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ANALYZING TRIP DISTRIBUTION SCENARIOS AND ITS CONSEQUENCES IN KHULNA CITY: A CASE STUDY OF WARD 10, 11 AND 12

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ABSTRACT

Living standards of people in Khulna city is improving rapidly due to educational and economic development. With cultural and economic transformation, many families are beginning to own motor vehicles in the city. Therefore, vehicles are increasing significantly. This changing trend of vehicle ownership is affecting the trip generation and distribution of the city residents. Moreover, the trip distribution depends on the land use setting that alternatively influences the uses of road networks and business activities. Existing transportation network is being used inadequately because the destination points of many trips (e.g., commercial, business, residential) are centrally located. Thus, huge traffic jam and transportation hazards (e.g., accidents) are appearing in some parts of the city. Considering the situation, this study has been conducted to investigate trip distribution scenarios in Khulna city and its impacts on existing transportation network taking wards 10, 11 and 12 as trip generation points. Household surveys were conducted to collect information regarding trip origin and destination. Using Cross-classification method trip generation of the city was estimated. Analyzing the data the study found that almost half of the trips were attracted to the south-eastern division of Khulna city. In contrast, remaining half of the trips was distributed in the rest of the city. The massive number of trips attracted towards south-eastern division of Khulna causes an increase in the number of traffic in the respective area compare to the other parts of the Khulna city. This characteristics pattern of trip generation and distribution is undermining the efficiency of the transportation network. Therefore, this study suggested decentralizing the trip distribution points by establishing different facilities (e.g., offices, commercial, and educational) throughout the Khulna city to alleviate transportation problems (e.g., congestion).

Keywords: *Transportation, trip distribution, cross-classification, decentralisation, traffic jam*

1. INTRODUCTION

In Khulna city the standard of living is increasing day by day. Now-a-days almost every adult owns a motor vehicle depending on income, age, land use and socio-economic status of the city resulting in a gradual increase of total traffic volume as well as traffic jam. On the other hand, city population is increasing over the years due to increased attractiveness of people towards it. Barnes and Davis (1999) stated that people tend to live in big cities because it offers advantages (e.g., better livelihoods, access to a wide variety of shopping and recreational opportunities) as well as few disadvantages (e.g., cost, noise, and congestion) that is not available in less populous areas. Because of the increased population transportations systems are evolving. Transportation is a cooperative process (i.e., metropolitan planning organization, state department of transportation and transit operators) designed to advance involvement by all the users of the transportation system through a dedicated participation process (TPCBP, 2007). Duranton and Turner (2012) stated that transportation and population increase are proportional to each other. To assess different aspects of a city's transportation system sequential demand forecasting is needed. According to Metropolitan Council (2012), it is an essential part of transportation planning which allows planners to identify and analyze travel demand markets and produces passenger estimates. Complex traffic patterns (e.g., trip generation, distribution and direction inconsistencies) are the main limitation for forecasting transportation demand. A thorough understanding of existing travel pattern is necessary for identifying and analyzing existing traffic related problems (Chatterjee & Venigalla, 2004). There are four stages of sequential demand forecasting (e.g., trip generation, trip distribution, modal split and trip assignment). Garber and Hoel (2014) stated that trip generation is the first step and trip distribution is the second. They added that the purpose of trip generation is to estimate the number of trips of each type that begin and end in each location based on the amount of activity in an area. In most cases trips are aggregated to a specific unit of geography. According to Daisa et al. (2013) trip generation model is used to estimate the number of person-trips that will begin or end in a given traffic analysis zone with each trip having two ends described in

terms of trip purpose. Trip generation models include trips made by a household to find out mandatory activities (e.g., work, school) and trips made to engage in activities that can be considered flexible (Goulias, Pendyala & Kitamura, 1990). One of the ways to measure trip generation is cross-classification method. Cross-Classification method measures the changes in one variable (e.g., trips) when other variables (e.g., land use) are accounted for (Caldwell & Demetsky, 1978). Using cross-classification method Al-Taei and Taher (2006) found that trip rates increase with increasing family size, car ownership and number of workers in the family. The generated trips distribute to different portions of the city for various purposes which significantly influence traffic flow (e.g., jam). The purpose of the trip distribution is to estimate 'zone to zone' movements (i.e., trip interchanges) (Chatterjee & Venigalla, 2004). Barnes and Davis (1999) declared that the purpose of the trip distribution is to find an appropriate balance between sometimes conflicting objectives (e.g., time vs. money) to determine where the trips from a given zone will go. Considering the situation this study investigates trip distribution scenarios in Khulna city and its impacts on existing transportation network taking wards 10, 11 and 12 as trip generation points.

2. DATA AND METHODOLOGY

Three wards of Khulna City Corporation (KCC) (i.e., wards 10, 11 and 12) out of total thirty one wards were selected for analysing trip generation and distribution patterns in this study. The reasons behind selecting these three wards are better connection with each other and position in the middle division of Khulna. Besides they are located very close to Jessore-Khulna Highway road which works as the spine of the transportation network of the city. For conducting this study, secondary data of wards 10, 11 and 12 were collected. Additionally, for estimating trip generation and distribution, a questionnaire survey was conducted in thirty one wards of KCC with the assistance from the Department of Urban and Regional Planning (URP), Khulna University of Engineering & Technology (KUET). A total seven hundred and seventy eight households were surveyed. Moreover, GIS based land use maps were collected from Khulna Development Authority (KDA) in order to generate ideas about the land use pattern of the area and also render a view of the important features facilitated (i.e., calculating the number of workplaces, commercial, recreational, educational, medical structures and restaurants). Questionnaire surveys collected physical and socio-economic condition of the households (e.g., income, vehicle ownership, possession of a driving license), origins, destinations and nature of the trips generated in the households. Cross-classification method was performed in order to estimate trip generation of wards 10, 11 and 12. Moreover, trip distribution percentage of the three wards was determined by assessing data from the surveys conducted. Finally, trip generation and distripbution data were incorporated for the purpose of analysis (i.e., determining the percentage and number of trips distributed from the study area to the south-easter, middle and north-western division of Khulna and respective reasons responsible for these patterns) and reaching a conclusion.

2.1 Trip Generation Method

Cross-Classification method measures the changes in one variable (e.g., trips) when other variables (e.g., land use) are controlled. Generally it is non-parametric, since no account is taken of the distribution of the individual values based on the assumption that the number of trips generated by similar households (e.g., same income, equal number of car ownership). The method predicts the trips produced in a zone by simply aggregating the total trips produced by all the households in that zone (Chakroborty & Das, 2003). Categories of households and rate of trip generation are determined by empirical observations and analysis. Several variables (e.g., income, vehicle owneship and trip purpose) are declared which are responsible for the trip generation. Besides, it can be also seen how the production of trips are changed with the change or constancy of the variables. For example, a study was performed in Dohuk, Iraq. The study used cross-classification method to describe the travel pattern from all socio-economic trend of that particular area. Socio-economic factors for trip production was car ownership, family size, income level and workers number. Car ownership was considered as the main factor (Al-Taei and Taher, 2006). Similar approach and methods are adopted in this study. However this study investigates the influence of family size, auto ownership, income, occupation, age and thereby analyse the trip generation in ward 10, 11 and 12. In cross-classification method, four sub-models named income sub-model (i.e., relating percentage of households to income zone and income class), auto ownership sub-model (i.e., relating percentage of households to income class and auto ownership), trip production sub-model (i.e., relating trip rates to income class and auto ownership) and trip purpose sub-model (i.e., relating percentage of households to income class and trip purpose) were developed in order to estimate trip generation. For the four sub-models Khulna city was divided into seven income zones (i.e., 12000, 21000, 23000, 27000, 33000, 36000 and 49000) depending on their income and geographic location (e.g., proximity). Moreover, income was divided into low (i.e., monthly income between 15000 taka), medium (i.e., monthly income between 15-35 thousand taka) and high (i.e., monthly income above 35000 taka) categories. For trip purpose sub-model, the purpose of trips were divded into Home Based Works Trips (HBW) (e.g., from home to office), Home Based Others Trips

(HBO) (e.g., from home to shopping mall) and Non-Home Based Trips (NHB) (e.g., from shopping mall to cinema hall). From the four sub-models, trip generation was estimated by using Equations (1) and (2).

Trip numbers based on Vehicle Ownerships = Number of the households based on income * Distribution of trip rates based on vehicle ownership * Trip rates of households based on vehicle ownership (1)

Trip numbers based on zonal income and trip purpose = ∑(Trip numbers based on Vehicle Ownerships) * Percentage of households based on trip purpose and income level (2)

Tables were constructed (see "Result" section) representing the relationships between the variables in Equations (1) and (2). The equations can also be represented with Equations (3) and (4).

Table 12 = Table 7 * Table 8 * Table 10 (3)

Table 13 = ∑(Table 12) * Table 11 (4)

2.2 Identification of the Points of Trip Attractiveness and Generation

In the study, Khulna city was divided into three divisions for estimating trip distribution pattern (i.e., calculating the magnitude of trip attractiveness in each division). Each division consisted of a number of wards. The divisions were Khulna (South-East) (the heart of the linear city because it contains the Central Business District consisting of wards 18-31), Middle Khulna (consisting of wards 6-17) and Khulna (North-West) (consisting of wards 1-5). Table 2 shows that Middle Khulna is the largest portion (24.62 km^2) covering 41% of the city with a population of 2,48,409. Khulna (SE) is the second largest division (21.28 km^2) with a population of 3,29,807 population and Khulna (NW) covers 13.67 km^2 (23% of the whole city) with a population of 85,126. Wards 10, 11 and 12 are positioned in Middle Khulna. People of various occupations and income level live in the area. The main occupation of the area is business. There is a mix of poor, middle class and rich people in the location. Land uses such as residential, educational, commercial and industrial are available. The main transportation modes of the area are auto-mobiles and auto-rickshaws. Many of the inhabitants own cars, motorcycle and bicycles for the easement of their transportation.

Table 1: Demographic condition of the study areas

Features	Ward no.		
	10	11	12
Population	27947	12373	21208
Area (acre)	201.92	91.92	161.55
Households	6713	3291	5179

Source: BBS, 2011

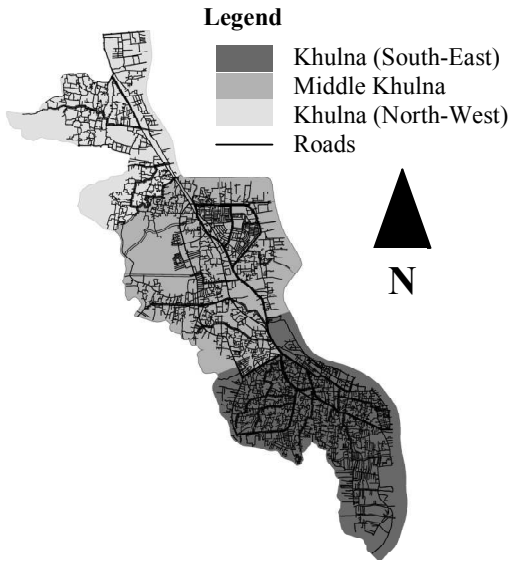


Figure 1: Different Portions of the Khulna City

Table 2: General information of the three divisions of Khulna city

	Khulna (SE)	Middle Khulna	Khulna (NW)	Total
Area (sq. km)	21.28	24.62	13.67	59.57
Percentage (%)	36	41	23	100
Population	329807	248409	85126	663342

Source: Calculated by the researchers, 2015

3. RESULT

3.1 Development of the Cross-classification Model

3.1.1 Income and Auto Ownership Sub-model

The first sub model developed in the study is Income Sub-model (Table 4, 5 and Figure 2) that categorized households into three groups based on their income (e.g., High, Medium and Low). The second sub-model, the Auto Ownership Sub-model (Table 4, 6 and Figure 3) incorporates households income with number of vehilces owned. For developing the sub-model income and car ownership data were used as independent variables. With information on number of trips, income and car ownership Tables 3 and 4 were constructed.

Table 3: Distribution of households in Seven Zones based on Income

Zonal Income	Percentage of Households			Total (%)
	High	Medium	Low	
12000	0	9.1	90.9	100
21000	9.7	43.7	23.3	100
23000	5.8	70.9	23.3	100
27000	17.8	60	22.2	100
33000	21.7	69.6	8.7	100
36000	23.1	69.2	7.7	100
49000	64.3	35.7	0	100

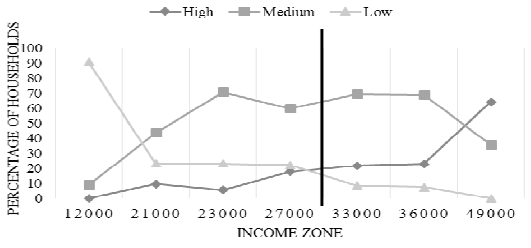
Source: Field survey, 2014

Table 4: Distribution of households based on Income and Vehicle Ownership

Zonal Income	Autos / Household (%)				Total
	0	1	2	3	
12000	75.00	12.50	0.00	12.5	100
21000	63.10	35.00	1.90	0.00	100
23000	47.90	45.80	6.20	0.00	100
27000	50.00	37.80	11.0	1.20	100
33000	45.70	47.80	4.30	2.20	100
36000	53.80	38.50	7.70	0.00	100
49000	28.60	64.3	7.10	0.00	100

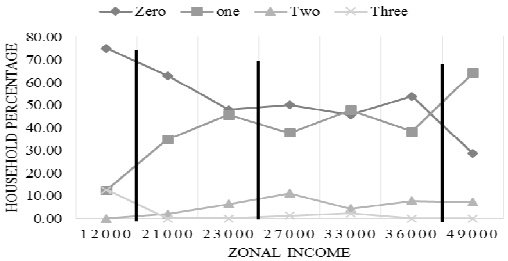
Source: Field survey, 2014

Tables 3 and 4 represent the number of households of the income zones according to income categories and number of vehicles owned. Based on the information presented in Tables 3 and 4, Income Sub-model curve and an Auto-Ownership Sub-model curve were developed. These sub-model curves (e.g., Figure 2 and 3) represent the character of the households based on their incomes and vehicle ownership respectively.



Source: Calculated by the researchers, 2014

Figure 2: Income Sub-model Curve



Source: Calculated by the researchers, 2014

Figure 3: Auto Ownership Sub-model Curve

The three curved lines in Figure 2 represent income class of the households. The curved lines denote the percentage of households (vertical axis) based on the income zones (horizontal axis). A broad vertical line was placed at the middle delineates the average income. The curved lines intersect the said vertical line on a specific set of values on the vertical axis. From the measured values Table 5 was derived to generalize the relationship between households and income. Moreover, the four curved lines in Figure 3 represent number of vehicles owned by the households. The curved lines denote the percentage of households (vertical axis) based on the income zones (horizontal axis). Three broad vertical lines were placed on the graph that represent three income classes (e.g, low, medium, high). The curved lines intersect the said vertical lines on a specific set of values on the vertical axis. From the measured values Table 6 was derived to generalize the relationship between households, income and vehicle ownership. Table 5 and 6 show the relationship between vehicle ownership and income categories of the households.

Table 5: Distribution of households based on income

Income	Frequency	Percentage
Low	148	19
Medium	482	62
High	148	19
Total	778	100

Source: Calculated by the researchers, 2014

Table 6: Relationship between vehicle ownership and income by percentage of households

Auto Ownership	Income / Households (%)		
	Low	Medium	High
0	71	48	40
1	22	42	54
2	6	8	6
3	1	2	0
Total	100	100	100

Source: Calculated by the researchers, 2014

Table 5 and 6 represent the income-household relationship and income-auto ownership-household relationship of Khulna city respectively. Tables 3, 5 and Figure 2 interprets that Khulna is largely occupied by people earning 15-35 thousand taka per month. One the other hand, Tables 4, 6 and Figure 3 interpret that households of middle income class have a higher ratio of owning single transportation vehicle. This may be because people of medium income class are greatly engaged in jobs compare to people of low and high income classes. Table 7 represents the distribution of households of wards 10, 11 and 12 based on income classes following the percentage distribution of households derived in Table 5. Table 7 distinguishes middle income class as it contains the highest ratio of household compare to low and high income classes.

Table 7: Number of the Households of Ward 10, 11 and 12 according to the Income

Income	Number of Households			Percentage
	Ward 10	Ward 11	Ward 12	
Low	1275	625	984	19
Medium	4163	2041	3211	62
High	1275	625	984	19
Total	6713	3291	5179	100

Source: Calculated by the researchers, 2014

3.1.2 Trip Production and Trip Purpose Sub-model

The Trip Production Sub-model (Table 8, 10 and Figure 4) establishes a relationship between the trips made by each household and vehicle ownership. The trip rate is simply the number of trips in each auto ownership and income category divided by the appropriate number of households in each auto ownership and income category. Trip Purpose Sub-model (Table 9, 11 and Figure 5) represents households based on trip purpose and income classes. Table 8 represents trip rates with respect to income zone and vehicle ownership. Table 9 represents the trips percentage distribution with respect to zonal income and trip purpose.

Table 8: Distribution of trip rates in seven zones based on vehicle ownership

Income	Trip Rate / Auto			
	0	**1**	**2**	**3**
12000	7.33	8	0	4
21000	6.62	8.28	18	0
23000	8.27	7.38	10.17	0
27000	6.15	5.39	7.11	12
33000	5.19	5	6.5	8
36000	4.62	5.07	4	0
49000	4.5	4.67	8	0

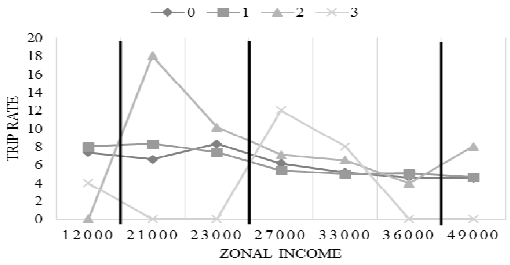
Source: Field survey, 2014

Table 9: Percentage frequency of trips based on zonal income and trip purpose

Zonal Income	Trip Purpose / Households (%)		
	HBW	**HBO**	**NHB**
12000	53.64	29.97	16.39
21000	59.09	24.6	16.31
23000	65.14	23.63	11.22
27000	54.21	22.86	12.91
33000	49.68	39.87	10.44
36000	57.41	36.39	6.19
49000	44.50	43.90	11.60

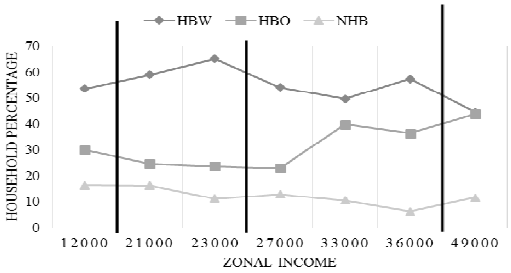
Source: Field survey, 2014

Based on Table 8 and 9 trip production sub-model curve and trip purpose sub-model curve were constructed (Figure 4 and 5).



Source: Calculated by the researchers, 2014

Figure 4: Trip Production Sub-model Curve



Source: Calculated by the researchers, 2014

Figure 5: Trip Purpose Sub-model Curve

The four curved lines in Figure 4 represent number of vehicles owned by the households. The curved lines denote the trip rates (vertical axis) based on the income zones (horizontal axis). Three broad vertical lines were placed on the graph that represent three income classes (e.g, low, medium, high). The curved lines intersect the said vertical lines on a specific set of values on the vertical axis. From the measured values Table 10 was derived to generalize the relationship between trip rates, vehicle ownership and income. Moreover, the three curved lines in Figure 5 represent trip purposes (e.g., HBW, HBO, NHB) of the households. The curved lines denote the percentage of households (vertical axis) based on the income zones (horizontal axis). Three broad vertical lines were placed on the graph that represent three income classes (e.g, low, medium, high). The curved lines intersect the said vertical lines on a specific set of values on the vertical axis. From the measured values Table 11 was derived to generalize the relationship between trip purpose and income. Table 10 and 11 represents the trip rates of the surveyed household based on vehicle ownership and the percentage of households based on income level and trip purposes respectively.

Table 10: Trip rates of households based on vehicle ownership

Auto Ownership	Trip Rates based on Income		
	Low	Medium	High
0	7	7	4
1	8	6	5
2	9	8	6
3	2	6	0

Source: Calculated by the researchers, 2014

Table 11: Percentage of households based on trip purpose and income level

Trip Purpose	Income / Household (%)		
	Low	Medium	High
HBW	55	60	50
HBO	28	26	40
NHB	17	14	10

Source: Calculated by the researchers, 2014

Tables 8, 10 and Figure 4 interpret that people of low and medium income class make more trips regardless of number of vehicles owned. This happens because people of low and medium income classes have offices in close proximity to their homes. This allows them to make home based trips a few times a day resulting in higher trip rates. On the other hand, Table 9, 11 and Figure 5 interprets that people of all income classes make more home based trips than any other.

3.1.3 Estimation of Trip Generation

Table 12 and 13 represent the trip productions of ward 10, 11 and 12 calculated from Equations (3) and (4).

Table 12: Trip number of ward 10, 11 and 12 based on vehicle ownership

Auto Ownership	Income / Trips		
	Low	Medium	High
0	14336	31626	4161
1	5144	23718	5415
2	1548	6024	1044
3	58	1128	0

Source: Calculated by the researchers, 2014

Table 13: Trip number of ward 10, 11 and 12 based on zonal income and trip purpose

Trip Purpose	Income / Trips			
	Low	Medium	High	Total
HBW	9935	37501	5537	52973
HBO	5903	16249	4430	26582
NHB	3585	8749	1108	13442
Total	19423	62499	11075	**92997**

Source: Calculated by the researchers, 2014

Table 12 and 13 interprets that greater number of trips are generated by household of medium income class because most of the people of Khulna city earns between 15-35 thousand taka. People of all classes make greater number of home based trips compare to home based others trips and non-home based trips. Moreover, households that own smaller number of vehicles makes greater number of trip because their homes are in close proximity to their workplaces.

3.2 Distribution of Trips Originated from wards 10, 11 and 12 throughout Khulna City

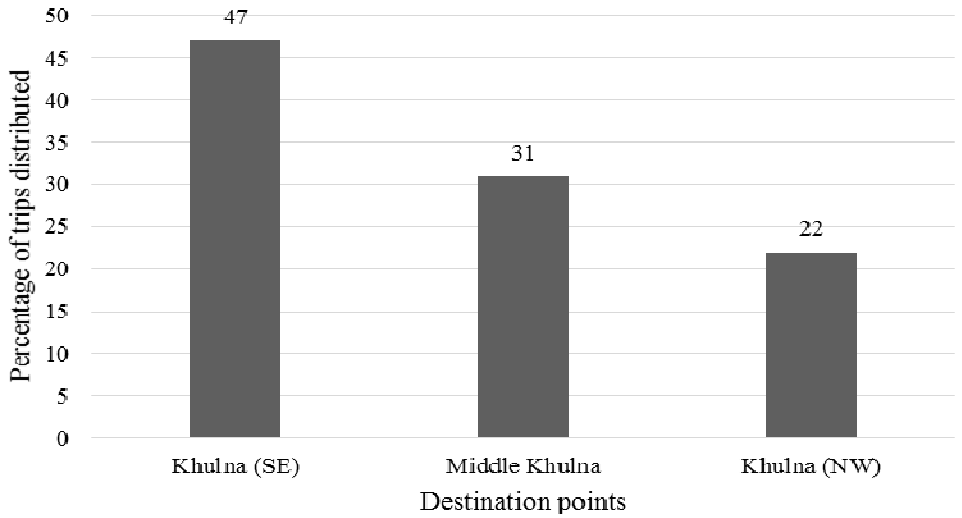
From the survey data the distribution pattern of the generated trips were estimated. Table 14 was constructed showing trip distribution pattern of ward 10, 11 and 12. Table 14 outlines that almost half of the trips generated from wards 10, 11 and 12 are diverted to Khulna (SE). In contrast, Middle Khulna attracts lower number of trips than Khulna (SE). Khulna (NW) attracts the lowest number of trips among the three divisions of Khulna.

Table 14: Percentage of trips from the study area to the different parts of Khulna

Wards	Percentage of Trips Distributed from Wards to Destination Points		
	Khulna (SE)	Middle Khulna	Khulna (NW)
Ward 10	42	36	22
Ward 11	48	29	23
Ward 12	51	28	21

Source: Calculated by the researchers, October, 2015

From Table 14 this study found that about 47% of the trips originated from the study area were distributed to Khulna (SE), 31% trips to Middle Khulna and 22% trips to the Khulna (NW) (Figure 6).



Source: Field survey, October, 2015

Figure 6: Trip distribution percentage of wards 10, 11 and 12

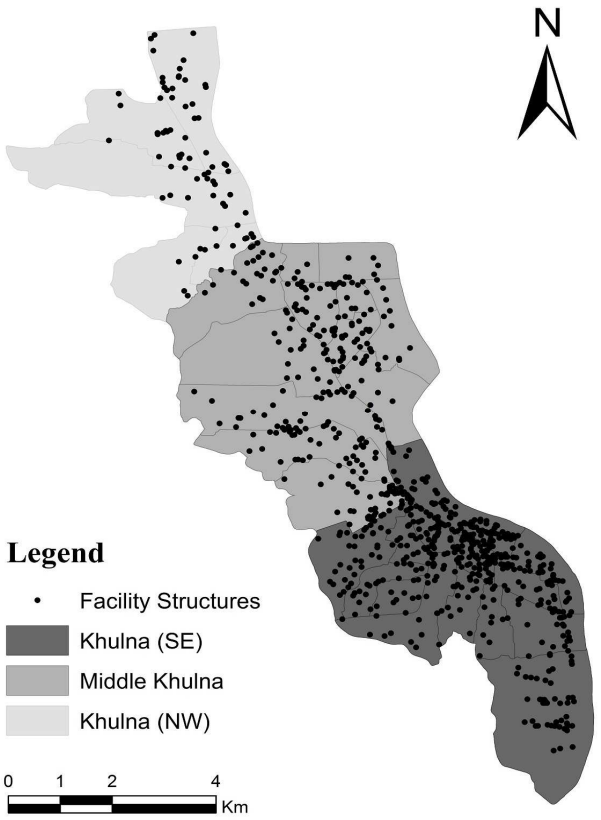
From Figure 6, this study found that among the total 92,997 trips generated each day in the study area, 43,709 (47%) trips distributes to Khulna (SE). 28,829 (31%) trips to Middle Khulna and 20,479 (22%) trips to Khulna (NW). The number of trips distributed to a particular area depends on the availability of different facilities and types of land uses. There are mainly six types of points of attractiveness (i.e., workplaces, commercial & business areas, recreational areas, education, medican & health institutions and hotels & restaurants) that influence trips on a regular basis. This study found that elders of the household often travel to workplaces, commercial areas and medical institutions. In contrast, students and the younger generations are object to educational facilities, recreational structures and restaurants.

Table 15: Facilities distribution on different parts of the Khulna city

Structures	Existing Numbers	Percentage (%)		
		Khulna (SE)	Middle Khulna	Khulna (NW)
Workplaces	510	62	30	8
Commercial Areas	65	55	35	11
Recreational Structures	16	47	40	13
Primary Schools	134	60	33	7
High Schools	87	47	39	14
Colleges & Institutions	45	40	51	9
Medical Institutions	73	67	29	4
Restaurants	45	84	10	6

Source: GIS based physical feature maps of Khulna (KCC, 2010)

Table 15 shows that there are higher number of facilities (e.g., workplace, recreational area, medical instituion) in Khulna (SE) than any other parts of Khulna. In terms of workplaces, the portion contains structures like offices, NGOs, Govt. offices, academies, mills, factories and banks. Commercial areas consists of bazar, markets, shopping malls and plazas. Cinema halls, community centers, stadiums and libraries make up recreational points. There is a significant number of medical institutions in Khulna (SE). A dot density map of the facility structures of Khulna city has been shown in Figure 7.

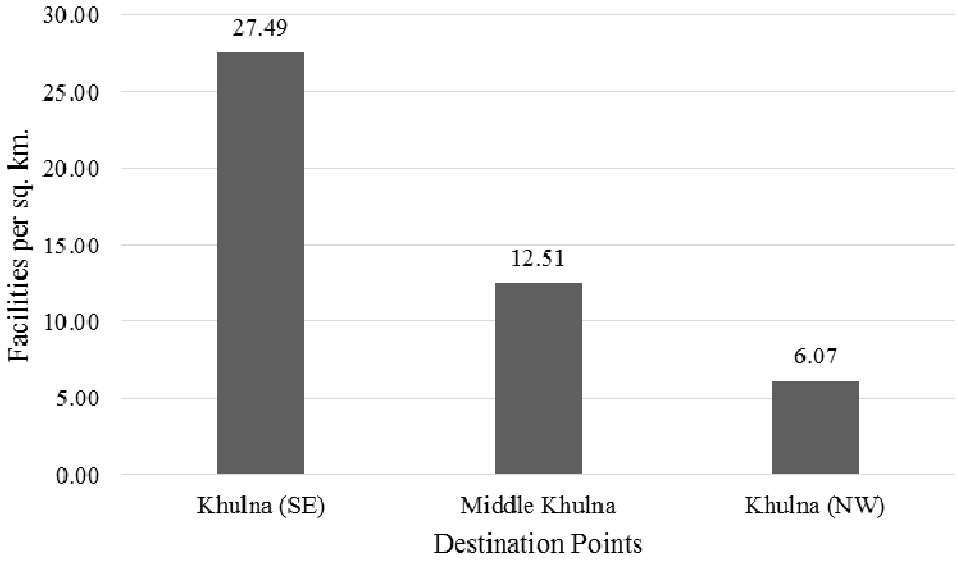


Source: Physical feature GIS map (KCC, 2010)

Figure 7: Dot Density Map of Facility Structures of Khulna City

Table 15 and Figure 7 show that there are more infrastructural facilities in Khulna (SE) than that of Middle Khulna and Khulna (NW). The reasons behind these scenario include-

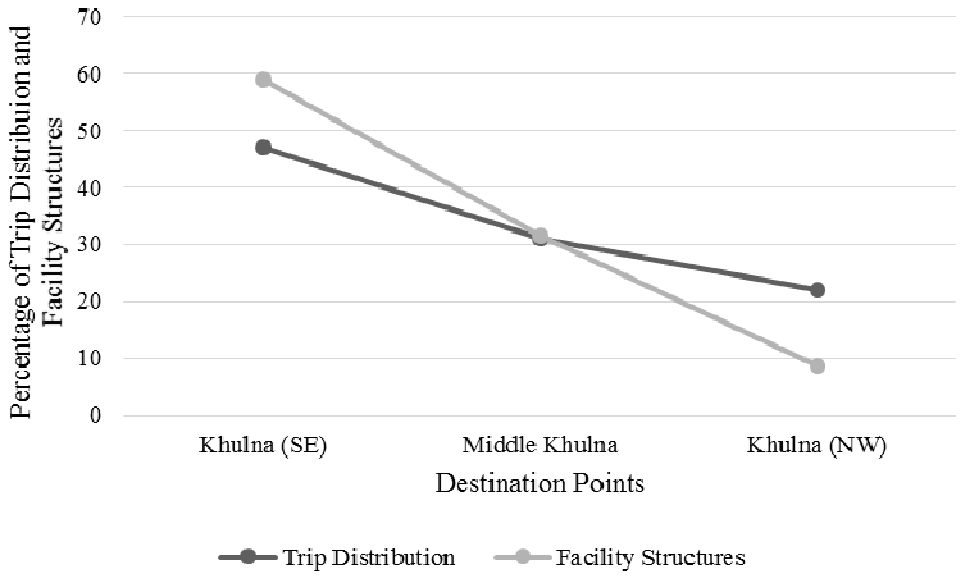
1. The population density in Khulna (SE) is higher than other parts of Khulna. Higher population density and higher number of facilities attract large number of people to Khulna (SE).
2. There are two large residential areas in Khulna (SE) namely Nirala Residential Area and Sonadanga Residential area. In contrast, there is only one residential area in Middle Khulna named Khalishpur Residential Area and no residential area in Khulna (NW). Therefore, larger residential areas in Khulna (SE) with higher demand of offices, commercial area, educational and medical institutions attract more people than othere areas with limited number of facilities.
3. Water transportation system in Khulna is relatively better due to close proximity to the Bay of Bengal. This transportation system is expediting business activities contributing to better road transportation. Consequently, facility structures are developing in Khulna city particularly in Khulna (SE) because of increased business activities. Development of these structures are attracting larger number of people.
4. Due to establishment of the rail station in Khulna (SE) significant number of hotels and restaurants are needed in close distance. Travelers are often coming to visit the city looking for places close to the station for staying. This is leading to a strong development of hotels and restaurants in this division.
5. Middle Khulna has a higher number of Colleges and Institutions compare to Khuna (SE) and Khulna (NW). Colleges and higher studies institutions need a different environment for the students. It needs to be away from the din and bustle of city life, so that the students can concentrate on studies more effectively and in a friendlier environment. Since, Middle Khulna attracts less trips than Khulna (SE), this portion has a greater viability for higher education institution. This magnitude of viability has led to the stong development of colleges and institutions in Middle Khulna.



Source: Calculated by the researchers, October, 2015

Figure 8: Density of facilities in Khulna city

Khulna (SE), Middle Khulna and Khulna (NW) accommodate a density of 27.49, 12.51 and 6.07 unit of facilities per square kilometer respectively (Figure 8). Khulna (SE) has a higher density of infrastructural facilities compare to Middle Khulna and Khulna (NW). This is one of the main reasons for greater trip attraction to Khulna (SE).



Source: Calculated by the researchers, October, 2015

Figure 9: Relation between number of facilities and trip distribution of wards 10, 11 and 12

Figure 9 establishes that trip distributions are proportional to the number of facility structures available in a specific area of Khulna city. Greater number of facility structures in a particular area influence and attract trips from all the wards of the city to that specific area and cause huge traffic jams at different intersections. During peak hours in the morning people from their origins to destinations. Consequently, heavy traffic jam appears in different intersections in Khulna (SE) (e.g., Shib Bari More, Ferry Ghat More, Dak Bangla More, Shat Rashta More, Sonadanga More and Moyla Pota More). In Middle Khulna, huge traffic jam also appears in Daulatpur area because most of the trips (i.e., 31% of the produced trips) generated in this area drive to Khulna (SE) for daily businesses. Similar scenario is also seen during peak hours in the afternoon and evening, when people return to their residences from their work.

4. DISCUSSION

It is found that the trip production and distribution are highly dependent on the density, availability and condition of facility structures located in different parts of Khulna city. Transportation network, population density and length of the journeys to their destination points influence trip generation by developing facility structures. But excessive trip to a certain location causes problems (e.g., traffic jam) and the city becomes exposed to accidents and pollutions. Therefore, future developments of facilities influencing trip destinations must be planned in such a way to distribute them evenly throughout the Khulna city to reduce traffic congestion and accidents. Hopefully, this method will ease Khulna (SE) from its overstress of traffic and bring efficiency to the transportation network.

5. CONCLUSION

This study found that trips attraction increases with economic activities. The higher number of facilities in Khulna (SE) encourage and support more investment both in public and private sectors ensuring a more flourished economy. Analyzing collected data by cross-classification method, it was observed that trip generation and distribution mainly depend on the land use of a particular area. All the land uses should be well connected by transportation networks. If transport networks are developed without considering the existing and future land use people will travel according to their own comfort. All the facilities (e.g., workplace, commercial, recreational areas) should be well distributed throughout the city and population. This will prevent concentration of inhabitants in a particular area. Otherwise the trips will be attracted to only one division of the city. Khulna (NW) does not have any residential areas, on the other hand the Khulna (SE) has two developed residential areas. So, facilities must be provided in Khulna (NW) and Middle Khulna in order to attract people and flourish economic activities. If the private investors are unable to invest then the government must provide subsidies for the sake of development.

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