



## FINDING THE CHALLENGES OF PLANNING AN INTEGRATED TRANSPORTATION SYSTEM FOR THE TIME OF CRISIS: A CASE OF KHULNA RAILWAY STATION AREA

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### Abstract

Khulna railway station is one of the oldest establishments which is situated almost at the heart of Khulna city center, known as the Central Business District (CBD) of Khulna city. To support the growing demand for transport services in the CBD area, the existing three major transport modes (railway, waterway, and roadway) of the railway station area are fully functioning. Though they are situated in the same area for serving the same purposes but work separately. This separate route plan of the three transport modes demands more support services which cause traffic congestion and space scarcity to accommodate heavy weight vehicles like cargo trucks and lorry. The rapid growth of the economy and population of the city demand an upgraded transportation infrastructure. This paper aims to explore the context-specific challenges for planning transportation infrastructure in the CBD and its settlement area. A field survey of the study area, face-to-face interviews of different stakeholders, and questionnaire survey were conducted to gather necessary primary data. Detailed Area plan of Khulna Development Authority (KDA), Khulna City Master plans, newspaper cuttings, journal and conference papers, etc. are analyzed. This paper provides an overview of hazardous conditions of the study area caused by the existing public and freight transportation. Respecting the existing problems and limitations, an integrated transport infrastructure planning guideline has been provided to meet the future transport challenges in the densely populated urban CBD area.

**Keywords:** Land uses, integrated transport, planning problem, traffic circulation, traffic load distribution, transport hazards.

### Introduction

To develop urban areas, efficient and sustainable urban transportation systems are necessary to guarantee the attractiveness of the area, enabling and maintaining economic activity and power and quality of life within that particular region (Ehmke, 2012). The rapid development of urbanization with poor planning and decision

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making policy has led to detrimental effect of urban environment that caused serious urban related problem one of which is transport (Morita *et al.*, 2004). According to BBS (Bangladesh Bureau of Statistics), 2009 the population of Khulna city was 1.39 million currently the population of the city is 1.5 million with a population density 67,994 per km<sup>2</sup>. It is projected that the city population will increase 2.64 million in the year of 2025 (UNHABITAT 2008/09). Khulna as a divisional city and being the 3rd largest industrial & commercial city of Bangladesh. Its railway, water way and road transportation are playing important role in transporting passenger and goods of the country. Though these three types of multimodal transportation meet together in a place, called Khulna railway station area, it serves separately in separated platforms. There are total number of roads 1215 including 158 km metaled road, 67 km semi-metaled road, 18 km un-metaled (Kancha) road (District Statistics, 2011). Khulna railway station has almost 195 acres of land in the heart of the city elongated with the river Bhairab. One of the major portions of this large area of land serves for commercial purposes as CBD area named Boro Bazar. Heavy industries are traditionally linked with rail- water based transport systems in Khulna. At the same time their supportive land transportation system is being shared by both passenger and freight transportation. This causes a very complex situation, frequently passenger has to suffer to reach the terminal building by overcoming transportation haphazard. Every day, 10 numbers of intercity trains, 9 numbers of passenger trains and average 3 numbers of freight trains run between Khulna & Dhaka including divisional town Rajshahi, and other routes of Bangladesh Railway (Ministry of Railway, Bangladesh, 2013). The earning of this station is remarkable. Moreover, after restarting train operation between Jessore-Benapole sections, the transportation of imported and exported commodities from India has been increased and the same is increasing rapidly day-by-day. The constantly increasing demand cannot be meet-up without development and extension of the facilities of the station area.

Transport oriented development of Khulna is also an important for tourism. Sundarban, the largest natural mangrove forest is an international tourist attraction and has an increasing demand of local and international tourists. New development proposals made by Government and projects has already been started aiming to increase the trade and commerce of this part of the country. This development proposal by Government is made based on fact that existing railway station building and yard was constructed in the 19th century on clay foundation with jack arched roof of lime and shurki. The economic or service life of the station has already been exhausted. To coup the present conditions and urban needs the development of the station complex and location of terminus, built in 1922 could be shifted in new locations. But some major issues associated with passenger and freight transportation system and the future growth of CBD area has been overlooked. Across developing countries, the cities ' main driving forces are economic and social forces to transform the city structure with increasing demand for urbanization and population.

A variety of measures for solving urban cargo transportation problems already exist in the study area (Alves *et al.*, 2016), each one suited for the context of its socioeconomic, political and historic contexts. That is, each city has its own set of characteristics which define peculiarities for cargo transportation. Just as the transport system is unique for each city, the measures taken to regularize, correct and improve the system are also unique and specific for each city (Taniguchi *et al.*, 2001a). Thus, this research aims to characterize and portray an interpretation of the present scenario. Holguín-Veras *et al.* (2015) point out the importance of this type of study for the development of sustainable urban transportation. From their point of view, in the absence of these studies, urban planners and transport authorities often do not have a clear picture of the quantity of travel that different commercial activities generate, which can lead to underestimation of the places needs and difficulties in finding appropriate solutions to the problem of urban transport (Alves, Roberta *et al.*, 2019).

There exists good road, railway and waterway communications linking Khulna with important regional economic centres. Taking advantage of these networks and modes of transport a large number of people commute to the city from the surrounding region. The traders use waterways as the cheapest means to haul their goods by barge as far as from Chittagong, Sylhet and Dhaka. However, low level of economic activities at Khulna and Mongla Port do not allow effective use of the existing transport infrastructure. The

City enjoys excellent inter-city bus communication with almost all the major urban centres of the country including the capital city. The most direct route to Dhaka from Khulna through Mawa will reduce time further. The intra city bus communication is not very efficient, in terms of both frequency and direction. In fact, there is a single public bus transport route in the city, the quality of service is not up to the mark. Major commuting trips to the city take place by bus and tempo. However, a large proportion of the citizens about 10 percent make trips on foot (BBS, 2011). Rickshaw, although widely available and comparatively cheaper, expensive for large low-income people. Khulna City is served by a broad-gauge railway line from Jessore, which established links with Khulna and western region of the country. Railway has also loop and spur facilities in the industrial and warehouse areas for easy movement of goods. There are 5 stations- Khulna, Daulatpur, Fultala Bajerdanga and Noapara. Khulna railway station enjoys the multi-modal transport facilities served by, railway. BIWTA (Bangladesh Inland Water Transport Authority) Ghat and road linked together. The railway operates passenger and goods trains from Khulna to 7 destinations in the north-western region. The up and down trips by trains from carry approximately 5500 passengers daily (Ministry of Railway, Bangladesh, 2013).

The objectives of this paper is to investigate the existing transportation system and find out the real scenario. This study focuses on a guidelines for upgrading a multi modal transportation system in CBD area considering the urban issues. To fulfil this aims discussions and interviews are performed with different stake holders and local responsible authorities.

### Materials and Methods

For Conceptualization and Problem recognition I have outlined the existing situation of the railway area then a reconnaissance survey has been conducted to trace the initial problems. And participatory discussion with local people helps to identify the real problem of Khulna railway area. Simultaneously different related paper, journal, Article and thesis reviewed to identify the problem.

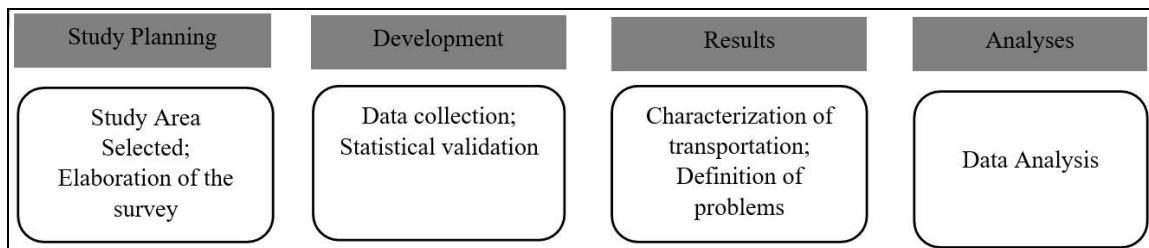


Figure 1. Stages of Methodology.

This study area has been selected to make the way of research considering the required parameter concerning the idea being released. Primary data includes both reconnaissance survey and questionnaire survey. Secondary data have been collected from different governing authorities, books, journals, newspaper and other reports of different organizations. During the field survey work, the community leaders have been purposively interviewed for recording their views and opinions. Microsoft Excel, computer software with statistical package for social science (SPSS), Microsoft word are used to analyse the information and data that have been collected through field survey and interviews. Photographs of the existing conditions are analysed through Adobe Photo shop and Corel Draw. For drawing plan, Auto-Cad has been used. A base map has been prepared showing the study area using Arc-View. For the special effect 3D Studio Max has been used. During the survey period I faced problems collecting data from different authorities due to lack of sincerity and communications among government authorities. Some information was collected from local persons and

observations that required painstaking efforts. It was difficult to find out the growth of the study area as there is no central database of growth.

#### *Location and extend of the study area*

The Khulna railway area is situated almost at the city center of Khulna city. It is adjacent to the CBD. Khulna railway occupied this land in 1884, railway yard was developed in 1912 and station building that is still serving was built in 1922 (KDA, 1998). The total railway area is 195.44 acres. City's old market place Boro bazar, BIWTA launch ghat (terminal) these are adjacent to railway area and recently some land was hand over to KDA (Khulna Development Authority). Operational area- 146.02 acres, business leased- 16.51 acres, agriculture and others- 32.91 acres (KDA, 1998). A satellite image of the study area is shown in Figure 2. In Figure 2 the white dot line denotes the boundary line of the study area (Railway station area), the orange line elongated with the study area denotes the main transport circulation line in the city, the yellow dot line indicates the entry of rail line in the city along with the railway station area and the blue lines indicate the access to land (BIWTA terminal) from Bhairab river.



Figure 2. Site surroundings of Khulna railway terminal area.

## **Results and Discussion**

#### *Land use of the study area*

Khulna railway area is mostly surrounded by commercial and administrative development. City's largest retail market is almost a part of it. The New Jessore road and Bhairab River are the edges of this site. From the analysis of land use distribution it has been found that the land use of the CBD of Khulna city is categorized into commercial, offices, residential, educational, religious, recreational and health services. In PPB and RMB, there are more Varieties in land uses than other two (Hasan, 2001). The current land uses is mainly commerce oriented in all the building blocks.

Figure 3 shows the detailed land use plan of the study area including Borobazar commercial area. "Dak Bangla Mor", "Boro Bazar" (means big market place) and adjacent areas determined as the main CBD area of Khulna city. According to the master plan, Khulna city was originated from the bank of the river Bhairab. The infrastructure development of Khulna city has been started from south-east portion at the pre-colonial period and "Borobazar" was the main CBD and still now, but city center has been shifted at "Shibbari more" and "Khalishpur" for industrialization to the north. (KDA Master plan, 2001-2020).

Table 1. Ground Floor Land use distribution of CBD area in different building blocks

Land Use Categories	Railway Market		Nixon Market	
	Area in Acre	%	Area in Acre	%
Commercial	2.32	80.56	2.2	63.40
Residential	0.04	1.39	0	0
Office	0	0	0.73	21.04
Educational	0.2	6.94	0	0
Religious	0.01	0.35	0	0
Health Services	0	0	0.34	9.80
Recreational	0	0	0	0
Others	0.31	10.76	0.2	5.76
Total	2.88	100	3.47	100

(Source: KDA Master plan, 2001-2020)

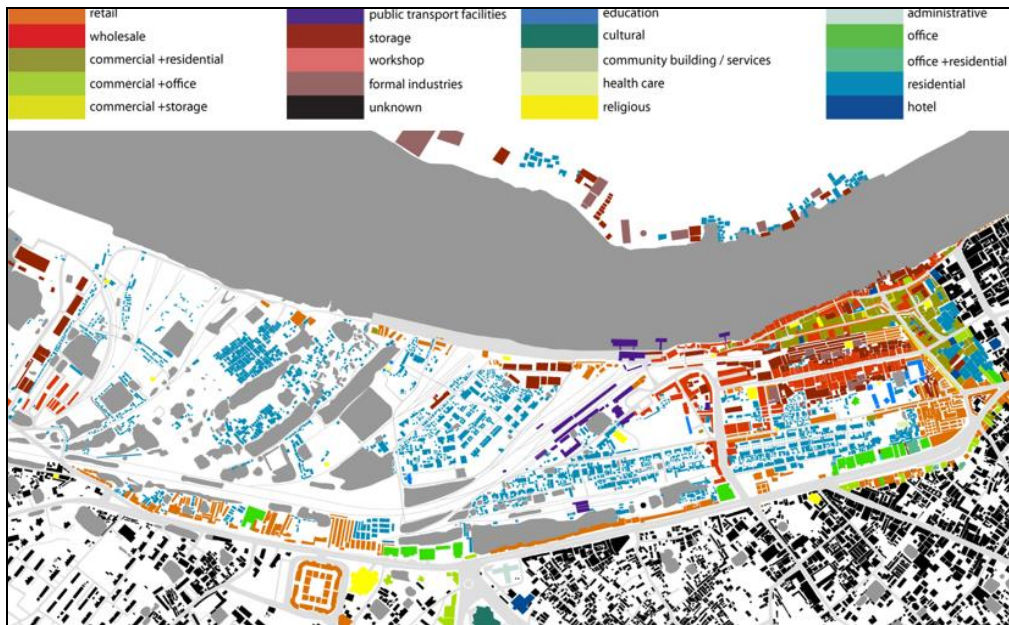


Figure 3. Land use plan of Khulna railway terminal area.

In Figure 4 the yellow marked area with green circle denotes the terminal area, the red marked zone denotes the warehouse development area, the green lines with arrow denotes the goods transport circulation, the dark blue color denotes the passenger transport circulation, red dot lines with arrows denotes the rail line and the blue lines with arrows denotes the access of goods transport from water way on the master plan. If we juxtapose the pedestrian, passenger and goods transport circulation, we will see the overlap of these circulations. That indicates that they share the same access road for different circulation modes. The red marked area in Figure 4 shows an integrated scenario situation among warehouse development, railway and BIWTA terminal location and terminal approach road.

In accordance with the spatial growth pattern of the CBD area with increasing roads, the business

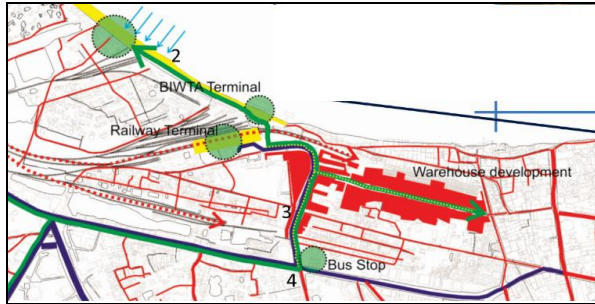


Figure 4. Integration between land uses and transportation.

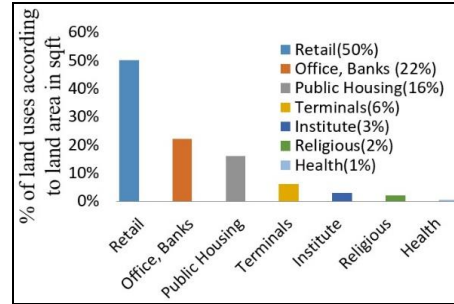


Figure 5. Percentages of land uses in the study area.

core has been increased linearly. And the initiative of business has shifted from mass people to government and transportation has shifted from water to road. The importance of water-based urbanism and river based trade has shifted to road based urbanism and trade nowadays. The varieties of land use and the changing city makes Borobazar a mixed use developed zone rather an entirely business or commercial zone. About 53% of the total land is used as commercial activities in Khulna railway and its adjacent area. The others are mixed used and some part of the total land are used as residential and mixed used area. Figure 5 shows the percentages of land uses in the study area according to the land area in square feet they occupied. Only about 6% of the total land is used for transport terminal purpose. As the city economic and business center Borobazar needs to be more dynamic. An efficient multimodal transportation system is needed for the CBD of Khulna city to cope with the future growth and development of the city, expanding trade and commerce and growth of population.

*Existing circulation pattern*

The circulation Pattern is one of the most powerful tools to control activity patterns, movement patterns of pedestrian and vehicles (Cruces, 1988). Four major traffic nodes touches the area- Dakbanglo Moor, Power House Moor, Shibbari Moor and Jora Gate Moor. Khulna new market, Bus stand, Stadium are at a reachable distant of this area. Residential blocks developed at the back of these commercial belt along the roads. In Figure 6(a) the red line indicates the major road transportation circulation, the red dot lines with arrows indicate the rail line access to the station, the green line indicates the secondary road transportation circulation, blue arrow indicates access to land from Bhairab river and the red dot line indicates entry of rail line in the city along with the railway station area. In Figure 6(b) major roads and road junctions or nodes with their names are shown.



Figure 6. Existing transportation circulation of Khulna railway station area.

The green arrow lines in Figure 7(a) shows the goods load distribution path from the study area. Here the yellow circle denotes the terminal area both the railway terminal and BIWTA terminal, red circle denotes the warehouse development area and the blue circles denote the major business area in the study area. Goods are distributed both from outside to terminal and from terminal to outside through circle marked area in Figure 7(a). Goods loads from freight train and launches are distributed through heavy vehicle like cargo truck and lorry from 8 pm to 8 am into the study area. It's a two-way transportation road that serves as well as passenger and pedestrian accesses road for both the train station and launch terminal at a time. From the field survey it is found that about 250 no of cargo trucks and Lorries are parked on the both side of the station approach road within the 1 km length from Power House Mordh to BIWTA terminal. On-road edge truck parking in station approach road for business and industrial goods transport are shown in Figure 7(b).

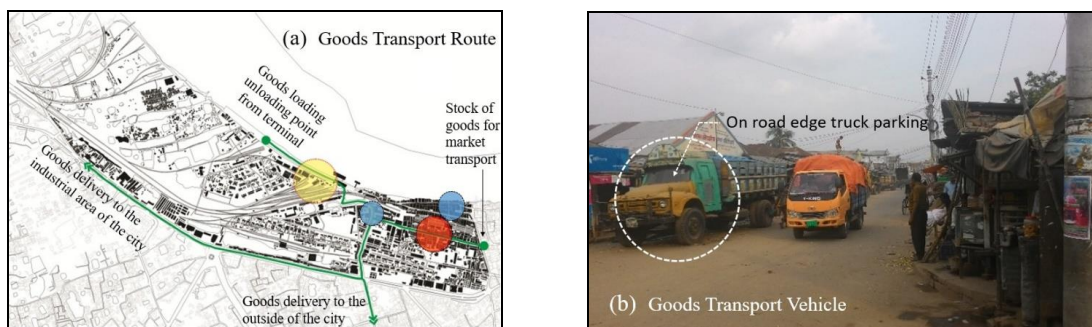


Figure 7. Goods load distribution pattern.

The green lines with arrows in Figure 8(a) denote the passenger circulation way of both from the terminal area to destination and from the destination to terminal area through road junction. In Figure 8(a) the yellow circle denotes the location of the terminal area of both the railway and BIWTA terminal and the blue circles denote the passenger distribution point of different road junction (node or “moor”) through pedestrian circulation. Junction 1, 2, 3 and 4 are the Shib-bari moor, Power house moor, Ferry ghat moor and Dak-bangla moor sequentially. Both the railway terminal and BIWTA river terminal use the same circulation road (Station approach road) for passenger distribution. Passenger load is distributed by motor car, auto rickshaw, private vehicle and bus through this shared road in 24 hours. Different transport modes of passenger load distribution vehicles in “Power house moor” the nearest road junction to terminal area is shown in Figure 8(b). The number of on foot access of passenger increases during different national and religious festivals and occasions.

In Figure 9(a) the yellow circle denotes the location of the terminal area of both the railway and BIWTA terminal and the blue circles denote the passenger distribution point of different road junction (node or “moor”) through pedestrian circulation. Junction 1, 2, 3 and 4 are the Shib-bari moor, Power house moor, Ferry ghat moor and Dak-bangla moor sequentially. The green lines with arrows denote the pedestrian circulation way of both from the terminal area to destination and from the destination to terminal area through road junction. The unsafe and hazardous pedestrian access because of shared road and the illegal parking of cargo trucks and goods van on the road side. The white dot line with arrows in Figure 9(b) shows the blockage and hazardous pedestrian access because of road side business material and truck parking in sidewalk of Station approach road. The traffic jam is increased during in different types of festival occasion in Bangladesh.

#### *Traffic flow analysis*

Traffic circulation involves vehicle and pedestrian road and pedestrian traffic movement, road access, road flexibility, and the variable that affects their flow. The main objective of the research is to understand the

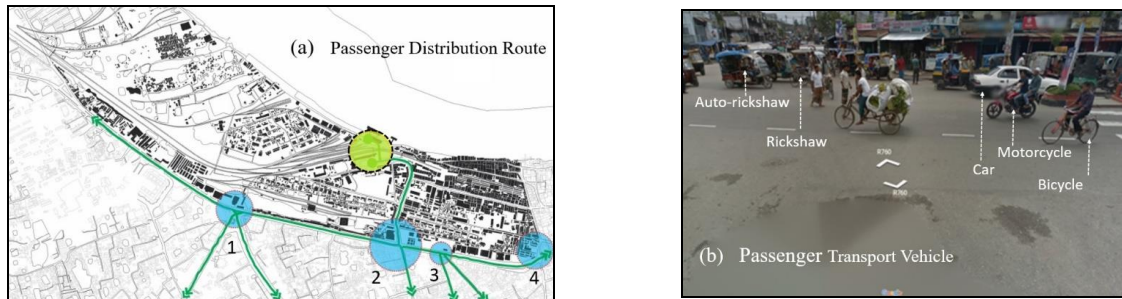


Figure 8. Passenger load distribution pattern.

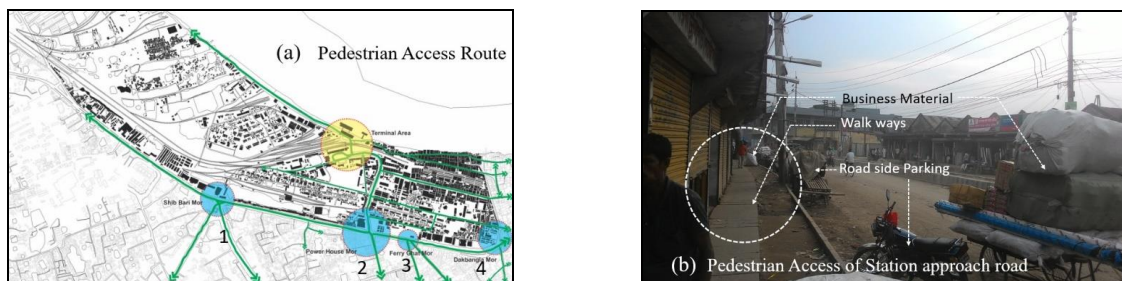


Figure 9. Pedestrian access pattern.

current movement pattern of the field of study by analyzing traffic access, its movement, traffic flexibility, traffic flow effects, and the problems faced by traffic. Circulation of various streets is influenced by active carriage width, parking facilities, on street parking, vehicle speed, signage, Road light and road marks, traffic signal and so many things (Goodman, 1968). Because of lack of data source the data given below is collected from field observation by time to time field visit and interview survey of the different stake holders and local authorities. According to the traffic loads major transportation roads are New Jessore road, station approach road and station road according to the traffic loads.

New Jessore road is the national highway that connects Khulna and Jessore districts. This road is mainly vibrant with Rickshaw, Auto rickshaw, Motor car and Goods van. Among the total percentage of the vehicular traffic almost 55% is occupied by auto rickshaw. After 8pm the vibrancy of goods cargo and truck is increased. It has been observed that the pick hour of traffic flow is 4pm-7pm. Figure 10(a) shows the percentage of pick hour traffic flow of different traffic modes in New Jessore road. Problems associated with New Jessore road:

- Parking on the edge of the road constitutes a serious emergency hazard wherever cars, rickshaw and auto rickshaw block the traffic flow and causes traffic jam.
- Parking, informal business, business and construction materials on footpath blocks the pedestrian access.
- Business and construction materials on the carriage way.

Station road connects the railway and BIWTA terminal with the CBD and the warehouse development area. The major traffic modes of the road are goods van and truck. About 33% truck and 38% goods van of the total traffics are parked here at the pick hour. The pick hour of the traffic vibrancy is

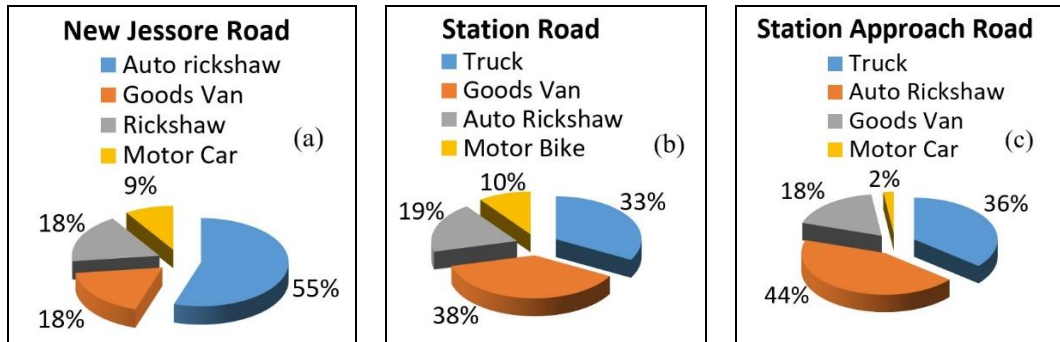


Figure 10. Pick hour traffic analysis of major roads.

observed from 4pm to 10pm. Figure 10(b) shows the percentage of pick hour traffic flow of different traffic modes in station road. Problems associated with Station approach road:

- On street goods van, truck and auto rickshaw parking at the road edge block the traffic flow.
- Parking, informal business, business and construction materials on footpath blocks the pedestrian access.
- Business and construction materials on the carriage way.

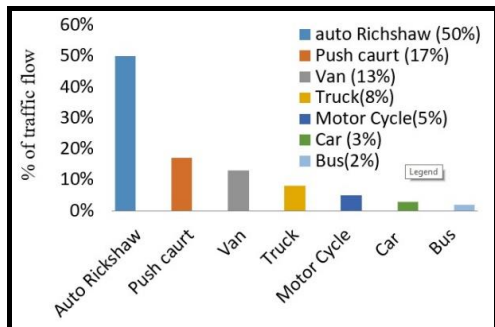


Figure 11. Traffic flow of station approach road by no. of vehicles.

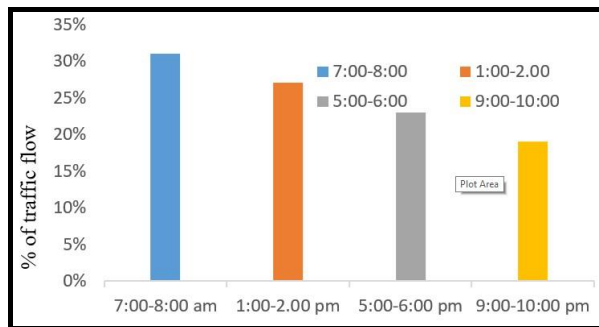


Figure 12. Percentage of traffic flow in accordance with different time period of station approach road.

Station Approach Road plays the most vital role in connecting railway terminal, BIWTA terminal, station market and warehouse development area with the main city circulation road. This road is the major concern because this is the common shared road of different user group. The major traffic modes of this roads are auto rickshaw and goods truck. Most of the day time cargo truck and lorry is parked on this road due to movement of heavy goods vehicle in metropolitan area is restricted from 8am to 8pm. It has been observed that more than 200 trucks are parked on road side from 1pm to 3pm. The pick hour of traffic vibrancy is observed from 4pm to 7pm. Figure 10(c) shows the percentage of pick hour traffic flow of different traffic modes in Station approach road. Figure 11 shows the percentage of traffic flow of different traffic modes in a day. Figure 12 shows the percentage of all traffic flow in station approach road in different time period. The most vibrant time period of traffic flow in station approach road is 7:00-8:00 am. Problems associated with Station approach road:

- On street truck, lorry and goods van parking at the road edge constitutes a serious emergency hazard.
- Informal business, business and construction materials on footpath blocks the pedestrian access.
- Business materials on the carriage way.
- Ramp breaking and inadequate road crossing facilities
- Road's dead end

Table 2 shows the number of vehicles in different roads connected to the study area in different time period. This number is calculated from the equation of Passenger Car Equivalent per hour (PCE /hr). The number of vehicles passes through an imaginary line in one hour is the Passenger Car Equivalent per hour. PCE is used for assessing the impact on traffic flow of different vehicle categories. Since traffic flow consists of several vehicle types, the PCE values are used to convert real traffic flow into a homogeneous condition (Subotic *et al.*, 2016).

Table 2. Vehicular Traffic Flow of Different Roads in PCE (Passenger Car Equivalent).

Road name	Direction	Traffic flow in PCE /hr			
		9.00-10.00	14.00-15.00	17.00-18.00	16.00-19.00
New Jessore Road	From Zero Point to east (Ferry Ghat)	1320	1082	2005	2526
	From east (Ferry Ghat) to Zero Point	1321	667	1723	2195
Old Jessore Road	Hoogly Bakery to Paper Stand	310	195	605	743
	Diana to Picture Palace	70	32	60	95
Lower Jessore Road	From Zero Point to West (Hotel Deluxe)	1040	704	1230	1045
	From West (Hotel Deluxe) to Zero Point	912	105	1029	1068
Clay Road	Zero Point to Nixon Market	665	405	788	357
	Nixon Market to Old Jessore Road	460	208	165	257

(Source: Field survey, July 2017)

#### *Findings from traffic analysis*

- There has no defined parking places for heavy vehicles like cargo truck and lorry. They usually park on the side of the major circulation road. As a result this parking problem and standing vehicle causes circulation blockage and traffic jam shown in Figure 13.
- Heavy, low weighted, public and private vehicles for passenger and good transportation share the same transportation road at the same time.
- Road-train-launch transportation interchange occurs within a single space in this place.
- Traffic jam occurs during this interchange especially in train services.
- Pedestrian risk for goods carrying and hazardous walking condition. The white circle in Figure 14 shows that on street informal business, business goods and the road side parking of goods van, push cart and trucks makes pedestrian blockage.
- Major roads of the study area become dead at night and unpleasant community appears. This causes social crimes.
- Traffic congestion due to unplanned goods loading unloading, illegal occupancy of pedestrians, dead end traffic etc. causes many hazards for the users.

- This place has been faced the problem of vendors.



Figure 13. Road side truck parking on station approach road.



Figure 14. Hazardous pedestrian condition of station approach road.

#### Recommendation

Several considerations for further development of transportation in the study:

- Response to the increasing number of goods transportation( truck) and their loadind, unloading and parking accommodation.
- Rethinking the future extension of CBD (Borobazar Commercial Area) & location of existing warehouse development.
- Response to the rapid interchanges among the existing three transportation modes- (a) water to road, (b) train to road (c) train to water
- Thinking about the new transportation modes and their interchanges for the future growth of Khulna city
- Focusing on the safe pedestrian environment for a walkable healthy city.

From the analysis of existing land use and functional dependency to each other it is seen that an integrated transportation system has already been grown up naturally within the study area. Considering these challenges with Govt. Development proposal, the recommendation form this research is to make an integrated transportation terminal as a multi-modal transportation hub. A seperate transportation system will not sustain in this place specially in such kind of mixed-use zone in Khulna. Because every use is dependent on other uses.

The major transport modes are Railway (Both Passenger & cargo), Launch (Both Passenger & cargo) and Truck services. Therefore, interchanges among the different modes are essential. The possible interchanges are water way to road way, railway to road way and rail way to water way. But the existing situation has no such facility. An integrated transportation terminal that will serve as a common platform for existing 3 kinds of transportation mode rail way, water way and road way will be more compatible for the CBD area in Khulna. A diagram has shown in Figure 15 shows which is an integrated terminal platform model that will accommodate all types of existing traffic modes grown naturally on the basis of needs in the study area. This platform should be more than a transportation terminal, it should also serve as a public interection and recreational place for ensuring social survalance and a walkable pedestrian friendly environment. Because there is a lack of social interactions in cities that evidently increases mortality risk signifi-cantly(Holt-Lunstad, J., Smith, T. B., & Layton, J. B. 2010).

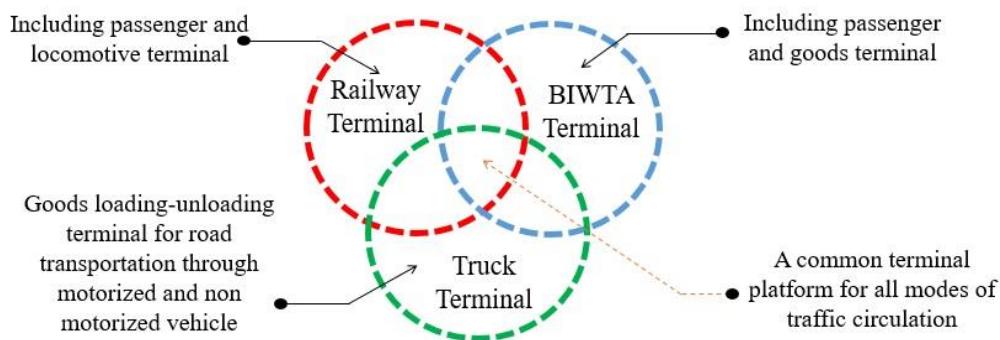


Figure 15. An integrated terminal platform for existing transportation modes.

## Conclusion

Due to good accessibility gradually, Khulna turned into a market place. Study area is almost the centre of Khulna City. It is around 195.44 acres is not compactly used in Khulna City. It's the major transition hub of Khulna city comprising Railway station, BIWTA ghat, ghat colony, 5 no terminal ghat. In these situations, this area plays an important role in transportation of Khulna city. Khulna railway area experiences multi-modal transportation facilities because of BIWTA launch terminal, Railway terminal, Truck and cargo docks. This area has a tremendous demand of freight services as well as passenger transport.

Considering, the opportunity of having rail, and water transport terminals together at the main railway station at Khulna this plan proposes to link road transport terminal near Ferry Ghat with the railway and water to make a multi-modal transport terminal system in Khulna City. Keeping in view physical form in the existing urban structure of Khulna, elongated shape, the existence of river and rail network together it is logical to state that a multi-modal transport network will increase the efficiency in transportation. The location of multimodal transport terminal system will be almost at the centre of the city, which will further facilitate the shaping of the city structure.

## Acknowledgement

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