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Road Transportation Challenges in Bangladesh: The case of traffic jam in Dhaka City

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Abstract

This study investigated the core challenges of road transportation in Bangladesh and more specifically in Dhaka city. Among the challenges, traffic jam cause unbearable damage in terms of economic, social, environmental impact and daily life problems.

The primary data for the study was collected from the websites of various ministries of Bangladesh and other relevant data sources, for example, the road and transportation website. Secondary data was collected from books, journal articles, the daily newspapers of Bangladesh and other online sources. This study had a qualitative research approach.

The primary data was analyzed by comparing it with that obtained from other developing countries with the same kinds of problems. The results suggest that the main causes of road transportation problems and traffic jams are mismanagement, poor infrastructure, ignorance, negligence to follow the traffic rules, limited use of advanced technologies and limited resources. In order to minimize the traffic conditions within its limited resources, the country needs to initiate a number of alternative solutions, for example, traffic demand control, widening the roads, providing more public buses and using the Intelligent Transportation System (ITS) along with an efficient management system.

Keywords/tags (subjects) Technology, Communication and Transportation

Miscellaneous (Confidential information)

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1 Introduction

Dhaka is the capital of Bangladesh with over 20 million people (BBS 2019). This is the most industrialized and overcrowded city of Bangladesh. However, the infrastructure of the city has not been developed with proper planning (Hossain, Ahmad, Islam, & Asadujjaman 2017). Due to this unplanned growth of infrastructure and increased private vehicles, traffic congestion becomes an unbearable daily life problem. Economist Intelligence Unit's livability Survey (2013) suggests that Dhaka is the second most unlivable city in the world. The population density in this city is as high as 46.997 per square kilometer (BBS 2019).

Yang, Purevjav, and Li (2019, 2) argue that in most developing and middle-income countries, severe traffic congestions are a universal problem in big cities. One top reason for that is the rapid increase of personal vehicles as well as inadequate infrastructure development. The primary cause of this unbearable traffic congestion in Dhaka city is the increasing demand of private cars, lack of public transportation, road transportation as the only means of transportation, inefficient management, lack of the use of Intelligent Transportation System (ITS), lack of resources and unplanned infrastructure (Khan & Chowdhury 2014; Hossain et al. 2017).

The living conditions have been worsening everyday especially due to traffic congestion in Dhaka city. Therefore, it is very crucial to find some solutions to reduce the traffic congestion so as to enhance the sustainable development of the city. According to Yang and colleagues (2019, 17), using road pricing as the first-best policy to address congestion has been drawing increased attention from the policy makers. Other alternatives include traffic demand control, use of ITS, developing public transportation facilities and developing expressways (Bertini 2014, Khan & Chowdhury 2014, Makino, Tamada, Sakai & Kamijo 2018, Yang et al., 2019).

This study focused primarily on traffic jams in Dhaka city and an overview of the overall transportation challenges in Bangladesh, which was also linked to traffic jams all over the country. The primary data was collected from the Bangladesh government websites and other statistical data sources related to transportation in Bangladesh. The data was analyzed in a qualitative descriptive manner.

1.1 Background of the study

During the last few decades, the world has witnessed that urbanization has been increasing dramatically as automobiles have been affecting the personal, social and economic life of countries as well as their environments (Pojani & Stead 2015, 7785). About one quarter of the world's population live in urban areas (ibid., 7785). According to the United Nations (UN 2011), urban population will be doubled from 2010 to 2050. In the developing countries, the situation is more acute. Due to the rapid growth of the number of automobiles, the cities have been experiencing multiple transportation related challenges including traffic jams, pollution, accidents, public transportation decline, environmental degradation and lack of accessibility for the poor (Pojani & Stead 2015, 7786). As a result, sustainable urban development needs to include proper transportation systems, which has a great impact on economy (ibid., 7788).

Bangladesh is one of the fastest growing economies in the world. The Bangladesh economy is the 32nd largest in the world in terms of purchasing power parity, and it is considered to be within the next eleven emerging market economies in the world (Chowdhury, Shahriar, Fahim, & Bhuiyan 2016, 60). In 2016, the country experienced a 7.1 GDP growth, which was the second fastest growing economy (IMF 2017). Since the last decade, the country has had an average GDP growth of 6.5% (ibid., 59). The primary source of revenue of the country is exported textile products. Bangladesh is the second top textile exporter behind China (Khan & Islam 2013). However, despite significant developments in many indicators, road transportation is one of the top challenges in Bangladesh (Nasir & Whaiduzzaman 2015). Every day there is news about accidents in the television or newspapers. Road accidents take away the lives of school going students, professional workers and other civilians (Khan & Islam 2013). According to Accident Research Institute (ARI 2019), annually, over 3000 accidents happen on average, which causes around 2700 people being killed and 2400 injured. Only in 2017, 4,979 accidents occurred which caused 7,397 people being killed and 16,193 injured. Economically, these accidents cause BDT a 40 billion loss, which is over 2% of Bangladesh's GDP (BPWA 2019).

Along with other transportation challenges, traffic jams in big cities, especially in Dhaka, cause unbearable difficulties for the residents and those who visit the city for

various purposes. The domestic and international business and most economic activities to some extent are involved with Dhaka city (Chowdhury et al. 2016, 59). Besides this, around twenty million people live in Dhaka city (Hossain et al. 2017, 89), which makes Dhaka city uninhabitable because of the huge traffic jams. People have to spend their valuable time on the street sitting in vehicles for long hours due to the heavy traffic jams. Students, officials and daily workers cannot reach their destinations timely. Even in emergency cases, for example, ambulances or fire trucks cannot reach the spot in time. People have to struggle to catch their domestic and international flights as they have to reach the airport by passing this excessive traffic jam in the street (Sarma 2009).

Although transportation has emerged as a major challenge in Bangladesh since the country became independent, there has been no remarkable development in this sector. Most of the previous governments of Bangladesh have promised to develop the transportation system, but the situation has remained the same during the last few decades (Hoque, Nasrin & Sultana 2015). Moreover, very limited research has been conducted on transportation challenges and traffic jams by the government, third sector and academics. Therefore, it is timely to conduct extensive research on how to develop the overall transportation system in Bangladesh and minimize traffic jams in the big cities, especially in Dhaka.

1.2 Study objectives and research questions

The citizens of Bangladesh have to face diversified transportation challenges every day in their life. This is not only causing serious economic damages for the country but also raising troubles in the social and personal domains. Among transportation challenges, traffic jams are on the top especially in the big cities like the capital, Dhaka. The inhabitants of Dhaka city routinely face traffic jams while going out for daily work. In addition, traffic accidents are very common, which often take many lives and leave families in a vulnerable situation. The primary objective of this study was to determine the main reasons for traffic jams. Other objectives included examining the relationship between the traffic jams and the transportation system management. In addition, addressing the main challenges, this study was hoped to provide some recommendations

for overcoming the situation. Following the research objectives, this study primarily investigated the following research questions:

Question 1: What are the main challenges of urban road transportation?

Question 2: What are the primary causes of traffic jams?

Question 3: To what extent is it possible to reduce traffic jams in Dhaka city?

1.3 Study method and data analysis

One of the major challenges of research is choosing the right method to conduct the research. Punch (2005, 13) categorizes six factors to consider when conduct research. The first one is the research question which can guide the method, or the method can guide the research question. The second one is choosing the research approach, for example, systematic statistical research or an explorative study of a phenomenon. The third and fourth factor involve availability of literature and feasibility to carry out the research. The fifth and sixth factor include the outcome and the style that the researcher prefers. This guideline inspired the author to conduct a qualitative study in order to obtain empirical evidence from the real-life situation. The transportation and traffic jam situation has been prevailing as a great problem for the citizens of Bangladesh. Therefore, the phenomenon demands explanation for the situation rather than a statistical data presentation. However, the author decided to collect all statistical data from various data sources from the Bangladesh government's website to demonstrate to them with explanations of the situation and its impacts. The following chapters describe the rationale for selecting the study area and methods.

1.4 Selection and data collection method

There are many different methods to conduct research. Qualitative and quantitative are the most common types of research methods. Quantitative research is a structured way of collecting and analyzing data obtained from different sources. Quantitative research involves the use of computational, statistical and mathematical tools for deriv-

ing results. The most common approach to quantitative research is a survey or questionnaire. Surveys can include interviews, which can be carried out using several different methodologies including face-to-face, telephone, online or computer assisted interviews. Quantitative approaches are usually more structured than qualitative methods. Qualitative research is a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data. (Bryman 2008, 366). Qualitative research is a scientific method of observation for collecting non-numerical data. Qualitative research mainly focuses on the clarification of empirical data and offering a clear understanding of a phenomenon. Interviews, group discussions, experiments, observations and simulations are the most widely used techniques for qualitative research.

This study focused primarily on traffic jams in Dhaka city and the overall transportation challenges in the country. It is understandable that traffic jams are both directly and indirectly involved with the transportation system problems. As a result, this study needed explanations for the phenomenon. Therefore, qualitative research was considered for this study as the best tool for investigating the real phenomenon keeping the social and cultural context in mind.

In qualitative research, researchers use many different methods to collect the data because all methodologies have some strengths and weak sides. Besides this, for a scientific study, different methodologies are more scientific and popular in different social, political, historical and cultural settings (Dawson 2002, 15, 34). However, due to the logistical problems, the data for this study was collected from Bangladesh government's websites, for example, the Bangladesh Bureau of Statics (BBS), daily newspapers, and other relevant data sources. In addition to this statistical data, secondary data was been collected for theoretical clarification as Marshall and Rossman (1989, 35) state that, "a *literature review refines and redefines the research questions and related tentative hypotheses by embedding those question in large empirical tradition."* Books, journals, government reports, scientific journals, articles, research documents and the world wide web were used for analyzing the key concepts such as transportation, traffic jam, management, Dhaka city and Bangladesh.

1.5 Selection of study area

With a vast population, the capital of Bangladesh has been struggling to serve its residents in many ways. However, traffic jams can be regarded as one of the top-most difficulties for all residents. A number of factors, including overpopulation, excessive vehicles, unfit vehicles, unqualified drivers, poor road conditions and other such factors primarily cause this unbearable traffic jam condition. However, very few studies have been conducted to explore the phenomena. Therefore, the author chose this city as a study area. In addition, literature suggest that there is a great number of big cities around the world facing traffic jam challenges. Therefore, the study carried out on Dhaka city might provide useful information for further research in the international arena.

1.6 Timetable of the study

This study was carried out between January 2019 and May 2019. This study initially developed theoretical knowledge concerning the issues of transportation, Bangladesh, traffic jams and Dhaka city. In addition, the right method was sought for collecting the data in order to conduct this study scientifically. All this process took around three months. The literature review and the Methods Chapter were written simultaneously. Finally, the last two months were spent in analyzing the data and finalizing the thesis. All efforts took around five months to accomplish the study.

1.7 Limitations of the study

The limitations of this study can be identified both theoretically and methodologically. Theoretically, this study deals with transportation challenges and traffic jams in Dhaka city. However, both the transportation challenges and traffic jams are caused in different locations for different reasons. However, in this study, it was not possible to deal with all of them. Therefore, this study was determined to focus specifically on Dhaka city. Methodologically, this study was carried out by using the qualitative approach based on statistical data from different sources. Empirical evidence from the study area could have been more extensive in order to gain in-depth information about the

phenomenon. However, due to background knowledge of the study area, statistical data could be verified with practical knowledge.

2 An overview of Bangladesh

As an independent country, Bangladesh emerged in 1971 after a bloody nine-month long liberation war against Pakistan. The area of Bangladesh is very small with a large number of populations, which is one of the primary reasons for population density all over the country. In Bangladesh 1252 people live in per square kilometers and it is the most densely country in the world (Chowdhury et al. 2016, 62). Due to a large number of people, the country faces many logistics challenges (Khan & Islam 2013). The road conditions are very poor, vehicles are faulty to drive and a great number of drivers are not well trained with valid driving licenses. As a result, despite significant development in many UN indicators, transportation, especially road transportation stays remain as a crucial development challenge in Bangladesh.

Geographically Bangladesh is located in South Asian region. The total area of Bangladesh is 1,47,570 square kilometers. The administrative capital of Bangladesh is Dhaka. Another big city Chittagong known as economic capital. In Chittagong there is an international sea port. Most of the international export and import take place through this port. Bangladesh has seven principal administrative units known as divisions. These are Barisal, Dhaka, Chittagong, Rajshahi, Khulna, Rangpur and Sylhet. There are 64 districts (zilas) under these divisions and again the districts have been divided into 462 upazilas and 34 thanas (Khanom 2011, 36). See below the map of Bangladesh.

Figure 1 Map of Bangladesh.

Source: https://www.google.com/search?q=map+bangladesh

Almost three quarter of Bangladesh is bordered by India. The southern part of Bangladesh surrounded by the Bay of Bengal. In the Southeast part, Bangladesh has a border with Myanmar. With India Bangladesh has many land borders. Therefore, these countries deal most of the commercial activities through road transportation. Bangladesh has 700 rivers that's why it is called riverine country. Bangladesh has 24,140 kilometers waterways. Bangladesh has 22 big river ports. Thus, there is good transportation system with this waterway for people and products. Bangladesh land is very flat. Only Chittagong division and Sylhet district there are some mountains and hills (Khanom 2011, 38).

Bangladesh is one of the most densely country in the world (UN, 2019). Over 160 million people live in a very small land. The situation is more pressing in Dhaka and other big cities. Bangladesh population is equivalent to 2.18% of the world population (Chowdhury 2013, 111). Bangladesh ranks number 8 in the list of most populated countries. The population density in Bangladesh is 1252 per Km^2 (ibid., 112) where as in Dhaka city this is much higher than this number. The median age in Bangladesh is 26.0 years. The capital of Bangladesh is Dhaka. Dhaka and Comilla is the most densely area compared to other cities (Khan & Islam 2013).

Bangladesh economy is predominantly agriculture based. The land of Bangladesh is very flat and fertile. The farmer can produce crops as much three times within a year. Therefore, many Bangladeshi earn their living from agriculture. Agriculture have been providing employment for 63% of the population and contributing 19.6% of Bangladeshi GDP (Hossain 2013, 112). The primary crops are rice, jute, maize and vegetables. Tea, wheat, cotton, sugarcane is also grown in Bangladesh. Jute and Tea is the most export revenue earner. Aqua products are also a source of revenue. Along with agriculture the top revenues come from export products and manpower working abroad (Khan & Islam 2013).

2.1 Bangladesh transport system overview

Transportation is needed for moving of goods, animals and persons from one place to another. The common forms of transportation are bus, truck, plane, automobile, ship and two wheelers like bike or motorbike. Due to technological advancement, all kinds of transportation system have become very modern and comfortable around the world. However, transportation system in Bangladesh especially road transportation is still far behind the standard level due to poor infrastructure, mismanagement and limited resources.

2.1.1 Road transportation

Although Bangladesh is called as a riverine country, road transportation is still the primary mode of transportation and to some extent rail transportation (Sarma 2009;

Shakil 2016). Rail transportation is not available all over the country. However, Bangladesh has good road transportation network. Road transportation is very effective and easy form of transportation in Bangladesh because it connects all the parts. The country's economy largely depends on road transportation (ibid., 2009). Bangladesh road network is made of three kind of road categories: National highways, regional highways, zilla road. Bangladesh has total 21,302.08 km road. The table below shows the road transportation details statistically (Khan & Islam 2018).

Table 1: Bangladesh road networks

(Adapted by Online Road Network (2019)

Classification	No. of roads	Total length (km)
National highways	96	3812.78
Regional highways	126	4246.97
District roads	654	13242.33
Total	876	21302.08

Although Bangladesh has made some roads for transportation, the size of the roads is not good enough, which often cause accidents. Most of the roads two lanes and tiny. In addition, the road conditions are very poor in most places (Hoque 2015). The conditions worsen especially in the rainy seasons. According to BRTA (Bangladesh Road Transportation Authority) Bangladesh has total 3419884 vehicles (BRTA 2019). However, literature suggest that a big portion of vehicles are technically fault to drive (Rahman & Nahrin 2012). However, due to mismanagement, these cars are somehow permitted to drive on the road which often causes accidents (Prothom-alo 2019).

2.1.2 Railways

Rail transport in Bangladesh began on 15 November 1862 during British colonization period (Hossain et al. 2013, 62). Bangladesh railway transportation could be one of the essential modes of transportation. However, still it is not as extensive like other countries of the world. The government controls Bangladesh Railway (BR) transportation. It operates and maintains the entire railway network of the country. BR is controlled

by the Directorate General of Bangladesh Railway under the Ministry of Railways along with Bangladesh Railway Authority (BRA) and which works for policy guidance of BR. In 2015, Bangladesh Railway serviced 489 railway stations. Kamalapur is the central railway station in Dhaka. Bangladesh has three kind of railway lines- broad gauge, meter gauge and dual gauge. Bangladesh Railway covers a length of 2,855 route kilometers and employs 34,168 people. In 2014, Bangladesh Railway carried 65 million passengers and 2.52 million tons of freight (Chowdhury et al. 2016, 59).

2.1.3 Airports

The aviation industry of Bangladesh started its operations just after independence in 1972 at Tejgaon Airport in Dhaka with only one aircraft. Later, the Zia International Airport at Kurmitola, Dhaka was constructed to cope with the increasing international and domestic travel demand and was opened for traffic in early 1980. The name of the airport was changed to Hazrat Shah Jalal International airport in 2009 (Chowdhury et al. 2016, 63). The Civil Aviation Authority Bangladesh (CAAB) regulates all aviation related activities in Bangladesh. Currently Bangladesh has three international and twelve domestic airports. The largest one is Hazrat Shah Jalal International Airport in Dhaka, second largest is Shah Amanat International Airport in Chittagong and the third one is Osmani International Airport in Sylhet (ibid., 64-65).

The three international airports carry 102,019 passengers each month and have capacity of carrying 150 MT yearly. The total number of annual international flights was 11,308 in 2011 (Chowdhury et al. 2016, 63). There are four customs offices in Bangladesh. These customs offices deal with air cargo. Bangladesh can be reached by air from any part of the world. A number of airlines have been operating their flights with Bangladesh airports (ibid., 62). Biman Bangladesh Airlines is our main airlines flying 26 major cities in the world. In 2016, 3815870 passengers have been flying to and from Bangladesh (ibid., 62).

2.1.4 Waterways

Bangladesh, is a country of thousands of rivers, water transport is a major mode of transportation of goods and people especially for certain regions due to a number of big rivers connected to these areas. It is also the cheapest mode of transportation

compared to rail and road transportation. Bangladesh total inland length of water ways is 24000 km. However, 6,000km are navigable during monsoon and 3,900 km during dry periods. There are over 22,300 registered vessels engaged in trade (Chowdhury et al. 2016, 59). Several hundred thousand handmade manual boats are traditional vessels, which have been plying inland and coastal waters for hundreds of years and play a key role as a rural mode of transport of goods and people. Inland ports and other facilities include 11 major inland ports, 23 coastal island ports, 133 launch stations and more than 1,000 minor landing points located in rural areas. Bangladesh Inland Water Transport Authority (BIWTA) is the authority who controls the inland water transport in Bangladesh (ibid., 59).

However, the infrastructure problems on the inland waterway system is poorly addressed (Chowdhury 2013). As a result, the inland waterway system is not used to its full potential, to some extent due to inadequate dredging and shortage of berthing facilities. By Improving waterways, it can have the potential to reduce transport costs for bulk cargo and provide better access to areas, such as in the North-West part of Bangladesh, where road access is compared to other region limited (ibid., 2013).

Sea transportation is crucial for Bangladeshi trade and commerce. The port of Chittagong is responsible for 30% of Bangladeshi GDP and handle 92% of Bangladeshi international and maritime trade (Hossain et al. 2017, 93). It is called the heart beating of Bangladeshi economy. The rest is carried out through Mongla and few other river and land ports. Chittagong is one of the oldest ports in the Bay of Bengal region. These two ports deal major portion of country's export import business.

3 Anatomy of traffic jam

3.1 Road traffic and transport network

Road traffic and transport network means the system in which different roads are connected each other for smooth transporting system (Bertini 2014). Due to technological

advancement and industrialization much more people have been moving to urban areas (Sharma 2012; Khan et al. 2018). Due to this demographic transformation number of vehicles and freights are also increasing (Khan et al. 2018; Yudhistira et al. 2019). Depending on the situation, developed countries adapt with transportation networking system by initiating many alternatives for example metro rail, tramline, road expansion, alternatives to avoid intersection and using Intelligent Transportation System (ITS) (Makino et al. 2018). However, for the developing countries it is difficult to manage the situation due to lack of resources, experts and traditional transport system (ibid., 2018). As a result, traffic congestion become a common phenomenon for poor and developing countries like Bangladesh (Sharma 2012).

3.2 Congestion

Traffic jam, according to the oxford dictionary means a long line of vehicles on a road that cannot move or that can only move very slowly. Following this definition, it can be said that, traffic jam occur when many vehicles on a road are stuck and move very slowly or stay remain stuck in the same place for long time. Traffic congestion primarily involved with people's experiences of commuting (Bertini 2005, 2). According to Federal Highway Administration (FHWA) (2004), traffic jam has no single definition because people may have different perception and expectation about the services based on the locations and time. One study among 480 transportation professionals and academics asked the definition of traffic jam (Bertini 2005, 2). About metropolitan congestion, they consider traffic congestion by separating freeway and signalized intersections. In the intersections, they need to wait second or more round of green signal due to heavy car flow. They consider it as traffic jam. They mention about time, speed and volume of cars. Most of the respondents emphasizes on time to define congestion, which concern travel time, speed, waiting time in the signal, and density of car (ibid., 3-4).

Traffic congestion is an increasing and ubiquitous problem all over the world. Economist (2014) reported that traffic congestion over the world cost over $1 trillion in 2013. The basic reasons for traffic congestion involve excessive cars in the road, inadequate transportation networking, traffic mismanagement and lack of awareness (Mahmood & Mohammed 2012). Although many believe that more road can reduce traffic jam,

study suggest that more road could not reduce traffic jam (Cramton, Geddes & Ockenfels 2018). Duranton & Turner (2011) argued that unpriced added capacity might not affect on traffic congestion. Therefore, pricing for driving can significantly reduce cars in the road, which in turn reduce traffic congestion (Salzberg 2017).

3.3 Impacts of congestion to economy and wellbeing

Traffic jam has diverse negative impact on people, economy and environment. In open eyes we can see that, traffic jam effects on valuable time and energy, decrease productivity, environmental degradation, carbon emissions and many other consequences. According to Bertini (2014, 4), traffic congestion wasted $63.2 billion in 70 metropolitan areas in 2002 for spending extra hours in the street. This author further added that every individual loses around $829 dollar for loss of time in the traffic congestion.

Along with economic loses, traffic jam causes serious environment pollution. Pojani & Stead (2015, 4) stated that in developed countries especially in Northern Europe, some cities have been trying to make cities especially downtown areas car free. A number of studies suggest that, public transport improvement, non-motorized modes, limiting the private car use, pedestrian zone and such environment friendly transportation system could have significant impact on traffic congestion reduction (Bertini 2014; Makino et al. 2018; Yudhistira et al. 2019).

3.4 Transport network in Dhaka city and challenges

The only transportation means in Dhaka city is road transportation. However, recently the government of Bangladesh has been planning to initiate alternative means for example tramline and metro rail system with road transportation network (Prothom-alo 2019). The city is built during the British colonization period of 200 years and ends in 1947 (Khanom 2011). The then government built most important road. However, after that, there were no significant improvement happen in Dhaka city road transportation network (Prothom-alo 2019). However, last few decades the population has increased dramatically. Therefore, vehicles especially private cars have been boomed since last decade. To adapt with the demand of traffic, the road transportation network has not been developed accordingly (Chowdhury et al. 2016).

There are diverse road transportation challenges exist in the country. Therefore, focusing on a single problem would not solve the problem. The responsible departments and stakeholders need to address the core reasons and act accordingly. Literature suggest that among other reasons, there are some key factors for example mismanagement, poor infrastructure and traffic control system cause road transportation challenges (Mahmud et al. 2012; Rahmatullah 2013; Chowdhury et al. 2016; Khan et al. 2018).

Mismanagement in road transportation involve inefficiency, limited resources and training (Hossain et al. 2017). Some daily newspaper and Transparency International report suggest that a number of traffic police are corrupted (TIB 2018; Prothom-alo 2019) According to these reports, despite knowing the fact that a number of drivers drive the vehicles without license, the authority do little action to prevent them from driving. In addition, duty officers are not active enough to monitor and control traffics on the road. As a result, very often drivers do not follow traffic rules, which cause accidents and unbearable traffic jam. Those who are involved in planning and designing transportation system have lack of knowledge.

According to the data of Roads and Transportation 2018, there are over 3.419.884 vehicles in different roads in Bangladesh (Prothom-alo 2019). However, there are about 488.730 vehicles without technical approve from the authority. Report suggest that these technically faults vehicles often cause accidents in the street. In addition to support the statement, statistical data suggest that there are only 200.000 drivers who has licenses, which indicate that remain vehicles are driven by the drivers without license or have a fake license (ARI 2019). According to ARI (2019), 47% vehicles are driven by fake drivers. According to Roads and highways department of the country, 62 percent of national and regional highways do not have proper junction arrangements (Prothom-alo 2019).

Although Bangladesh has been developing in many different sectors, the roads and infrastructure are still underdeveloped. Most of the roads even the highways are very congested. In addition, all types of vehicles are driven in the same street for example, bicycle, CNG, easy bike, rickshaw, bus, truck, motorcycle, cars etc. (Hossain et al. 2017, 90). Many roads in Dhaka city, there is no separate lane for bicycle or slow-moving

vehicles (Hossain et al. 2013). Even, hawkers occupy the footpaths made for the pedestrians illegally (ibid., 2013; Khan et al. 2018). Consequently, accidents and traffic jam are very common scenario in most of the densely areas of urban and suburban areas. Addition to this, drivers in Bangladesh use to work low paid and long hours (Khan et al. 2018). They usually do not get proper rest. Therefore, they have to drive in spite of tiredness, which cause accidents (ibid., 2018).

Another crucial problem causes road damages is natural disaster and long rainy season (Razzaque 1997). Natural calamities are very common in Bangladesh. There are arguments that most of the road builders do not put proper materials to make the street strong enough (TIB 2018; Prothom-alo 2019). Therefore, while heavy rainfall or floods, most of the roads damage. The government have to struggle to repair the roads every year. Therefore, many roads remain damaged, which cause accidents while driving on these roads.

One another significant problem is traffic-controlling system. In Bangladesh, only big cities have traffic lights, which often either not working or drivers are not following (Rahmatullah 2013, 38). As a result, traffic jam occurs in every crossroads for long hours. Additionally, there is no traffic light system in district or sub-urban roads. Pedestrians as well contribute to traffic jam as they do not follow traffic lights and pass across the roads neglecting zebra crossing sign nearby. These risky passing very often causes accidents and most cases end up by loss of lives. In Bangladesh, the roads are not monitored with automatic cameras. As a result, drivers often drive reckless and make accidents. The figure created by the author below shows the causes of traffic jam for diverse road transportation challenges.

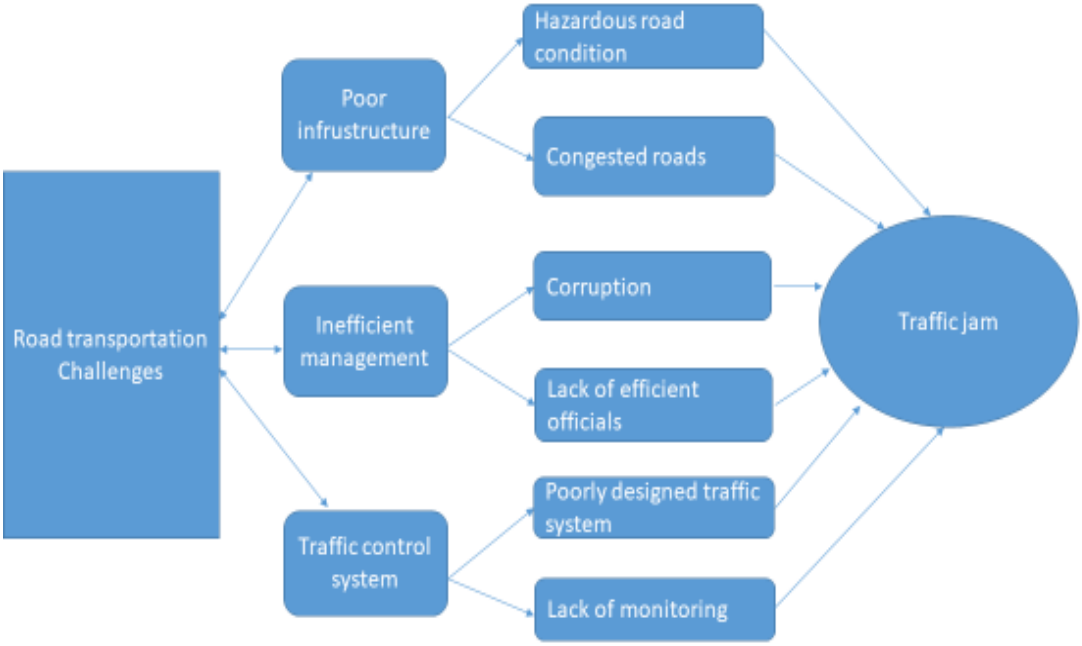

Figure 2 Traffic jam by diverse road transportation challenges

The figure 1 shows that road transportation challenges primarily causes by poor infrastructure, inefficient management and traffic control system. Poor infrastructure contributes to hazardous and congested road conditions. In addition, lack of traffic control system makes transportations more challenging. Since this study primarily focusing on traffic jam and its effect on economy and social life, following paragraphs will specifically focus on traffic jam and its consequences on the residents of Dhaka city in Bangladesh.

3.5 Main reasons and Impacts of Congestion in Dhaka City

3.5.1 Over population and important establishments

Around 20 million people live in Dhaka city, which is over 46.997 per square kilometer (BBS 2019). Moreover, around 400.000 people move to Dhaka city each year (Chowdhury et al. 2016, 59). Because of over population, it increased the number of vehicles in the roads of the Dhaka city. Besides this, study suggests that, there are very few public transport services available in Dhaka city (Khan et al. 2018). Therefore, private sector occupies the road and often break transportation rules in many ways for example, using technically faulty vehicles and drivers without license.

Most of the countries business run from the capital. In addition, most of the public and private headquarters are located in Dhaka city. For example, army headquarters, border guard of Bangladesh headquarters and a number of educational institutions occupies major part of Dhaka city. In addition, most of the garment's factory located in every corner of the city. Therefore, these poor people establish slums here and there. Along with this huge population, every day people use to visit Dhaka city for many purposes, which services could be delivered locally if those offices are decentralized. Although, the population and other establishment have been increasing steadily, the roads and other infrastructures are not developing simultaneously.

3.5.2 Poor traffic administration and application

Among other reasons, enforcement of traffic law is top most one. It happens for many reasons for example lack of resources, lack of training, corruption and negligence to apply the rules, unconsciousness, lack of traffic knowledge etc. It is an open secret in Bangladesh that most of the officials in transportation department are corrupted (TIB 2018; Prothom-alo 2019). Therefore, despite knowing the problems, the officials can hardly take any action against those who break traffic rules in various forms. See below the example of traffic intersection condition of Dhaka city.

Figure 3 Traffic Intersection Condition in Dhaka City.

Source: https://www.google.com/search?q=Transportation+in+Dhaka+city

In addition, a big number of drivers do not have enough driving skills as because the driving test system is not much stricter (Prothom-alo 2019). For example, when someone apply for a driving license, the authority does not take theoretical test in proper way. Even the practical test is been taken in a small place thus not proven that s/he can drive in every situation (ibid., 2019). Transparency International Bangladesh (TIB) (2018) report suggest that most of the driving license are issued by taking extra fees, which is grabbed by the authority illegally. Besides this, many drivers do not have driving license (TIB 201; Prothom-alo 2019). Consequently, they did not have enough knowledge about the traffic laws. These unauthorized drivers eventually have little

knowledge about traffic rules and regulation, which contributes to traffic jam in Dhaka City. Not only the drivers, many inhabitants of Dhaka City have the tendency to violate the traffic rules (Hossain et al. 2017). Pedestrian often cross the roads directly even though there are underpasses, over bridges or zebra crossing (ibid., 2017).

3.5.3 Congested roads and one road for all kinds of vehicles

The Dhaka city corporation could not develop the infrastructures according to the demand for frequent movement. Most of the roads of Dhaka City are very congested. Some roads especially inside the residential areas are very tiny. Therefore, it is difficult to drive two vehicles from opposite directions. In this kind of situation, if both cars from opposite direction go into the lane, the vehicles need to cross each other very slowly. Otherwise, they might collide each other. Addition to this, these types of roads often have a long line of traffics due to slow moving vehicles. Besides this, the hawkers occupy almost every single road in each corner of the city. They use to give bribes to the authority so that the authority does not evacuate them from the street (TIB 2018). As a result, the pedestrian often walks on the streets. See below a picture of the condition how all vehicles drive in the same road.

Figure 4 Types of vehicles in the same street.

Source: https://www.google.com/search?q=Transportation+in+Dhaka+city

Another significant problem is, all types of vehicles – cars, buses, three wheelers, manual rickshaw, motorbike, and bicycle are driven in the same street. Since the streets are very congested, faster vehicles cannot overtake the slow vehicles for example manual rickshaws. There are approximately 500.000 rickshaws in the Dhaka city (Chowdhury et al. 2016). These slow-moving rickshaws are one of the major reasons of traffic jam in Dhaka city. As a result, there is always big line of vehicles in every road become a common scenario in Dhaka city. Addition to these, when a driver tries to overtake and be stuck, it takes hours of time to clear the jam.

3.5.4 Unplanned infrastructure and wrong parking

The authority of Dhaka City Corporation to some extent failed to control building infrastructure in the city (Chowdhury et al. 2016). For example, a big number of shopping malls, private universities, preliminary and secondary schools, commercial buildings, private hospitals, government offices, private clinics and diagnostic centers are built in the residential areas of Dhaka city. As a result, these residential areas become very busy with lots of traffics, which often cause traffic jams all over the city. In addition to these problems, most of these institutions have very limited parking places. Consequently, officials, customers and other stakeholders often park their cars and other types of vehicle on the streets, which also contribute to traffic jam.

3.5.5 Lack of resources, plans and implementation of traffic rules

Dhaka has been considered as one of the mega cities in the world in terms of population (Hossain et al. 2017). According to UN (2015) data, Dhaka city is the most inhibited cities in the world. However, with the pace of development in other sectors, transportation system has not been developed in Dhaka city. For example, study suggest that, a well-designed city should have at least 25% roads. However, in Dhaka city there are only 7.5% roads available (Chowdhury et al. 2016, 62). As a result, unbearable traffic

jam and frequent accidents have become a common scenario in this city (Prothom-alo 2019). Dhaka City Corporation and the department of the traffic police could not prepare the effective plans and strategies for the development of the traffic system of Dhaka City. There is lack of traffic lights and digital controlling system of traffic. As a result, drivers are not feared to get fine and penalty for reckless driving, which is one of the top most reason for traffic jam in Dhaka city (Hoque 2015).

Although there is no specific reason for traffic jam, it is understandable that unplanned city growth and inefficient management and unconsciousness or negligence to follow traffic rules are the primary cause of traffic jam in Dhaka city (Sarma 2009; Hossain et al. 2017; Khan et al. 2018). In many occasions political parties block many vital roads in the daytime to conduct meeting for their party's interests, which cause heavy traffic jam in Dhaka city (Hoque 2016; prothom-alo 2019). The rich people in Dhaka city owns several cars for a single family, which increase traffics in the street (Khan et al. 2018). In addition, there are very few circles and 'U' turns to turn the cars in opposite directions. Therefore, drivers take risky turn that may cause either accidents or blockage in the road. All these issues cause traffic jam, which is not only affecting personal life but contribute to a huge damage in economy, social and environment (Hossain et al. 2016).

3.6 The impact of traffic jam

Traffic jam in Dhaka city has already become unendurable (Khan et al. 2018). Almost in every road, a huge traffic jam especially in the peak hours, when everyone rushes to reach their working place need to stay remain in the street standstill for many hours (ibid., 2018). It is not only causing individual mental stress and environmental damage but also contribute a large number of economic loss for the country (Hossain et al 2013; Hoque et al. 2016). These losses occur in many ways for example, unproductive hours spent on the street, vehicles fuel cost during traffic jam, environmental and sound pollution, mental and health problems and so on (Chowdhury et al. 2017).

The economic impact of traffic jam is huge. According to Hossain et al. (2017) the residents of Dhaka city loss around Euro 4600 per hour for working hour loss in the street

and around five Euro for vehicle operating cost per half-kilometer road. This study suggests that people of Dhaka city loss around five million working hours each year only for traffic jam, which cause Euro 3700 million loss per year. According to Chowdhury et al. (2016, 64), with proper traffic management and efficient public transportation could save at least 60% of the losses amounting to Euro 2220 million. Due to traffic jam, fuel costs and vehicle damages supplement the losses.

Due to traffic jam, the social and personal life have also been affected negatively in many ways. Bangladesh is a tropical country. Thus, most of the time the temperature is over 30 degree Celsius except around two-month winter time (Khanom 2011). Therefore, while staying in the road, often people have sickness in various forms- dizziness, headache, vomiting, high blood pressure and such problems. When they reach working place, they become tired (Chowdhury et al 2017). Consequently, to some extent they loss their concentration to work. Finally, when they reach home after jobs, they are completely exhausted, which affect their family and social life. Addition to this, the employees are always under threat to loss their job due to the delay in the office caused by traffic jam. It also affects their productivity and job satisfaction (Hossain et al. 2013).

Another major consequence of traffic jam in Dhaka city is environmental damage due to air and sound pollution (Hossain et al. 2017, 62). Most of the people do not follow traffic rules (Hossain et al. 2013; Prothom-alo 2019). The drivers use to give horns continuously. Sometimes even without any reasons, they give horns and drive fast. The city corporation do not clean the city properly (Prothom-alo 2019). The people also throw their waste on the street or sides of the road instead of placing them in trashcan. In addition to these thousands of vehicles have been burning fuels as they standstill for many hours in the traffic jam. It causes air pollution (Hossain et al 2013). Because of this hazardous air pollution, many people have been dying every year or have been suffering from many diseases (ibid., 2013; Hoque et al. 2016; Chowdhury et al. 2017).

3.7 Policies initiated to tackle the issues in Dhaka City

In the capital city around 20 million people have been living, which is over 8% of the total population. Inside Dhaka Metropolitan Area (DMA) the only means of transportation is road transport (Raafat 2010, 1). All types of vehicles like bus, truck, engine-led three wheelers, motorbikes and manual rickshaw are coexistent in the street. Bangladesh government initiated 'Strategic Transportation Plan (STP) in 2005 in cooperation with the World Bank (ibid., 2). The project is for 2004-2024 period named as 'Urban Transportation Policy' under Dhaka Transportation Coordination Board (DTCB) under the Department of Ministry and Cooperation (MOC).

Among the proposals, the committee recommended to decentralize population and employment opportunities in nearby areas that Dhaka city can relieve from overpopulation (Raafat 2010, 5). The nearest towns and district are economically very integrated with Dhaka metropolitan area. Therefore, this committee recommended decentralizing number of government establishments and private properties. See below the figure 4 of the committee's urban development plan.

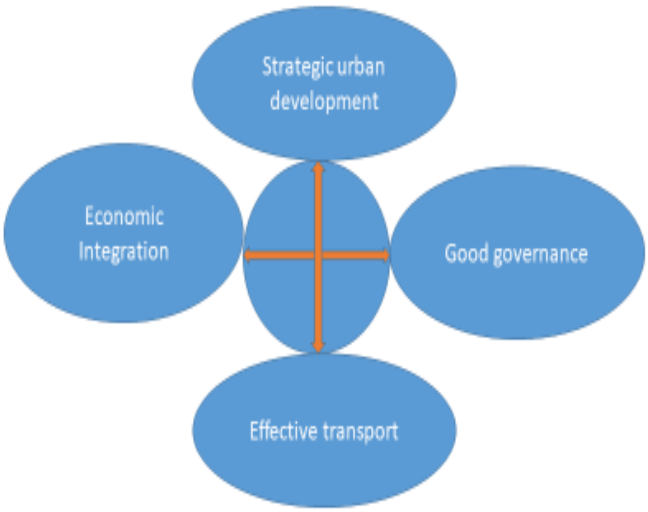

Figure 5 Concept of urban Region.

Adapted by Raafat (2010)

According to the plan, the future development of the city will be distributed from urban center to nearest district include, Gazipur, Tongi, Savar, Purbachal and Narayanganj. See the map of Dhaka and nearest areas.

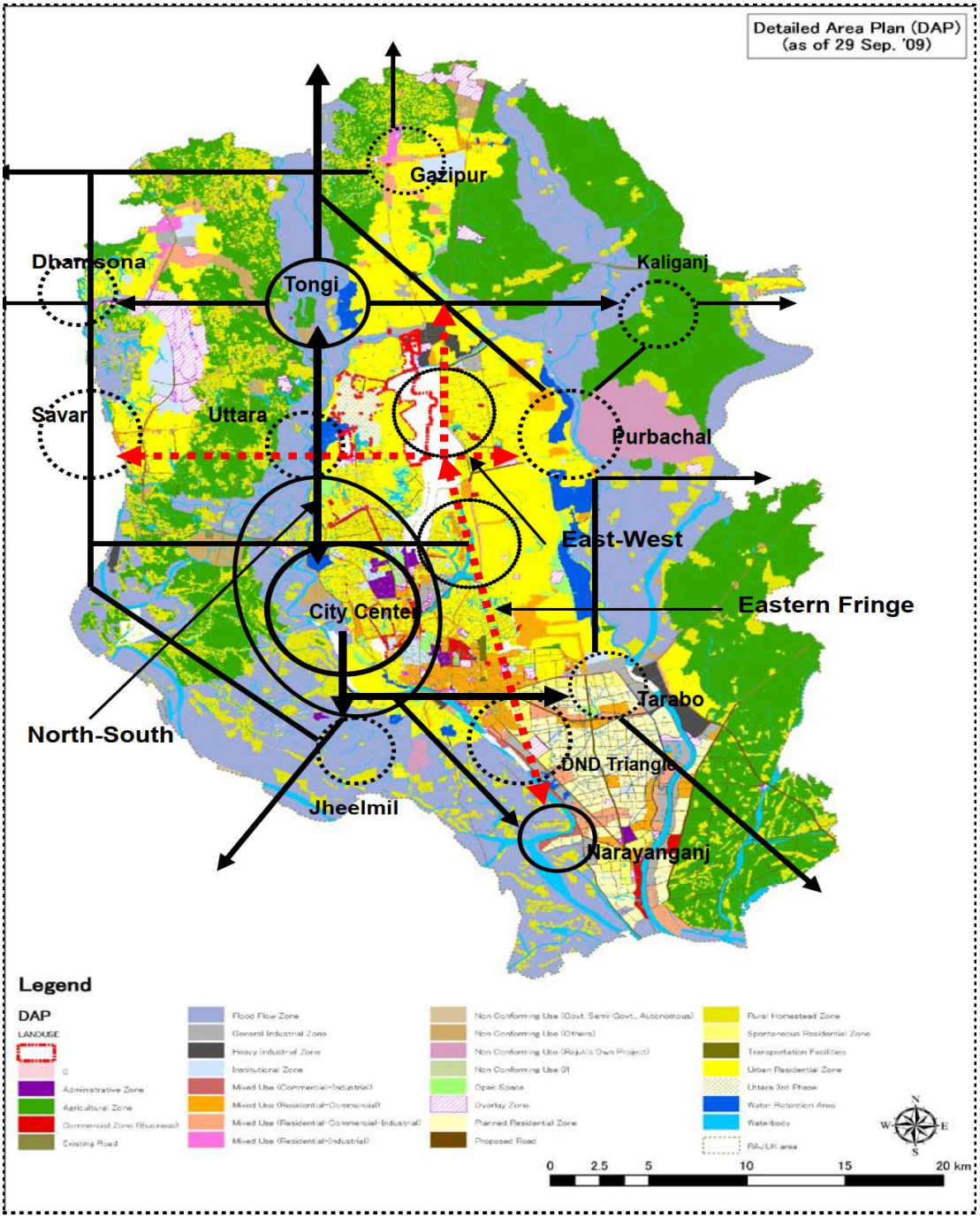

Figure 6 Proposed future Dhaka urban structure.

Adapted by Raafat (2010)

The committee also identified core transportation problem as

- Heavy and chronic traffic congestion
- Concentration of population in urban areas
- Poor road transportation system without fulfilling traffic demand
- No proper traffic management and traffic awareness (Raafat 2010).

Following the problems, the committee set their vision as

- to achieve a sustainable social and economic growth
- to ensure social equity
- to ensure a healthy and secure urban environment

In order to achieve these missions, the committee set three mission in terms to develop Dhaka urban transportation system. They are

- efficient and effective transport system
- equitable mobility for people
- safe and environment-friendly transport system (Raafat 2010).

Following the missions, the committee recommended to introduce innovative transportation system following other Asian countries how they have improved their transportation system to alleviate traffic jam from urban area. Along with other decisions, the committee primarily emphasizes on conventional public transportation improvement, road network, proper traffic management, travel style and behavior of people, increasing mobility, accessibility and shortening travel time.

4 Traffic congestion and initiatives taken in other countries

In Dhaka city, the only transportation system is road transport (Hoque et al. 2016). Therefore, the policy of Bangladesh government is to improve road transportation system following other developed and developing countries as example. This study has taken Beijing, China, Jakarta, Indonesia and Tokyo, Japan as case cities to understand how these countries have initiated their transportation management to resolve the problem. At the same time, to understand how the policies effect those cities traffic congestion problem.

4.1 Traffic congestion: The case of Beijing, China

Traffic congestion has become one of the most challenges in China cities especially in Beijing. The country has experienced steady and significant economic growth last few decades, which has boomed household car increase in big cities. In Beijing, since 2001 to 2015 the population has increased 55% and vehicle stock from one million to around six million (Yang, Purevjav, & Li 2019, 2). According to Wen, Sun, & Zhang (2014, 483), Transportation Demand Management (TDM) greatly affect congestion of traffic. For example, after Olympic Games in 2008, Beijing witnessed household car booming (Wen et al. 2014, 486). According to data, around 500,000 new vehicles were registered, which is approximately 15% increase per year. By 2010, 800,000 new cars added to the road, which causes severe traffic congestion in Beijing. However, during this time only 2% road mileage has been increased. This dramatic increase of population and vehicle ownership have been overwhelming the provision of public transits resulting serious traffic congestions. Data suggests that average traffic speed in congested road is only around 15 miles per hour in the pick hours (Yang et al. 2019, 22).

Along with TDM theory (Wen et al. 2014, 487), the causes of traffic jam in urban areas are diversified due to different conditions. Yang et al. (2019, 2) argue that, urban traffic congestion primarily occurs due to the background reasons for example going to work and school in peak hours. In holidays, people use to travel a lot. Therefore, morning peak is a predictable scenario. The same reason, in September when primary and middle level school term starts have intensified traffic congestion than the summer vacation time. Going out for work or other purposes is obvious for residents. However, if they know the road situation, they might think of available alternatives for example going later or changing route to reach the destination. The new generation technologies for example floating car traffic information collection technology provides such information (Wen et al. 2014, 486)

Traffic congestion is a situation that can be seen in urban roads and highways. The traffic congestion phenomena in big cities in China and all over the world have become a burning issue concerning, urban livelihood, social and economic development (Wen at al. 2014, 484). In addition, vehicles not only generate congestion but also air pollution, carbon Dioxide emissions, and accidents (Parry, Walls, & Harrington 2007, 375).

There was a survey in 2016 in 390 cities from 48 countries that were conducted based on real time data suggest that, among top 20 most congested cities with population of over 0.8 million, one are from developing countries and eight from China (Yang et al. 2019, 28). The top in the list, Mexico City drivers spent 66% more travelling time (227 hours per year) than they would have been driving in free flow condition. Beijing, in this list numbered 10 spent 46% extra time, which is 179 hours extra commuting time per year (UN, 2014).

In 2011, China started using Traffic Performance Index (TPI) to measure traffic congestion conditions (Wen et al. 2014, 490). Using clustering method based on TPI China has developed a dynamic macroscopic index to show congestion intensity in major cities of the country in 2007 (ibid., 490-492). However, they argued that evaluation of traffic congestion by TPI is only a first step. Understanding traffic congestion needs more research concerning why it happen, factors contributing more and such influencing factors.

The quantitative data of TPI can describe qualitatively the traffic congestions. It can identify the congestion pattern by accumulating large amount of data. Therefore, it can be understandable to finding out the corresponding factors, which influence traffic congestion. They have also established a floating car traffic and congestion evaluation system in real time. This system obtains GPS location data every minute of nearly 40,000 cars in Beijing in real time. At the same time GPS data has been process in every five minutes to obtain the speed (Guo, Wen, & Chen 2007, 40; Zhu, Wen, & Sun 2008, 77). Following the congested mileage of per link calculated by VMT, in every 15 minutes dynamic TPI of main areas of Beijing city is calculated. For traffic congestion evaluation system, TPI is the main index in Beijing city. Study suggests that congestion in Beijing city varied upon days and time (Wen et al. 2014, 486). For example, working days traffic congestion is much higher than the holidays. In addition, peak hours for example office time in the morning 7:00 to 9:00 and return time from office 17:00 to 19:00 are the most traffic congested than other time (ibid., 486).

Based on the conditions and influencing factors, the government of China has made several decisions to reduce traffic congestion from Beijing. For example, banning private cars following odd and even license plate during Olympic games, banning car for one day in a week etc. (Wen et al., 2014, 490). Yang et al. (2019, 2) argue that in most

developing and middle-income countries severe traffic congestion is a universal problem in big cities. One top reason for that is rapid increase of personal vehicles but inadequate infrastructure development. According to Yang et al. (2019, 17), using road pricing as the first-best policy to address congestion has been drawing increased attention from policy makers. In addition, the authority took action, which include lottery system to reduce cars limiting to 240,000 per year in 2014 (Yang et al. 2019, 2).

4.2 Effects of traffic management – the case of Jakarta, Indonesia

Study suggests that along with pollution, mental stresses, labor cost and accidents, American roads loosed over US$306 billion in 2017 due to congestion (Cookson 2018). This kind of losses are common on most of the world's congested cities. Most of the traffic congested cities take various initiatives to reduce traffic congestions. However, the most efficient management system gets optimal success. Although road expansion and public transport service development are the most likely solutions, restrictions in traffic demand is one of the most used management policies in many countries (Yudhistira et al. 2019, 3).

However, according to Luechinger & Roth (2016, 2), financial-based incentives may influence more positively on congestion reduction than control policies. Despite the fact, control policies is still popular due to the easiness of implementation (Button, 1990). Jakarta, the capital of Indonesia is the top most congested cities in the world (Santos et al. 2010; Cookson 2018), which cost over US$5 billion per year due to inadequate public transportation, rapid urban growth and motorization process (Burke, Batsuuri, & Yudhistira , 2017; Jakarta Post 2017). The government of Indonesia initiated odd-even policies to reduce this unbearable traffic congestion since 2016.

According to the odd-even policy, for example, the odd number plate cars can only drive during odd number days of the month. As like odd numbers, even plate number cars are allowed to drive in even dates of the month. However, Ambulances, taxies, public buses and motorcycles are free from the rules. Although this odd-even policy get more significant attention, the provincial government of Jakarta initiated '3in 1 policy since 2004 (Yudhistira et al. 2019, 1). According to this policy, no car can drive in road from morning 7:00 to 19:30 if the passengers are less than three. This policy

was decided to be abolished in March, 2016. Instead of '3in 1' policy, they later initiated odd-even policies in large segments of Jakarta roads since August, 2018.

One study suggests that after using odd-even policy to restrict traffic demand, according to Google Map travel time data from 1st of July to 31st of August, 2018, hourly traffic congestion in the road segment reduces on average 3% in Jakarta roads, which considered as not much significant as it was expected (Yudhistira et al. 2019, 1). However, the effect was higher in weekend and afternoon rush hours. In addition, the same study also suggests that after a certain period the effect of odd-even policy has lessened (ibid). This study suggested that, this odd-even policy need to implement in broader range, for example, all the major road sections together with other sought policies to focus comprehensively on reduction of traffic congestions. One major significance of this study is they have evaluated the effect empirically. A number of cities has implemented this odd-even policies as traffic demand control for example Beijing, China (Li & Guo 2016; Gu et al. 2017), Delhi, India(Kreindler 2016), Santiago, Chile (Gallego et al. 2013), Mexico City, Mexico (Davis 2008), Bogata and Medellin, Columbia (Ramos et al., 2017) Quito, Ecuador (Carrillo et al. 2016). There are also other forms of restriction implemented to control traffic congestions for example passenger's restriction policy (Li & Guo 2016; Hanna et al. 2017), parking restriction (Santos et al. 2010) and car-free day policy (Wang et al. 2014).

4.3 Intelligent Transport System (ITS) in Japan

In recent time, most of the Asian cities along with other part of the world have been experiencing increasing urbanization and private car ownership, which have been causing increased number of car accidents, endurable traffic congestion and environmental damages (Makino et al. 2018, 49). However, introduction of Intelligent Transport System (ITS) has brought revolutionary positive effects on various traffic issues. ITS is kind of system that use information communication technology to solve different kind of road problems. Although many countries have been introducing the system, there are still many challenges to implement them due to lack of know-how the technical issues by specific country's staffs, lack of coordination, lack of resources and management (ibid, 2018). Therefore, it is important for specific countries to adapt the system according to their existing capacity and transportation system.

Japan has been implementing the ITS system practically to reduce traffic congestions and accidents. They have used the practical application of Vehicle Information Communication Service (VICS) and Electric Toll Correction ((ETC) in the whole country based on the concept of Cooperative Vehicle Infrastructure System (V2I) (Makino et al. 2011). In 2011, Japan launched a project named “ETC 2.0. This project combines vehicle information communication service (VICS) and electric toll correction (ETC) functions on a single On-Board Unit (OBU) together with many new functions (Makino et al. 2018, 1). This project, ET C 2.0 is easy to use since the system OBUs communicate with a Road-Side-Unit (RSU) in certain areas. The OBU system consists basic application interface functions that enable multiple ITS services through a combination of those common functions (Makino et al. 2018). This system is also very cost effective since any new function can be added just by developing RSU with new applications. ETC 2.0 system also support privacy and security of the people uses private and rental cars (Makino et al. 2018). In addition, it may help to install compatible functions for safe driving and dynamic route guiding through advanced navigation system. The DSRC at 5.8 GHz enables to get information to control safe driving and traffic jam within an approximate area of 1000 kilometers. International Telecommunication Union certifies this system as ISO 14906 (Makino et al. 2018, 51).

Japan started expressway by getting a loan from world bank after Second World War. Since then, they also started construction under toll system for all constructed roads. First, they started national longitudinal expressway which connect major cities and then developed crossing expressway to connect local cities and the expressway (Makino et al. 2018). Most importantly, they developed ring expressway to reduce urban transportation problem. Here, it is mentionable that, ETC played a key role to develop expressway in many ways. For example, ETC is an advance technology that helps to collect tolls securely with low cost (Makino et al. 2018,51). The system also enables to offer various motivational offers for example tool discounts in different times of the day and in the streets, which reduce traffic congestions dramatically.

This ETC is also provide accurate information about the spots of densely congestion and accidents spots. As a result, the government or transportation authority can take proper action to reduce the congestion and accident trends. In addition, CCTV cameras

can detect if there is any car stopped on the blind carve with image processing. Besides, the sensor in vehicle can detect the condition of road surface, any objects on the road or any other elements, which can cause danger for the vehicle and cause accidents. Another function of ETC 2.0 is detecting heavy load vehicles. This is universally accepted that heavy vehicles cause road deterioration. Therefore, if ETC is able to identify them, transportation authority can charge extra for road usage.

5 Discussion and Conclusion

The data suggests that the transportation authorities in Dhaka city have to struggle continuously to adjust the ever-increasing traffic demand with limited resources (Khan & Chowdhury 2014). It is a usual trend of people in the urban areas in developing countries to use automobiles for their convenience. However, due to these dramatically increased numbers of automobiles in Dhaka city, traffic congestion has become unmanageable. The primary reasons for the traffic congestion include unplanned infrastructure and congested road conditions, limited resources, lack of awareness, limited use of technology and poor public transportation facilities. As a result, in order to reduce traffic congestion and make the Dhaka city transportation system sustainable, a number of initiatives need to be taken. However, it is imperative to consider that Bangladesh is a developing country with a number of other challenges that they have to address at the same time. Therefore, all the initiatives need to be adjusted with the existing system with cost minimization. For example, using advanced ITS all over the city is not practically possible due to the lack of resources, such as skilled manpower and a functional infrastructure. Some alternative solutions are discussed below.

5.1 Congested roads and way forward

The data suggests that one of the primary reasons for traffic jams is congested roads (Hossain et al. 2017, 62). Since all types of vehicles are driven on the same roads, slow moving vehicles are the top-most problem for the traffic jams in Dhaka city. According

to the Dhaka city corporation data, there are around 85,000 thousand licensed rickshaws in different streets in Dhaka city (Prothom-alo 2019). However, this same report also suggests that the number is as much as 600,000, which means that they are not licensed but driving illegally in Dhaka city. In addition, on different occasions, for example, at the Eid festival times, additional 100,000 rickshaws come to this city from different places for additional income (ARI 2019).

As mentioned earlier, all types of vehicles are driven in the same street. Most of the streets in Dhaka city are very narrow and one lane based. Therefore, when these rickshaws are in front of a fast-moving vehicle, the vehicle needs to drive slowly and follow the rickshaw or another kind of a slow mover, which eventually causes a traffic jam. In addition to this, the rickshaw pullers often stay in busy places due to their need to earn more money. Therefore, busy areas become more congested, which goes beyond control.

As mentioned, slow moving vehicles, especially rickshaws, create traffic jams significantly, and one of the best solutions could be removing rickshaws from the main roads and the busy areas. The Accident Research Institute (ARI) (2019) survey data suggests that 18% of the residents think rickshaws should be banned from Dhaka city. The government of Bangladesh has already issued some restrictions on the rickshaws for driving on very important roads (VIP roads) (ibid, 2019). However, rickshaw pullers often break the rules (Prothom-alo, 2019). Therefore, strict implementations are needed to control the neglect or breaking of the traffic rules (Hoque, 2015).

However, to some extent rickshaws are very useful for small lanes especially in the residential areas or on short roads (Hoque, 2015). They are also affordable for low-income people. In addition, most of these rickshaw pullers are the source of income for their families. Therefore, if rickshaws are banned, these 600,000 rickshaw pullers' families may fall in a vulnerable situation. Therefore, the government needs to consider this issue and take care of the families.

One of the best solutions to reduce traffic jams could be widening the roads with multiple lanes and making alternative roads or such arrangements. However, in practice, it is not possible to widen most of the roads due to unplanned high-rise buildings,

other infrastructures and limited resources. However, it can be easier for the government to make separate lanes for rickshaws and other slow-moving vehicles. It may radically reduce traffic jams in Dhaka city when the speedy vehicles are not jammed by slow moving vehicles.

In addition to this, there are no tramlines or Metrorail services in Dhaka city. Tramline and metro services could be good solutions for reducing traffic jams. The government can initiate both tramline and metro services not only in Dhaka city but also in other big cities. The government initiated the plan recently (Prothom-alo 2019). It would be a revolutionary step for Bangladesh to reduce traffic jams if the project becomes successful.

5.2 Traffic Demand Control

Excessive numbers of private cars cause traffic jams all over the world (Yang et al. 2019). Dhaka city is not an exception from this (Khan and Chowdhury 2014). It has been found that many families own several cars, whereas for the middle class and low-income people, rickshaws and public buses are the cheapest and only means of transportation (Hoque 2015). However, the public transportation system is very poor in Dhaka city (Hossain 2016). The public buses are of very low quality or technically faulty (ibid, 2016). In addition, unlicensed drivers often drive them (Prothom-alo 2019). As a result, these buses and drivers have also been causing traffic jams and accidents.

As in other big cities, traffic jams reach a peak in the morning when people go to work and school or visit the city from other cities, and in the afternoon when they go back (Yang et al. 2019 & Hossain 2013). In the residential areas in Dhaka city, there are big numbers of schools and colleges. Most of those students use rickshaws as a means of transportation. At the same time, employees in different institutions also use the rickshaws as a means of transportation. The reason behind using rickshaws is limited public transportation. The government of Bangladesh stopped the subsidization of public transportation and gave this department to the private sector in 1993 (Chowdhury 2013). Currently, there are around 3,500 private buses in Dhaka city, whereas the need is over 6,000 buses (ibid 2013).

If public bus services were available, the situation could be better. In addition to them, double decker buses could be very useful means of transportation for this overpopulated city. There are some double decker buses already in the city. However, the number of the buses is limited. The government and private companies can bring more of these buses according to the public transportation demand for the residents of Dhaka city. Especially, if there were certain public buses for specific routes, people would use those specific buses. It could reduce travel time for the residents and traffic congestion at the same time. Therefore, the government and private sector need to invest in affordable and adequate public buses in the street. At the same time, the transportation authority needs to discourage owning more than one car for a family. The government can increase the taxes on private cars especially with those who have more than one car in a family.

5.2 Implementation of traffic rules and regulations

Breaking traffic rules and regulations are common practice for drivers in Dhaka city, which is a prime reason for traffic jam (Chowdhury 2013; Hoque 2015, Hossain, et al., 2016). There are several ways of breaking the rules, which include negligence, mismanagement, and lack of awareness are on top (Chowdhury 2013). It is evident that, traffic jam is higher in intersections of roads, and rail crossings. There are many traffic lights in the intersections do not work or neglected by the drivers (Hossain et al., 2016). As a result, traffic jams are higher in all intersections.

Another important issue is occupying footpath by the hawkers. There are over 163 kilometers of footpaths in Dhaka city. Among them 60% has been occupied by street vendors, street front shopkeepers and Hawkers (Chowdhury 2013 111). It is reported that, despite knowing the situation, authority do not take any action to evacuate the footpaths (TIB 2018; Prothom-alo 2019). Sidewalks and some important roads also filled by construction materials without any permission, garbage even become home for the beggars and homeless people. As a result, often pedestrians have to walk on the main street, which become dangerous for their life (Chowdhury 2013). In addition, there are very limited parking places in the roadsides. Therefore, drivers often park their cars in the footpath or in the main street, which disturbs normal flow of traffic.

The authority knows the situations. However, until now they have not yet taken any proper action to ensure drivers strictly follow traffic rules and regulations (Chowdhury 2013). Study suggests that a number of traffic police in the street receive bribes and permit illegal drivers and vehicles (Chowdhury 2013, 111). These technically faulty vehicles also cause air and sound pollution. The authority needs to monitor traffic polices are working properly.

To implement all above issues, awareness is a vital issue. The government and responsible departments need to aware publics, duty officers and management. When everyone will be aware, the situation will change. The awareness can be built in many ways. For example, using electronic medias, social medias and newspapers. The authority can also make campaign on the street and publish them in various media. If the people and drivers do not change their behavior to follow the traffic rules and regulations, nothing will be changes. Therefore, awareness is very important together with the application of rules and regulations.

5.3 Lessons from other countries

Most of the mega cities have traffic congestion problem. Different countries have taken different initiatives to tackle the problem. Among the strategies, traffic demand control, developing infrastructure and use of ITS are on top. Although many countries have introduced ITS to solve transportation problems especially traffic congestion and accidents, lack of strategy and system architecture results poor effect on them (Makino et al. 2018, 54). This also cause extra cost and difficult to expand in the future. Therefore, every country should get proper planning and training before launching ITS within existing system. Since the developing countries struggle with limited resources, the government can allow private sector to invest. They can also find loans from international agencies. Since high technology has been applied for toll collection, the loan can be returned when vehicles start using those express ways.

As discussed earlier that, most of the important establishments are located in Dhaka city. In addition, public and private universities, schools and colleges, huge number of garments factories, corporate offices made the city highly densely. A recent report suggest that Dhaka is the top most traffic jam city in the world (Prothom-alo 2019).

Therefore, the government need to think of transferring some important establishments. For example, if the government just transfer army headquarter and Bangladesh Border Guard headquarter from Dhaka city, significant spaces will be empty, which can be used for building residential areas. At the same time, if the government transfer all garments and factories from the capital, significant places will be evacuated to use for building new roads and residential areas (Raafat 2010).

5.4 Conclusion

Finally, the world has been witnessed significant technological development since last few decades. Therefore, using technology in transportation network is an inevitable demand for efficient transport system. Many developed countries have already adopted Intelligent Transport System (ITS) to manage their transportation system. Although Bangladesh needs more time to adapt high technological system with current setting, they can start using ITS gradually. For example, using digitalized cameras to monitor and control driving behavior, smart card payment in public buses, collecting tolls and driver's information and smart phone application to get emergency information concerning accidents and hazards. The government and other stakeholders need to implement ITS in transportation system gradually along with other initiatives for example, traffic demand control policy, incentives, wide roads and providing affordable and sufficient public transportation facilities. Besides this, extensive research from both government and academics are needed.

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