy Institute (2013). Transportation Cost and Benefit Analysis II – Congestion Costs. [On line] available http://www.vtpi.org.
Wang, W. X., Guo, R. J., & Yu, J. (2018). Research on road traffic congestion index based on
comprehensive parameters: Taking Dalian city as an example. *Advances in Mechanical Engineering*, *10*(6), 1687814018781482.
Wondwossen Taddesse (2011). Assessing & Quantifying the Level of Traffic at Major Intersection in Addis Ababa, a Case for East-West Corridor. Addis Ababa Institute of Technology, Addis Ababa.
Yared Haregewoin (2010). Impact of Vehicle Traffic Congestion in Addis Ababa. The case of Kolfe Sub-City: Total – Ayer Tena Road. Ethiopian Civil Service College, Addis Ababa.