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Case Study Paper

Impacts of freight logistic hub in a densely populated city: A study on Tejgaon Truck Stand of Dhaka

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Abstract

Tejgaon truck stand was an important logistic hub for Dhaka city for about a century. Initially it was on the outskirt of the city, as the city was much smaller spreading up to Tejgaon area on the northern periphery. However, with the growth of Dhaka city, it became surrounded by commercial and mixed land uses, and Tejgaon area became one of the central places of the city. Though the government started to control truck movement in the city during the daytime, the location of such a logistic hub in a central city area created several problems. This study looked into the environmental and traffic impacts of the logistic hub using primary data and secondary sources. The study identified noise pollution, traffic congestion, traffic speed, variability in traffic flow and road space scenarios with and without trucks. Existing policies and stakeholders' views were also analysed through thematic analysis. The results unveiled the negative impacts of the logistic hub through noise pollution at night time and increased congestion on the access road and arterial road till midnight. Traffic speed and flow were highly affected due to illegally parked trucks on the adjacent roads caused by shortage of space within the truck stand. The analysis and discussion showed that relocation of this logistic hub could improve the traffic flow and reliability of the road traffic in the area. However, the stakeholder groups had conflicting opinions on relocation and in-situ improvements for this hub, which requires further investigation for a fruitful solution.

Keywords Tejgaon truck stand, traffic impact, stakeholder, freight logistics

1. Introduction

Dhaka's Tejgaon Industrial Area (TIA) has undergone rapid transformation, evolving from an industrial zone to a mixed-use development area. The Tejgaon truck terminal was established during the Second World War (Ullah, 2001). At that time, heavy weapons for the war were carried by railway. Food items for the army were also used to be carried by rail. Later, all types of goods began to be dispatched by trucks (Ullah, 2001). Since the last decade, this terminal started to become overwhelmed with hundreds of trucks every day (Thoiba, 2016). It stood on the land of Bangladesh Railway. Due to the incapability to meet soaring demand of parking, many trucks were seen being parked illegally on the side of the roads.

Tejgaon truck stand is now situated in the center of Dhaka (Figure 1). It covers about 27.89 acres of land area of Tejgaon. This truck stand was initially built outside the main Dhaka city. However, with the expansion of Dhaka city, the existing location has turned into a more commercialized zone. The adjacent roads were used by all types of transportation modes for through traffic.

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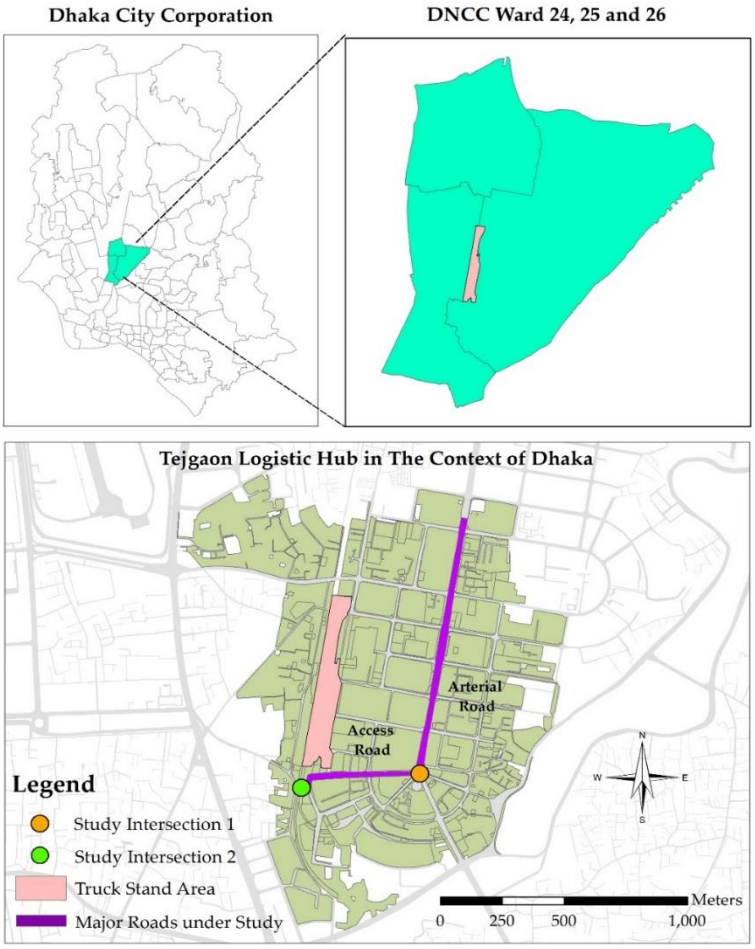


Figure 1. Two adjacent roads of the truck stand under the study and surveyed intersections (Source: Field survey, 2023)

Dhaka North City Corporation was considering to build a multi-storied parking complex through acquiring land from Bangladesh Railway (Abdullah, 2023). Two thousand trucks might be able to park in this logistic hub, while regular use would reach up to five thousand after the proposed development. The late mayor of the city, Anisul Huq transformed the congested and nearly impassable *Sat-rasta* route adjacent to this logistic hub of Tejgaon into a functioning hub by eliminating unlawful truck parking, installing broad pavements and thorough design improvements (Alam, 2020). However, after his death in 2017, the road started to get congested again as the trucks started parking on the roads again (Abdullah, 2023). Local stakeholders related to this hub were badly in need of either increase in the capacity or provision of a suitable alternative. The place was surrounded by administrative, commercial, educational and industrial land uses being at the center of Dhaka city. Apart from congestion, the safety concern was also highlighted after an incident involving a pedestrian who was killed after being hit by a mini truck near this logistic hub.

This study stemmed from the urgent need to address the challenges posed by urban freight transport in Dhaka. Rapid urbanization and population growth led to increased traffic congestion, environmental degradation, and safety concerns (Fattah et al., 2022; Rahaman et al., 2023). The freight logistic management system, banning of trucks, and illegal parking of trucks throughout Dhaka city necessitated a comprehensive analysis of the current logistics framework, including the optimal and existing location of the freight logistic hub (Rahman et al., 2021). In Tejgaon truck stand, truck traffic and illegal parking became a common practice, disrupting the regular activities of the surrounding users. It arises a

question on the need for such a logistic centre within a commercial mixed-use area like Tejgaon. Therefore, it was required to explore viable solutions for relocating or managing the logistics operations in this hub to enhance the efficiency of the freight management and safety of dwellers.

Furthermore, the existing policies and plans did not adequately address the integration of freight transport within the urban fabric of Dhaka (Saha et al., 2024). Despite recognizing the need for better logistics management, there was a significant gap in actionable strategies that align with sustainable urban development goals (ESCAP, 2022; Saha et al., 2023). This study aimed to understand the impacts of such mismanagement regarding the logistic hub at Tejgaon. In addition, the perspectives of regulatory bodies and local stakeholders were incorporated to get an overview of the challenges for overcoming the identified impacts.

2. Literature Review

There are numerous issues relevant to freight transportation in metropolitan areas, like traffic congestion, harmful environmental effects, and excessive energy use (Bosona, 2020; Gayialis et al., 2022; Pan et al., 2021). As a result of urban traffic congestion, transportation expenses are rising, which was getting worse because of truck traffic (Kreindler, 2024). It can be explained by the frequent transportation of small loads of goods in order to meet customer demands and save inventory expenditures. When it comes to harmful effects on the environment, diesel trucks are significant producers of NOx, SOx, methane, and carbon dioxide, which may lead to acid rain (Deng et al., 2021). Noise pollution is also rampant (Čižiūnienė et al., 2020). In Surat city of India, city expansion led to a 40% increase in trip lengths and additional carbon dioxide emissions, highlighting the need for holistic urban freight planning (Mahadevia et al., 2023).

Public logistics terminals can be referred to as complex buildings serving a variety of purposes, such as transhipment facilities, storage facilities, retail marketplaces, data centres, exhibition halls, and conference rooms (Cruz-Daraviña & Suescún, 2021; Haarstad et al., 2024). Researchers have been working on the technical issues of locating such logistic hubs within a city where they are required (Ambrosino & Sciomachen, 2012; Russo et al., 2021). The optimal locations of those logistic terminals are generally suggested at junctions of expressways and closer to large cities. However, studies have shown the problems for locating urban logistic terminals in city areas as it creates city-wide congestion (Škrinjar et al., 2012). Therefore, another group of researchers suggest locating such freight logistic hubs at outskirts of the city area (Faugère et al., 2020).

On the other hand, logistic terminal locations are greatly impacted by any improvements made to the road network, even if such improvements are not located close to the terminals (Čižiūnienė et al., 2020). It is because improved roads lowered the cost of transportation for delivery and pickup vehicles (Taniguchi et al., 1999).

In the case of freight movement, reliability is an important measure. The fundamental concern of the supply end is that, regardless of the type of freight being moved, operators might maintain the effectiveness of the logistics as well as transportation services and fulfil legal requirements with the help of extremely predictable route times (Fowkes et al., 2004). Pu (2011) highlighted several reliability measures adopted by different organizations. Several literatures have used the buffer index and planning time index as the travel time

reliability measure for freight transport. Locating truck terminal is a part of integrated freight planning. It alone cannot solve the associated problems. Rather, it works as a system (MoUD, Government of India, 2020).

DHUTS (2010) identified that long travel time, high transport cost, less modal integration, and less foreign investment for infrastructure form a vicious cycle which was continuing to leave the freight system disabled and defunct. However, the National Land Transport Policy 2004 provided the scope for a synergetic plan involving current and proposed strength and opportunities of the city. Some of its proposals were as follows: (i) mandating the commercial and industrial developments to incorporate off-street parking facilities for trucks, (ii) day-time truck ban in Dhaka to be reviewed in future, (iii) creating new facilities for trans-shipment to/from container trucks for Dhaka etc. (Ministry of Communications, 2004). Though it has been almost 15 years since the promulgation of the policy, there is still a vacuum in the details and lack of integrated freight planning in Bangladesh.

2.1. Review of Major Policies

Relevant plans, policies and laws were reviewed in this study to understand the present state, necessity and opportunity of the Tejgaon truck stand as a freight transport stand. The master plans for alternative modes (e.g. railway, waterway) also helped to evaluate the future growth of road-based freight and feasibility of trucks against alternative modes in future planning.

Tejgaon industrial area was included in 'Sub region 11' in Detail Area Plan (DAP) 2022-35. DAP identified the industrial characteristics of Tejgaon as a major problem for the future growth. Rather, following the plan of DMTCL and Revised Strategic Transport Plan (RSTP) 2015, the MRT-5 (south) was promoted with Transit-Oriented Development (TOD), which indicates a need for relocation or removal of Tejgaon truck stand. Total nine TOD areas were located in this area and high mixed use was proposed throughout the area (RAJUK, 2022).

Dhaka Metropolitan Police ordered on July 2012 to restrict trucks in Dhaka city during specified time table, allowing truck movement inside city area only between 9:30 pm and 8:00 am (only during the night) (DTCA, 2015). So, the existing location of the logistic hub had been posing a large disadvantage to the freight transportation efficiency and optimum operation. Six major truck terminals had a total capacity of 5,100 trucks, while the number of trucks in Dhaka city was reported as 23,888 by Dhaka transport coordination authority (DTCA). So, all freight vehicles cannot be accommodated in this central city region as expansion is not an option here (e.g. Tejgaon truck stand). Relocation of the logistic hub remains as the only solution, where all logistic operations could be carried out efficiently.

In other policies (e.g. National Land Transport Policy 2004, Railway Master Plan 2014, Bangladesh Regional Waterway Transport Project 2016) some of the issues related to freight transportation were addressed, such as promoting a greater share of freight through railway and waterway, removing financial regulation (Ministry of Communications, 2004; Ministry of Railways, 2014; Ministry of Shipping, 2016). Though Tejgaon could be an ideal place for rail and road integration, the possibility of this transformation has not been studied yet. The National integrated multimodal transport policy 2013 mentioned the construction of truck terminal beside highway for resting and truck parking. Reliable and flexible intermodal freight service as per customer need was supposed to be planned through a higher number of logistic parks, container depots and freight stations. But the ideal locations of those freight hubs were not specified in the

policy. Developing multimodal corridor was another necessity for prioritizing high-speed freight network, which could not be achieved by locating any major logistic hub within the city (Ministry of Communications, 2013).

Parking policy for DMDPA (Dhaka Metropolitan Development Plan Area) by DTCB on 2005 addressed the congestion created by freight traffic operation in the major city area, which was solved through day-time truck ban (Dhaka Transport Coordination Board [DTCB], 2005). Still, the intercity trucks used Dhaka as the through route. Many trucks had to use logistic hubs like Tejgaon, which was located within city to avail their required services. But all trucks had to wait at the city entrances till the ban time was finished. It created high congestion at the entrances and increased the travel time of the trucks exceedingly. Despite all the mentioned disadvantages, this policy suggested five locations for truck terminals including Tejgaon. So, the parking, waiting and congestion issues generated from the placement of freight logistic hub in the core city area were ignored. In addition, RAJUK was mentioned to have the responsibility to identify the locations for new truck terminals to accommodate the growing logistic need of Dhaka-bound freight vehicles (RAJUK, 2022).

The relocation of freight logistic hub was not a clear objective in the policies of Bangladesh (RAJUK, 2022; Ministry of Communications, 2004). It could have resulted from undermining the social and environmental impact of such areas on the life of city residents. DAP 2022-2035 of Dhaka mentioned the Tejgaon area as a TOD area for future use. So, shifting the logistic hub could be an option that the city authority had envisioned. Incorporating the issues of SDG, national adaptation plans, and ecological protection, the minimizing of environmental impact could be considered in freight movement as well.

2.2. International Case Studies on Freight Management

Truck terminals at Kolkata, India

The proposed master plan in Kolkata in 2001 delineated the location of truck terminals outside the city in a linear pattern. Most of the freight transport used to take place with the western parts. They shifted from their initial motto of "If wholesale trade moves out, truckers will stay out" to "If truckers move out, wholesale trade will stay out". Thus, an attempt to shift wholesale activities outside the core city was taken. As the Kolkata city has developed along the Hoogley river resembling Dhaka city, their approach to freight logistic hub could be implemented in Dhaka with slight modification. The master plan of Kolkata opted for the respective locations of truck terminal to be determined according to the market demand at the periphery. Thus, there was room for economic boom through ensuring efficient and least costly cargo transport (Mukhopadhhay, 2004).

Truck terminals at Bengaluru, India

The city of Bengaluru did not have any truck terminals in the Central Business District (CBD). They had all the freight logistic hub outside CBD, but inside the outer ring except for one terminal. The ring road around the city along with the radial roads were used in developing an efficient cargo management system with optimum location for the logistic hubs. So, the inner city could remain congestion free (Saw & Kataria, 2022). In Dhaka, there was a proposal to construct inner and outer ring along with a radial distribution of roads (DTCA, 2015). If truck terminals can be planned considering this formation, there will be immense improvement in freight management and overall traffic condition of Dhaka.

Urban Logistics Space, Paris, France

The geographic distribution of logistic facilities inside the metropolitan region of Paris resulted in a significant rise in the distance that trucks and vans had to travel to transport goods within the city. It raised CO_2 emissions drastically. The city implemented a freight policy that prioritized the creation of experimental measures to encourage innovative approaches to delivery to the city centre. The development of minor logistical facilities in the city core was one of the objectives of this approach. One such instance was Chronopost Concorde, a creative parcel delivery service that used clean delivery cars and an urban logistics space to serve the seventh and eighth boroughs of Paris. With 3,500 workers, the company delivered 240,000 packages citywide every day. It accounted for 18% of the market in those areas. And it was delivered to the destinations by vans without emissions (MoUD, Government of India, 2020).

These freight logistic management processes demonstrated a potential for revising the present use of Tejgaon truck stand. A relocation of the logistic hub to outskirts of the city could be one option and replacing the trucks for alternative sustainable modes to deliver goods could be another. In the second case, the Tejgaon truck stand could be used to provide logistic support to those alternative vehicles (e.g. van, cart).

2.3. Critical Analysis of International Solutions

Cities like Paris, Bengaluru, and Kolkata had approached freight logistics differently, each of which could be a lesson for Dhaka city. Although each of those strategies had both advantages and disadvantages, they all demonstrate how cities might improve freight management.

Outside the city, Kolkata designed a straight line of truck terminals. Bengaluru avoided placing freight hubs in the city center altogether. Instead, it used its ring road and radial roads to create an efficient system. Paris focused on sustainability. It created small logistics hubs within the city that used clean vehicles for deliveries.

It will be difficult to adapt these concepts to Dhaka. It is challenging to construct new infrastructure in the city due to its dense population and limited area. The problem is made worse by incoherent policy and poor governance. Also, the existing regulations cannot be utilized adequately, as those remain frequently unenforced.

To accommodate the growing freight demand in Dhaka, the city authority might begin by constructing freight hubs outside of the city, such as Bengaluru. Following Paris, the authority might also test cleaner delivery vehicles and urban consolidation centers. It can also be beneficial to use technology such as route optimization software. Overall, Dhaka may design a freight system that meets its specific requirements by taking a methodical approach (Gatta et al., 2017).

3. Methodology

Secondary data on land use and road networks were collected from the City development authority (RAJUK). Traffic flow count, velocity survey and stakeholder survey were conducted for primary data collection. These three surveys were completed in three separate days.

Traffic flow count was conducted at the selected points in two intersections (**Figure 1**). The time of survey was selected considering the allowable travel period of trucks due to day

time truck ban in Dhaka city (between 10 PM – 6 AM). The period of survey, 10 PM to 12:30 AM was chosen considering the safety of surveyors. The surveyors counted different categories of vehicles passing through the two selected intersections manually and from the video recording of this period (**Figure 1**). Six surveyors were engaged in the data collection process with three persons at each of the intersections to collect data from different angles. The number of vehicles was counted under seven categories (e.g. truck, bus, private car, motorbike, non-motorized traffic, microbus/*leguna* and CNG). In each intersection, 15 minutes long survey was conducted, which was repeated four times for each intersection. The traffic volume and velocity were determined later from video recording. Google map was utilized to observe the congested areas (e.g., light and dark red colour) of the access and arterial road on different times of the night. This data from Google map was collected every 30 minutes from 10 pm to 6 am time period (e.g. using live traffic data). It was necessary to understand the congestion caused by trucks when the daily ban time was over.

Understanding the social dimension of logistic hub's location was also important along understanding the impact of the traffic. So, stakeholder survey was conducted with the relevant authorities and the local people (**Table 1**). Relevant authorities responsible for planning, regulation and management were listed for key informant interview (KII).

Table 1. Participants of the FGDs and KIIs.

Data Collection Method	Serial Number	Participant Number in Each Session	Average Duration	Institutional Identity	Place of Collection
FGD	FG 1-2	7 - 10	30-40 min	Truck Drivers	Truck stand
FGD	FG 3-4	4 - 5	25-30 min	Truck Owners	Truck stand
FGD	FG 5-6	5 - 7	20-30 min	Mechanics	Truck stand
KII	KI 1-2	1	40-50 min	RAJUK, DTCA	Respective office
KII	KI 3	1	1 hour	Traffic Police	Police Station
KII	KI 4-5	1	30-35 min	Local Leaders	Truck stand

Source: Field Survey (2023)

Data analysis began with understanding the impact of the hub on land use, which involved a discussion on the local level plan for Dhaka city and how it envisioned the future development of Tejgaon area. Among the possible types of environmental impact, noise level was measured using smartphone software and compared with standards mentioned in relevant policies. Considering the residential characteristics of the Tejgaon neighborhood (**Table 3**), noise pollution could be a major impact on the local residents.

The freight hub was located between two busy areas of the cities, where thousands of people were travelling for different purposes. So, the location of the freight hub and the corresponding movement of trucks had a direct impact on the travel conditions of those people. As the adjacent roads have a variety of vehicles and passerby movements, the impact on those traffics needed to be evaluated. Therefore, the traffic impact was a major consideration in this study. It involved the calculation of several values to understand the performance of adjacent roads with and without trucks. The equations and calculation

mechanism of the performance values are provided here. The passenger car unit (PCU) was calculated to understand vehicle flow on the access and arterial roads adjacent to the truck stand (Mohan & Chandra, 2018; Sun et al., 2022). Equation (1) was considered for PCU calculation. The PCU factors were used from **Table 2**.

$$PCU = \sum F \times C \times \frac{60}{T} \quad (1)$$

Where, PCU = Passenger car unit per hour, F = Conversion factor for vehicle type, C = Number of vehicle count, T = Duration of vehicle count (in minutes)

Then, peak hourly factor was determined for both roads for all types of vehicles. It helped to determine the road condition during the busiest period of the area (Bassan, 2013). The statistics on each type of vehicle would identify the volume and effect of each type of vehicle on the road during peak hours. The equation used for this purpose is demonstrated in equation (2).

$$PHF = \frac{Hourly\ volume}{4 \times Peak\ 15-minute\ volume} \quad (2)$$

The speed of the vehicles was determined from the videos through measuring the time to cross a pre-determined length of the road.

Table 2. PCU conversion unit used in the study

Travel Mode	Passenger Car Unit Factor
Truck	3
Bus	3
Private Car	1
NMT	0.8
Bike	0.75
Microbus	1
CNG	0.5

Source: Adnan, 2014; Chowdhury, 2018; Mohajan & Hossain, 2016

The two most accepted methods in literature - buffer index and planning time index have been used to underscore the travel time reliability through equations (3) and (4) (Pu, 2011). Free flow speed was considered as the highest speed found on those roads from field survey and calculation from the video.

$$Buffer\ Index = \frac{90th\ percentile\ travel\ time - Average\ travel\ time}{Average\ travel\ time} \times 100\% \quad (3)$$

$$Planning\ Time\ Index\ (PTI) = \frac{90th\ percentile\ travel\ time}{Free-flow\ travel\ time} \quad (4)$$

The congestion level was calculated following the ratio of the road length showing deep red or light red colour in Google Maps application from the screenshots collected from web browser (Mujtabe et al., 2024). The calculation of the congested road length was conducted in ArcGIS software after georeferencing and projecting in WGS 1984 46 N. The equation used for this calculation is provided in equation (5).

$$Congestion\ Level = \frac{Length\ of\ the\ road\ with\ congestion}{Total\ length\ of\ the\ road} \times 100\% \quad (5)$$

Data provided in Levinson & Lomax (1996) was used for determining the level of service. It was done by comparing the mean speed of the trucks with the corresponding threshold speed of each category.

All these variables were calculated to get an overview of the traffic condition and evaluate the demand and supply side of the adjacent roads of the truck stand. Demand was understood using the flow analysis, congestion level, speed/ level of service, etc., while the supply side was evaluated by calculating road capacity (e.g., PCU, PHF) and parking condition.

The impact on the stakeholders was identified through qualitative analysis of the interview and discussion data. The qualitative data (e.g., FGD, KII, policy documents) were analysed through content analysis and thematic analysis. The discussions were categorized to identify the common issues among different stakeholder groups. Thematic analysis results were demonstrated through Venn-diagram. Policies related to freight transport, overall transportation system of Bangladesh, and local area plans of Dhaka were skimmed through searches with appropriate keywords. The main tool used in policy analysis was content analysis. The quantitative data were analysed through different indices and values using different equations formulated by researchers.

4. Analysis and Discussion

4.1. Impact of the Truck Stand on Land Use

The DAP (2022-2035) shows that residential land use is 26.19% and industrial land use is below 2% in 'Sub-region 11' (**Table 3**). The proposed plan had a reduction in residential land use area. Moreover, mixed-use development was proposed for more than 40% of the land, increasing from 30%. Nine specialized zones for Transit-Oriented Development (TOD) were marked within the proposed plan. From the study of JICA and RAJUK, the TOD areas in Tejgaon would be included in 'Institutional', 'Urban Center' and 'Urban Neighborhood' typologies. As these TODs will be designed with commercial and mixed-use development mostly, industrial land use would be discouraged by the authority (RAJUK, 2023). In this plan, institutional land use was promoted along with the maximum possible mixed-use development areas. With the shifting of huge number of industrial units to Narayanganj and Gazipur, the efficiency and usefulness of the truck stand were reduced significantly in recent decades. If the authority determines to relocate rest of the industries from Tejgaon area, the relocation or demolition of Tejgaon truck stand might be the best solution.

Table 3. Comparison between existing and proposed Land Use of 'Sub-region 11'.

Land Use	Existing (2022)	Proposed (2035)
Industrial	1.93%	NA
Institutional/ Government	5.49%	19.45%
Residential	26.19%	7.59%
Mixed Use	30.05%	40.36%

Source: RAJUK, 2022

Therefore, Tejgaon truck stand could be relocated outside Dhaka city so the area can be assigned to other land uses. Before starting the implementation period of MRT-5 (south) and BRT-3 (3rd phase) stations, which would be running through Tejgaon, the relocation of the truck stand could help assign the necessary land uses for planned TODs. The mayor of DNCC had a plan of building multi-purpose truck terminal in Tejgaon (Alam, 2020), which directly contradicts the scope of DAP (2022-2035). Dhaka elevated expressway, MRT-5, and BRT-3 lines were proposed in different plans through the study area, Tejgaon. EIA report of Dhaka Elevated Expressway identified that the loop intersection of Tejgaon truck terminal might have a traffic disruption during the construction phase. The *Sat-rasta* intersection could also have additional traffic (BUET, 2014). There was no additional plan for maintaining the extra congestion created on the adjacent highway during the construction phase of the project. The other two projects, MRT-5 (Southern part) and BRT-3 (3rd phase) have not started yet. No data about the traffic impact of these projects could be obtained from online sources. Surrounding residential areas might be facing difficult situations due to noise pollution and disruption in daily activities as the truck stand remained operational throughout the night. So, land use inconsistency and disruption for the residential dwellers should be considered as a major impact on land use due to this truck stand.

4.2. Impact of the Truck Stand on Environment

The surrounding mixed-use and residential use areas were affected by the loud noise from the trucks and other vehicles that were constantly moving on the adjacent roads. The level of noise was disruptive to people who live and work in the area, considering the residential and mixed-use nature of the location. According to Detail Area Plan (2022-2035), the maximum allowable limit of sound in a mixed land use area was mentioned as 60 decibels during the day and 50 decibels at night. However, the area had an average noise level of over 76-77 decibels. Even the highest noise level was reached at 84-85 decibels (Table 4).

Table 4. Noise level of the Tejgaon Truck Stand area during night movement of trucks.

Location	Time	Average Noise	Maximum	Minimum
Intersection 1	9:30 pm – 11:30 pm	77 decibels	84 decibels	72 decibels
Intersection 2	9:00 pm – 11:15 pm	75.8 decibels	85 decibels	71 decibels

Source: Field Survey, 2023

4.3. Impact of Truck Stand on Regular Traffic

4.3.1. Truck Stand (Logistic Hub) Capacity

The Tejgaon Truck Terminal has a land area of 27.89 acres, and the authority was aiming to expand the truck stand on 13.02 acres of land owned by the Bangladesh Railway Authority (Alam, 2020). According to 'Bangladesh Truck and Covered Van Transport Agency Association', 400-500 trucks could be parked in Tejgaon Truck Terminal (Mithu, 2022). Under optimal conditions and efficient layout, the Tejgaon truck terminal could accommodate approximately 800 trucks, considering standard U.S. truck parking dimensions and necessary maneuvering space (Shelley, 2024).

According to DAP (2022-2035), the parking length for a truck should be ten meters. There was no instruction about the width of truck parking lot. So, bus stand standard was used as a proxy. The width of the bus stop lane was considered as three meters (Rahman, 2007). The width of a carriageway lane was supposed to be a minimum of 3.5 meters (Ministry of Communications, 2000). After leaving the space for mechanical space, as observed from the field survey, the terminal could facilitate parking for 615 trucks at a time. But the trucks were found parked in an unorganized manner. Also, the adjacent roads were covered with hundreds of parked trucks of different sizes (e.g., 117 large trucks and 11 small trucks). Specially, the access road could not function properly due to the large number of trucks parked on both sides.

4.3.2. Traffic Flow

4.3.2.1. PCU and PHF

In Table 5, traffic flow characteristics on arterial and access roads in the study area were highlighted. Trucks on the south-bound arterial road dominated the overall traffic in the case of road space with the highest PCU value (1058.73). The high PHF (0.88) value indicated substantial truck traffic during peak hours. On access roads, truck traffic was much lower in both directions, showing a higher preference of the arterial road use by the truck drivers. However, the consistent flow of the trucks during the survey could be a result of daytime truck ban in Dhaka. All the trucks need to wait till 10 pm to move out from the logistic hub of Tejgaon. So, the trucks require continuous movement throughout the night time.

Table 5. Capacity of the roads through PCU and PHF.

Vehicle	Road	Direction	PCU	PHF
Truck	Arterial	South-bound	1058.73	0.88
	Access	East-bound	186	0.78
	Access	West-bound	165	0.65
Bus	Arterial	South-bound	114.55	0.80
	Access	East-bound	0	-
	Access	West-bound	0	-
Private Car	Arterial	South-bound	439.33	0.70
	Access	East-bound	58	0.63
	Access	West-bound	22	0.61
NMT	Arterial	South-bound	69.6	0.66
	Access	East-bound	377.6	0.83
	Access	West-bound	136	0.66
Bike	Arterial	South-bound	269.32	0.74
	Access	East-bound	119.25	0.70
	Access	West-bound	12	0.40
CNG	Arterial	South-bound	162.73	0.89
	Access	East-bound	35.5	0.59
	Access	West-bound	10	0.71
	Arterial	South-bound	58.27	0.81

Vehicle	Road	Direction	PCU	PHF
Microbus/ Leguna	Access	East-bound	10	0.42
	Access	West-bound	0	-

Source: Field Survey, 2023

In different developing countries, truck bans were imposed to reduce or control air pollution in the cities. However, many of such cases did not produce any satisfactory results. In Columbia, air pollution did not reduce significantly even after the timely ban on trucks in Medellin City (Ocampo-Giraldo et al., 2019). In Mexico City, the truck ban increased congestion and emission levels of toxic gases in selected routes due to increased freight pressure (Lyons et al., 2017). However, in Brazil, the restriction on heavy vehicles successfully reduced pollutant levels and congestion on the roads (Pérez-Martínez et al., 2017).

The logistic hub in Tejgaon area was also creating extra pressure on the overall traffic condition of the adjacent areas. The people of Dhaka start traveling towards their homes in the evening, and most of them return by 12 am (Zannat et al., 2022). So, an additional traffic pressure between 10 pm to 12 am on the arterial road might hamper the returning trips in the city. From **Table 5** it can be seen that buses were present only on the arterial road with a PCU value of (114.55) and PHF of (0.80). As the bus remains available on the arterial road, many people keep using the bus till 12 am to reach their respective destinations. This consistent use of bus also indicates the need for suitable public transport on the access road during this hour. The absence of cheaper public transport (e.g., human hauler, van, minibus) on the connecting road (between Tejgaon and Farmgate) could be criticized, as the road was at least 500 meters long and induced a lot of traffic. Apart from walking and NMT services, those low-cost transit service could ensure a better experience for the general public.

Private cars also had a notable presence on the arterial road (PCU 439.33, PHF 0.70), but a lower volume of cars was present on the access road. Non-motorized transports (NMT) were found in higher numbers on the access roads, especially east-bound (PCU 377.6, PHF 0.83) returning trips were dominating the NMT numbers. The areas on the west of the access road were mostly commercial and institutional. So, many people were returning from those areas, causing a consistent NMT flow. Bikes and CNGs (compressed natural gas vehicles) had moderate volumes on arterial roads with comparatively lower numbers on the access road. Microbus was scarcely seen on the roads during the survey. Overall, the data reflected high arterial road usage by trucks and private cars, while NMT was the largest mode in the access road.

4.3.2.2. Speed

As the trucks were basically using the arterial road as their preferred transportation media, the speeds of different vehicles were analyzed for the road in **Table 6.** The motorbikes had the highest travel speed among all modes. The maximum speed of bikes was also far higher than all other modes. After motorbikes, CNG and private cars had somewhat higher speeds than other vehicles. Though these modes were the regular transport of the residents of Dhaka, the vehicles were costly to afford for middle and low-income people. The alternatives were bus and non-motorized transports (NMT). However, those vehicles had much lower speeds compared to bikes, CNGs, or cars.

Also, the high SD (standard deviation) value of the bus indicated a large variation in bus speed, which might discourage bus use among the passengers. The trucks had an average speed of 19 km per hour, which was close to the lowest among all modes. The minimum speed recorded for trucks was the lowest among all modes. So, the operation of trucks after 10 pm was not very useful for the efficiency of the mode itself. On the arterial road, the trucks were reducing the LOS for other travel modes through inducing congestion till 12:30 am (**Figure 3**). The logistic hub could not operate efficiently with sufficient speed of the freight vehicles at this location due to the competitive use of road space by different types of modes until midnight. Freight transportation could have a better solution sought in other countries, like relocation of the logistic hub to city limits in Vienna (Dorner et al., 2020; Markvica et al., 2019).

Vehicles	Average Speed (km/h)	Median	Maximum	Minimum	SD
Truck	19. 01	20	27.5	7	5.36
Bus	17	17	23	11	8.49
Private Car	23.68	23.25	36	11	5.58
NMT	19	19	22	16	4.24
Bike	29.45	27	42	22	6.11
CNG	25.6	27	33	18	4.27
Microbus	-	-	-	-	-

Table 6. Speed dimension for all types of vehicles on the arterial road

Source: Field Survey, 2023

4.3.2.3. Occupation of Road Space (Illegal Parking)

From the observation and Google Earth images, it was clearly understood that both access road and arterial roads could not be used to the full of their capacity. **Table 7** shows some statistics where the effect of the trucks in Tejgaon area could be understood clearly. The trucks were illegally parked on the roads, which occupied almost half of the access road and 11% of the arterial road. As a result, the operational lane number decreased from six to two in the access road, drastically reducing the traffic flow on the road. Only by removing those illegally parked trucks, the traffic flow could be increased up to three times. The relocation of the logistic hub could increase the traffic flow by 4,917 PCU per hour, which would be higher than the existing flow of the arterial road. However, relocation of the hub should incorporate the removal of all illegal parking and no trucks entering those two roads.

Table 7. Change in flow rate when truck parking/ use of truck on these roads are removed.

Road Characteristics	Access Road	Arterial Road
Length	533 m	760 m
Average Width	19.1 m	33.5 m
Number of Lanes	3+3	5+5
Maximum Flow rate in Ideal Condition (PCU/h)	11400	18050
Space Occupied (Illegal Parking)	47.02%	11.33%
Effective Width	6-8 m	28-30 m

Road Characteristics	Access Road	Arterial Road
Existing Flow Rate	1131	2172
Road Area in sq. m. (No Parking)	10,172.39	25,462.81
Flow Rate (No truck)	1639	4722
Flow Rate (No parking)	3393	2715
Flow Rate (No truck and No parking)	4917	5902

Source: Field Survey, 2023

4.3.3. Temporal Variation

It was seen that the highest PCU traffic available on the arterial road is between 10:30-11:00 pm (2nd 30 minutes). However, drastic changes were not observed in traffic flow between 10pm and 12am. Rather, after 11 pm the traffic started to reduce slightly. The access road had the highest flow during 10:00-10:30 pm (**Figure 2**) and the traffic did not reduce like the arterial road. So, the flow in access road was more consistent in the two hours period. Local trips were common during this hour in Tejgaon. However, the volume of traffic was always higher in the arterial road.

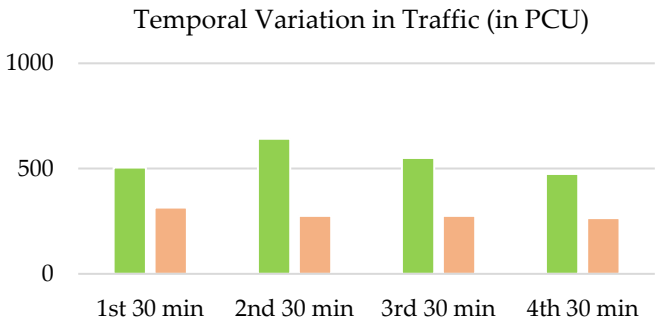


Figure 2. Temporal variation of traffic PCU in both roads (Source: Field Survey, 2023)

4.3.4. Traffic Congestion

Considering the congestion in those two roads, the constant use of access road was again visible (**Figure 3**). Till 12:30 am, a highly congested access road was observed as about 30% of the road was marked in red (source: live Traffic in Google Map). The access road had congestion till 2:00 am, after which the road became completely green (source: live traffic in Google Map) showing a free-flow state of the traffic. But unexpectedly, the congestion peaked at 2:00 am just before the road became free. As the intersections were controlled by traffic police, they could be holding the traffic for

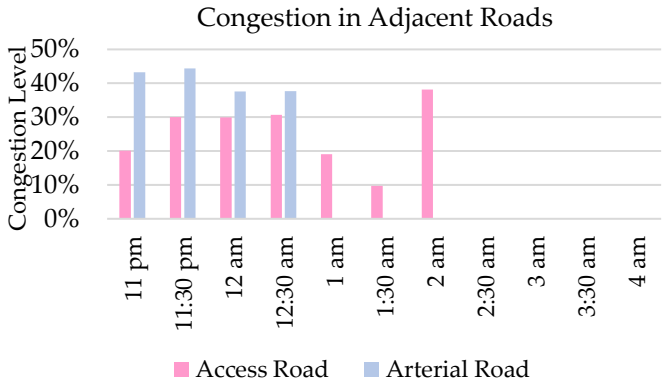


Figure 3. Congestion in the adjacent roads during truck operational hours (10 pm – 6 am) (Source: Google Maps, 2023)

longer than usual. But it could not be verified through field survey.

The congestion on the arterial road (**Figure 3**) was similar to the temporal variation in **Figure 2**. The congestion kept reducing till 12:30 pm. Afterward, the road became free. There was no further congestion till 4 am on the arterial road. Though these roads were provided for truck movement after 10 pm, other local traffic movement was also observed. But the arterial road could be freely used after 12:30 am, and access road could be freely used after 2 am. So, the returning trips to the respective homes of the local people had to face additional obstacles and congestion due to the presence of this logistic hub on their way back. Worldwide, freight logistics were planned considering the commercial goods distribution efficiency and cost of congestion. As the logistic hub in Tejgaon could not utilize any modern technology to increase efficiency, the use of those adjacent roads created extra pressure on the returning traffic till 12:30 am at least (Arnold, 2014; Schuur & Kellersmann, 2022; Xu et al., 2021).

4.3.5. Traffic Reliability

The calculation of the traffic reliability indices indicated almost similar results (**Table 8**). Considering the vehicles separately, the trucks could require 26% additional time to reach the destination through those roads, which was only better than bus and private car. NMTs were the most reliable following the buffer index as only 12-13% extra time is required to reach the destination.

Table 8. The traffic reliability and improvement indices for all traffic separately, including and excluding trucks.

Vehicle	Buffer Index	Planning Time Index
Truck	26.09%	2.04
Bus	28.24%	1.98
Private Car	30.60%	2.12
NMT	12.63%	1.34
Bike	20.94%	1.79
CNG	23.88%	1.64
Microbus	-	-
Overall	35.33%	2.625
Overall (Excluding Trucks)	28.52%	2.25

Source: Field Survey, 2023

The planning time index showed the second highest value for trucks indicating a requirement of almost double time than planned with free flow speed to reach the destination. Though, the excess number of private cars and the respective impact of cars were most alarming for Dhaka city from many perspectives, the number of trucks travelling along the roads of Tejgaon were also reducing traffic performance on the arterial and access roads. When considered with all traffic, the exclusion of trucks improved the requirement came down from 35% to 28%. So, the removal of trucks from those roads

should probably have some positive impacts on the traffic and the local residents returning home between 10 pm and afterward.

4.3.6. Pedestrian Movement

Pedestrian volume was very low on the footpath beside the primary road as this was the night time. However, a higher number of pedestrians was found on the access road. The footpath was not continuous. Small shops selling vehicle parts and serving for maintenance are hinged on the footpath in the link road. Only one access road had the non-motorized lane, which was shabby, dirty, and visually unpleasant. It was segmented, i.e., without continuity and devoid of any vehicles. There should be provision for zebra crossing as the trucks cover a major portion of roads and blur the visibility. Both footpath and non-motorized vehicle lanes should be made continuous surrounding the study area in order to minimize the heterogeneity of traffic and ensure pedestrian safety. Only one road had a non-motorized lane, although it was defunct. If it was rejuvenated in addition to expansion to the surrounding roads, it could ensure smoother traffic flow. To accomplish this, policy should be made and backed by proper implementation authority. Thus, traffic flow can be more efficiently channelized.

4.3.7. Road Safety and Management Issues

Bangladesh's road safety was deteriorating due to population growth, motorization, urbanization, and inadequate investment (Rahman, 2012), causing a rise in road accidents over the next decade. Dhaka's road links and intersections are becoming increasingly complex due to the diverse traffic. These traffic are also exceeding capacity and the use of varying speed and manoeuvring time modes. Urban intersections were a major concern due to the significant issue of differential approach speed (Ahmed et al., 2014).

In Dhaka, nearly 60% of urban trips involve walking, leading to a high prevalence of pedestrian accidents. From 1998 to 2014, Dhaka experienced a pedestrian fatality rate of 67% (Bhuiyan, 2018). From 2009-2014, the study area, "Sat rastar mor" (Intersection 1) experienced a total of five accidents, with four of them being pedestrian-related (Pervaz et al., 2016). Dhaka's pedestrian accidents are primarily caused due to inadequate road network planning, traffic control, inadequate facilities, reckless driving, pedestrian carelessness, less foot traffic, lack of footpaths, and inefficiency in law implementation (Pervaz & Newaz, 2016; Bhuiyan, 2018). Many roads were primarily used for non-motorized traffic, including pedestrian bicycles, rickshaws, pushcarts, and animals (Rifaat et al., 2017). Rickshaw problem in Dhaka city worsened traffic congestion due to the combination of NMT and motorized vehicles, reducing overall speed in intersections (Rahman, 2012). It was seen that at the Sat-rasta junction, there existed a considerable volume of auto rickshaws and three-wheeler vans.

Traffic management, such as zebra crossings, underpasses, and overpasses, are insufficient and rarely utilized due to poor law enforcement (Rifaat et al., 2017) . Lack of awareness has led to insufficient pedestrian crossing facilities, resulting in 34% of accidents between 1998 and 2014 (Bhuiyan, 2018). Many pedestrians disregard safety regulations and engage in risky walking and crossing behaviours (Rifaat et al., 2017). On March 2020, a pedestrian was killed while crossing the road (“Empty roads”, 2020). At the Sat-rasta intersection, there is no Zebra crossing, underpass, or overpass. Pedestrians often cross roads randomly. Sometimes, individuals cross the road in front of running vehicles. The installation of a zebra crossing could enhance pedestrian safety.

Insufficient road markings and roadside parking can lead to accidents when drivers drive fast (Rahman, 2012). There are buses parked illegally at our study area intersection, which blocks half the roadway, causing chances of accidents. Implementing more strict enforcement of speed limits and safe driving practices at intersections is crucial. Enhancing the road markings, signage, and establishing designated parking areas away from critical intersections can help address these issues. Globally, the majority of road accidents are caused by buses, with 35.2%, motorcycles at 12.31%, and heavy trucks at 10.14% (Jianxin et al., 2021).

Overall, day time truck ban reduced the travel reliability of freight vehicles in Dhaka but didn't affect congestion, temporal variation, safety, and movement of other modes adequately. The major contributor to higher congestion was the roadside illegal truck parking, which occurs due to insufficient space for trucks to park in the logistic hub. Thus, proper logistic design with efficient management could be taken to manage freight traffic in Dhaka by reducing the parking need at Tejgaon Truck Stand. For selecting the location of such logistic hubs, stakeholders, especially business owners, should be negotiated and separate lanes for freight should be given for traffic management within the city area (Dablanc, 2007).

4.4. Impact on Different Stakeholder Groups

Apart from understanding land use, environment and traffic impact, local people's view were also crucial to make any major decision. So, the local residents, as well as the responsible authorities were involved through KIIs and FGDs (**Table 1**). The stakeholders pointed out their opinions on the future of the existing logistic hub in Tejgaon. Many of them had common issues regarding the hub. However, some of them had separate interests, producing some opposite results, which need further investigation for a balanced solution (**Figure 4**).

4.4.1. Common Interests (Negative Impacts)

Inadequate Parking and Space Issues: All groups emphasized on the insufficient capacity of the current logistic hub. It produced much congestion as many trucks had to be parked in surrounding roads.

Traffic Congestion: Multiple sources described congestion issues from different perspectives. From several FGDs, congestion due to rickshaws and large buses was reported. One key informant emphasized the problem near flyovers and roundabouts creating delays in vehicle movement due to inefficient design.

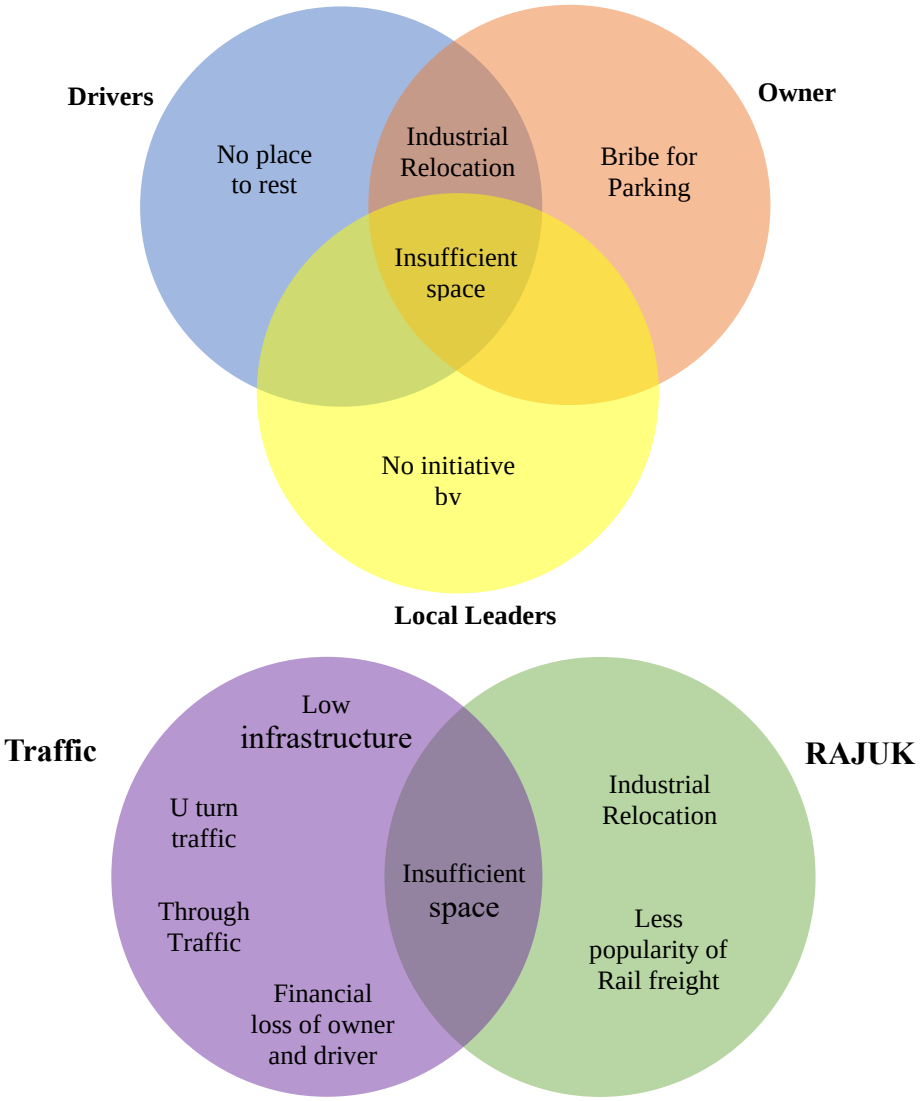
Economic and Social Impacts: Different groups mentioned the increased operational costs for truck drivers, causing financial burden and need for a secondary employment. Accommodation issues for drivers and mechanics were mentioned in several interviews and focused group discussions.

4.4.2. Common Interests (Suggested Improvements)

Need for Relocation or Expansion: Most groups suggested expanding the current truck stand or relocating it to peripheral areas of Dhaka (e.g., *Gazipur, Rajendrapur, Tongi, Ashulia, Joydebpur*). Also, the need for a permanent truck terminal was emphasized across FGDs and by the Truck Owners' Association.

Government Involvement and Plans**:** KIIs and FGDs mentioned government plans for building a new truck stand and potential extensions to existing infrastructure like flyovers. The use of Bangladesh Railway land for the current truck stand and potential conversion into a railway station was highlighted by KIIs and FGDs.

Figure 4. Summary of stakeholders' opinion (Source: Field Survey, 2023)



4.4.3. Conflicting Interests

Opinion on Relocation Area: Some truck drivers wanted to relocate to areas like *Gazipur* and *Rajendrapur*, citing their proximity to industries and highways. But other truck drivers preferred the opposite, which was on-site improvement of the Tejgaon Truck Stand. Contrarily, the majority of the stakeholders from 'Truck Owners' Association' didn't have a solid standpoint like the truck drivers. They (owner group) mentioned either relocation near rivers or suggested a multi-storied facility in the existing location for better

management of trucks. 'Mechanical Workers' group was also reluctant in choosing between relocation or on-site improvement. Rather, they mentioned having designated mechanic spaces at multiple strategic locations around Dhaka. So, they won't have to face much difficulty finding a job, even if relocation occurs.

Role of External Factors: In some FGDs, seasonal impacts on truck movement, like reduced trips during the rainy season was mentioned. Being located in the core Dhaka city, the regular water logging incidents were affecting their trips during the rainy season. Some key informants emphasized that the shift in land use from industrial to business in Tejgaon was a contributing factor to reduce the need of a truck stand in Tejgaon. Similarly, Key informant-1 agreed that the logistic need at the moment did not require the hub to be located in a core city area like Tejgaon.

While all groups agreed on the inadequate capacity and need for action regarding the Tejgaon logistic hub, their perspectives varied on solutions. Relocation and in-situ improvements were preferred by different groups to fulfill their own interest. The police and truck owners highlighted infrastructural challenges, while truck drivers and mechanics pointed out the socio-economic impacts and practical needs of their operations.

5. Recommendations

Some new and innovative technologies could be incorporated as policies in urban freight mobility for Dhaka city. These policies could be applicable to the logistic hub in Tejgaon as well. The recommendations are summarized in **Table 9** and **Table 10**.

Table 9. Recommendation for land use modification, environmental and traffic impact reduction

Type of analysis	Problem	Possible solution
Travel time reliability	Unreliable, leading to higher transportation costs and excessive inefficiency	Truck-only lanes (for logistic hub outside Dhaka city), through lanes, Synchronizing traffic signal
Level of service	Number of traffic exceeds the road capacity	Truck-only lanes (for logistic hub outside Dhaka city), through lanes, Synchronizing traffic signal
Traffic safety	Pedestrians are unsafe	Evicting illegal encroachments on footpaths, enhancing continuity in footpaths
Pollution	Sound intensity is beyond the threshold level	Buffer zone, relocation of educational and residential buildings

Source: Field Survey, 2023

Table 10. Recommendation from stakeholder consultation

Type of stakeholders	Problem	Possible solution
Local leader	Inadequate number of parking facilities for trucks	Enhancing the capacity
	Flyover is improperly planned	Traffic management should be revised considering the flyover design.
Truck drivers	Inadequate number of parking facilities for trucks	Needs further negotiation and strong interest of the authority to either relocate or to accommodate the needs of the drivers through a balanced solution for all stakeholders.
Law enforcement agencies	Large number of pass-by traffic. As the truck owners are incurring a higher loss from this business at this moment, the trucks couldn't be kept operational.	Public subsidy for freight movement Government policy to relocate Essentials Drugs Limited, Land office, CMSD etc., or relocate the truck stand

Source : FGD conducted by the authors, 2023

6. Conclusion

This study highlighted the pressing challenges urban freight transport faced in rapidly growing cities like Dhaka, particularly focusing on the Tejgaon area. The significant increase in truck traffic, exacerbated by inadequate infrastructure and outdated policies, led to severe congestion, environmental degradation, and safety concerns. Drawing from the stakeholder analysis and supporting case studies, it was realized that shifting such logistic hubs outside the core city was one of the popular and successful measures. The findings suggested that without strategic relocation and development of logistics hubs outside congested urban areas, the cities will continue to struggle with inefficiencies that hinder economic growth and quality of life for its residents. Apart from the relocation of the logistic hub, multi-modal freight transport integration (including rail, water, and air with the existing truck stand) could be a viable solution as well (Ingrao et al., 2021).

Addressing the urban freight challenges in Dhaka requires a multifaceted approach involving policy reform, infrastructure investment, and stakeholder collaboration. Relocating logistic hubs is an important solution, but future research should also look into how technology can make freight systems more efficient and sustainable. For instance, freight movement planning may become more intelligent and efficient with the use of IoT (Internet of Things) and AI (Artificial Intelligence) (Ridaoui et al., 2024). The potential operation of autonomous delivery vehicles in Bangladesh could potentially be investigated by researchers. These concepts could be helpful in developing a contemporary and dependable freight system in Dhaka and other cities in the global south.

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