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Developing a Generic Methodology for Traffic Impact Assessment of a Mixed Land Use in Dhaka City

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Abstract

A proficient transportation system has a great importance on the infrastructural as well as the overall economic development of a country. But the traffic volume of Bangladesh especially of the capital city Dhaka is growing at an alarming rate with the large number of population and development projects. The result is ultimately an inefficient transport system with traffic jam, congestion, irregular parking, low level of service, injured road network etc. A traffic impact assessment or TIA is an evaluation of the potential effects that a particular development's traffic will have on the transportation network in its impact area. TIA includes formulation of traffic management schemes and recommendation of infrastructure for possible transportation and traffic problems that will be encountered during the construction and operation phases of projects. This article primarily focuses on developing a framework of TIA methodology for a mixed land use in context of Bangladesh. This study will use the TIA process to evaluate the effects of an ongoing project on its adjacent roads' transportation system. From the ultimate result it is seen that, before the project was completed, the level of service of the New Market-Science Laboratory section of Mirpur road was E at base year condition (2009), but after the completion of the project the level of service of the same road has been turned into F at 2013.

Introduction

Traffic impact assessment (TIA) is a powerful tool for engineers and planners to determine the possible effects of a project on the transportation and traffic system (Regidor and Teodoro, 2005). A traffic impact assessment or TIA is an evaluation of the potential effects that a particular development's traffic will have on the transportation network in its impact area (URL 1, 2010). Often it is applied only to the direct impact area and countermeasures for potential negative impacts are specific for the development (Regidor and Teodoro, 2005). Compatibility of a particular land use with adjacent road can also be measured from the traffic impact study. The magnitude of these studies will vary depending on the type, size and location of the project (URL 1, 2010).

Traffic impact analysis is the key means to take the transportation planning and land-use planning into account together. And also it has been considered as an efficient means to harmonize the relationship of land exploitation and transportation development (Wang and Lu, 2003). Ideally, TIA should accompany developments which have the potential to significantly impact the

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transportation network (URL 1, 2010). In recent years, the infrastructure has been built up in every country in the world. In Asia, the land-use is developed deeply (Wang and Lu, 2003). In developed cities, the TIA is now performed routinely, but in the developing cities, it has just been utilized from the last decade (Limapornwanitch. *et al*., 2005).

In a developing country like Bangladesh, efficiency of road network acts as a catalyst to solve the overall transportation problem. Efficiency of road network can be achieved through proper transportation planning and impact assessment of particular land uses indicates the possibilities of transportation planning. But traffic impact assessment is not conducted in Bangladesh even for huge project where in developed countries TIA is frequently used as a tool for evaluating the success or efficiency of a particular road network as well as compatibility analysis between land use and traffic. As Dhaka, the capital of Bangladesh is being congested day by day; this congested condition has prompted planners to necessarily implement TIA in this mega city.

Dhaka is being over burdened with newly constructed buildings. Many land development projects have been approved for construction over the city areas. These new buildings and structures are generating and attracting new traffic flows that inevitably impact the traffic network of the adjacent areas as well as the entire city. No TIA is conducted before approving these projects because of lack of consciousness of the Government, lack of budgeting etc. For these, the city is being congested and unusable for fluent communication. As TIA includes the forecasting of the distribution and assignment of the project generated traffics that helps the planners to estimate whether the project will have positive or negative impacts on its surrounding areas' land use and transportation system, so it has become a compulsory to conduct TIA of the proposed developments in Dhaka city. In this context, this study aims to develop a methodology for TIA process in Dhaka city for identifying the traffic impacts of the development projects.

With this background of the research, the objective of this study is to develop a methodology for Traffic Impact Assessment (TIA) of a mixed land use in Dhaka city

Methodology and Study Design

The preliminary step of the study starts with extensive literature survey and review to develop clear understanding of the concept of TIA and its application for a new proposed development in the perspective of Dhaka city, Bangladesh. The objective has been fixed. Then the study area has been selected. The data of the study area have been collected from secondary sources. Then the baseline year is fixed. Surveys of two reference buildings (situated nearby Mirpur road) have been done to estimate the future traffic condition of the study area. Based on the collected data and traffic survey of the baseline year the traffic volume, level of service of the forecasting year is calculated. In this way the traffic impact assessment of the proposed mixed-use development is carried out.

Selection of the Study Area

The selection of the study area is made considering three criteria. Firstly, in developing countries, TIA process is compulsory for large projects and above a certain size. For example, in Thailand especially in Bangkok, all projects occupying more than 300 parking units or larger than 2000 square meters of gross floor area must be studied about traffic impact (Limapornwanitch. *et al*., 2005). Secondly, TIA is Compulsory for those projects which will generate more than 100 new traffics in the peak hour (Ahsan, 2010). The availability of baseline traffic data is considered as the third criteria.

Based on the above criteria, the ongoing project of Biswas Builders named as The New Market City Complex, a residential cum commercial building and which is situated along New Market Post Office-Chandrima Super Market Road has been selected as the study area. Because the

project accommodates 217 parking units and the gross floor area of parking lot is 8164.87 square meter (approximately). And it is expected that the project will generate more than 100 new traffics (Ahsan, 2010) and the baseline data regarding traffic characteristics of the adjacent road network will be available. The adjacent road networks within 1.5 km of the project area including Nilkhet-New Market intersection, Mirpur road and the Post Office Road behind New Market are also considered as the study area.

For the estimation of the development traffic generated by the project, a residential and a commercial building (situated beside Mirpur road that is being used for several years) have been selected.

Data Collection

The data including information about the adjacent road network and structures in the vicinity of the project (New Market City Complex) i.e. the data of existing vehicular and pedestrian traffic volume of adjacent road of the project, Mirpur Road and the land use data have been collected from secondary sources. Traffic volume data of 2009 have been collected for 8 AM to 12 PM and from 4 PM to 8 PM.

Developing a Methodology for TIA

No studies regarding Traffic Impact Assessment (TIA) have been carried out in the context of Bangladesh from the planning aspect. An extensive literature review has been conducted to develop a clear understanding of the concepts of TIA and for identification of the methodology of conducting TIA in Bangladesh. On the basis of that a methodology for Traffic Impact Assessment has been developed for a mixed land use of Dhaka city.

Development of Methodology for TIA

Developing methodology for Traffic Impact Assessment (TIA) is the most essential part of the research. To identify and develop a methodology for TIA, forecasting of background and development traffic volume has been done.

Forecasting Traffic Volume

The forecasting includes two parts, one being the background traffic volume forecasting and the other being development traffic volume forecasting. The future development traffic volume has been found by adding these two.

Forecasting of background traffic volume

Background traffic volume refers to the existing traffic volume without considering the additional volume the development project will bring about (Wang and Lu, 2003). The background traffic volume data has been collected by secondary sources. The background traffic volume is divided into two parts:

Pass-through traffic: The pass-through traffic are those, the starting points and destinations of which lie beyond the scope of the project (Wang and Lu, 2003). As these are the traffic mainly consist of growth of existing traffic on adjacent road within the time span of TIA, so it has been forecasted using growth-factor modeling. Based on the traffic survey of previous studies, the growth factor will be found. Through using the traffic data of year 2003 and 2009 the average growth rate of traffic within the study area has been found. Considering this growth rate volume of pass-through traffic of 2013 has been found.

Traffic volume of other projects: These are the resultant traffic volume on the road network caused by other development projects within the scope of new development project. There is no ongoing development project at present within the scope area of the project building. For this reason traffic volume generated from or attracted to other projects has not been considered for background traffic volume forecasting incase of this study.

Forecasting of development traffic volume

The traffic volume of residential portion and commercial portion of the project has been calculated by using the trip generation rate of the respective reference buildings. These two volumes have been added to find the total development traffic of New Market City Complex.

Determination of Growth Rate

Forecasting of traffic is needed to determine the traffic volume at 2013. For this purpose, growth rate of traffic has been determined using the traffic volume at 2003 and 2009. To calculate the growth rate traffic volume of year 2003 and 2009 has been converted into PCU. Thus three peak hour PCUs have been found for both year 2003 and 2009 along two directions (New Market to Science Lab and Science Lab to New Market). For calculating the growth rate of traffic volume total PCU of a particular hour of both directions has been summed up for each year data.

The highest hourly PCUs of each year dataset has been taken for determining or calculating the growth rate of annual traffic in the particular study area. The highest hourly PCU for 2003 is 1911.6 (during 9:00 AM to 10 AM) and for 2009, the highest hourly PCU is 3559.9 (during 8 AM to 9 AM).

Using these PCU values of three corresponding years, two growth rates have been found. Considering this growth rate volume of pass-through traffic after completion of New Market City Complex has been found. Annual growth rate for forecasting traffic volume has been found as 14.37%.

Forecasting of Pass-Through Traffic

For forecasting of pass through traffic volume data of year 2009 has been used. Only highest peak hourly volume has been taken to get the pass through traffic in 2013. For 2009 highest hourly data has been found during 8:00 AM to 9:00 AM.

As the yearly growth rate is 14.37% it has been multiplied by four for conversion of traffic volume from year 2009 to 2013. This is then multiplied by the volume of different vehicles. Then, the increased number of traffic volume is added with the previous volume to get the total resultant traffic volume in the year 2013. Using the growth rate (14.37%) found from previous growth trend of traffic volume following peak hourly volume has been found in 2013. Then the volume of different vehicles has been multiplied by their corresponding PCUs to get the total PCU/hour.

For New Market to Science lab lane total PCU is 2613.53808 / hour and for the opposite direction (Science lab to new Market) total PCU is 2992.592 / hour. The PCUs per hour of both direction have been added to get the total PCU/ hour of the carriage way. Total pass through traffic (2613.53808+2992.592) = 5606.13 PCU/hour.

Forecasting of Development Traffic Volume

Two reference buildings situated nearby Mirpur road are surveyed to estimate the trip generation and trip distribution rate for forecasting the traffic volume of New Market City Complex. These rates of reference buildings are used to forecast development traffic volume. Prince Tower (residential land use) and Eastern Mollika Shopping Complex (commercial land use), both situated along Elephant road connecting with Mirpur Road have been taken as the reference building for modal share estimation.

Survey Findings of Residential Reference building

Total person trip of eight hours has been found as 908. Survey was done on two weekdays. Among them the value of that day has been taken on which the volume of person trip has been found the highest. Data have been collected on the basis of half an hour which is converted into one hour. From the survey it has been seen that, the highest trip occur between 6 PM to 7 PM. It may be because of the fact that, in this time more people arrive home from office and people go out for shorter trips.

Average Rate of Person Trip

Prince Tower is 17 storied each floor occupied 9510 square feet and total floor area of this residential reference building is 161670 square feet. Then Person trip per hour per 1000 square feet has been calculated.

Person trip per hour per 1000 sq ft = (908*1000) / (161670*8) = 0.70204738

This rate has been used for estimating or forecasting development traffic of New Market City Complex in 2013 when it will come into full operation (trip generated from only residential portion). Residential Peak and off peak Hourly Rate of Person Trip also have been used to get peak and off peak PCU / hr.

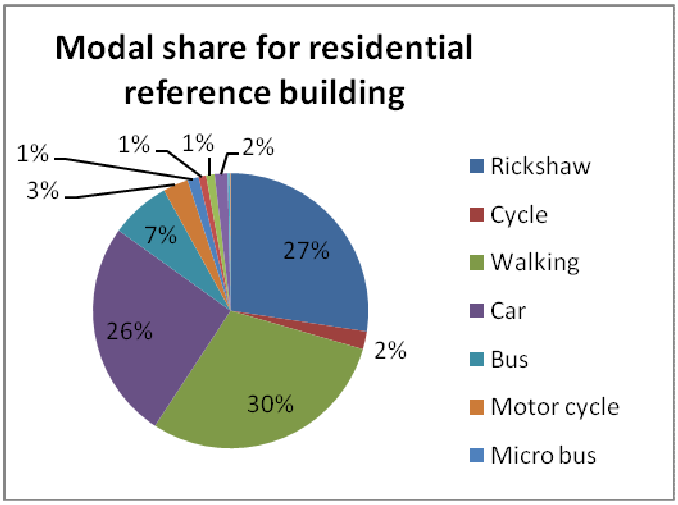

Fig. 1: Modal share of Residential Reference Building

To get the modal share, total 908 people were surveyed. From their information, the number of different vehicles availed by them have been found. Then the percentage of the vehicles have been calculated which is shown in the pie chart in Figure 1.

Traffic Volume generated from Residential portion of the project building (City Complex)

Total residential floor area of New Market City Complex is 378540 square feet. To get the person trip per hour per 1000 Square feet from the project building the rate found from the reference building has been multiplied by 378540.

Table 1: Average, peak and off peak hourly trip generation (Residential)

	Trip Generation Rate per hour per 1000 sq. ft	Total residential area of City Complex (sq. ft)	Number of person trips for City Complex (Rate*Area/1000)
Average Person trip per hour	0.702047	378540	266
Peak hour Person trip	0.79174		300
Off Peak hour Person trip	0.58762		223

From the modal share found from residential reference building, number of person trips generated through different vehicles has been determined. The average person trip per hour for Residential portion of City Complex is 266. The peak and off peak person trip per hour for City Complex is 300 and 223 respectively. Modal Share found from residential reference building has been used to calculate the number of person trips from city complex for different types of vehicles.

Vehicle number has been found through dividing number of person trips by specific number justified (for example: Rickshaw: 1, Cycle: 1, Car: 2, Bus: 30, Motor cycle: 1, Micro Bus: 4, Office vehicle: 8, Taxi: 2, CNG: 2, Human Hauler: 12, School bus: 15).

Survey Findings of Commercial Reference Building

Eastern Mollika Shopping complex was surveyed two days (weekday and week end). Each day total five hours have been surveyed divided into two time range. 11:00 AM to 1:00 PM and 3:30 PM to 6:30 PM were the survey hours.

Average Hourly Rate of Person Trip

From commercial reference building survey weekend peak hour 'In' person trip and 'out' person trip are respectively 10 and 8 (per hour per 1000 sq. ft). Besides weekend off peak hour 'In' person trip and 'out' person trip are respectively 7 and 5 (per hour per 1000 sq. ft).

Commercial Peak and off peak Hourly Rate of Person Trip also have been calculated. Highest person trip number has been taken from weekend survey finding and lowest person trip number has been taken from weekday survey finding. Because incase of commercial land use, less number of person trip generated in weekday in comparison to weekend.

Total person visiting the reference building in two days (5 hours each day) are 11186. Among them 1316 people were surveyed randomly, which was not a pre determined number and this sample size is 11.76% of the total people visiting the commercial reference building. Figure 2 shows the combined modal share of peak and off peak hour on both weekday and weekend.

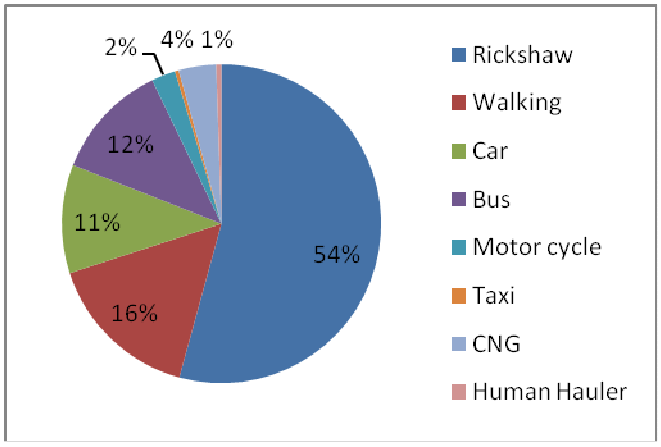

Fig. 2: Combined Modal share of peak and off peak hour (weekday + weekend)

Traffic Volume generated from Commercial portion of the project building (City Complex)

Total commercial floor area of New Market City Complex is 104213 square feet. To get the person trip per hour per 1000 Square feet from the project building the rate found from the reference building has been multiplied by 104213.

Table 2: Average, peak and off peak hourly trip generation (Commercial)

	Trip Generation Rate per hour per 1000 sq. ft	Total commercial area of City Complex (sq. ft)	Number of person trips for City Complex (Rate*Area/1000)
Average Person trip per hour	*	104213	1678
Peak hour Person trip	23		2397
Off Peak hour Person trip	8		834

*The average person trip has been calculated using Peak and Off Peak hourly rate.

From the modal share found from commercial reference building, number of person trips generated through different vehicles has been determined. Modal Share found from commercial reference building has been used to calculate the number of person trips from city complex for different types of vehicles. Vehicle number has been found through applying the same procedure as residential portion volume calculation.

Table 3: Total PCU/hr from New market City Complex at different condition of hourly rate

	Average hourly PCU	Peak hourly PCU	Off Peak hourly PCU
Residential	106.5	119	90.7
Commercial	806.7	1245.5	435.2
Total (Residential + Commercial)	913.2	1364.5	525.9

*The average hourly PCU (913.2) has been used for further capacity analysis along surrounding road sections of project building

Total development traffic (5606.13+913.2) = 6519.33 PCU/hr

The procedure of performing TIA is described in detail for the particular study building (New Market City Complex) in this article. Methodology developed for TIA in this study is given in Figure 3.

Determining Parameters for Assessment

When the project (construction of New Market City Complex) will be completed and put into full operation in 2013, the volume of traffic and level of service will be compared with the previous condition that is before completion of the project in 2009 (base year condition). In this method, the hourly traffic volume at rush hour will be estimated to conduct level of service analysis, and to calculate the ratio of entire traffic volume in relation to the capacity of the road, so as to determine the impact level of the new project on the nearby road network.

Assessment of Traffic Impact (Level of Service Analysis)

Level of Service (LOS) analysis is an effective way to analyze the efficiency of roads. The Highway Capacity manual, TRB (1985) has introduced the concept of Level of Service (LOS) to denote the level of facility one can derive from a road under different operating characteristics and

traffic volumes. The LOS is determined by calculating the volume and capacity ratio of the road. There are six designated LOS. Each represents a range the extreme of which is defined by the upper volume limit and lower speed limit.

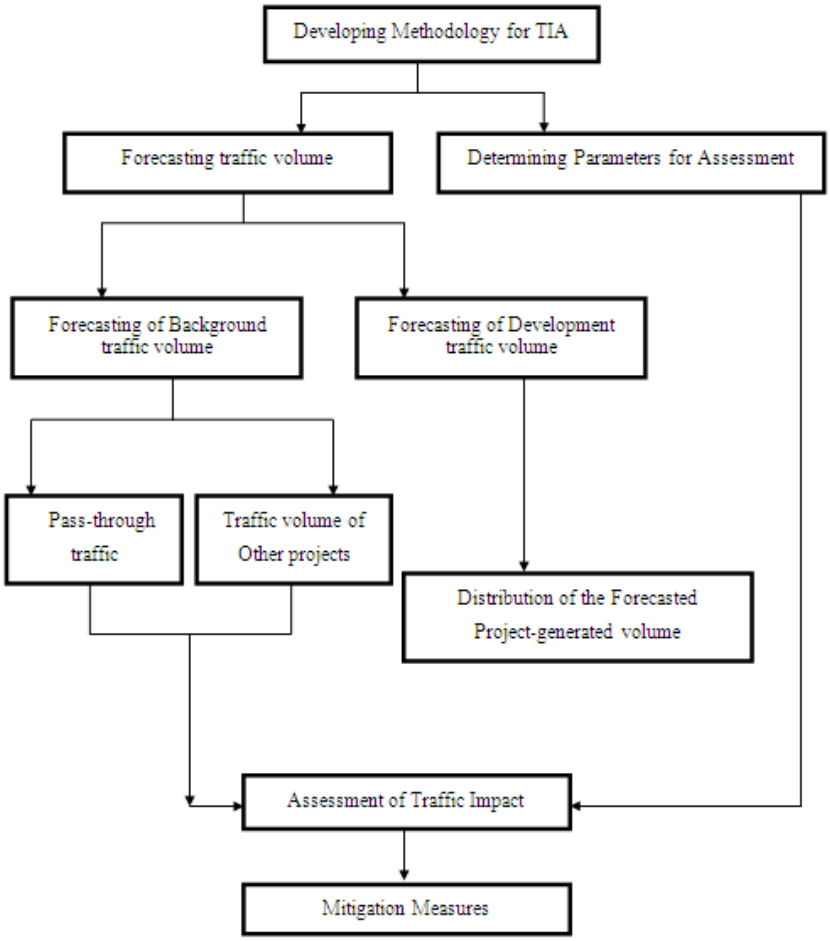

Fig. 3: Methodological framework for TIA

Capacity of Mirpur Road

In general, the design capacity of urban arterial road is 1400 PCU/lane/hour according to DITS (1994). In the New Market-Science lab section effective carriageway width 33'2" and total effective capacity 3870 PCU (Mamun, 2006).

Level of Service of Mirpur Road for Average Hourly Traffic Flow

From the Level of Service analysis it can be observed that before the project was completed the Level of Service (LOS) of the adjacent portion of Mirpur road was E. Here the Volume capacity ratio for baseline year is 0.919. According to standards prescribed by IRC, the LOS of that specific road section is E. The delay per vehicle is high for LOS E. This high delay values generally indicate long progression, long cycle lengths and high V/C ratio.

Table 4: LOS of Mirpur Road for baseline year and forecasting year

	Traffic Volume (PCU/hr)	Estimated Capacity (PCU/hr)	V/C ratio (Traffic volume/Capacity)	Level of Service (LOS)
Year 2009	3560	3870	0.9199	E
Year 2013 without Development Traffic	5606.13		1.4486	F
Year 2013 with Development Traffic	6519.33		1.6846	F

The LOS of forecasted traffic volume shows that the LOS falls to F, which is the worst case situation. The LOS at the forecasting year is F for both with and without the development traffic. In this stage, forced flow condition prevails with low speeds, where volumes are beyond capacity. In the extreme, both speed and volume can drop to zero.

Here it can be easily understood that without any traffic contribution from New Market City Complex at 2013 because of the normal growth rate of traffic, road congestion will occur and traffic volume of the specific road exceeds the estimated capacity and shows a Level of Service F. On the other hand when the development traffic volume will be added with the forecasted volume of Background traffic (pass through traffic), total volume increase by a comparatively small number (913.2 PCU/hr) and just make the volume capacity ratio increase by 0.24 (from 1.45 to 1.68).

Conclusion

The purpose of a TIA is to provide decision makers with sufficient information concerning the impacts of a project on the transportation system and to determine appropriate mitigation measures where impacts exist. This study introduces the concept, content and procedure of the traffic impact analysis, analyses the important issues during the traffic impact analysis, presents the methodology of impact assessment of a mixed land use.

In this article the scope area confines only to develop a methodology for TIA and up to forecast the background and development traffic for the specific development (New Market City Complex). Analysis of pedestrian movement, impact on road efficiency, traffic volume addition for the project (City Complex) and its impact, performance state of surrounding adjacent roads, impact of added number of rickshaws for project on the nearby road network, major parking issues and problems of the area are also have been given priority and relevant analysis has done under developing the methodology for Traffic Impact Assessment of New Market City Complex. But this portion has not been included in this article.

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References

Regidor, J. R. F. and Teodoro, R.V. R. 2005. "Traffic impact assessment for sustainable traffic management and transportation planning in urban areas", *Journal of Eastern Asia Society for transportation studies*, Vol-5, pp: 2342-2351, 2005.

URL 1: http://www.cv.titech.ac.jp/~jsps/activity_report/2007/JR.Regidor.pdf accessed on 4 April, 2010, "Comparison of traffic impact assessment in Asian countries".

Wang, J. and Lu, H. 2003. "The Research on the Method of Traffic Impact Analysis", *Proceedings of the Eastern Asia Society for Transportation studies*, vol. 4, October, 2003

Limapornwanitch, K., Hokao, K., Montablo, C. M. and Fukuda, A. 2005. **"**The implementation of traffic impact assessment in South-east Asian cities: case studies of Thailand and the Philipines"**,** *Journal of Eastern Asia Society for transportation studies,* Vol-6, pp: 4208-4223, 2005.

Ahsan, H. M. 2010. "Traffic Impact Assessment: Importance and Guidelines", Lecture note of Short Course on Traffic and Transportation Engineering.

DITS, 1994. "Greater Dhaka Metropolitan Area Integrated Transport Study" *Working Paper 14: Volume 2*, Government of Bangladesh Planning Commission, United Nations Development Program and Department of Development Support and Management Services, BGD/88/011, January 31, 1994.

Rahman M. M. 2006. "Study of parking Facility for the New Market Shopping Zone in Dhaka City " Unpublished MURP Thesis, Department of Urban and Regional Planning, Bangladesh University of Engineering and Technology, Dhaka.