MANAGING EFFICIENCY OF URBAN ROAD TOWARD BETTER TRANSPORT SYSTEM

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Abstract

Increased traffic volume introduces congestion on road affecting efficiency of road. Efficiency assessment could be defined as the comparison between current status of roads in terms of road capacity, traffic volume, geometric design, etc. and standard of roads prescribed for well-functioning of roads. After the opening of Rupsha Bridge in Khulna of Bangladesh, the study road gains some additional trips: the trips previously used Rupsha Ferry terminal and trips from city center people make to visit the Bridge. The burden of traffics in an urban road result congestion on it and which makes necessity of studying whether the road is efficient or not to serve all its traffic flow. This study presents a methodological approach toward measuring efficiency of an urban road and also depicts when and how such measure might be required for an urban setting. This study conducts traffic volume, geometric design status and problem analysis to identify the problems making traffic congestion. Datasets of the road, comparing with the road standards, prove the road as an inefficient road. The authors also discovered what the vehicle types responsible for such inefficiency are. They suggested with appropriate reasoning that motorized vehicles required to be eliminated from the road to have efficiency serving the residential trips and additional visitor trips on the road. The authors concluded by designing an alternative road for the eliminated motorized vehicles.

Keywords: Road efficiency, urban road, Rupsha Bridge, Khulna City

I. INTRODUCTION

Roads on urban spaces are fundamental means of communication and transaction. Thus the roads need to be well-functioning and efficient to serve the demand. As

becoming industrialized city and divisional town with a port at *Mongla*, Khulna is the country's third largest city in Bangladesh having a higher transportation demand (Asian City Development Strategies, 2000). Khulna city area is separated from its outer eastern portion by *Rupsha* River. Ferries over this river helped to share the transportation facility among south-western regions and the eastern as well as the north-western regions of Bangladesh. It was the route to link the *Mongla* sea port with Dhaka and north-western regions of the country. As a result, both sides of the river were introduced as a place of trip generation with two bus terminals. To improve the transportation system, *Rupsha* Bridge has been constructed to connect the south-western part of the country with the north-western regions (Das, 2005). Construction of *Rupsha* Bridge has brought a great change in transportation system of the south-western regions of Bangladesh.

Due to establishment of *Rupsha* Bridge, *Labanchara* Main Road becomes the only approach road for entering into the Khulna city. Hence volume of that road has been increased. Moreover, this Bridge is a highly prestigious establishment for inhabitants of south-western region and that's why, a good number of visitors come to visit the Bridge daily. Many visitors from the city and its surrounds use the *Labanchara* Main Road to reach at the Bridge. *Labanchara* Main Road was constructed as a flood protection embankment in the ancient time of Khulna. The people lived in *Labanchara* area then used that embankment as a walk-way. With the increase of population, in 1980's, the top of the embankment turned into a Brick Flat Soling road to meet the travel demand of that locality. And after that, it was arrived as *Labanchara* Main Road with Bituminous Carpeting. The history says that construction of that road was not planned. As a result, planning considerations like design standards, capacity, design speed, allowable traffic etc. were absent for it (Jabbar, 2006). An extra pressure on road is resulting from such generated trips. All those trips have generated in additional to the locally generated trips. There are also some industrial establishments in the area which use that road for freight movement. So, the demand of *Labanchara* Main Road for several purposes to different users is very high. The present situation is it is a road having high traffic volume with various types of vehicles.

The concept, 'Road Efficiency' has been brought out from the concept of 'Transport Efficiency'. The study targets to perform the measurement of urban road efficiency for the study road in context of its capacity and current demand of movement. This measurement performs a comparison between the current demand and the standard capacity of a road in relation to its specific geometric design. The study contains a calculation of traffic volume to measure the existing travel demand on the road. The problems related to vehicular movement have also been identified in this study, to find out alternative initiative(s) required for making the road efficient in serving its demand.

The structure of the paper will be as follows. After this introduction, an overview of the concept of road efficiency is elaborated. Methods and analysis results are given for the next two sections, followed by interpretations and conclusion.

II. KEY CONCEPTS

Urban transport is meant for land transport of people and goods in urban areas. The term 'transport system' refers to socio-technological systems for transport of people and goods: These systems consist of vehicles-energy-infrastructure-organizations-people embedded in an urban, social, cultural and geographical context (Volvo Research and Educational Foundations, 2004). A transport system with its components is able to provide economies of scale and specialization of urban based industrial and commercial activities. As a result activity generation and concentration is managed through transport system (Dimitriou, 1992). Again, transportation demand influences transport system in its function (Benson, Bugg and Whitehead, 1994). Transportation demand is derived in nature; that means, it depends on the social demand for other goods and services. Transportation demand is also influenced by the modal choice of the users (public or private carriage). Such modal split of passenger carriage is also affected by availability of alternatives, comfort, dependability and safety (Lieb, 1985).

Transport efficiency is a quality of transport system that is able to meet the travel demands of the traffic. Such efficiency relies on various levels like efficiency at planning level, infrastructure level, institutional level etc. The efficiency of urban transport system is greatly affected by the management, capacity, and conditions of the transport system under which the system operates (Dimitriou, 1992). Efficiency of urban transport can be brought through effective decision making process including plan preparation, technology adoption, assessment of demand and supply of transport facility, modal allowance, signage, traffic control and management etc. (Camagni, Capello and Nijkamp, 2005). Design considerations for transport infrastructure and traffic management during the planning level also affect efficiency of road transport (Dimitriou, 1992). Efficient road also relies on institutional arrangements which include coordination among different sectors of planning, management and maintenance system of the authority, institutional support etc. (Dimitriou, 1992).

Road efficiency matters, especially, in peak hours which are defined as the time from 7 to 9 A.M. and 4 to 6 P.M. and the remaining are off peak hours (Lieb, 1985). In peak hours the number of travelers rises so high that the urban roads have to meet unavoidable traffic congestion. Moreover rapid growth of motorization has deteriorated the condition of urban transport system in the third world cities. At present most of those cities are with serious transportation problems like rapid traffic growth, traffic congestion, Lack of maintenance,

inefficient transport system, mix and misuse of transport technology, ineffective traffic management, higher road accidents, environmental degradation, weak institutional support etc. (Dimitriou, 1992).

III. METHODOLOGY

To measure efficiency of road existing demand of roads was assessed by counting the frequency of vehicles at different time period, i.e., traffic volume study was performed in hourly pattern. Traffic volume means the number of vehicles passing a particular section of the road per unit time at a specified time. Such traffic volume study may be done mechanically or manually from different stations and such stations are located where traffic volume is heavy (Singh and Singh, 1978). Manual counting method was applied for this study and traffic variations were measured for different hours of a day and then variation in different days of a week. The traffic count survey was performed for a week continuously at different hours on a day. Traffic was counted in both peak hours and off-peak hours. To identify the generated problems on the study road visual observation survey and focus group discussion was conducted at different stations for different time periods within 'he surveyed days. In visual observation survey required information are collected and stored in *Check List* sheets. Focus Group Discussion (FGD) has been conducted with road users like, *Rickshaw* pullers, *Van* pullers, Truck drivers, Bus drivers, Auto drivers, Hawkers, pedestrians and neighboring households.

The City authority of Khulna and Roads Highways Authority of Bangladesh provide the secondary information like, design – including the road design aspects of length, width, carriage way, camber, shoulder etc., mode of transport – information about the considerations undertaken in designing for the vehicles that will travel on that road, service area – the area that the road will serve to meet the travel demand of the people, demand – the travel demand of the people within its service area that was considered in designing, designed capacity – the volume of traffic (vehicle) that the road will be able to support in a prescribed time considered while road was designed, road pavement – materials use for road surface construction, road map – refers to the map of the *Labanchara* Main Road along with other link roads and road design standards – contains cross-section design standards, geometric design standards etc.

After data collection and analysis the road features were compared with the road design standards fixed out by Roads and Railways Division under the Ministry of Communication of the Government of People's Republic of Bangladesh. In this comparison the existing volume was converted into Passenger Car Unit (PCU) values. Then the comparison was brought using road cross-section standards in geometric design standards depending on PCU values. For this measurement the

analyzed data and the secondary document (road design standards) was used. That analysis was offering a Yes or No answer, "Is this road enough efficient to allow the present volume of traffic?"

IV. EFFICIENCY RESULTS

Measurement of the efficiency includes comparison the generated PCU value on the study road with the standards fixed out by the Government of the People's Republic of Bangladesh. Geometric design standards are summarized in Table 1 for cross-sections fixed out by the Roads and Railways Division of the Government of Bangladesh. There are six standard cross-sections (Design type 1 to 6) each of which is suitable for a specific range of traffic volumes.

Table 1. Road Cross-section Standards

Design type	Traffic volume in PCU / peak hour	Cross-section widths in meter		
		Crest width	Carriage-way (no. of lanes)	Paved shoulder
1	4500 – 8500	36.2	2 x 11 (6)	1.8
2	2100 – 4500	21.6	2 x 7.3 (4)	1.8
3	1600 – 2100	16.3	7.3 (2)	1.5
4	800 – 1600	12.1	6.2 (2)	1.5
5	400 – 800	9.8	5.5 (2)	1.5
6	< 400	9.8	3.7 (1)	1.2

Source: Government of the People's Republic of Bangladesh, 2000.

The standards applicable for the study road is with design type 4 (Table 1). Because the study road has a carriage-way width of 6 meter and number of lanes are also 2. As a result comparison had carried out with the standard PCU value range (800 – 1600) in design type 4 with the average daily generated PCU value on the study road.
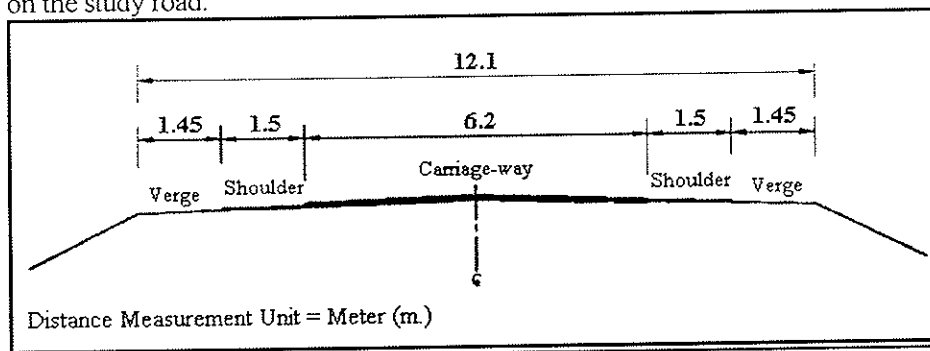

Figure 1: Standards of cross-sectional elements applicable for study road
Source: Government of the People's Republic of Bangladesh, 2000.

Figure 1 is showing the standard widths of different cross-sectional elements having a 6 meters carriage-way width. The study road is without any space required for shoulder and verge on it as mentioned in design standards.

The following table (Table 2) is representing the average PCU values generating on the road on surveyed day basis separately along with the different survey time. Such average value for a day is the arithmetic mean of counted PCU values at different stations surveyed.

Table 2. Average generated PCU values on road for different days

Survey time	Total PCU							Average daily PCU
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	
Peak (Morning)	1937.3	1874	1872.5	1880.3	1915	1943.8	1936	1908.4
Off-peak (Noon)	1271	1215.5	1237.5	1205.8	1259	1288	1237	1244.9
Peak (Evening)	1742.8	1763.5	1697.8	1808.5	1633.8	1717.3	1801.3	1737.9

Source: Field Survey, 2006.

Table 3. Existing scenario on the road versus design standards

Sectional element	Width (meter)	Standard width (meter)	Generated PCU/ peak hour	Standard PCU / peak hour
Crest	---	12.1		
Carriageway	6	6.2	1823.2	Maximum: 1600
Shoulder paved	0	1.5		
Verge	0	1.45		

Source: Field Survey, 2006 and Government of the People's Republic of Bangladesh, 2000.

The average PCU value generating on the road in peak hour was computed 1823.2 (mean of average daily PCU at morning and evening hours). From Table 3, it is clear that the study road had higher PCU value in peak hours generating on it than the standard value applied for comparison and the variation was very high. Hence, it is identified that, the road is not efficient to meet the traffic demand with standard quality on it. In this circumstance better transport system is required to mange such inefficiency of transport system in an urban setting.

V.   TOWARD BETTER TRANSPORT SYSTEM

Form the problem analysis it has been identified that Bus, Truck and non-motorized low speed Rickshaw-Van are the leading problem generating vehicles. As a result, alternative measures have been considered for those vehicles to increase efficiency of the study road. After constructing *Rupsha* Bridge, new bus route has introduced on that road that was absent in previous. So, now it is necessary to make sure that the study road has minimum requirements for functioning as a Bus route. On the other way, it is also needed to evaluate the requirements or restriction (if exists) regarding movements on the study road of other vehicles like Truck, Rickshaws and Van.

Labanchara Main Road, the study road has a carriageway width of 6 meters. Buses are moving on this road to come in and getting out from the city using the *Rupsha* Bridge. But the standard minimum width of carriage-way for a Bus road is 7.5 meters (ACT Government of Australia, 2006). The carriageway width of the study road is below the minimum requirement, so alternative bus route may be used to increase the road efficiency. Khulna City Corporation has restricted the access of Truck on the city roads from 8 A.M to 8 P.M. – mainly peak hours of a day. The rest of the time or off-peak hour Trucks have access on the city roads. The reason of such restriction is to normalize the pressure of traffic on roads and to minimize traffic jam (Jabbar, 2006). The study road is characterized as a city road and Truck is not permitted to come on that road within the restricted time period. But form the field survey movement of Truck has found in the time of restriction. Execution of that restriction of movement for truck can be useful to increase the road efficiency. For the movement of non-motorized vehicles, minimum carriageway width 3 meters has standardized by the Roads and Railways Division of the Government of the People's Republic of Bangladesh (2000). The study road with 6 meters carriageway width is allowable for NMVs. So, the alternative way for the movement of Vans and Rickshaws (most problematic NMVs) are not necessary to consider. As a result. to increase the efficiency of the Road it is required to identify alternative Bus road and to take proper steps restricting access of Truck in restricted time period. Elimination of Bus and Truck from the road on peak hours results PCU of 1736 which is also not efficient condition of the road (*Please see also* Table 4). Only if all motorized vehicles could be eliminated from the road on peak hours the road will be efficient.

Table 4. Efficiency status after identifying alternatives

Vehicle type	PCU of exclusion in per peak hour	Remaining PCU/peak hour (*1823.2 – PCU of Vehicle*)	Efficiency status
Truck	17.8	1735.5 (greater than	Not
Bus	69.9	1600)	efficient

Vehicle type	PCU of exclusion in per peak hour	Remaining PCU/peak hour (*1823.2 – PCU of Vehicle*)	Efficiency status
Total	87.7		
All Motorized Vehicle	229.9	1593.3 (less than 1600)	Efficient

Source: Field Survey, 2006.

Roads that have minimum requirements (carriage-way width is more than 7.5 meters) for being a Bus road were considered in suggesting alternative Bus route. National Highways spread over the Khulna City have carriage-way width more than 7.5 meters. Thus alternative road assigning operation was performed utilizing the National Highways. The resulted alternative bus route had started form *Sonadanga* Bus Terminal shifting from *Rupsha* Bus stand. Buses are to depart from that terminal, using *Sonadanga* Outer By Pass Road. Thus the route would be *Sonadanga* Bus terminal, *Sonadanga* outer By Pass road, *Sher-e-Bangla* Road (*Khulna-Satkhira* Road) at *Gollamari* and at the intersection of *Rupsha* Bridge Approach Road and the Bridge. On this route the most vulnerable area having possibility of generating congestion is on the node at *Gollamari*. Node improvement through extension of width may be useful to minimize it (*Please see* Figure 2).

VI. CONCLUSION

Inefficiency of the study road was identified from traffic congestion observed on the road. *Rupsha* Bridge, being a pride of people of Khulna, produces a huge number of traffic of people come daily to visit the Bridge on that road. It was not properly thought that, an infrastructural establishment can make an approach road inefficient, when the road was made to serve the neighboring residential trips. Elimination of vehicular movement heading to other places crossing the Bridge has been established as the core theme to increase efficiency. The authors suggested to eliminate Buses and goods carrying Trucks from the Road that carrying trips for other purposes except residential trips of neighboring road areas and trips of visitors that are coming to see the *Rusha* Bridge. Such elimination is increasing the efficiency of the road. The alternative road for motorized vehicles is identified based on existing traffic volume on the road and capacity of the road. This study is potential planning to massive establishments and their approach roads. the methodology used in this study can very friendly be used for other roads that are making congestion and functioning inefficient.
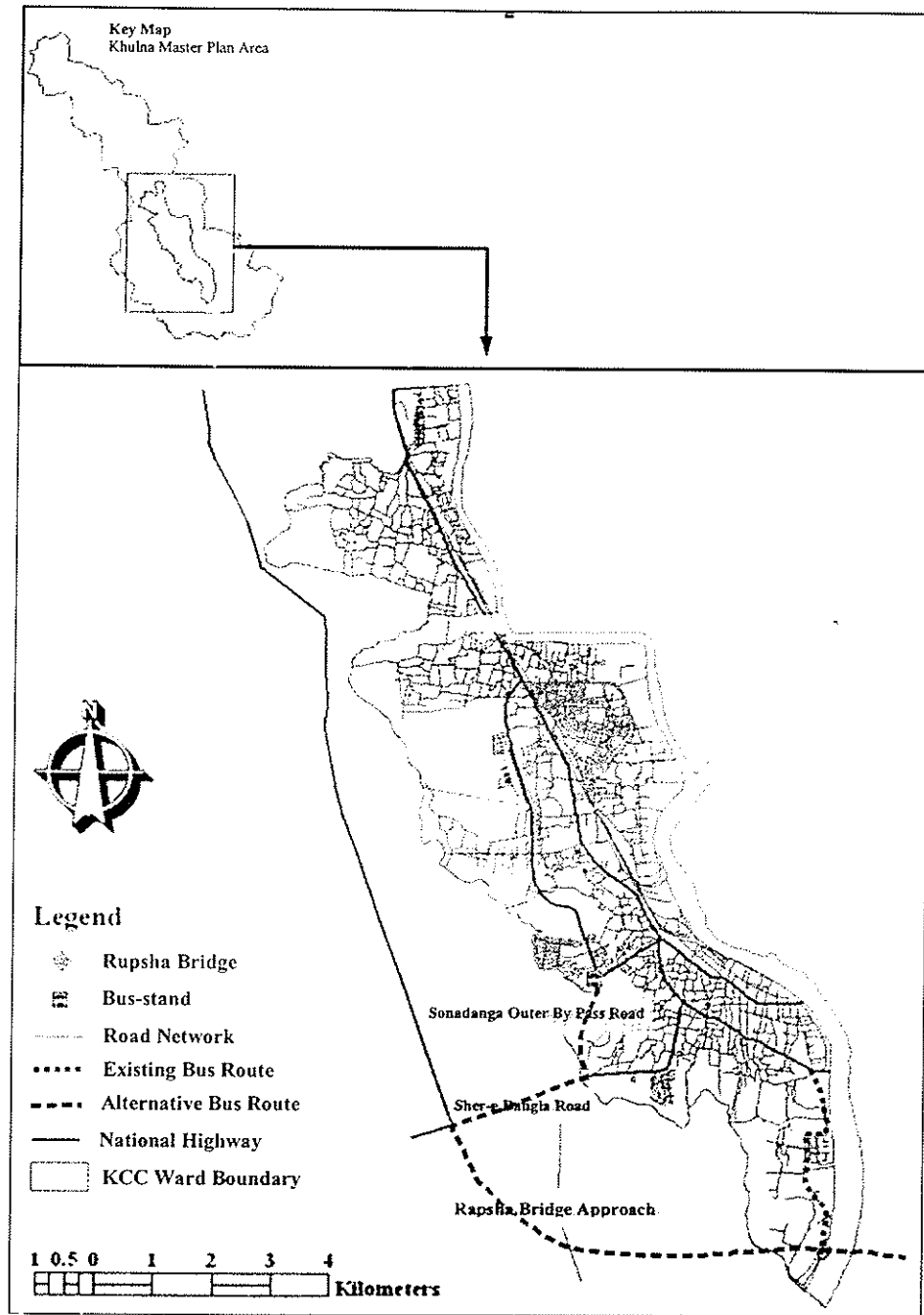
Figure 2: Map of identified alternative bus road
Source: URP, 1999.

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