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Factors in deciding Metro Rail in Developing Countries: A study on the proposed Metro Rail system for Dhaka

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Abstract

While metro schemes have been suitable investments for some western cities and some Asian cities, like Hong Kong and Singapore, they are not necessarily the most appropriate options for cities in developing countries. Although urban transport problems, like congestion and pollution seem to be similar everywhere, the suitability of a metro solution is more questionable for cities in developing countries owing to their distinctive social, economic and spatial characteristics, and their existing transport technologies and the travel habits of their inhabitants. A critical examination of such issues is undertaken for the proposed metro for Dhaka. The study concludes that due to high population densities, transport users favour metro rail construction. On the other hand, the existing spatial structure of the city, patterns of land use, economic aspects and existing trip characteristics suggest metro is an inappropriate choice.

Introduction

Mass rapid transit projects are often taken by the government of developing countries. Developing countries in Asia are undertaking rail based system especially metro[1] as a solution to solve the problems of urban traffic congestion and for meeting rapidly increasing travel demand. This is also targeted for controlling environmental pollution and boosting up economic growth. Experiencing projects in Hong Kong and Singapore, and cities in South Asian countries, like Delhi, Mumbai, Calcutta (India) and Dhaka (Bangladesh) are found to rely on metro for the growing travel demand as ultimate solution.

For developed world, Walmsley and Ken Perrett (1992) identified several reasons why countries like Canada, France, Germany and the United States adopted rapid rail transit systems. Along with environmental goal achievement, cities with increasing economic growth planned for rapid transit to make it congestion-free, faster and reliable for the movement of people. Golias (2002) argued that any new public transport system should be based on the perceived impacts, such as increased market share for public transportation, reduced automobile dependence, positive effects on environment and urban development. Among them, most important and common issue is to reduce car use and increase the use of public transport. On the other hand, developing cities choose metro mainly to meet the high travel demand which often can not reduce congestion. A study on mass rapid transit in 13 developing countries (whose aim were to increase capacity of public transport and the quality of services) was carried out by Halcrow Fox

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[1] Metros – these are fully segregated, usually elevated or underground. It is the segregation that is critical to providing a rapid service, and the technology that allows a high mass ridership to be carried (Halcrow, 2000).

and Associates who concluded that none of the developing cities got a notable reduction of traffic congestion by implementing metro system (David Walmsley and Ken Perrett 1992, p.106). Calcutta in India is one of the prime examples of financial loss by metro rail in developing countries (Singh, 2002). Similarly, there are a number of failures in developing countries despite having high transport demand for developing metro that could be differed from the developed world. Thus, Godard and Lequeux (1998) claim that metro seem to be applicable only for developed country for reducing congestion or managing travel demand. In his words, to escape from an existing situation of public transport is often unfavorable or even intolerable. However, Knowles and Fairweather (1991) mentioned that investment on light-rail may have an impact on reducing congestion but there is no guarantee to do so. Having such controversy, why Bangladesh is going for metro is analyzed here from different perspectives.

The government of Bangladesh approved a long-term mega project (Strategic Transport Plan, STP 2005) to establish an integrated environment-friendly traffic management system in greater Dhaka reducing troublesome traffic congestion. From a set of investment options including road with Bus Rapid Transit (BRT) or Metro Rail Transit (MRT) or various combinations of these (along various level of road investment), the recommendation was in favor of BRT and MRT along with moderate investments on the improvement of roads as a solution to meet the challenges of the future transport demand of Dhaka. The planned Metro rail in Dhaka is about 60 km. in length and is comprised of three lines (MRT in green, grey and purple lines in Figure 2). This could be a good response to the prevailing worse traffic situation. It, however, raises some questions which cannot be ignored in any circumstances. These issues also provide some indications to think about further assessment of metro considering different aspects before going to implement the project desperately. This research is an endeavor on that pursuit.

Framework of Analysis

Analysis includes critical assessment of the major issues which have definite impact (or vice versa) on Metro rail primarily. The assessment was done in two different ways: by qualitative analysis of some issues indicated by key interviewees who are knowledgeable about the current research problem; and secondly, by advanced quantitative assessments where different regression models were used for transport behavior analysis to explore the user characteristics and modeling their mode choice characteristics. Details about the methods of study e.g. data collection, sample size, data analysis are discussed in relevant sections.

Study Area Characteristics

Location: According to Hossain (2008) Dhaka is the largest urban center and capital of Bangladesh accommodating nearly 40 percent of the total urban population in the country. It is about 360 sq. km in area (Dhaka City Corporation) which accommodates 10 million people at the moment making it one of the most populated cities in the world (Bangladesh Bureau of statistics, 2009; The Daily Star, 12 November, 2006).

Transportation Network and transport modes: Strategic Transport Plan (2005) mentioned that the land use for transportation is between 6% and 10%. Andaleeb et al. (2007) provides more accurate result of 8% roadway, specifying that two-thirds of these roads are non-engineered surfaces which are very low compared to most developing countries of 13% (ADB 2002).

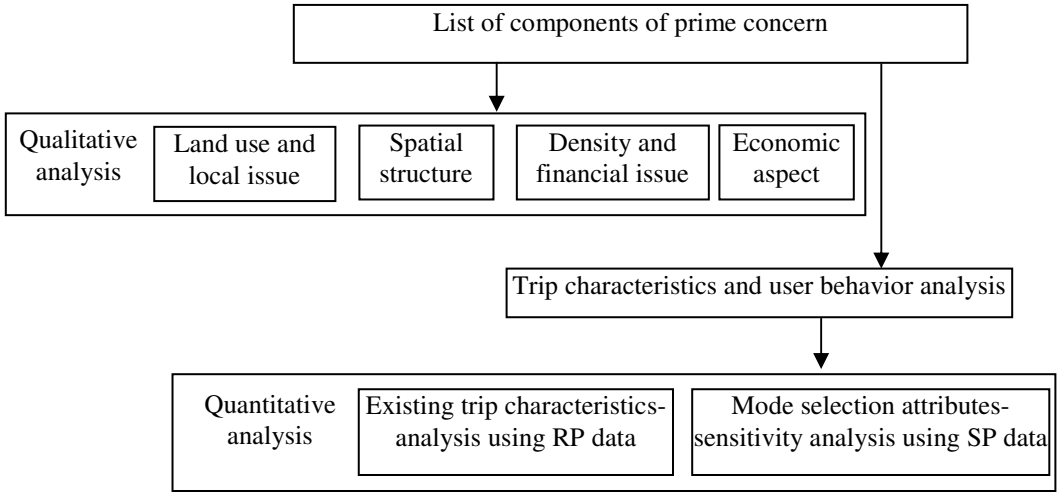

Fig. 1: Methodology of analysis

The road network of Dhaka city is composed of 199 kilometers of primary roads, 109 kilometers of secondary roads, 152 kilometers of collector roads, and about 2540 kilometers of access roads and others (Quium, 1995 cited in Alam J 2009). The prime public transport is buses. According to BRTA, 16,000 buses are running on the city roads to meet transport demand of 7.5 millions trips (Staff Correspondence, 2010). However, registered vehicles e.g. bus (Table 1) in Dhaka are low compared to those of currently running in the street. Recently, on April 14, 2009, bus route franchising was introduced in 30 kilometers of roadway (Anon n'd).

Table 1: Registered vehicles in Dhaka

Vehicle type	Number	Percentage
Motor Car	147283	27.93
Jeep/St. Wagon/ Microbus	58608	11.12
Taxi	10682	2.03
Bus	8210	1.56
Minibus	8317	1.58
Truck	30015	5.69
Auto-rickshaw/ Auto-tempo	14820	2.81
Motor-Cycle	219443	41.62
Others	29907	5.67

Source: BRTA, Dhaka, 2010

According to STP and BRTA, the number of automobiles in Dhaka (cars, jeeps, station wagons, pickup trucks and small vans) increased significantly in the recent years from 80,000 in 1994 and 166,000 in 2003 to 205,891 in 2010. According to registered fleet, the auto ownership is about 16 per 1,000 population or 1 per 15 households (STP 2005). In

any consideration, the primary mode is rickshaw[2] (except walk) e.g. BRTA mentioned currently 8.4 millions trips are done by rickshaws (Staff Correspondence 2010). Dhaka Urban Transport Project (DUTP) and STP found that the modal share is always significant for rickshaws and pedestrians (20% and 34% respectively).

Analysis of the Research Components

Trip characteristics and behavioural Aspect: Most of the big cities in developing countries can be characterized by insufficient mass transport provision which triggers massive congestion on road and cause of longer travel time. To response to the problem, the policy makers often chose the expensive metro projects in order to remove congestion and meeting the increasing transport demand. Such thinking is not often well justified because of a question about sustainability. It is almost impossible to bear huge capital cost by a developing country itself. Most of the cases, it is found that the developing countries hardly can built metro lines in every well demand corridors and serve the network efficiently. Policy makers of Bangladesh support metro although the country has poor economic condition to meet traffic demand. What is the response of transport users in this respect is a burning question. This section tries to reveal what are the users' perceptions and their major characteristics. To analyze the trip characteristics and travel behavior, the study includes revealed preference (RP) and stated preference (SP) methods and these are included in the questionnaire. In RP, existing travel behaviour has been analyzed responding to different questions, where SP is analyzed by the predicted travel behavior on the basis of the answers that respondents have provided while they are given different alternative scenarios to choose.

The sampling frame in the study includes people who are using the routes that follow the proposed metro lines. For each three types of questionnaires, samples are taken by non-probability sampling method[3] more specifically 'convenience sampling' (although a widely regarded problem is to define who will be in the sample, transport users are easily identified in this case and careful survey overcomes the other problem of biasness). Face to face data collection also ensures the sample of the intended users, those using bus, rickshaw or car. Thus, other primary mode users are almost omitted from the beginning of the study. For each of the experiments, two sample points for each primary mode user were chosen and data has been collected on five consecutive days (Table 2).

Total sample size for each mode is more or less 100 and in each location about 50 questionnaires have been conducted. Survey locations were selected either interchanging stations or people gathering places within 200 meters of the route (Figure 2). The other consideration for choosing sample locations were on the basis of the principal mode dominating the area and being within 200 meters of the planned metro route, for instances in Gulshan area (car dominating area) or old Dhaka (rickshaw dominated area) and other areas (Table 2).

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[2] Rickshaws (non-motorized transport) can be characterized by many aspects, such as it provides door-to-door service, highly individualized service and it is environment friendly as no fuel is needed.

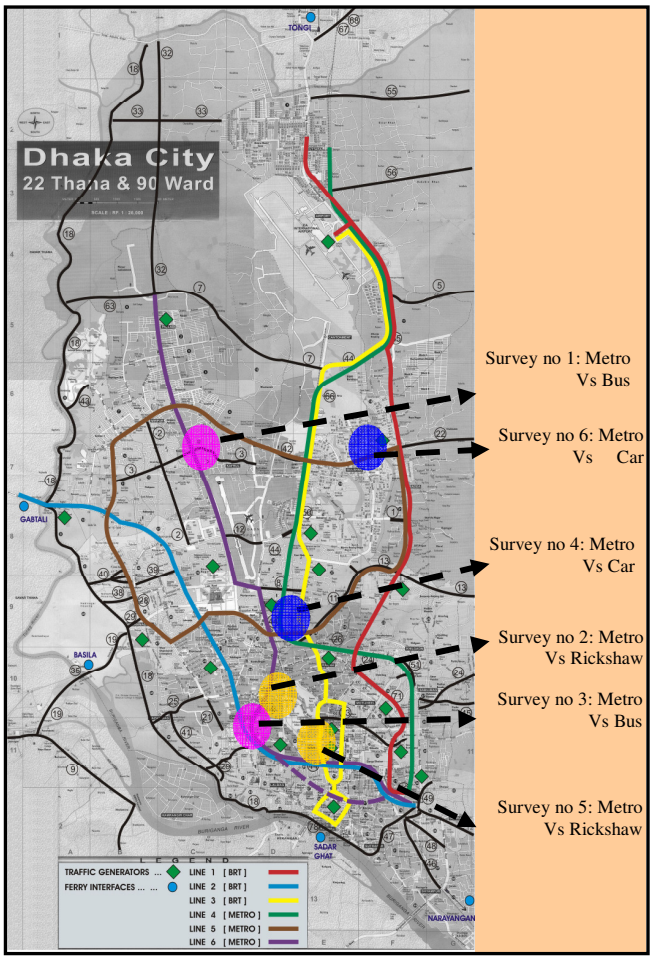
[3] Each member of the population has an unknown probability of being selected.

Table 2: Questionnaire survey sample location, time and date

Survey no.	Sample User	Sample Location	Description	Time, Date	Experiment Type
1	Bus	Mirpur 10	Bus stop	8am- 2pm, 15-07-09	Bus v Metro
2	Rickshaw	Eastern Plaza	Shopping Area	3pm- 6pm, 15-07-09	Rickshaw v Metro
3	Bus	Eden Mohila college	Bus stop	12pm- 6pm, 16-07-09	Bus v Metro
4	Car	Basundhara Shopping area	International shopping complex	11am-4pm, 17-07-09	Car v Metro
5	Rickshaw	BUET area, old Dhaka	Student area	10am-1pm, 18-07-09	Rickshaw v Metro
6	Car	Gulshan	Gulshan commercial /shopping area	10am-4pm, 19-07-09	Car v Metro

Impact of different socio-economic aspects on user perception: Whether perception about the metro to reduce congestion is supported by the different respondents has been examined by ordinal regression. The influence of more variables on a particular issue having ordered opinion exits, the ordinal regression analysis can be used. The formula of ordinal regression model, is – Ln $(\theta_i)= \alpha_i - \beta X$, where θ_i can be θ_1, θ_2…….. θ_k. means, probability of (score of 1) / probability of (score greater than 1) , similarly, probability of (score of 1 or 2) / probability of (score greater than 2) or Probability of (score of 1, 2, or 3) / probability of (score greater than 3). Each logit has different α value but have same β which means that the influence of the independent variable has the same for different logit. This assumption provides the influence of the variables on the scale value. The results (Table 2) suggest that some of the influencing factors are significantly associated with decreasing (as variables are strongly agree, agree, unsure, disagree and strongly disagree, responses moving from strongly agree to agree means support in favor of metro reduces) support for metro rail and in some cases factors are negatively associated with decreasing support for metro rail. The variables- economic status, gender, and income level and trip frequency are significantly associated with decreasing support metro rail. However, income level shows the opposite result that was expected: the decreasing support of the people of middle class and below (35000 taka or below/ £318 or below per month) increased with congestion reduction perception by metro decreased. This means that the middle and lower middle class people do not have high exception about metro congestion reduction capability.

Car availability and age variables have no significant effect on the perception. But, economic status (employed full or part time), gender (male) and trip frequency (4+ per week) have significant effect and negative value of the co-efficient shows that support are decreasing with the decreasing support for the metro, however middle class and below people have opposite opinion. This is completely logical if we consider that employed and frequent trip (more than 4 which are mostly work trips) makers use the road and suffer mostly by the congested traffic condition. The following tests are also supporting the arguments.



Source: Modified on Map from STP 2005

Fig. 2: Showing the Metro route and potential sample locations in the Study area

Table 3: Influence of different criteria on the perception of congestion reduction by metro

	Estimated coefficient	Standard error	Significance
Constant (Strongly agree)[a]	-.368	.420	.412
Constant(Agree) [a]	1.346	.434	.000
Constant (Unsure) [a]	3.128	.567	.000
Car availability(Car) [a]	.142	.258	.581
Economic status(Employed, full or part time) [a]	-.287	.310	.059
Gender(Male) [a]	-.352	.324	.078
Income level(middle class and below) [a]	.284	.745	.039
Age 24-54(Working class age) [a]	.110	.275	.623
Trip frequency (4 and more) [a]	-.189	.374	.051

[a] Strongly agree, Agree and Unsure are the level of agreement for reduced congestion criterion; reference categories are 'no car' for Car availability, Unemployed, keeping house, Student and retired for economic status; Higher income group (35000+ taka/£318+ per month) for income level; 16-24 and 55+ for age and less than four trips per week are considered.

Impact of extra journey time and frequency on user perception: From the congestion tolerance perspective, whether the proposed metro will reduce congestion or not, the respondents provided answers on a similar five point scale (strongly agree, agree, unsure, disagree, strongly disagree). Thus, the chi-square test on those answers with extra time and trip frequency separately provides a valuable opinion. The first test indicates a significant association between the congestion reductions expected with the extra congestion time experienced usually (In these analysis, the first two and last two responses are coded as positive and negative respectively about the effect and unsure was omitted from the analysis).

From Table 4, it is found for positive responses that observed counts are greater for above 11 minutes extra time than the expected counts which means that positive view about the metro increases with the increased extra time needed.

Table 4: Chi-square table showing relationship between perception about metro and assumed extra time needed

			Extra time					Total
			0-4 min	5-10 min	11-15 min	16-20 min	21+ min	
Perception on congestion	Positive	Count	27	44	29	48	82	230
		Expected Count	24.1	55.1	28.4	46.5	75.8	230.0
	Negative	Count	1	20	4	6	6	37
		Expected Count	3.9	8.9	4.6	7.5	12.2	37.0
Total		Count	28	64	33	54	88	267
		Expected Count	28.0	64.0	33.0	54.0	88.0	267.0

Note: Significant Association, Pearson Chi-Square value 22.78 (df =4) p =.001

The second test result found that the trip rate is significantly associated (p= .003) with congestion perception. The research hypothesis is accepted that expectation of the metro reducing congestion increases as more trips are made. Table 5 reveals that a positive view of congestion reduction have differences in the observed and expected count for higher trip frequencies and as observed count is greater it means that the variables have significant association.

So, employed and regular trip makers, who need longer extra time to complete the trips have great exception about the metro for congestion reduction.

Road user perception on congestion: To explore whether there is any co-relation among total journey time and extra time, an analysis has been conducted. The analysis considered, whether half of the total travel time differs from the assumed (extra) congestion time, considering mean, median and distribution or not. For analyzing the query, the t-test has been performed and following result obtained. So, the null hypothesis has difference between sampling variation.

Table 5: Chi-square showing relationship between perception about congestion reduction ability of metro and trip frequency

			Trip frequency in a week				Total
			less than 1	2-3	4-5	6 and more	
Perception on congestion	positive	Count	42	56	64	68	230
		Expected Count	53.4	58.6	58.6	59.4	230.0
	Negative	Count	20	12	4	1	37
		Expected Count	8.6	9.4	9.4	9.6	37.0
	Total	Count	62	68	68	69	267
		Expected Count	62.0	68.0	68.0	69.0	267.0

Significant Association, Pearson Chi-Square value 30.925 (df=3), p =.001

Table 6: Output of t-test between half time of destinations and assumed extra time

	N	Mean	Std. Deviation	Std. Error Mean
Half of total travel time	299	19.3980	11.23963	.65000
Assumed extra time	292	20.2534	14.70690	.86066

Note: No Significant difference, p =.427

The test confirmed that there is no significant variation between means; alternatively, there is no variation between half of the time needed for total travel time and congestion time.

Table 7: Output of Mann-Whitney Test between half time of destinations and assumed extra time

	N	Mean Rank	Sum of Ranks
Half time	299	296.76	88730.00
Extra time	292	295.23	86206.00
Total	591		

Note: No significant variation, p =.913

Similarly, from the Mann-Whitney Test (Table 6) and Kolmogorov-Smirnov test (Z = 1.03, p = .238), it is found that there is no significant difference in median and distribution between half of total travel times and extra congestion time. Thus, it is easily understandable that road users always consider a significant proportion of the total journey time for extra/congestion time regardless of trip length. Thus, longer trip makers considered longer extra time. Although, the extra time does not accurately represent the actual congestion time in Dhaka, the user perception on the congestion time shows the worse traffic congestion scenario. The longer trips makers are, however, optimistic about metro.

Captivity on mode selection: Respondents' use of alternative modes, is quite interesting (Table 8). The sample was divided according to whether or not respondents planned their journey in advance (which means whether they select mode choice before the

journey they performed). Bus users who have planned ahead, use alternative modes more than any other users. If they do not have an advance plan, this trend is still found although it is less prominent. It means that they are more choice riders rather than captive ones. On the other hand, car users are less eager to change the mode in any circumstances.

Table 8: Use of alternative modes by different mode users whether they have advance plan or not

People who plan in advance		Primary mode (usually use)			Total
		Rickshaw	Bus	Private car	
Yes	Use Alternative mode	17	23	15	55
	Doesn't Use Alternative mode	23	7	68	98
	Total	40	30	83	153
No	Use Alternative mode	11	25	1	37
	Doesn't Use Alternative mode	29	57	13	99
	Use Alternative mode	40	82	14	136

Thus it is interesting to note that car and rickshaw users are more captive in natures that are less likely to use alternative modes, but bus users are likely to use alternative mode. So, apart from any other users, bus users have the probability to switch to new mode, if it is introduced.

Table 9: The attributes for different experiments

Mode	Attributes	Value /level	Unit	Used in Experiment
Metro	Fare	8 and 14	Taka per km	1,2,3
	Journey time	1 and 3	Minutes per km	1,2,3
	service interval	10 and 20	Minutes (headway) between services	1
	Accessibility	1 and 3	Low accessibility for door to door service on 5 point scale	2,3
Bus	Fare	3 and 6	Taka per km	1
	Journey time	8 and 12	Minutes per km	1
	service interval	8 and 15	Minutes (headway) between services	1
Car	Cost	5 and 10	Taka per km	2
	Journey time	6 and 8	Minutes per km	2
	Accessibility	3 and 5	High accessibility for door to door service on 5 point scale	2
Rickshaw	Fare	5 and 10	Taka per km	3
	Journey time	10 and 15	Minutes per km	3
	Accessibility	3 and 5	High accessibility for door to door service on 5 point scale	3

Note: Experiment 1 means Metro v Bus, Experiment 2 Means Metro v Car, Experiment 3 means Metro v Rickshaw

Influence of attributes in mode choice: In a congested poorly served network, it is expected that people will be biased on new mode. In a stated preference analysis, it discovers the truth. The attributes (Based on mode characteristics) and their level selection (determined by linear regression for 1km distance) is considered carefully in Table 9 for three different experiments for comparison of metro with three prime modes.

The SP part of the questionnaire differs for three modes and are named as experiment 1 (Bus v Metro), experiment 2 (Car v Metro) and experiment 3 (Rickshaw v metro). The binary logistics regression formula used in these experiments for analysis is-

Ln (probability of Y)/ (1- probability of Y)) = $\beta_0 + \beta_1X_1+\beta_2X_2+\beta_3X_3……..\beta_kX_k$

Here, "probability of Y" represents the probability of using metro, while "1- probability of Y" represents the probability of using the other modes e.g. rickshaw or car or bus etc; β_0 is the constant; β_1X_1 represents co-efficient of the cost difference between the two modes being considered, β_2X_2 represents co-efficient of journey time difference, β_3X_3 represents co-efficient of service interval difference (experiment 1) and co-efficient of accessibility of accessibility difference (experiment 2 and 3).

Table 10: Binary logistic regression output showing variable influence and significance

Variables		Estimated Regression Co-efficient	Standard Error	Significance
Metro-Bus difference	Fare Difference	-.204	.025	.001 (<.05, Significant)
	Time Difference	-.061	.037	.098(>.05, Marginally Significant)
	'Service interval' Difference	-.030	.012	.014(<.05, Significant)
	Constant	1.785	.382	.001(<.05, Significant)
Metro-Car difference	Fare /cost Difference	-.106	.025	.001(<.05, Significant)
	Time Difference	-.027	.070	.695(>.05, Not Significant)
	Accessibility Difference	.140	.061	.022(<.05, Significant)
	Constant	2.082	.397	.001(<.05, Significant)
Metro-Rickshaw difference	Fare Difference	-.240	.033	.001(<.05, Significant)
	Time Difference	.072	.043	.094(>.05, Not Significant)
	Accessibility Difference	.338	.059	.001(<.05, Significant)
	Constant	3.065	.580	.001(<.05, Significant)

From Table 10, it is found that there is marginal or no influence of time on the mode choice which is very interesting. This can be explained by the huge biasness towards metro. Binary logistics regression should predict that the probability of choosing an

option from two modes will be the same if the influence of the variables, such as cost or time do not differ between the modes. If the constant is statistically and significantly different from zero then it indicates a bias in favor of one mode and against the other, which can be estimated from. Using the equation: $\mathbf{e^{constant}/(1+e^{constant})}$, probabilities of the modes are calculated, the results for all samples are given in Table 11.

Table 11: Enhancement of accuracy of the stated preference analysis

Sample scenario	Metro v Bus		Metro v Rickshaw		Metro v Car	
	constant only	Probability (Metro)	constant only	Probability (Metro)	constant only	Probability (Metro)
All sample data	1.785	0.8236	3.06	0.955	2.08	0.8878

It is found that for three types of mode users, the people are very optimistic to metro proposal which may not work in practice and inclusion of such issue in metro building consideration may become very dangerous.

Land Use and Local Issues

Inadequate and ineffective development control, the prime residential areas are now converted to commercial areas in Dhaka. Among them, Dhanmondi, Gulshan, Banani are mentionable. Dhanmondi is now more commercial in nature than residential. Non residential uses are increasing in Dhanmondi residential area. This was 28% in 1984, 35% in 1993 and about 50% in the year 2000 (Hashem and Maqsud, 2001). Similar conditions occur for other prime planned residential areas, such as Gulshan and Banani. Thus, mixed land use often trigger multidirectional and short trips which are difficult to incorporate in transport modeling for big cities. This modeling problem is particularly important for Dhaka having diverse category of land use including major share of unplanned land use (Table 12) and narrow primary roads which are suitable for slow modes especially Para-transit like rickshaw. Due to such land use of the city, its road system has been developed in an unplanned way. To tackle such nature, STP considered both Metro rail and Bus system development. Unfortunately, past evidence says that such integration is hard to achieve. Halcrow (2000) noted that Integration with the bus system is particularly necessary to metro viability, and often difficult to achieve.

Table 12: Land Use (%) of Dhaka City

Landuse	Percentage (%)
Commercial/Industrial	3.81
Institutional/Educational Facility	3.07
Health Facility	0.41
Mixed	8.67
Planned Residential (including Dhanmondi and other residential areas)	13.47
Unplanned Residential	30.04
Road	7.33
Slum	0.22
Others	32.98

Source: Gani Bangla (2004) and Ishrat I. et al. 2009

In estimation of STP 2005 , the 76% of short trips, 34% modal share for rickshaw and 14% walk (although HDRC 2005 estimated 23% share for walk) which means less scope for longer trips. This is because the land use pattern of the city, which is very much supportive to slow modes. Similarly, existence of different types of para transit is also a problem for patronage gain due to fare competition. Babalik-E. (2002) pointed out that low-income neighborhood may be unsuitable for rail operation, especially where modes are not integrated and have higher possibility of getting fare competition.

Similarly, Walmsley and Perrett (1992) identified three factors of gaining patronage for metro rail which are fare elasticities, the presence of alternative services and incorporate facilities. Thus, presence of rickshaw, mini-bus will be definitely the competitor for the short trips of metro in present land use. For a short trip, it is unlikely that people will go to the metro to make such trips. Because of the access, egress time and waiting time, the availability of rickshaw will be more attractive for short trips. Moreover, it will not be expected every time that for 2 km journey, people will come to use metro because the same journey by a rickshaw having 9 km/hr (an average speed of 5 to 12 km/hr over distances of up to 40 km, Replogle 1992 cited in Rahman M.M *et al* n'd, p 3) speed will take approximately 12 minutes. Similarly, people traveling 5-6 kilometer will not be attracted to use metro as changing at stations will cause waste of considerable time. Domencich, Kraft and Valette (1968) provided a more accurate view who estimated elasticities of demand for public transit which revealed that demand would decrease by 7 percent for each 10 percent increase in access, egress, and waiting time.

Beside, if the proportion of trip time spent on the access and egress stages is considerable, public transport trips will be considered a less suitable choice as these stages involve much physical effort (Bovy and Jansen, 1979). Moreover, many Asian cities lack underpasses and thus pedestrian have to cross roads at grade. Thus signal time plays an important decision for modal choice for those potential passengers who have to come a significant distance by crossing the road. So, the metro stations may not be highly accessible, or to make most stations highly accessible grade separation or sophisticated signaling system is needed which cost huge amount of money. Because, the existing pedestrian facilities may become very crucial for metro as a mode choice as Hall and Hass-Klau (1985) noticed that rapid transit in pedestrian zones get more patronage when comparing rapid transit systems in Germany and Britain. Unfortunately, the existing contest is disappointing. In Dhaka, there is only 400 kilometers of footpath where only 240km can be effectively used (STP, 2005 claimed that 40% of the city footpaths are illegally occupied).

Spatial Structure of the City

The patronage for public transport sometimes depends on the spatial pattern of the city which motivates to choose alternative mode of transport rather highly capable public transport. However, urban rail becomes particularly important when high density urban development expands to create distances that are too great for efficient bus transport, and usually when employment remains centralized—Tokyo and Seoul being the obvious cases. Whether rail-based system is indispensable or not in big developing cities for efficient transport system, largely depends on the city characteristics and development pattern. If the dense city expands horizontally but employment remains centralized,

road-based system alone like bus and private car may not be suitable to provide efficient transport facilities to the mass people (WB 2000). Thus, developing cities having less strong central business district (CBD) or having more sub-centers like Dhaka are not likely suitable for metro.

In Dhaka, the one and only Central Business District (CBD) was once Motijheel. But, by the time being new CBDs have emerged. A recent study (Ishrat I. et al 2009) mentioned the city is more polycentric (city with multiple centers) in nature. Besides, emergence of employment sub-centers triggers transport problems which are difficult to serve by inflexible rail based system. From a transit perspective, polycentric cities are difficult to serve, since their geography is a byproduct of changing land values, economic agglomeration, and non-transit related functions. (Alonso 1964, Greene 1980, Kelly 1994, Gordon and Richardson, 1996 and Anas et al. 1998, cited in Modarres A., 2003). It must be remembered that decentralization, which is already observed in Dhaka has a negative impact on transit use. Greene (1980 cited in Modarres A., 2003) suggests that the decline of transit usage in American cities began in the 1950s, when decentralization of employment began to occur. Consideration of urban form is also a very important issue.

Moreover, rail based system cannot match with high growth rate of the developing cities. Considering the city characteristics of Dhaka, which has a very high population growth and urbanization rate (having a 2% annual growth rate, Dhaka (DMDP)[4] is expected to have a population of 30 million by 2024 according to STP working paper, September 2004), will have less flexible option dealing with the pace of growth for rail based system. According to Knowles and Fairweather (1991), the arterial nature of the rail based system cannot serve as many people as bus or automobiles do, thus often regarded as slower for door-to-door services. Moreover, STP provided warning that metro will not be suitable for the growth of Dhaka city mentioning the evidence of Calcutta, Cairo and Shanghai (STP working paper, September 2004).

Density and Financial Aspect

Babalik-E. (2002) identified several factors for successful rail operation mentioning that local economic conditions also influence the success of urban rail system from the perspective of revenue. Dhaka can be characterized by the densely populated area (2,500 people per square mile, Staff Reporter, 2005) with continuous shrinking land-person ratio. This also provides some argument that there is scarcity of land for road-based system and need higher capacity public transport. It must be remembered that higher volume can be served by frequent road public transports than rail based only. But, the assessment of the actual potentiality of existing main corridors was never evaluated. So, there may be option for BRT system in Dhaka as in Bogota. The higher density is also very much suitable for the use of public transport. Newman and Kenworthy (1989), who collected data from many cities around the world, concluded that cities with higher urban density were more dependent on viable public transport systems for travel. Similarly, Gakenhemir (1990) noted that having market, the developing countries have

[4] DCC means Dhaka City Corporation area which is a part of DMDP area (Dhaka Metropolitan Development Plan area comprise of 1590 sq. km) cited in *Asian City Development Strategies:, City Profiles n'd*

"better chance of success" of building rail transit. However, Thomson *et al.* (1990) concluded from several developing cities that metros in developing cities cannot be financially viable but can provide a good economic return in right conditions. Although, Dhaka is a capital city and its population density promises a good economic return, the weak economic base makes it vulnerable for such expensive metro project.

It is reported in the literature that population under the poverty line in Dhaka is between 37 and 48 percent (Asian City Development Strategies: Dhaka n'd). Thus, there is a chance for less patronage, if the fare per km is high compare to what they used to pay now. However, meeting capital cost and operational cost, there is no chances of reduced fare or competitive to existing fare.

If the infrastructure cost can be separated from the operating cost, the system may become viable in financial terms. However, revenue generation if not as predictable, the operating cost will rise. The fare will be up and more passengers will avoid metro. In such cases, government will have to subsidize it. In such separation of infrastructure cost from the operating cost, the funding will have to come from the external donor or from general tax revenue which is very dangerous for the overall economy. If the argument is to transfer the risk to the private sector, there is counter argument as an example is already given by STP (2004). If loss is occurred, government will have to nationalize the metro system and the subsidy cost would fall on tax payers.

The burden of metro may influence public finances is also mentionable. Kuala Lumpur, Malaysia has KILA and Monorail which have been suffering from serious shortfalls in patronage. Bangkok and Singapore are the other two examples. Thus, the STP paper mentioned "…regional illustration of the financial burden of expensive metro systems carrying salutary warning for Dhaka" (STP working paper 6, 2004). Thus, this huge density with poor financial condition will be no use, if they are considered as advantages of patronage gain, even if the infrastructure cost is excluded for fare calculation.

Economic Aspects

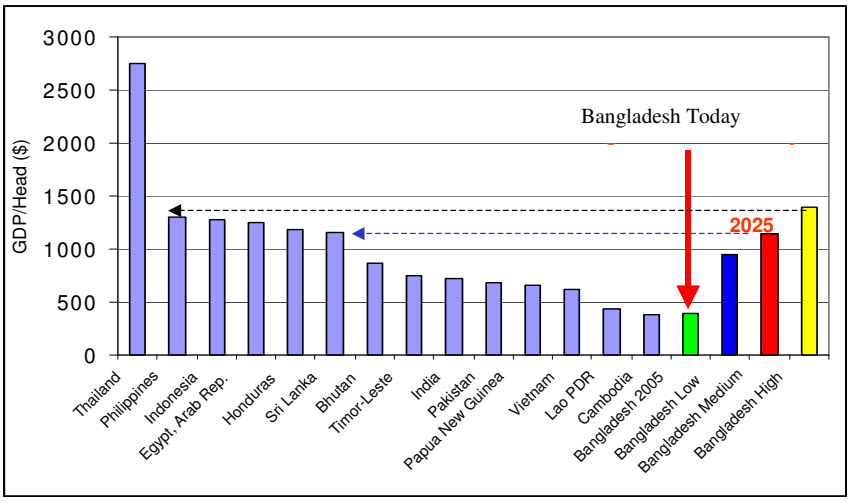
"Many large cities seem to want metros, and those who can rationally afford them should be developing such projects. Unfortunately, the link between the desire and the means to afford them is not always made (Halcrow, 2000 pp 120). In the same research paper, Halcrow mentioned that Metro has macro-economy effects whose call on resources is large relative to national and city resources. So, such resource and its opportunity cost for a country like Bangladesh should be a major concern. Even for countries with better economic condition should be cautious in such investment. Philippines found the opportunity cost of one BOT metro incur a public sector cost equal to twice the Philippines' annual transport budget. Similarly, Colombian national government estimated that its 70% share of the construction cost of Bogota's first metro (a 30 kilometer line), would require a commitment of 30% of the total investment of the national budget for the next decade. On the other hand, the 60-km metro railway has estimated expenditure of Tk 10,000 crore (Ali, 2008) which is considerably a big amount for Bangladesh.

Rahman (2008) mentioned for this case - "the core question for decision-makers is how to balance the conflicting objectives of poverty alleviation (which implies a low tariff/quality MRT system) and controlling congestion with its associated pollution and safety costs (which implies a higher tariff/quality MRT system) within the means of government budgets". This will be very common for the developing countries, where

governments have to fight with the poverty. Moreover, Penalos, who scrapped proposals for a LRT system and a metro before implementing BRT in Bogota, stated that "….. generally they (third world upper class) prefer subways and metros, because they imagine that by putting the poor underground, traffic problems will go away. Then rail systems are chosen in Third World cities, limited funds permit building only a couple of lines and that serves not more than 15 percent of daily trips" (Wroblewski, 2005 cited in Rahman, 2007). This literature review provide a warning that inclusion of couple of metro lines is questionable to serve the total daily trips of Dhaka using such huge expenditure where a considerable share of people are below poverty line in Dhaka.

Dhaka cannot sustain the huge project cost by itself with its limited income (Bangladesh Country Profile, Capital: Dhaka n'd). The financial strength of Dhaka is very low although some Asian countries also opened metro at the same economic condition. Halcrow (2000) mentioned that to be successful in metro project per capita income of the city population must be at least $1800, where in Bangladesh[5] per capita income is about $599 (Priyo 2008) marked below the requirement. Beside, Bangladesh with maximum growth trend[6] in GDP will reach Philippine's present condition in 2025 who found the opportunity cost is extremely high for metro rail, having a comparatively better economic position.

The Calcutta metro system has suffered serious financial loss from the metro rail. According to Singh (2002), forecast of passengers was 623.7 million by 2000 but only 55.8 million passengers used the system in 1999-2000, which was about one eleventh of the estimated traffic. The estimated revenue loss was $ 1.09 million in 1990-91 which has become $ 12.96 million in 2000-01. The key identified issues behind the loss are parallel bus services, high sensitivity to fares and excess staffing. Some issues are found similar for Dhaka, like parallel para-transit services, sensitivity to fare (Table 10 & 11).



Source: Road Master Plan 2009, Roads and Highway Department

Fig. 3: Comparison of Bangladesh Forecast on GDP with other Asian Countries

[5] Dhaka data is not available, however, GDP is \ current Dhaka GDP which is PPP$ 2100

[6] In Road Master plan of RHD considered 4.5%, 5.5% and 6.5% as low, medium and high growth rate.

Most important thing is that Halcrow (2000) noted that Calcutta results must cast doubt on the prospects of any metros in the Indian subcontinent until income levels are considerably higher. In the present context, it should also be noted with extreme care that the low value of time which contributes negatively to practical economic viability of metro project.

Interpretation of Results

According to Thomson et al. (1990), all alternative solutions for the prevailing traffic problem in the developing cities must be studied before metro investment. The existing worse traffic scenario e.g. higher extra time for congestion shows that transport users, those occupy the roads frequently and for longer time have great exception from metro. In general, all the users are very biased in favor of metro, which may not work in practice. Because, rickshaw and car users are found captive in nature so they may have less possibility to use metro. Besides, users in general, have less concern for value of time, thus a good share of people may remain in the existing mode, rather than using metro for higher fare in trade of time saving.

Thus, a simple issue that is lack of passengers will make metro unsustainable anywhere. But if government decided to go for it, several things have to be clear to promote metro in a sustainable way. To get the advantage of large population, related contextual factors must be examined properly; particularly those may affect the public transport system. Right condition is directly related to financial return, as because it considers incorporated facilities and all necessary infrastructures like pedestrian environment including road crossing facilities, transfer of mode facilities etc. These are crucial to attract people to the station but Dhaka has substandard supply of these facilities. If ridership is low here by any chance (if less people arrives to station), the low the economic return will be when the fare remain constant and there may incur huge loss. However, if the fare rises to offset the loss, the impact will be as usual - the loss of ridership and thus low economic return. Thus, ensuring right condition is very much crucial for sustainability of the Dhaka metro project. At the same time, it is cost intensive on the top of particular metro building capital cost.

Conclusion

Long term planning goal, integration of policies and emphasis of spatial planning should be taken into consideration to save the city, rather than going only for such supply driven approach. The decision that is arguable at the moment might be a total in vain, as there is no effective planning control over the population, emerging centers, land use, city size etc. Thus, with over or less population and new emerging centers, the metro project may face unavoidable loss. Heavy investment on metro for increasing accessibility and efficient movement of people seems to have a great chance of backfire hitting the whole economy. Thus, the scopes for potential alternatives need to be evaluated, such as different demand management measures and simple solutions, which are not cost intensive.

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