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Investigating the prospect of introducing traffic management measures in Dhaka city

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ABSTRACT: Traffic management is a vital tool for improving the roadway capacity. This study is intended to explore the prospect of introducing three most common traffic supply control management measures - Tidal Flow, One-Way Operation and Signal Coordination in Dhaka city. The study is undertaken for Dhanmondi R/A bounded by Mirpur road, Satmosjid road, Dhanmondi Road# 2 and Road# 27. Volume surveys are conducted at the two end points with Mirpur road to find out the distinctive flow imbalance during the determined peak hour in the morning. The resulting directional flows are found to be 21%, 79% and 46%, 54% respectively leading to absence of tidal flow. Implementation requirements of other two regulations are also investigated. The pre-requisites are not met and the underlying reasons behind this failure are found in this study as the inherent weakness in the planning of road network and the consequent mixed type of land-use pattern.

1 INTRODUCTION

Dhaka is an overly populated city with minimum usage of land for its road network. Consequently, the traffic demand frequently exceeds the supply with severely congested conditions in most of the routes where expansion of facilities and roads is difficult and expensive requiring low-cost traffic management tools to improve the existing roadway capacity. Of the many types of management regulations, Tidal Flow Operation, One-way Operation and Signal Coordination are very common low cost traffic management techniques. But the implementation of such management tools has some certain pre-requisites to be fulfilled in order to be warranted. To apply these management measures in the roads of Dhaka, the potentiality or the implementation requirements need to be investigated to check whether they are warranted or not in the context of Dhaka.

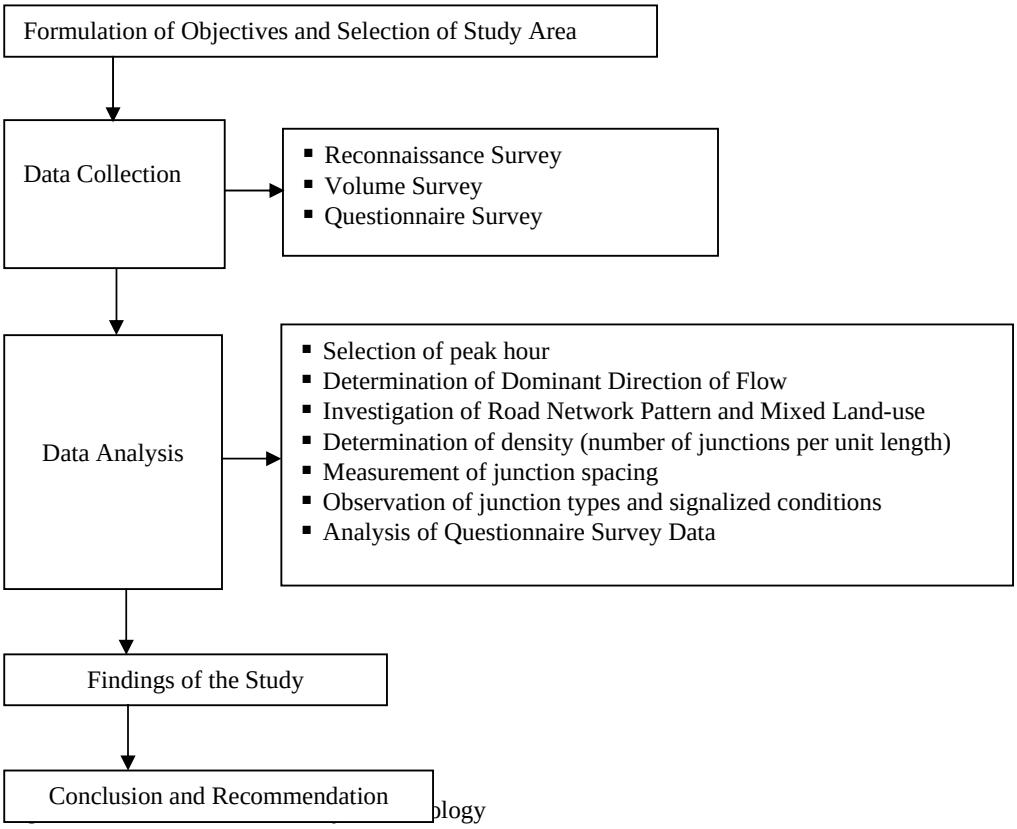
2 OBJECTIVES

The specific objectives of this study are as follows:

- To investigate the applicability of the stated management regulations as per their implementation requirements
- To assess the pattern of road network, land-uses, trip generation and distribution within an area
- To identify the problems within the existing system in applying these tools

3 METHODOLOGY

The term traffic management is frequently used to refer to and understood as parking control, control of side friction of the roads which are usually demand management approaches. So far, these factors have been given more priority and considerable efforts have been taken as well. On the contrary, supply management approaches are self enforcing, effective and low-cost measures that are not considered for eliminating the congestion problems in Dhaka city. Therefore, this study is undertaken on this management approaches with a view to investigate the applicability of these management regulations. Figure 1 shows the compendium of the study methodology.



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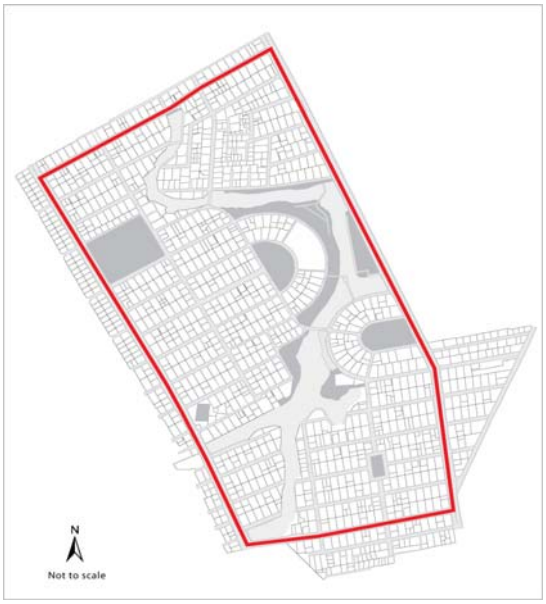


Figure 2. Map Showing Road Network of the Study Area (Source: Chowdhury et al.2008)

3.1 *Study Area*

Dhanmondi residential area surrounded by two primary roads (Satmosjid road and Mirpur road) and two access road (Road # 2 and Road # 16 (old road # 27)) is selected for the case study. Therefore the study area lies within the internal Dhanmondi area bounded with these four roads as shown in the Figure 2. According to the reconnaissance survey, of the 27 interconnected local roads, 14 are directly connected with Satmosjid road and the rest 13 are connected with Mirpur road.

Two important assumptions regarding this study are:

- The impact of the traffic only generating within or destined to the Dhanmondi residential area on the traffic distribution and intensity of Mirpur road is taken into consideration
- The portion of Mirpur road within the two end points of the study area is taken for the experimental research

4 RESULTS & DISCUSSIONS

For investigating the potentiality of the three major traffic management regulations (Tidal flow, One-way operation and Signal Coordination) in specified roads of Dhaka city, the following studies have been conducted:

- For Tidal Flow operation - Determination of peak hour and dominant direction of flow
- For One-way operation - In addition with the dominant direction of flow, investigating the road network pattern
- Justification for Signal Coordination – In addition with above two requirements, determination of density in terms of numbers of junction or side roads per unit length of the main road, types and spacing of the junctions, existing signals, traffic flow characteristics etc. required for Platoon formation

4.1 *Designation of the Locations and Directions of Data Collection*

From Figure 4, it is seen that the portion of Mirpur road from intersection I1 to I2 is marked as *A* direction and/or point and the opposite direction is marked as *B* direction and/or point. The direction or the point of Mirpur road that passes I1 toward outside of the study area is marked as *C*. At I1, Mirpur road gets divided into three parts, the other part being directed towards Science Laboratory which is marked as *D*. And the direction or the point of Mirpur road at I2 is marked as *E* which is opposite to the direction *B*. In general, it can be said that *AB* is the outside of Central Business District (CBD) direction and *EC* and/or *ED* is inside of CBD direction.

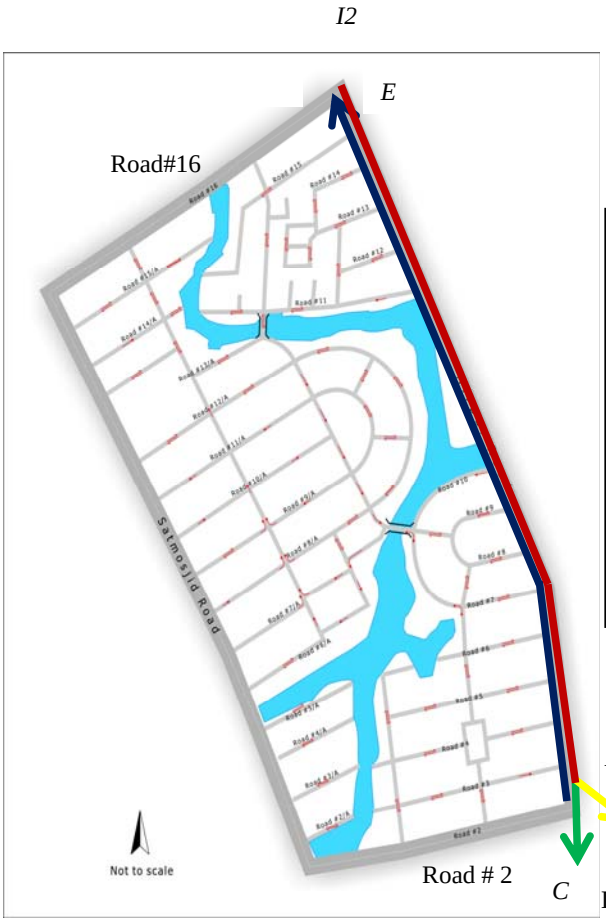


Figure 3. Geometric Data of Selected Section of Mirpur Road

Length = 2.07 km

Width = 30.7 m = 100.7 ft (8-lane road) (With Shoulders and Medians)

Total Number of Junctions = 15

Number of Side Roads of Dhanmondi Connected with Mirpur Road = 13

4.2 *Determination of Peak Hour and Dominant Direction of Flow*

From the reconnaissance survey, it is obtained that pure commuter traffic is found in the morning period since it is less likely to be mixed up with other purpose traffic in the morning. In general, this peak occurs within 8:30 AM to 9:30 AM. For obtaining the dominant direction of traffic flow of Mirpur road, both-direction traffic is counted during the pre-determined peak hour at the specified locations of *A, B, C, D* and *E*. For the volume survey, One-day data collected on a typical working day to get the general traffic condition are shown in Table 1 and 2. The total number of vehicles is estimated to determine the directional imbalance. In this survey, various types of vehicles are counted including buses, private cars, jeep, motorcycle, CNG and microbus.

Table 1. Mirpur Road through Traffic Passing Road # 2

Number (%) of Vehicles in the Direction/Point of			Total Number (%) of Vehicles
A	C	D	
908	2143	1388	4439
(21%)	(48%)	(21%)	(100%)

(Source: Field Survey, 2009)

Table 2. Mirpur Road through Traffic Passing Road # 6

Number (%) of Vehicles in the Direction /Point of		Total Number (%) of Vehicles
B	E	
3300	3860	7160
(46%)	(54%)	(100%)

(Source: Field Survey, 2009)

From the Table 1, it is observed that in *A* direction, percentage of total vehicles is 21% whereas the combined percentage in *C* and *D* direction (combined percentage because *C* and *D* is opposite to that of *A*) is 48+31 = 79% which means that the directional variation is significant at this location between the two directions. Tidal flow condition can be satisfied if this directional imbalance also prevails for the other location of Mirpur road intersection with Road # 16.

It is seen from the Table 2 that the percentages of total vehicles observed at this location, are 46% in the direction *B* and 54% in the direction *E* respectively. Therefore, considerable amount of traffic flow in both directions at this point which is contrary to the condition of tidal flow and completely different from those obtained in *A* and *C+D* directions at the previous location.

Analyzing the data obtained from the Tables 1 and 2, it is clearly understood that the additional vehicles in the *AB* direction, i.e. from *A* to *B*, (3300-908) = 2392 vehicles are joining from the side roads of Dhanmondi (Road # 3, 4, 5 etc) and/or Greenroad. Also of the 908 vehicles passing Road # 2 or the point *A*, some or many of them may have turned to some other direction(i.e. side roads of Dhanmondi or Greenroad), not going straight along the path *AB*. But, it is clear that the rate of joining of vehicles in this direction is significantly higher than that of the diverting vehicles from this direction.

Again, comparing the total number of vehicle in the directions *C* and *D*, which is 2143+1388 = 3531 (Table 1), with that in the same direction at point *E*, which is 3860 (Table 2); it is clear that the vehicle number is not significantly different between at these two points or the amount of flow is more or less constant along the direction *EC* and/or *ED*, i.e. 3860-3531=329. This difference is found to be much less than that along *AB* direction between points *A* and *B*, i.e. 2392. This somewhat reduced number from 3860 at *E* to 3531 at (*C+D*) indicates that all the vehicles are not coming straight and may turn to Greenroad or side roads of Dhanmondi. Also some vehicles may have joined the stream from other directions. In spite of joining vehicles, because of the reduced number of vehicles at (*C+D*) than that at E, it is clear that the rate of diversion of vehicles from the stream is more in this direction.

From the above calculations, substantial flow imbalance is found at one end whereas it is not found at other end of this experimental passage due to addition and diversion of vehicles from and to the side roads of Dhanmondi. Therefore, this result is wholly related with the road network and land-use pattern of the area influencing traffic demand, trip generation and attraction or distribution. So it is required to investigate the existing road network and land-use pattern.

4.3 *Investigating Road Network Pattern*

The fundamental requirement of one-way operation is the grid-iron road network and the availability of suitable alternate parallel routes with same O-D. From the reconnaissance survey, it is observed that the local roads of Dhanmondi residential area are of grid pattern and there is no alternate parallel road of Mirpur road. Grid-iron network is the most effective network for a commercial area, not for a residential area. Consequently, Dhanmondi has turned into a semi-commercial area resulting in scattering of CBD and mixed type of land-use. This internal grid pattern has severe impact on the traffic movement of main road including increased traffic load, indisciplined traffic stream and disturbance to main road through traffic movements. For this reason, it was not possible to find a major demanding direction during peak hour on the Mirpur road.
A 2-day volume survey (Table 3) is conducted on Road # 6 at intersection with Mirpur road to represent the extent and influence of lateral movements on the main road and also in order to check the possibility of distinctive and predictable flow imbalance within the internal roads. In this case, time duration is taken from 9.00 AM to10.00 AM.

Table 3. Volume of Traffic on Dhanmondi Road # 6 at the Intersection with Mirpur Road

Date	Number of Incoming Vehicles		Number of Outgoing Vehicles		Total Number of Vehicles	Incoming Vehicles (%)	Outgoing Vehicles (%)
	NMV	MV	NMV	MV			
09.04.2009	350	138	380	274	1142	43	57
16.04.2009	418	88	422	396	1324	38	62

From the Table 3, on the first day, 350+138=488 incoming vehicles and 380+274=654 outgoing vehicles are found. On the second day, 418+88=506 incoming vehicles and 422+396=818 outgoing vehicles are found. These data were obtained considering both the MV and the NMV. When all the vehicles both NMV and MV are taken into consideration, it is seen that incoming traffic of 43% and 38% for the two days respectively is entering Dhanmondi area whereas the percentages of outgoing vehicles for the respective days are 57% and 62% respectively; i.e. variation between two directions is not significant. Excluding the NMV, which are permitted only to cross straight between Dhanmondi Road # 6 and Greenroad and are restricted in taking turns, the percentage of incoming traffic becomes 33.5% and that of outgoing traffic becomes 66.5% for the first day data. The second day data gives the above percentages as 18% and 82% respectively. This data reveals that although there is a somewhat flow imbalance, there is no certainty of the amount of lateral movements of traffic. For this reason, a definite pattern of traffic stream can be found, neither within the internal road nor on the Mirpur road.

4.4 *Justification of Signal Coordination*

Important requirements include determination of Density in terms of number of junctions per unit length of Mirpur road, intersection spacing, junction types and signal which in turn influence the traffic flow characteristics on the main road. Density is calculated by Equation 1.

$$d = \left(\frac{N_j}{L} \right) \quad (1)$$

where d = density; N_j = Number of junctions; and L = Length of the road.
According to geometric data (Figure 3) on selected section of Mirpur road,
Density = 15 / 2.07 = 7 (nearest integer) junctions / km

And, Side road Density = 13 / 2.07 = 6 (nearest integer) junctions / km

4.4.1 *Spacing of Intersections*

The spacing of all the intersections on Mirpur road with side roads of Dhanmondi within the experimental corridor are measured by odometer (Table 4) in order to check whether uniformly spaced or not. It is clearly understood from the Table 4 that the junctions are not uniformly spaced. The smallest clear spacing is between Road # 14 and Road # 15, i.e. 88.8 m and the highest clear spacing is between Road # 10 and Road # 11, i.e. 512.3 m.

Table 4. Spacing of the Intersections on Mirpur road within the Experimental Passage

Intersection		Clear Spacing	Spacing c/c
From	To	(m)	(m)
2	3	99.5	120.4
3	4	99.6	112.6
4	5	103.5	116
5	6	102.2	116.15
6	7	103.5	116.95
7	8	101.3	115.95
8	9	115.6	128.65
9	10	101	113.6
10	11	512.3	526.35
11	12	110.6	125.2
12	13	105	117.4
13	14	105.2	118.6
14	15	88.8	103.55
15	16	96.3	114.1

4.4.2 *Junction Types and Signals*

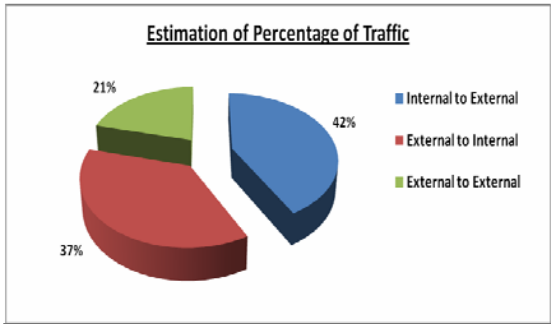
Intersections of Mirpur road with the two access roads, Road # 2 and Road # 16, other intersections of side roads of Dhanmondi – Roads # 3, 6,7,8,10,11 and 12 are cross intersections. Rest of the junctions of Dhanmondi side roads with Mirpur road only provide access to and from main road. Of the cross intersections, only junctions with Roads # 2, 3, 6, 7, 10 and 16 have signals. So, the junctions are not of the same types along the passage and also not all the junctions are signalized resulting in an indisciplined traffic flow with consequent certain variations in travel speeds. The traffic access to and from the Mirpur road varies from junction to junction which does not satisfy the condition of forming a platoon.

4.4.3 *Summary of the Results for Signal Coordination*

- The spacing of the intersections are uneven which condition is contrary to formation of platoons necessary for an effective signal coordination
- Great number of Density of side roads reveal huge lateral movements making the flow random and unrelated adjacent intersectional flow as a result of which platoon formation is not possible
- Since the junctions are not of the same types and also not all the junctions are signalized, consequently traffic volumes and travel speed will vary from one intersection to another, the cycle lengths will not be constant as required for the signal coordination

An extent of the growing non-residential activities due to grid pattern road network of Dhanmondi residential area and their impacts on Mirpur road are revealed by the questionnaire survey conducted both for the residents of Dhanmondi and non-residents but using Dhanmondi roads or Mirpur road. The analyses are made on the combined results of both the surveys; the results may vary from the actual situation with more data than it is done for the current study (ten for each) and hence more accuracy.

4.5 *Analysis of the Questionnaire Survey Results*



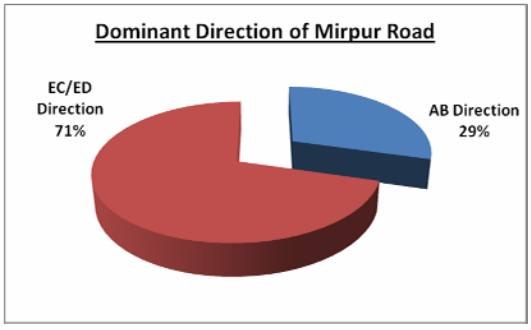
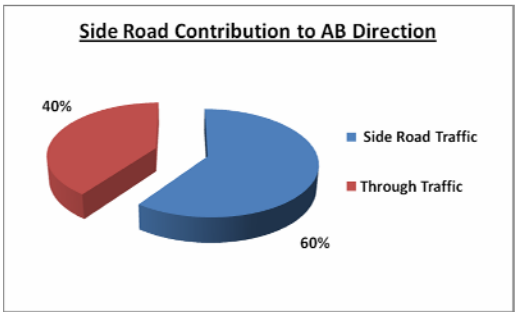


Figure 4 and Figure 5. Estimation of Percentage of Traffic and Estimating the Dominant Direction of Mirpur Road

It is found from Figure 4, 42% of the trips are originating within Dhanmondi residential area with destination outside of the area; 37% of the external to internal traffic represent the non-residential traffic which is a significant amount. 21% of the trips as through traffic within the study area reveal that other traffic are individually even more than the through traffic representing a higher amount of lateral movements on Mirpur road. Apparently, from the Figure 6, the dominant direction of Mirpur road, used by 71% respondents, from Road # 16 to and passing Road # 2 (EC/ED direction). But this result is obtained without considering the destination of the trips or the side road contributions (Figure 4 and 5).



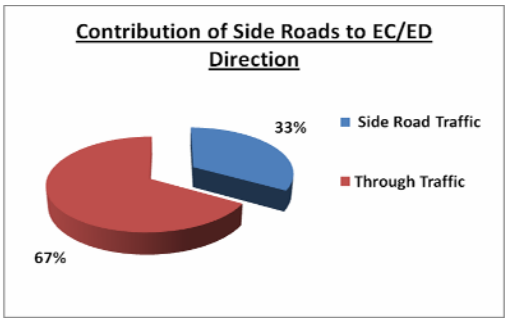


Figure 6 and Figure 7. Contribution of Side Roads along *AB* Direction and Contribution of Side Road along *EC/ED* direction

In these Graphs (Figures 6 and 7), it is seen that due to lateral movements, traffic demand along a particular direction of Mirpur road does not remain constant throughout the passage providing a distinctive flow imbalance, as the origins and destinations may lie within the area other than being through traffic using the road to reach a fixed CBD.

The origin of the traffic moving in *AB* direction is not necessarily the point *A* or Road # 2 and the destination is not necessarily point *B* or Road # 16 or beyond this point. From Figure 6, it is seen that the contribution of different side roads in terms of origin and destination in this direction is 60% which is greater than the through traffic of only 40% of the total traffic in this direction. From the Figure 7, it is observed that through traffic is 67% and side road traffic is 33% which means more than two times greater amount of through traffic than the side road traffic of Dhanmondi. Combining the two Figure 6 and 7, it can be understood that due to considerable amount of side road traffic along *AB* direction, i.e. 60%; in spite of having higher amount of through traffic in *EC/ED* direction, i.e. 67%; significant amount of traffic flow in both directions and hence a dominant direction of flow cannot be obtained.

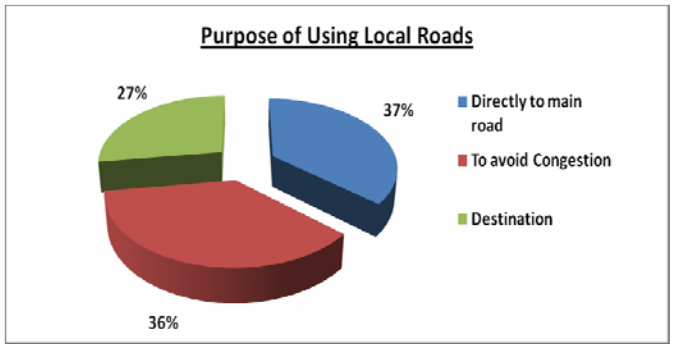


Figure 8. Most likely Cause of Using Local Roads

It is observed from Figure 8 that almost the same amounts of traffic – 37% and 36% respectively of the total traffic within Dhanmondi are using the local roads for direct access to main road and for following a shorter route throgh the grid pattern local roads to avoid congestion to get to the main road. A substantial percentage of traffic (27%) enter the area for the destination which represents a significant amount of non-residential activities relative to internal traffic in the study area.

5 CONCLUSIONS & RECOMMENDATIONS

5.1 *Conclusions*

The major finding of the study is that the traffic management tools stated in the study cannot be implemented as effective measures to accomplish the objective of reducing traffic congestion in Dhaka city within the ex-

isting system capacity. The findings will be discussed in two parts – Problems in Implementation and Hypothetical Solution.

5.1.1 *Problems in Implementation*

The specific problems that are identified in implementing the three management tools – tidal flow, one-way operation and signal coordination can be summarized as below –

- Not obtaining a dominant direction of flow
- Minimum number of primary roads and non availability of grid-iron pattern road network in the main roads and of parallel alternate route with same O-D
- Excessive lateral movements
- Indisciplined traffic stream and rapid flow

All these problems are the consequences of the combined effect of unplanned road network and uncontrolled land use which are again interlinked with each other and these are in fact the problems that will be faced in implementing any management regulation in Dhaka city under prevailing road network. Hence, the land use pattern is also disorganized making a mix up of residential and commercial purposes. Grid pattern road network in the local roads, cause disturbance to main road traffic flow by excessive lateral movements, scattered commercial activities, rapid or random flow, weak intersection operation and low directional imbalance during the peak periods of the day. Also the absence of parallel alternate routes with same O-D for the main roads, cause concentrated traffic load on the single primary road serving the area and do not allow one-way operation. So, it is clear that the roads in Dhaka have been constructed on the basis of short-term demand without considering for the future demand and expansions of different activities. It is a planning failure which is responsible for such irreversible damage. No management regulations can be actually successful under the prevailing condition. So, before forcing the well-established traffic management measures of the developed world in Dhaka city to control the alarming situation of traffic congestion, it is to be realized that neither the roads nor the existing traffic flow condition is in a state to cope up with these new regulations. Rather, first, this requires some alternative well-planned and sustainable solution to achieve a control over the present land-uses and trip distribution. After this preparatory treatment, the management regulations can be attempted.

5.1.2 *Hypothetical Solution*

- By limiting or confining the non-residential trips towards Dhanmondi, a sufficient number of trips would be avoided reducing the lateral movements
- Control of planned land-use pattern can be readily accomplished through planned road network. An ideal residential area's road should contain a cul-de-sac discouraging the through traffic. If Dhanmondi had to be planned and maintained as a residential area, then the internal road network should not have been of grid pattern. Then the land use control would be also easier with control over the generation and destination of trips.
- Maintaining fixed type of use for a particular area, i.e. a fixed CBD, a distinctive, predictable significant flow imbalance would be obtained during an easily identifiable peak hour
- Mirpur road is wide enough (8-lanes) to provide central two lanes as tidal flow lanes and the outer three lanes on each side of the central lanes, provided lane-based movements, could be used as permanent one-way for the particular direction

5.2 *Recommendations*

Although Dhaka has already become a city of disorganized road network and mixed land-use pattern due to faulty planning, still some corrective measures may be taken by a strong regulation authority like RAJUK through strict control of the land-use for existing or for any new residential or commercial area to prevent indisciplined trip generation, attraction and distribution.

For Dhanmondi area, some of the particular non-residential uses, i.e. schools, colleges, offices etc. can be shifted to some other places with proper planning and considerations over the short and long-term consequences and other effects.

Most importantly, while planning some new town-project, responsible efforts must be taken so that this type of irreversible damage and mistake do not occur in future. Town planner should concentrate on the potentiality of the road network not only on the basis of the capability to meet the current demand, but also for future expansions and overall management actions.

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