

Traffic Congestion in Megacity Dhaka: Case Studies from Seoul and Copenhagen Analyzing the Potential Measures

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ABSTRACT

Traffic congestion is a contemporary urban problem in many cities around the world. The capital megacity, Dhaka, in Bangladesh, also faces a tremendous traffic congestion problem as it hampers the city's efficient commute system, reduces the average transport speed on urban roads, and significantly destroys the productive working hours of the city people. The Bangladesh government has taken packages of strategic plans to reduce traffic congestion in Dhaka. This study analyses two case studies from Seoul in South Korea (Republic of Korea) and Copenhagen in Denmark to learn from their adopted measures to minimize traffic congestion on urban roads. Based on the analysis of the potential measures, this study suggests that promoting the public transportation system and its effective integration with the walking and non-motorized biking infrastructures may help reduce traffic congestion in Dhaka.

1. INTRODUCTION

Traffic congestion on urban roads is a common aspect in many cities all over the world. Traffic congestion occurs when the sheer demand for transportation causes an outrageous physical presence of the transports on the streets, slowing down the average speeds of the vehicles and hampering the regular transportation flows [1]. Traffic congestion destroys a comfortable urban commute system and kills the urban dweller's productive time. Urban planners worldwide take different initiatives to control, reduce, or eliminate traffic congestion from the vibrant urban transportation streams. The context of Dhaka city in Bangladesh is not different from the urban impacts of traffic congestion, which brings much distress and destroys the productive hours of the urban inhabitants.

Dhaka is the capital city of Bangladesh, a South Asian developing country. Dhaka is a megacity with a population of 19.5 million in 2018 (megacities are cities with a population greater than 10 million). The United Nations projects that the city may have a population of more than 28 million by 2030 [2]. Dhaka contributes 36% to the country's Gross Domestic Product (GDP) and holds 31.8% of the country's total employment, which denotes the high importance of this megacity in the country's development [3]. This megacity's population density is 43,578 people per square kilometre, making it one of the world's densest cities [4]. The population increase rate of Dhaka city is 3.96% per year, which is contributed by both natural increase (1.47%) and regional migration to the city (2.49%) [3]. Due to the city's primacy in the prospective economic growth, the city attracts internal migration from the other regional areas, adding the migrated peoples to the natural population increase. Dhaka has become the most significant economic

centre of the country, attracting businesses, factories (e.g., garment factories), real estate developers and labour flows. The city's massive population is enhancing transport demands, and the city's bottlenecking of low infrastructural capacities has made the city people face tremendous traffic congestion problems. The traffic congestion problem has become an enormous burden in the daily urban life of the city people as it destroys a significant amount of working hours by being stuck in Dhaka's streets [1], [5]. This paper attempts to analyze the nature, impacts and practical measures to reduce the traffic congestion problem in the megacity of Dhaka. It will bring two case studies regarding the best practices for traffic management from two world cities: Seoul in South Korea from an Asian context and Copenhagen in Denmark from a European context. Based on the lessons learned from these two case studies, the paper will analyze the vital policy measures adopted for managing traffic congestion in Dhaka and discuss the potential policy measures on the way forward.

This paper consists of seven sections. The first section introduces the megacity Dhaka, the traffic congestion problem, and the scope of this article. The second section discusses the methodology of the paper, revealing the sources of the data and the analytical methods. The third section promotes an analysis based on literature reflecting on the nature, urban impact, and the adopted policy measures for reducing the traffic congestion problem in Dhaka. The fourth and fifth sections introduce two case studies from Seoul in Asia and Copenhagen in Europe regarding the best practices for adopted measures to reduce urban traffic congestion. The sixth section promotes an attentive discussion on contextual practices or policy measures to tackle the traffic congestion problem and reflect on the way forward. Finally, the seventh section develops a conclusion

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and indicates the scope of further research on the urban discussions the paper may help delve into.

2. METHODOLOGY

The study relies on analyzing the secondary data from journal papers, books, government and international organization reports, and other relevant policy papers. The article discusses the case studies and relevant insights based on the information collected from the secondary sources cited in the study. The study follows a mixed method of data analysis, focusing on quantitative and qualitative reasoning where appropriate.

This paper adopts the case study-based approach from two different cities of the world (from Asia and Europe) to analyze the problems and the adopted measures and promote a discussion. The case study approach of this study stands on the methodological ground of ‘comparative urbanism’. Comparative urbanism is a trend of urban research that promotes urban theorization based on learning from elsewhere in the cities around the world [6]–[9]. This trend develops an openness for ideas from other places while accepting the located-ness of the conceptualizations. It may help build innovative ideologies by thinking of similar problems with different experiences, limits and productive measures [6], [9]. Such an exploration may significantly enhance the realm of pragmatic practices, the revisability of the conceptualizations and the inspiration to learn from the differences [6].

The case study is a research method that accepts the process of maximizing learning to promote a better understanding of the studied problem and finding solutions. This research process accepts “multi-perspectival” methods of analysis for a common problem operating in different contexts [10]. This attribute of the case study method may contribute to concentrating on a problem and learning from different perspectives to find solutions or improve the prevailing measures. Such methodological avenues of the case study may warrant us developing the “multi-perspectival” discussions of the common problem of traffic congestion and finding innovative solutions based on our learning from different world-city’s contexts, adopted measures, problems that arose for the measures, and their outcome’s scopes. It also promotes a justification for this study to learn from different world contexts, develop discussions for innovative, out-of-the-box measures, and understand their scopes as validated by their positive outcomes. It positions this study’s scope to engage in the discussion to learn from world cities to promote innovative responses for a common problem of traffic congestion or understanding ‘what has been done’ and ‘what can be done’. So, the scope of the research is not to discuss the contextual differences of a problem but to promote discussions for innovative solutions by learning from the differences in the adopted measures.

Following its methodological trait, this study first delves into understanding the nature of the traffic congestion problem in Dhaka based on literature analysis of secondary sources. Then, it discusses the case studies of adopting innovative,

practical measures by two other global cities: Seoul and Copenhagen. Based on the insights, it promotes a discussion on the prospective, sustainable policy measures for reducing traffic congestion in Dhaka.

3. THE NATURE OF TRAFFIC CONGESTION PROBLEM IN DHAKA

3.1 Causes of Traffic Congestion

It is difficult to explain any core cause or a universal motif of causes of traffic congestion in Dhaka city. Many issues contribute to the traffic congestion problem, and this paper tries to indicate the significant concerns discussed heavily in the available literature in this research field. Dhaka’s population density is higher than other parts of the country as it is a megacity. Throughout history, this capital city has emerged as a prime city for economic opportunities. For promoting a sustainable urban transportation system, cities may need to have 25% of their area available for use as road infrastructure in general [11]. Mahmud et al. [11] discuss that Dhaka city has a total road area of 1286 km in length, and considering the city’s area, only 9% is the road infrastructure. Among the city’s road infrastructure, only 5% comprises the primary roads, and 36% of the total road network has a narrow width of less than 4.75 m.

Moreover, the Bangladesh Road and Transport Authority (BRTA) reports that many new transports are registered annually in Dhaka city [12]. This indicates that there is a heavy demand for transportation in Dhaka. Though a massive volume of new vehicles are registered yearly, the roads have not increased considering those [13]. So, inadequate road infrastructure in the face of high transportation demand may significantly cause traffic congestion problems.

The reluctance to follow the traffic rules also creates traffic congestion problems [14]. Public transport like buses tend to board passengers elsewhere from the road and hardly follow the traffic rules. Mixing non-motorized vehicles with motorized ones on the same street may be another cause of slowing down the speeds of the transports [15]. Drivers are most often reluctant to follow the lanes of the traffic movement on the road, which creates a haphazard movement in the transportation system [13], [14]. There is also a lack of a well-defined plan for pedestrians to follow for crossing the roads and moving along the sides of the streets. Some parts of Dhaka have foot overbridges for pedestrians to cross the vehicular roadways, but they are hardly adequate than necessary. However, pedestrians become unwilling to use those as there is less consideration for the elderly, sick or tired pedestrians to climb up to its significantly high level with its stairs to cross the roads [14], [16]. Some studies have reported that the condition of the pedestrian way or the footpath is not inviting enough for walking as those are occupied mostly by street hawkers, garbage, construction works or materials, and often remain broken, impelling the pedestrians to walk on the main roads [14], [17], [18]. Chowdhury [14] reports that 60% of the city’s total 163 km long pedestrian ways are occupied by street hawkers,

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roadside shops and construction materials. Parking of vehicles beside the roads, parking rickshaws (a type of non-motorized vehicle) to collect passengers, and grabbing of the road spaces by the street hawkers and petty businesses are also the issues that reduces the usable areas of the roads for free traffic movements [19], [17].

BRAC Institute of Governance and Development (BIGD) conducted a rigorous survey on the public consensus about the causes of traffic congestion in Dhaka city among the city's transport users [20]. The result of the study is presented in Fig. 1.

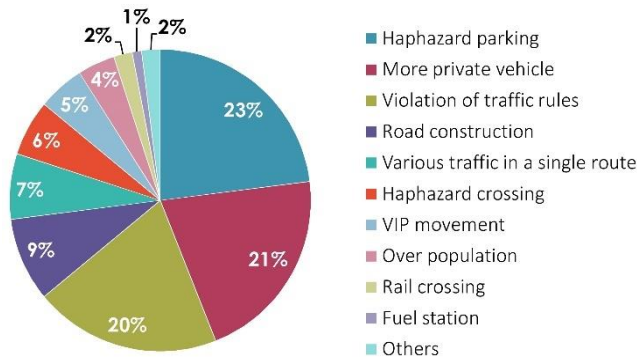


Fig. 1: BIGD survey on the public consensus about the causes of the traffic congestion in Dhaka city.
Source: Based on [20].

The major trend of the responses in Fig. 1 shows that 'haphazard parking' is reported by 23% of the respondents as being a cause of traffic congestion, while 'violation of the traffic rules' is reported by 20%. The high presence of private vehicles moving on the roads, indicating the lack of public transportation services, is reported by 21% of respondents as a prominent cause of traffic congestion in the city.

3.2 Impacts on Urban Life

Fig. 2 shows that the average travel speed in Dhaka is gradually reducing for traffic congestion. Due to traffic congestion, the average travel speed on the roads of Dhaka was reduced to one-third in 2017 compared to 2007, as the average travel speed plummeted from 21 km per hour to 7 km per hour during this period. Reports show that the average travel speed in 2018 was five km per hour during rush hour in Dhaka, which is close to the human's average walking speed of four km per hour [21], [22].

Traffic congestion causes a significant loss of working hours for city people and creates physical and mental stress for them. Reports show that every day, due to traffic congestion, 3.2 million productive work hours are getting destroyed on the roads in Dhaka. The national loss for traffic congestion in a year is around 370 billion USD, equivalent to 11% of the country's national budget [23].

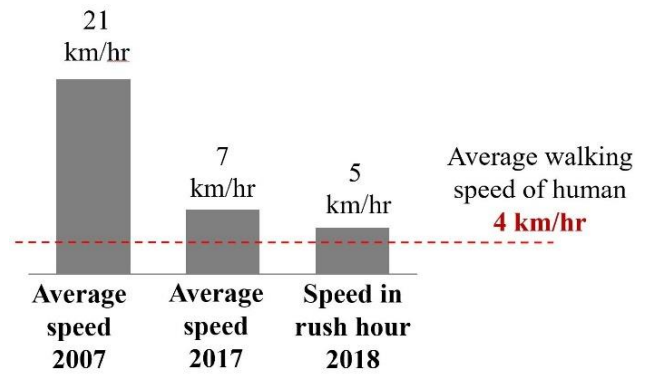


Fig. 2: Reduction of the average travel speed in Dhaka due to traffic congestion. Source: Author's composition based on [21], [22].

3.3 Transport Modal Share in Dhaka

Dhaka city's transport modal share and its variation over time are presented in Table I. It may help analyze the preferred modes of transport of the city people and signify the potential of developing a sustainable transport system in Dhaka.

Table I: Dhaka City's transport modal share (Percentages of share).

Modes	DITS (1994)	DUTP (1997)	JBIC Study (1999)	STP (2005)	JICA Study (2009)	DSP ¹ (2016-2035)
Walk	60.1	62.82	62.05	14.0	19.09	19.80
Rickshaw	20.1	20.04	13.28	34.0	38.19	38.30
Bus	12.8*	10.42*	10.22	44.0*	29.83	30.0
Auto-rickshaw			5.83		5.73	6.60
Passenger Car/ Cars	7.0**	6.72**	3.97	8.0**	4.3	5.10
Others			4.65		2.86	0.20***
Total	100	100	100	100	100	100

* Transit

** Motorized (non-transit)

*** Railway,

¹ DSP: Dhaka Structure Plan 2016-2035.

Source: Author's composition based on [24], [3].

The transport modal share of Dhaka city in Table I shows that the share of walking as a mode has reduced significantly from 60.1% to 19.8% from 1994 to 2016. This change may indicate that walking is gradually becoming a less preferred method of transportation in Dhaka. During this period, the share of rickshaws increased from 20.1% to 38.30%, almost doubling. From 1999 to 2016, the share of buses as a mode

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increased almost three times as its share ascended from 10.22% to 30.0% by this period. Such a change may indicate a rapidly growing high demand for public transport in Dhaka. The modal share of passenger cars has an increasing trend from 3.97% in 1999 to 5.10% in 2016. It may imply that the car dependency of the city people is increasing. However, from 2016 data, it is evident that walking, rickshaw, and bus modes cumulatively constitute the paramount share (88.1%) of the total transportation system in the city when compared to the other modes. Such analysis may support an argument that advocating a good walking environment, non-motorized transportation facilities and promoting public transport systems in Dhaka may have prospective scopes for developing efficient urban transportation.

3.4 Measures Adopted

Dhaka city planning authority has adopted 'Strategic Transport Planning' (STP), which contains different policy initiatives to reduce traffic congestion in the city. It promotes a master plan for 20 years, from 2016 to 2035, to develop an efficient transport system in Dhaka. Some of the vital initiatives are discussed in the following sections.

3.4.1 Developing the Ring Roads

Dhaka Structure Plan (DSP) for 2016-2035 proposes constructing three concentric ring roads around Dhaka's central part, allocating a budget of 2 billion USD [3]. The total length of the ring roads will be 273 km, and the inner, middle, and outer ring roads will have a radius of 10 km, 15 km and 20 km respectively [3]. The purpose of these three ring roads is to segregate and divert the cross-traffics toward the outer roads, resulting in the city centre accumulating less traffic. It will prevent vehicles from unnecessarily crossing the city centre to travel to the outer city destination. This policy foresees increasing the average travel speed in Dhaka's city centre, reducing the number of vehicles occupying the roads in that area [3].

3.4.2 Bus Rapid Transit (BRT)

BRT is a mode of low-cost urban transportation that fosters an economically responsive way for mass urban transportation in developing countries with resource constraints. The cost of a BRT project for urban services is one-third of that of the urban Light Rail Transport (LRT) project [24]. Dhaka Structure Plan (DSP) 2016-2035 proposes to develop three separate BRT lines in Dhaka named BRT corridor- 1, 2 and 3. Their routes are as follows as per the planning:

- BRT corridor-1 travels from Uttara to the Saidabad bus terminal by connecting DIT circular and Toyenbee roads.
- BRT corridor-2 travels from Gabtoli to Saidabad bus terminal via Mirpur.
- BRT corridor-3 travels from the city's international airport to Ramna via the airport road [24].

Studies foresee that the BRT corridors will help reduce 48.84% of present travel time [25]. The World Bank and

Asian Development Bank (ADB) are actively supporting the government in implementing the BRT project in Dhaka [24].

3.4.3 Metro-rail: Mass Rapid Transit (MRT)

Dhaka Structure Plan (DSP), in its master plan for up to 2035, has proposed developing five rail-based Mass Rapid Transit routes (MRT-line 1, 2, 4, 5 and 6), allocating a budget of 15 billion USD. DSP foresees that these five lines of MRT may have an urban promotion area of 66.31% when people's catchment belt (walkable area) is considered two km. DSP projects that per year, the trip volume in Dhaka would be composed of 60 million passengers and the MRT system with its fully functional five lines in 2035 may serve the total passengers' 10% [3]. MRT demands the development of an entirely new infrastructure and management system, which may accrue high costs for a developing country. The government has implemented MRT-line 6 (21.26 km) running from Uttara to Kamalapur central railway station; part of it is presently open to the public. Gradually, in different time phases, the other line will be constructed. The government is getting support from the Japan International Cooperation Agency (JICA) for the MRT project [26].

3.4.4 Management of Non-motorized Rickshaws

Following the Land Transportation Policy 2004, a new policy has been adopted in the Dhaka Structure Plan (DSP) 2016-2035 for managing the non-motorized rickshaws in the city. The new policy confines the movement of the non-motorized rickshaws within the city's residential areas, not hampering the movement of the motorized bus routes [3]. This policy focuses on increasing the speeds of motorized vehicles on the streets, avoiding the congestion caused by the slow-moving non-motorized rickshaws. The policy has empowered the Dhaka City Corporation and the Dhaka Metropolitan Police Department to ban non-motorized rickshaws on the city's busy motorized vehicular roads. The policy also directs the law enforcement authorities to actively check the licences of the rickshaws and ban the movement of unauthorized ones on the streets [3].

3.4.5 Foot Over Bridges and Sidewalks

Through the initiatives of the Clean Air & Sustainable Environment (CASE) project sponsored by the World Bank, Dhaka city developed sidewalks and foot-over bridges at different essential locations of the city for pedestrians [3]. However, the proportion of the sidewalks and the foot overbridges is inadequate in this overly populated city.

3.4.6 Policy Outcomes

The government of Bangladesh has taken different long-term steps in its strategic plan (the master plan for 2035) for Dhaka's transport. Implementation of such long-term policies would require some time, and the policy outcomes would be prominent when the city people could access the facilities in full swing.

4. CASE STUDY FROM SEOUL, SOUTH KOREA

Seoul is the capital city of the Asian country South Korea (Republic of Korea), with a population of 9.9 million in 2018 and a projection to increase to 10.1 million by 2030 [2]. Seoul achieved the 'Lee Kuan Yew World City' international prize in July 2018 for developing sustainable solutions enhancing urban liveability, defeating 28 other competitor world cities, including Tokyo (Japan) and Hamburg (Germany) [27]. Some of their adopted measures for managing urban traffic congestion can be studied as the best practices following the scope of this paper.

With the economic development, the city people in Seoul became inclined to use private cars as a predominant mode of transportation. In 2000, the transport modal share of private cars was 77%. Between 1970 and 2002, the number of registered private cars increased 39 times. However, the city's road infrastructure did not increase in the same proportion as the studies show there was an increase of 3.7% in road infrastructure from 1999 to 2003. The high modal share of private cars was causing great suffering, contributing to the city's traffic congestion. To improve the urban transportation system by reducing traffic congestion, the Seoul Metropolitan Government (SMG) has taken some sustainable policy measures that significantly reduce the problem. The following sections will unpack some of those measures.

4.1 Policies to Promote Public Transport

Seoul focused on reducing private car dependency and enhancing public transport use to decrease traffic congestion [28]. A milestone policy was taken in 2004 by the SMG to promote a public-transport-oriented urban system. The policy aimed to increase the modal share of public transport by up to 70% and the average travel speed to 20 km per hour by 2020 [29]. An integrated public transport network was advocated to achieve such targets using metro services, buses, and other public facilities. Fig. 3 shows the city's target plans to achieve the policy goals.

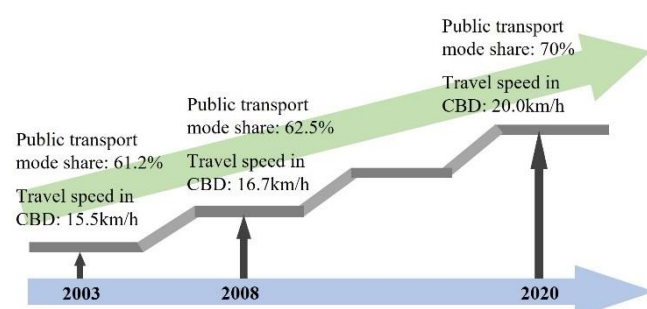


Fig. 3: Seoul's plan to achieve the goals of public-transport-oriented policy. Source: Author's illustration based on [29].

4.2 Seoul's Experience with Metropolitan Rail Service

In 1974, Seoul first constructed an eight-kilometre Metrorail line that was developed into a network of 487 kilometres by

2004 with 389 metropolitan rail stations [30]. 8.4 million people travel daily on the metropolitan rail from Seoul's urban and suburban areas. Seoul's number of everyday metropolitan rail passengers is double the number of New York City's subway commuters per day. However, Seoul found that metropolitan rail infrastructure as a mode of urban transportation is costly as it provoked 80% of the city's total debt (6 billion USD). In 2003, the passenger's fare only contributed 75% to the total cost of operating the metropolitan rail service, incurring a 634 million USD deficit in the operating cost of the metropolitan rail [30]. The SMG faced massive pressure to manage the metropolitan rail service's high cost incurred from its construction, operation and management. This phenomenon led the SMG to look for a cost-effective and sustainable way to promote public transportation, such as developing the bus's infrastructure [30].

4.3 Promoting BRT and BMS

The SMG promoted the Bus Rapid Transit (BRT) network with 7,484 buses on 360 bus routes by 2013. Differentiated by colour-coded bus routes, it followed the 'trunk-and-feeder' system connecting different parts of the city such as suburban areas (blue busses), subway stations (green busses), other metropolitan downtowns of the city (yellow busses) and the other satellite towns (red busses) [30], [31]. Fig. 4 illustrates the 'trunk-and-feeder' concept for managing the bus routes serving urban commuters in different regions. By 2012, the SMG had developed 115 km BRT lines and adopted a plan to increase the BRT line to 223km in the future to support the city's public-transport-focused policy [31].

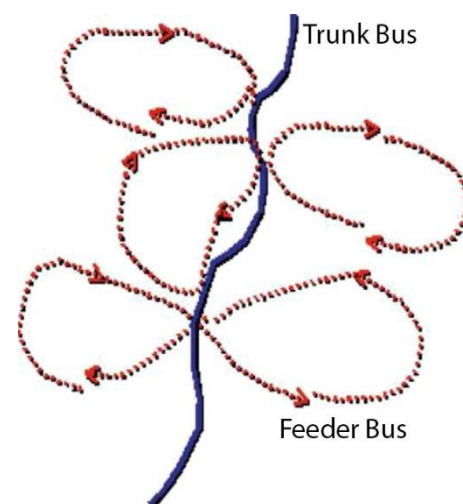


Fig. 4: Illustration of bus route's 'trunk-and-feeder system'. Source: Adopted from [28].

The SMG has also developed an integrated Bus Management System (BMS) in Seoul with state-of-the-art technologies. It has introduced median bus stops on the roads and low-floor buses for easy access for uninterrupted transportation. It has also become oriented to electric buses, replacing the previous CNG-driven buses. The SMG follows the quasi-

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public revenue management, combining the SMG and the bus companies. It fosters a competitive attitude among the bus companies to provide quality services [31].

4.4 Smart City with Intelligent Traffic Management

Seoul TOPIS (Seoul Transport Operation & Information Service) is a management centre for the integrated, intelligent and effective system of urban transportation networks [31]. Using state-of-the-art technologies, it collects information from different networks of sources and transmits relevant data to different management systems, such as various sorts of urban transport systems, police departments and other types of unmanned enforcing segments. It also enforces an effective CCTV vehicle management system for managing the parking lanes, violation of the traffic rules, median bus tracks, and bus stops. Fig. 5 represents an interior view of the Seoul TOPIS control room [31].



Fig. 5: Seoul TOPIS control room, interior view.
Source: adopted from [31].

4.5 Congestion Pricing and Parking Policy

Seoul has introduced a 1.5 USD fee for accessing the tunnels connecting CBD with the areas located at the southern part of the Han River (Nasman 1 and 3 tunnels) since 1996. It reduced 24% of traffic (vehicles per day) accessing the CBD, and the traffic speed significantly increased from 21.6 km-per-hour to 33.6 km-per-hour [28].

SMG has reduced the parking requirement in the new building's planning and design from the previous 40% to 20% in the central part of the city (in the CBD) to discourage city people's orientation to private cars [28]. Along with this, SMG has reduced the public parking facilities and the spaces for street parking with the intention that car users need to focus more on private parking spaces, incurring more costs (parking fees), which may help discourage them from using private cars [28].

4.6 Impacts of the Adopted Measures

The SMG's sustainable policies brought a positive impact as they helped to decrease traffic congestion significantly while elevating the movement speed of vehicles and increasing the satisfaction level of city people. Fig. 6 shows that transport

speeds in the city centre and the outer city areas increased successively between 2004 and 2013. It also shows that during this period, the movement speed of private cars and public buses increased.

Fig. 7 shows that the total modal share of the city's public transport in 2016 reached 65.1%, composed of the modal shares of the public bus (28%) and the subway system (37.1%). Fig. 8 shows that in 2003, the average satisfaction level was 4.76, which started to increase gradually after the introduction of the new transport policy in 2004, and in 2012, the citizens' satisfaction level was recorded to be 7.5. Seoul's feedback methodology to understand the impact of the policy reform shows a tremendous positive impact of the transport policy on the city.

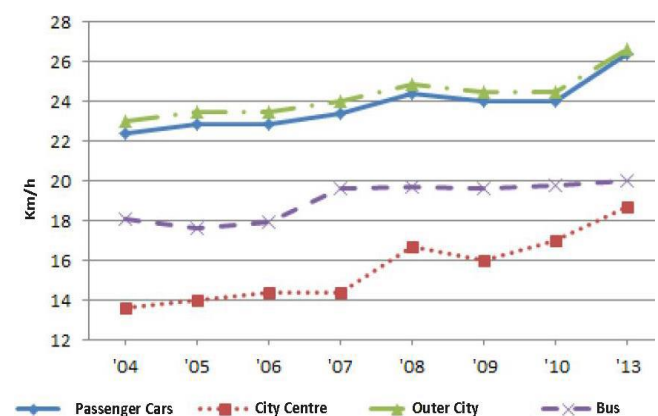


Fig. 6: Gradual increase of vehicular speed in Seoul from 2004 to 2013. Source: Adopted from [28].

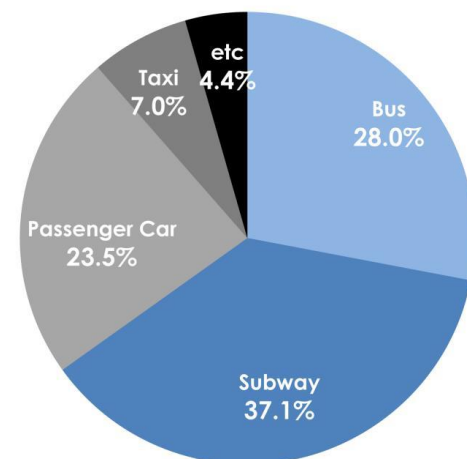


Fig. 7: Seoul's transport modal share in the year 2016.
Source: Adopted from [31].

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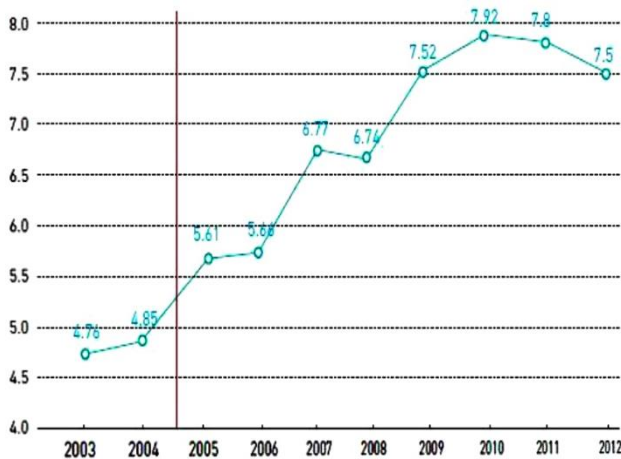


Fig. 8: The citizens' satisfaction level in Seoul has increased gradually in different years.
Source: Adopted from [31].

5. CASE STUDY FROM COPENHAGEN, DENMARK

The city of Copenhagen is the capital city of Denmark in northern Europe, having a population of 1.3 million in 2018, with a projection to increase to 1.4 million by 2030 [2]. The city has adopted the transport policy's path dependency to promote walking and biking as the city's primary modes of public transportation. The city promotes biking as a safe, environment-responsive and cheaper mode of urban transportation and focuses on developing well-connected bike networks integrated with other modes of public transport like public buses and urban railway services [32].

The city adopted a 'strategic plan' in 2000 to improve the cycling facilities further by 2012. The city allocated a budget of 9.1 billion USD in 2000 to improve its transportation system, where one-third of this budget was utilized to improve the city's cycling infrastructure [33]. The city aimed to increase the proportion of city people considering cycling as a safe transport mode to 80% by 2012 from 57% in 2000. It also aimed to elevate the proportion of the city's active cyclists from 34% in 2000 to 40% in 2012. The city's strategic plan focused on obtaining the modal share of cycling to be 50% among all the transport modes by 2016 through the enhancement of the urban cycling experience, ameliorating safety, comfort, and services. [33].

Moreover, the city's 'CPH-2025 Climate Plan' stressed cycling as an environmentally responsive transportation mode that reduces carbon emissions [34]. It developed a policy target to attain 75% of the total trips in the city to be covered by walking, biking, and use of different public transport modes by 2025. The plan also aimed to contribute to making Copenhagen a carbon-negative city by reducing 10% emissions from urban vehicles. The 'Copenhagen's cycle-strategy plan' for 2011 to 2025 developed a policy target for the consistent increase in the city's travel speed by 5%, 10% and 15% by 2015, 2020 and 2025 respectively [34]. Some key measures of Copenhagen for attaining such policy goals are discussed in the following sections.

5.1 Developing Bike-networks

The city people have an age-old culture of using bikes as a mode of transportation since the 1960s or 70s. The number of cyclists had increased significantly by 2016, such that one in every three city inhabitants owns a bike [33]. On both sides of the motorways, the city government has built separate infrastructural networks of bike lanes having a total length of more than 3,000 km. Such bike lanes are a separate infrastructure from the motorized and pedestrian circulations and contain a width of 2 meters for bike movements (see Fig. 9).

Along with the bike lanes, the city has focused on developing and managing efficient bike parking facilities. The city has also introduced cargo bikes that bring the facility to carry goods or other heavy baggage using the bike infrastructures. 26% of families in the city containing two or more children possess such a cargo bike [35].

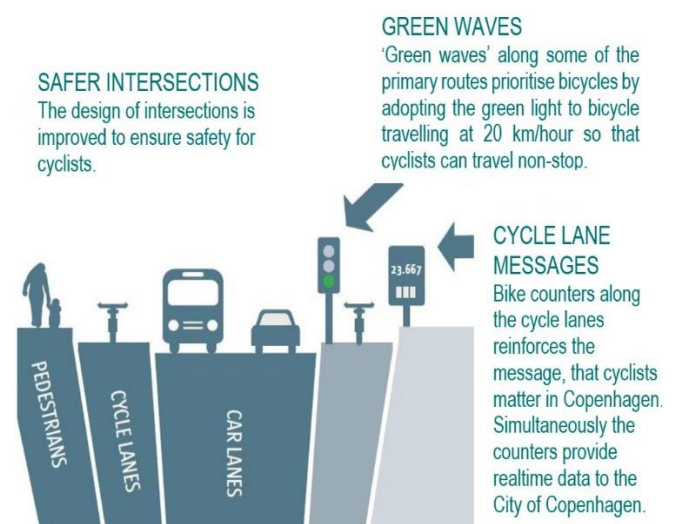


Fig. 9: Separate bike lanes in Copenhagen.
Source: Adopted from [36].

5.2 Greenways and Bridgeways

The city has developed 43 km of urban greenways and adopted a plan to build another 54 km to help cyclists move away from the motorways and come close to the green nature or the public recreational spaces [35]. The city has also constructed two bridgeways for bicycles over the watery parts of the city to develop a connected bicycle network. Such initiatives may enhance comfort and promote a good biking environment for the city people coming close to nature [36].

5.3 Promoting Public Transport

The city has developed an efficient public transportation service with the A-bus, S-train and urban metro services that 0.75 million urban people use for travelling each weekday. The city plans to elevate the urban inhabitants' use of public transport by 3.4%. Reports show that 98% of people in

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Copenhagen may find access to public transportation facilities within a distance of 350m. All the public transportation systems in the city are managed by the ‘intelligent traffic management system’ using state-of-the-art technologies to enhance efficiencies [37]. The bike infrastructures and the public transport services are interconnected to promote an efficient network of urban transport systems (see Fig. 10). 27% of the people who use urban rail services for long-distance commutes use bikes for accessing the rail stations [38].



Fig. 10: Copenhagen’s framework for promoting interconnected bike routes and public transport.
Source: adopted from [38].

5.4 Impacts of the Adopted Policies

The satisfaction level of the urban inhabitants in Copenhagen for the total network of bike lanes developed was boosted from 64% in 2004 to 80% in 2014. Their satisfaction level for the effective maintenance of the bike lanes also increased from 50% in 2004 to 63% in 2014 [35].

Reports show that 88% of Copenhagen’s urban inhabitants consider cycling a faster, safer and more convenient mode for city travel [36]. Fig. 11 shows that for all the urban journeys in Copenhagen made in the year 2014 having the purpose of education and work, the city’s transport modal share for cycling was 45%, while the modal share of public transport, car, and walking was respectively 27%, 23% and 5% [35]. Here, it is significant to note that the transport modes of cycling, walking and public transport comprise 77% of the total urban modal share, while the car contributes 23%.

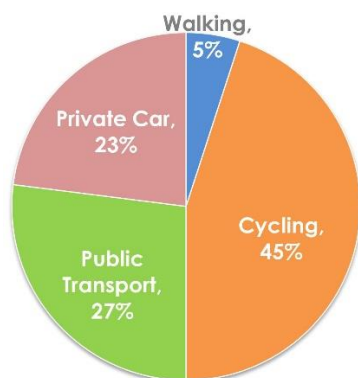


Fig. 11: Copenhagen’s transport modal share in the year 2014 for education and work-related trips.
Source: Author’s composition based on [35].

Fig. 12 shows that in 24 hours on a weekday, the number of cars travelling in the city centre of Copenhagen decreased from 0.46 million in 1970 to 0.32 million in 2014 [35]. During this period, the number of cycling trips to the city

centre has increased by more than double [35]. A city generally accumulates more cars over the years, but the number of cars in the city centre has reduced significantly due to Copenhagen’s sustainable transport policy.

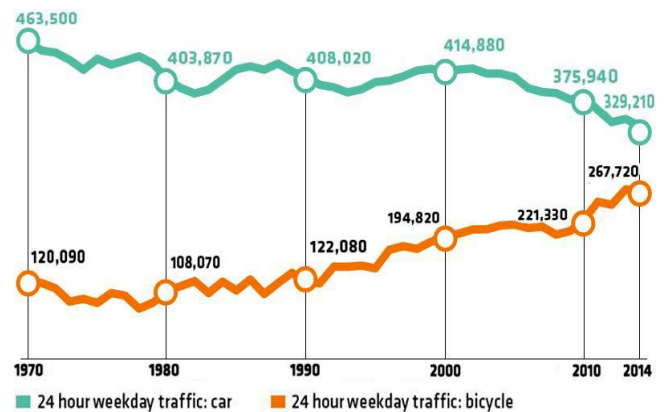


Fig. 12: Number of vehicles travelling to and from the city centre in Copenhagen in 24 hours.
Source: Adopted from [35].

6. DISCUSSION: INSIGHTS FROM THE CASE STUDIES AND THE WAY FORWARD

Dhaka city is a densely populated megacity, and the city is accumulating more people due to migration from other regional places in Bangladesh. Though the contexts of the case studies presented in this paper are different from Dhaka city, they may offer different lessons based on the adopted measures, the practicalities of different sorts of transport policies and the positive outcomes of those. As Dhaka contributes highly to the country’s economy, it develops the significance for the city’s transport planning to consider learning from the world of cities for managing common or similar problems and developing creative, local and sustainable urban solutions. Sustainability is always a locally situated issue that satisfies any practice’s environmental, economic, and socially viable aspects. The context of Seoul documents the successful implementation of the action plans for the adopted public-transport-oriented policies in the face of traffic congestion due to the city’s high car dependency. The context of Copenhagen from northern Europe presents the city’s orientation to a greener arrangement for public transportation, focusing highly on walk-bike urbanism. Both case studies show the public acceptance of the transport policies as the citizens’ satisfaction levels have increased.

Dhaka city is rapidly growing with the increased population, which may cause a fast rise in urban transportation demands. There is a lack of workable data regarding the behaviour of the mass people, the traffic loads on different roads, the city’s informality, people’s levels of responsiveness to the laws, and the projection for future traffic demands. Both case studies show that smart cities adopt high-quality urban data using state-of-the-art technologies that support planning for and managing integrated and efficient urban transport systems. Dhaka city may have the scope to improve the use of state-of-the-art technologies for developing urban

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transport networks as the city promotes a vital contribution to the county's economic development.

Dhaka city's transport modal share shows that in 2016, the city's major share (88%) of the trips was covered by rickshaws, buses, and walking, which determines that there remains a good scope for promoting public transportation and walk-bike urbanism. The data for the major modal share in Dhaka justifies that improvement of the facilities for public transportation and walk-bike urbanism may also have a profound public acceptance, satisfying the socially viable aspects of sustainability.

The government of Bangladesh has taken a package of strategic plans for the long term to decrease the traffic congestion problem in Dhaka city and has sanctioned an investment budget of over 37 billion USD [3]. Regarding the adopted policy measures, the proposed MRT networks (metro rails) and the BRT lines will help enhance the public transportation facilities in Dhaka. However, from the case study of Seoul, it may be pointed out that the metro rail service may be a costly mode of transportation for promoting public transportation in a developing city. To promote an efficient metro rail network in Dhaka city, new infrastructure, operating and management systems need to be set up. Seoul's case also documents that the urban bus rapid transit (BRT) system may promote a low-cost and relatively easy-executable infrastructure for a city in a developing country with resource limitations compared to the metro rail system. Both the initiatives of developing MRT and BRT in Dhaka are robust measures that may help reduce traffic congestion in Dhaka, and the government must continue to implement such public-transport-oriented policies successfully.

The government's plan to develop separate 'ring roads' around Dhaka city may help decrease traffic congestion, reducing the number of vehicles in the city centre by diverting the vehicles crossing the city redundantly to go elsewhere. As discussed, Dhaka city's total road infrastructure is less than what is required for sustainable urban transportation, which will also be improved with such ring roads. Along with this, congestion pricing may be introduced for the bustling roads in the city centres to discourage car users from using the overloaded routes. Rates of such congestion pricing may vary depending on the travelling time (peak or off-peak rates) on these busy routes. The case study of Seoul shows that congestion pricing has helped reduce the traffic on the busy roads in the city centre and enhance travelling speed.

The case study of Copenhagen points out that walking and non-motorized biking by city people may promote a city's major transport mode, reducing car dependency, traffic congestion and carbon emissions. The study documents that transport modes of walking and non-motorized vehicles can be effectively integrated with the motorized public transport system. Dhaka's transport modal share shows that non-motorized vehicle rickshaws had a 38.3% share in 2016, which has occupied an increasing trend over the past few years. The government's policies for non-motorized vehicles

may help increase the speeds of motorized vehicles, but it demands more robust planning regarding the routes of non-motorized vehicles. The non-motorized vehicle routes need to be well-organized and well-planned to integrate with the motorized public vehicle routes to promote a sustainable urban transport system. Besides, Dhaka city does not have a separate bike infrastructure at present. Planning for the routes for non-motorized vehicles may help incorporate bicycles and cargo bikes as a mode of mass transportation. Along with the planning and successful implementation, the urban people may need to be encouraged to cycle in the city, and necessary signposting must be provided for the cyclists' ease of integration with the public transport routes. The case of Copenhagen shows that designed bike routes having safety intersections, green waves (speed limits), cycle lane message boards, and the setting of greenways to connect with nature and public places have enhanced the safety and comfort of cyclists.

Dhaka's transport modal share shows that the modal share of walking has a decreasing trend as it plummeted from 60.1% in 1994 to 19.8% in 2016 (decreased 32.9% in 20 years). It documents that walking in Dhaka city is becoming a less popular mode of transportation. The footpaths (pedestrian ways) in Dhaka need to be planned well to enhance the walkability and comfort of the city's people. The footpaths need to be made free from obstacles like construction materials and encroachments of the street hawkers. An integrated design with the vehicular way, separate bike lane, footpath, and a well-designated space for street hawkers alongside the footpath may be developed. Dhaka city's policy measures to develop foot overbridges for pedestrians are good initiatives for safely crossing busy roads, but the foot overbridge's universal accessibility, comfort, and maintenance need to be carefully addressed.

The case study of Seoul shows that reducing publicly available parking facilities and impelling car owners to pay high parking fees may discourage car dependency. Dhaka city may strengthen the traffic laws for unauthorized parking near the roads and promote separate places designed for vehicular parking with parking fees to discourage car dependency.

Both case studies show the importance of the state-of-the-art intelligent traffic management system providing real-time GPS-tracked transport information. Dhaka may need to plan for developing, implementing, and maintaining an intelligent traffic management system. It will help efficiently manage the transport system, promote traffic rules and send relevant information to law enforcement agencies and the users. Both cases have presented the city's innovative methodology to perceive the feedback and public acceptance of the adopted policies (such as citizens' satisfaction levels, speed and number of vehicles on the roads) to plan effectively in the urban areas. Dhaka city may develop a methodology to understand the impacts of the policies and take necessary steps based on that on the way forward. Without a good monitoring and feedback system, no responsive planning and positive outcomes would be possible.

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The discussion above regarding the learning from the case studies and the way forward for Dhaka city to reduce traffic congestion demonstrates that some of the measures adopted by the government may positively impact decreasing the traffic congestion problem, and the government must continue to implement the strategic plans successfully. This study builds on the present strategic plans and discusses additional innovative measures justified by their application by the other cities to determine the potential avenues to follow. This study has found that the promotion and successful implementation of the contemporary walk-bike urbanism concept and its effective integration with an efficient urban public transport system may help reduce the traffic congestion problem in the megacity of Dhaka. Such integrated transport planning for Dhaka may have the capacity to advocate an environmentally green, economically responsive, and socially acceptable system fostering sustainability.

7. CONCLUSIONS

This paper focuses on the traffic congestion problem in the megacity Dhaka and has analyzed its significant causes, impacts on urban life and the adopted policy measures to reduce the congestion problem. It discusses that the government of Bangladesh, through the Strategic Transport Planning in Dhaka, has commissioned a long-term master plan for 20 years (2016-2035). This paper bears significance in suggesting innovative and potential measures to reduce the traffic congestion problem based on the learning from the case studies. This article brings two case studies from Seoul in South Korea and Copenhagen in Denmark to discuss and learn from the best practices of the adopted measures reducing traffic congestion in urban areas. The study suggests that improving Dhaka city's public mass transportation facilities with urban bus and train services may help reduce traffic congestion. Lessons from the case studies document that promoting walking and non-motorized transportation systems in Dhaka city may have tremendous potential to reduce traffic congestion significantly. To promote an efficient urban transportation system, walking and non-motorized biking infrastructure must be integrated with the public transportation routes. The case studies also support the idea that Dhaka needs to adopt an intelligent traffic management system and an effective monitoring and feedback method to learn about the responsiveness of the adopted policies to minimize the congestion problem. The study may promote the scope for further research regarding how the city peoples' responsiveness to different policy measures contributes to reducing the traffic congestion problem in Dhaka.

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