

ESTIMATING CONGESTION INDEX FOR VARIOUS ROADS OF ASHULIA-SAVAR AREA

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CERTIFICATION

The thesis titled “ESTIMATING CONGESTION INDEX FOR VARIOUS ROADS OF ASHULIA-SAVAR AREA” submitted by Md. Tanjil Islam (Student id:-193-47-1076) and Md. Abu Hena Mostofa Kamal (Student id:-193-47-1077) has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

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ABSTRACT

This survey work presents the congestion index in Bangladesh in the Urban Areas of Dhaka. The traffic congestion index reflects the state of traffic flow. The detection and analysis of traffic congestion index can be used to estimate the operation status of roads, to plan and organize road traffic for traffic managers, and to make reasonable decisions for travelers to travel. This survey includes measuring travel time, and distance to find out the vehicle's speed to see the volume of congestion. Find out the congested roads in the Ashulia-Savar area. Traffic congestion varies at different times such as off hour and pick hour. This survey will find out the causes of traffic congestion and its impact. This paper also discusses the solution or appropriate way to reduce this problem.

ACKNOWLEDGEMENT

In the name of Allah, the most gracious and the most merciful. I am thankful to Almighty ALLAH for giving me the strength, knowledge, ability, and opportunity to undertake this study and complete it satisfactorily. I would like to thank my respected teacher and supervisor Assistant Professor Saurav Barua for providing facilities to carry out this survey work on such an important topic. I consider myself fortunate to work under his supervision. Special thanks go to me, I Md. Tanjil Islam and Md. Abu Hena Mostofa Kamal for help and hard work during the data collection in the survey areas.

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Dedicated to

Our Parents

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CHAPTER 1

INTRODUCTION

1.1 General

Bangladesh is one of the most traffic-congested cities in the world. The worldwide phenomenon known as urbanization is spreading quicker throughout all of the world's nations. As a result, both industrialized and developing nations urban centers have become increasingly dominated by automobiles in recent decades. The need for infrastructure and cars is growing simultaneously. That means vehicles are highly used all over the world. This issue has increasing, traffic congestion all over the world. Developing countries are particularly facing challenges like traffic congestion, accidents, pollution, etc. Like other developing countries, in Bangladesh the level of traffic congestion is getting extremely high. Traffic congestion on important roads is causing immense suffering to the people by retarding them to reach their destination at scheduled time. A huge number of slow-speed vehicles create huge congestion due to a lack of proper management.

1.2 Background

Congestion Index is a metric used to quantify and measure the level of congestion on road networks in urban areas. It provides insight into the efficiency of transportation systems and helps in identifying areas where traffic congestion is a significant issue. The issues presented by growing urbanization, population growth, and the ensuing increase in motor traffic are the foundation of the road congestion index. Day by day this problem rises. The survey goal is to identify the congestion index's issues and its solutions.

1.3 Objective

1. Identify congested areas.
2. To analyze the impact of traffic congestion.

1.4 Work Plan

Specifying the geographic area or road network under consideration. Identify and gather relevant data sources, including traffic flow, vehicle speed, vehicle density, and road infrastructure data. Use advantage technology such as GPS, traffic cameras, and sensors for real-time data.

1.4.1 Data Collecting & Preprocessing

Clean and preprocess data to get rid of errors and inconsistencies. Need to be sure the data is accurate and of high quality.

1.4.2 Choose Methodology

Select a methodology for calculating the congestion index based on survey goals and also available data common methodologies for the average speed calculations, travel time and more advanced algorithms considering multiple factors for congestion.

1.4.3 Parameter Selection

Determine particular parameters for the congestion index, such as travel time, traffic volume and vehicle density.

1.4.4 Analysis and Modeling

Utilize the selected methodology to evaluate the information and determine the congestion index.

1.4.5 Visualization

Create visual representations of the congestion index data, such as maps, graphs, and charts. Which will make it easy to understand traffic congestion.

1.4.6 Documentation

Document the methodology, take data, and analyze procedures used to find out congestion. Provide clear documentation for future reference and also potential replication.

1.4.7 Recommendations

In observation find out the main problem, discuss, and find out the solution. Finding a solution is very important otherwise survey will be neglected. Provide suggestions or recommendations for better futures.

1.5 Summary

The whole world is developing in a very fast way. This new problem is also created by us. The traffic congestion index is one of the themes. This is most common all over Bangladesh. To solve these issues from observation about road condition and traffic congestion need to take necessary steps. And this can be a helping hand to upgrade the lacking traffic congestion of roadways, it will take our country's development to a further level.

CHAPTER 2

LITERATURE REVIEW

2.1 General

This chapter presents a review of the literature on congestion index beginning of a research or survey work and it suggests that the majority of research or survey projects are restricted to the identification. An extensive literature survey of the documents on relevant research and studies to find out about road congestion index in urban areas. Traffic congested areas, especially in the urban areas traffic jams are an annoying and harmful problem to the residents and travelers. The field survey gives clear information about the road congestion index urban area in Dhaka of Ashulia-Savar area.

2.2 Transport System in Dhaka

Survey location set in Dhaka urban areas. The transport system of Dhaka is mainly road-based. However, there is a limited use of waterways such as the Buriganga river flow beside Dhaka. The rail and air transportation for movement is very few. The road network in Dhaka determines the accessibility to the different locations of the metropolitan area. Dhaka is one of the biggest busy cities in Bangladesh. About 10 million people live here. Uncountable schools, colleges, hospitals, parks, and restaurants are here. And any kind of job or work available here. For this large numbers of population live here. Many roads see in Dhaka city for this, there are many roads in different connecting areas. That is the reason for the problem of road traffic congestion in the city and also in rural areas, consequent air pollution and so on.

To understand traffic congestion some ideas must be known, here are some definitions to better understand.

2.3 Traffic & Volume Study

Traffic: The movement of people, vehicles, aircraft, ships, train or any entity from one place to another is called Traffic. The movement of vehicles on roads is generally called road traffic.

- Heavy
- Medium
- Light

There are two types of traffic congestion- 1. Recurring 2. Non- recurring

Recurring is occurring again periodically or repeatedly and non-recurring is irregular accidentally happen.

Volume: Volume on a road is the number of vehicles passing the measurement point during a specified time interval. Volume studies are usually conducted when certain volume characteristics are needed, some of which follow:

- 1. Daily Volumes:** A common time interval for volumes is a day. Daily volumes are frequently used as the basis for highway planning and general observations of trends.
- 2. Peak Hour Volume (PHV)** - the maximum number of vehicles that pass a point on a highway during 60 consecutive minutes. **Vehicle Classification (VC)** - concerning the type of vehicles for cars, two-axle trucks, or three-axle trucks.
- 3. Average Daily Traffic (ADT)-** the average of 24-hour counts collected over several days greater than one but less than a year.
- 4. Average Annual Daily Traffic (AADT)-** the average of 24-hour counts collected every day of the year.
- 5. Vehicle Miles of Travel (VMT)-** is a measure of all the miles driven within a specified area and time frame.
- 6. Demand:** is a measure of the number of vehicles (or passengers, or persons) waiting for service in the given period.
- 7. Capacity:** the maximum number that can reasonably be expected to be served in the given period.
- 8. PCE:** Passenger car equivalent is essentially the impact that a mode of transport has on traffic variables (such as headway, speed, and density) compared to a single car.
- 9. PCU:** Passenger car unit. It is a vehicle unit used for expressing highway capacity units.

Congestion Index (CI): is a measure of vehicle travel density on major roadways in an urban area.

Travel Time: the time spent traveling from the moment of departure from one activity to the moment of arrival at the new activity.

2.4 Pavement

In engineering terms, a pavement means a man-made surface on natural ground that people, vehicles or animals can cross. Any ground surface prepared for transport counts as a pavement. The pavement is the part of the road that carries the traffic and has a set of layers or material placed over the natural ground (subgrade).

There are many types of pavements. In Bangladesh, commonly use in the highway –

Rigid Pavement Flexible Pavement Composite Pavement

Those pavements are using on the highway. There also use marking on road for such as for

Overtaking

Left, right sign, u-turn

One way and so many

2.5 Summary

To find a congestion index needs to know all basic content about traffic and its useful parameters. Based on daily volume, demand can find a busy road. Roadway pavement is also an important parameter. CI use for urban area or roads with consider a value to measure congestion level.

CHAPTER 3

METHODOLOGY

3.1 General

Depending on road conditions all over Bangladesh congestion index will be different. Measure a single place located in Dhaka urban area road. The road condition was quite good with many vehicles. Here seen different types of vehicles. The survey was done with many numbers of private cars. With many roads in both directions.

3.2 Criteria

1. Slow the speed of the vehicle
2. Narrow roads
3. Many vehicles in a time
4. Passers walk on the roadside
5. Not good condition road

3.3 Location:

The location was set urban area near Dhaka called Ashulia-Savar roads. Which is linked with Dhaka city in many parts. Routes given below –

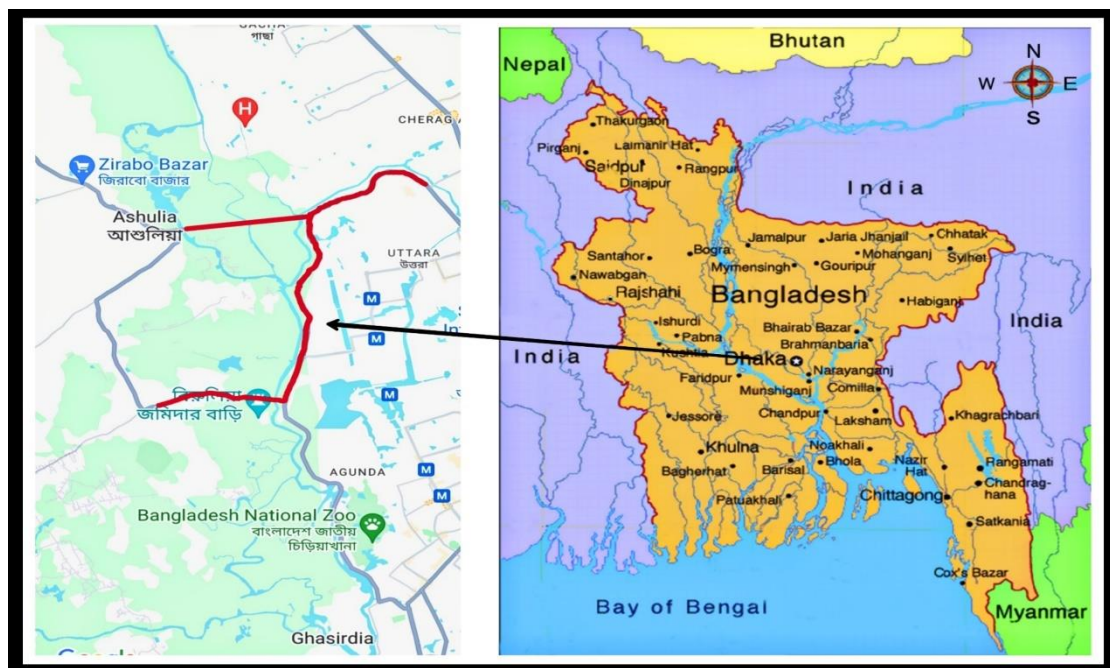


Figure 3-1: Survey Location

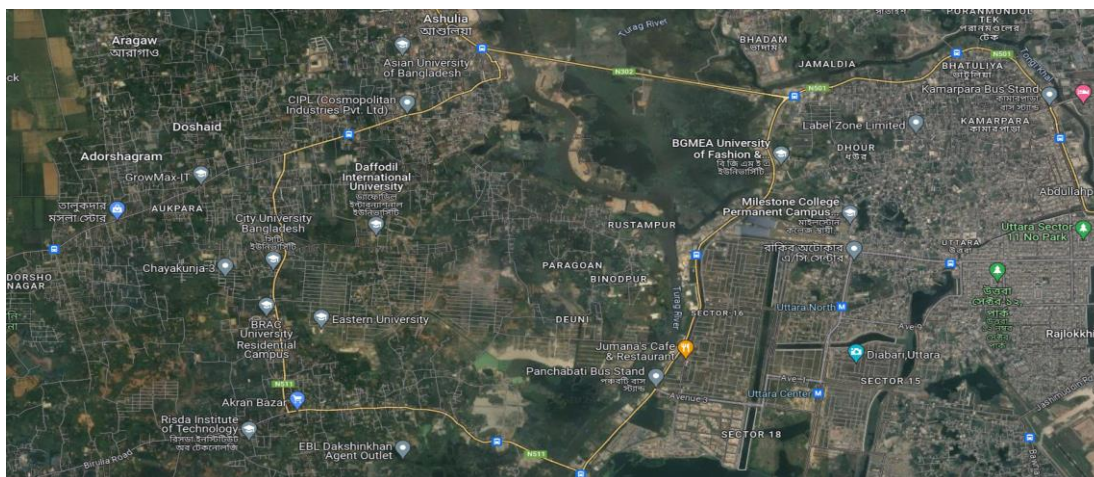


Figure 3-2: Map of Sampling Sites

Table 3-1: Location Details of Sampling Sites

	Location	Distance (km)	Direction
1	Birulia Bridge – Turag Thana	3.6	Both
2	Kamarpara – Dhour Police Check Point	3.3	Both
3	Birulia Bridge – Akran Bazar	3.1	Both
4	Dhour Police Check Point- Ashulia Bus Stoppage	3.2	Both

3.4 Sampling Points:

Selected four places for the survey. For this taking value from both directions as upstream and downstream. There were many types of vehicles moving. Such as-

- Bus,
- Private car,
- Auto-rickshaw,
- Cycle,
- Bike,
- Compressed natural gas vehicles,
- Microbus,
- Truck and many more.

All routes are busy roads connecting with Dhaka city. All routes are not the same. There is variation in length and width. A variation in road condition also. On roads, many people walk on the roadside at high risk. Sometimes roads get congested due to slow-moving vehicles. Many roads with huge dust which inconveniences the passengers and drivers.



Birulia Bridge - Turag Thana





Kamarpara - Dhour Police Check Point





Birulia Bridge - Akran Bazar





Dhour Police Check Point - Ashulia Bus Stoppage



Figure 3-3: Map of Sampling Locations

That is a kind of manual method with the help of an electronic device. Using a stopwatch, pen, paper, mobile phone (to take pictures of the running car), etc. In this case, we don't have any mechanical device that can automatically record our selected cars with travel time. So taking pictures and recording times.



Figure 3-4: Working Day Photos

3.5 Work Procedure

1. On the selected day, the selected location stands with a notebook, stopwatch, and mobile in two locations. Stand with two fixed points as entrance point and the exit point.
2. The selected car was recorded by registration number with time. Also, take pictures of many of them.
3. Using audio conference our location entry and exit times were measured by private car.
4. Take record in both Upstream and Downstream.
5. Also check road conditions and traffic conditions.
6. For cross-checking also take pictures in both directions both of us.

In this way, we have recorded four days of traffic congestion data on weekdays, off-days at different times, and in different areas.

3.6 Summary

Nowadays the urban road also become a traffic congestion area. That creates problems for the passengers. People lose valuable time due to this traffic congestion. This survey will provide a clear idea about this particular road condition and traffic congested area which will help to solve or reduce this type of problem in future.

CHAPTER 4

DATA COLLECTION

4.1 General

The process of obtaining and evaluating information on variables of interest is known as data collecting and also taking records for tests or future explanations and so on. In addition to providing a method for overcoming an obstacle, gathering data will enable assessment of the solution's effectiveness and the possibility of long-term adjustments or modifications. It can be easier by

- Surveys,
- Direct observations,
- Documents and records.

4.2 Field Survey

The survey locations of the study were set :

Dhaka

There were four locations. Locations were discussed in the previous chapter. Here the count of both directions, there were eight routes. From the survey here shown some pictures of it.









Figure 4-1: Some recorded vehicles

4.3 Data

On the roads, many vehicles were moving very fast. Lots of vehicles move at a time. Just selecting private cars ensures its entry time and exit time to a fixed location, that recorded for fifteen cars in one direction. Taking both directions car records get a clear idea about the road.

Average travel time = Total travel time/number of vehicles

Speed = Distance/travel time

Average speed = Total travel speed/number of vehicles

Free Flow Travel Time = Distance / Travel Time

Congestion index = $(C - C_0) / C_0$, where C is the total travel time and C₀ is the free flow travel time

Those are all formulas used to find CI. After taking the car's number and time, calculate and find out the result.

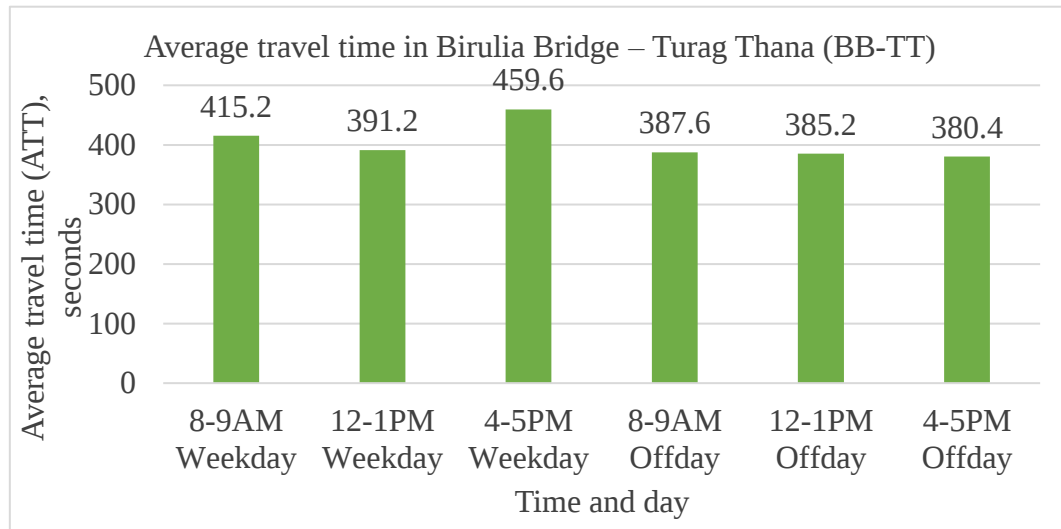
Average travel time BB-TT

Figure 4-2: Average travel time (BB-TT)

Observation

1. On weekday at morning average travel time was less compared to the afternoon, 4-5pm average travel time which was higher than any other time.
2. Off-day average travel time was almost similar with weekday 12-1 pm.

Recommendation

On this route both sides see huge sand which causes inconvenience for drivers. There were many illegal bus stoppages. Morning and afternoon buses wait many times on both roads site. Which needs to be controlled.

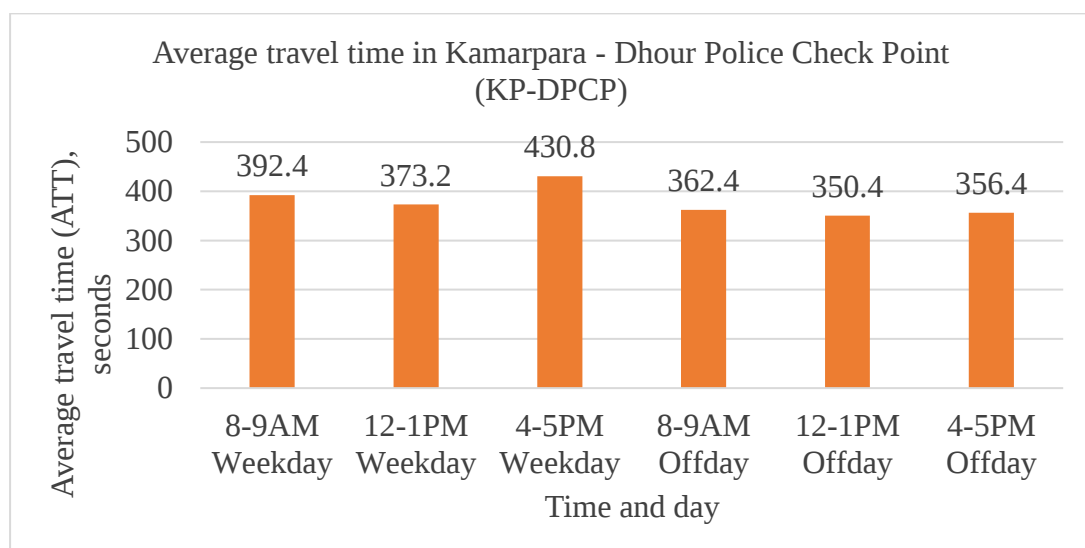
KP-DPCP

Figure 4-3: Average travel time (KP-DPCP)

Observation

1. There was many different with morning, noon, afternoon week day average travel time which shown in graph.
2. On off-days morning was more busy time than any other time compare to all off-day.

Recommendation

On this route many city buses and long-route buses are available and some roads are under construction. In the afternoon large number of vehicles passed on this road. Proper maintenance needs for roads and the speed limit for buses.

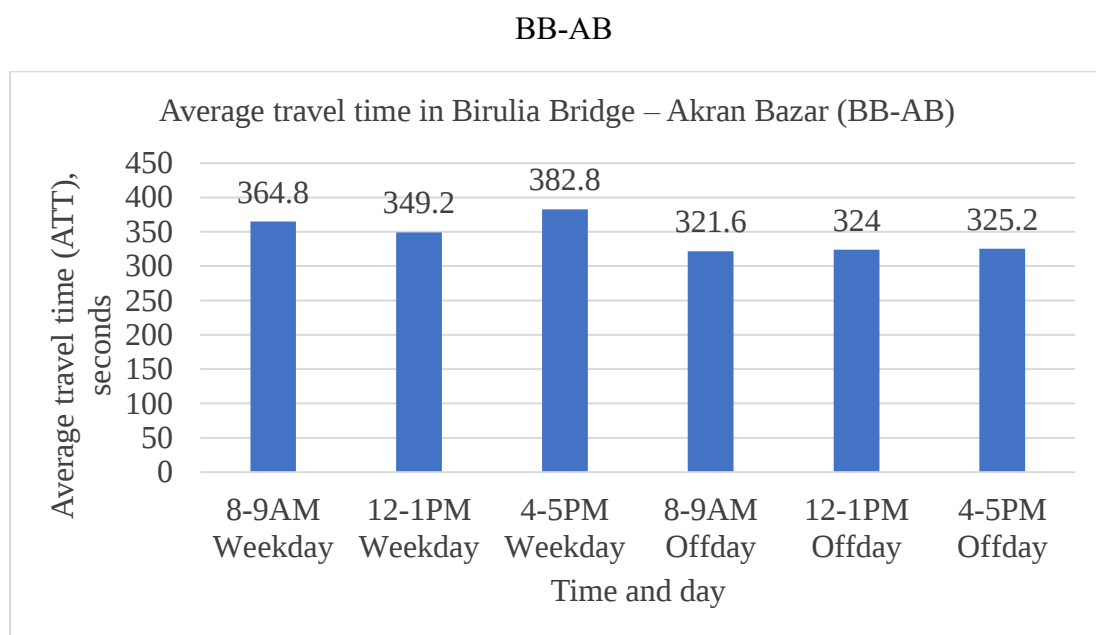


Figure 4-4: Average travel time (BB-AB)

Observation

1. On weekdays most busy roads in the afternoon at 4-5 pm. Which takes more time to the travelers.
2. On the Off-day morning, noon, and afternoon was quite similar average travel time. That's indicate same congested traffic.

Recommendation

On this road, many auto-rickshaws are hugely used in the morning and evening. Those always stand on roadways and busy local areas for a long time in search of passengers. Which need to be under control for less congestion.

DPCP-ABS

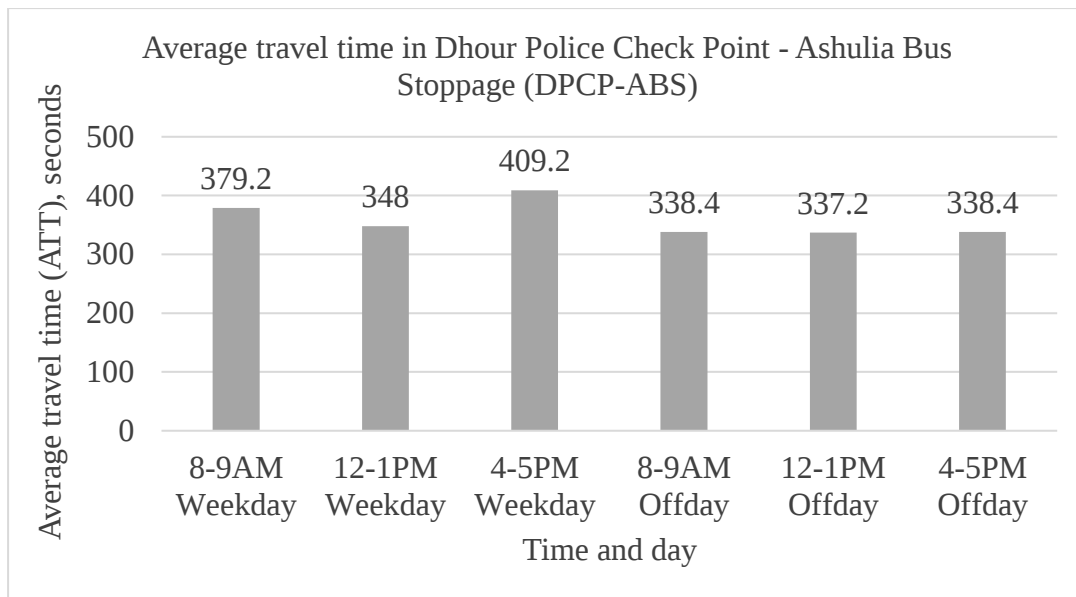


Figure 4-5: Average travel time (DPCP-ABS)

Observation

1. On weekday at afternoon 4-5pm traffic was higher that's cause slow moving vehicles.

Recommendation

Dhour & Ashulia both two points have bus stoppage, which causes slow-moving vehicles. There needs to be a fixed place for bus stoppage.

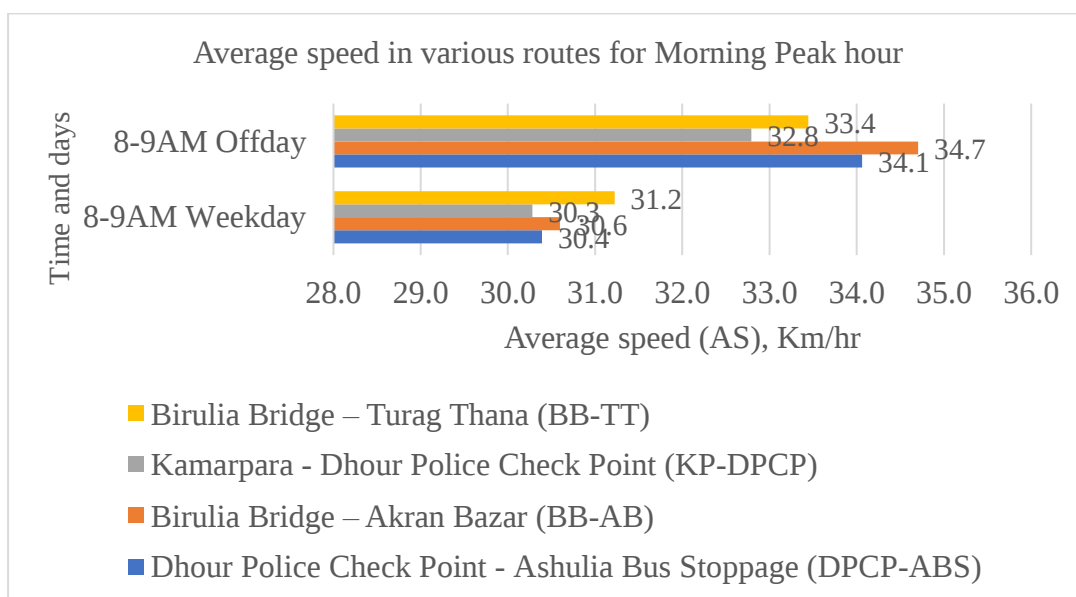
Average speed

Figure 4-6: Average speed in morning peak hour

Observation

1. Off day among four roads Birulia Bridge-Akran Bazar roads had higher average speed value.
2. In weekday most congested area was kamarpara - Dhour Police Check Point at office time.

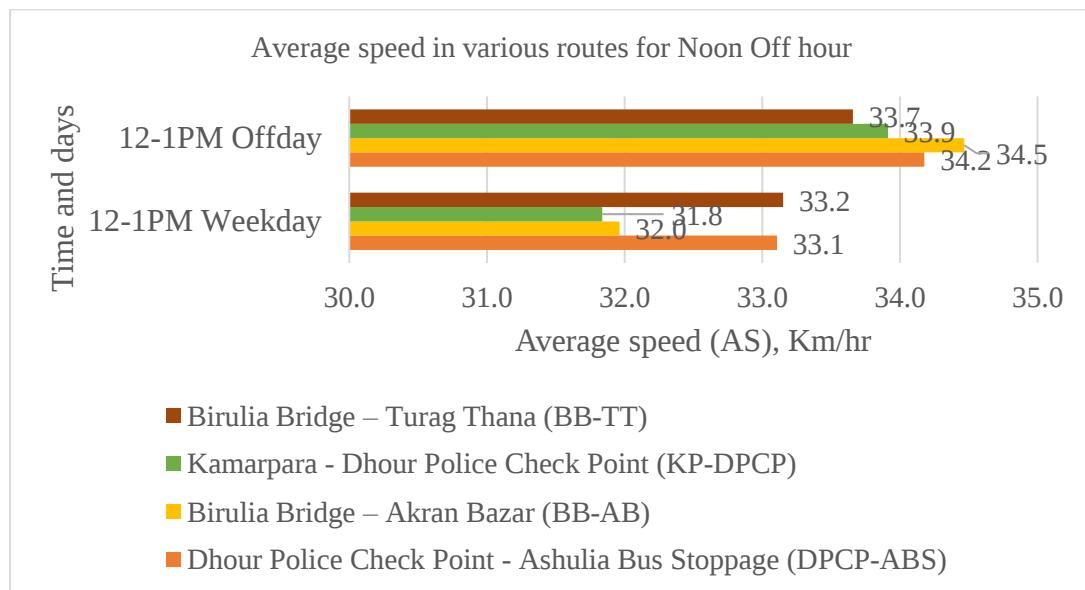


Figure 4-7: Average speed in noon off hour

Observation

1. Weekday at Birulia Bridge- Turag Thana was most free road among all the roads. Here needed less time to the passengers.
2. Noon period on off day average speed was higher at Birulia Bridge-Akran Bazar. So cars maximum speed founded here.

In this chart shows roads speed which is find out by formula by using travel time to the selected private cars. All roads were flexible pavement except Birulia bridge to Akran bazar roads. Which was composite pavement. Because there was flexible pavement for the last many years ago. Recently there were changes and made rigid pavement which becomes the composite pavement.

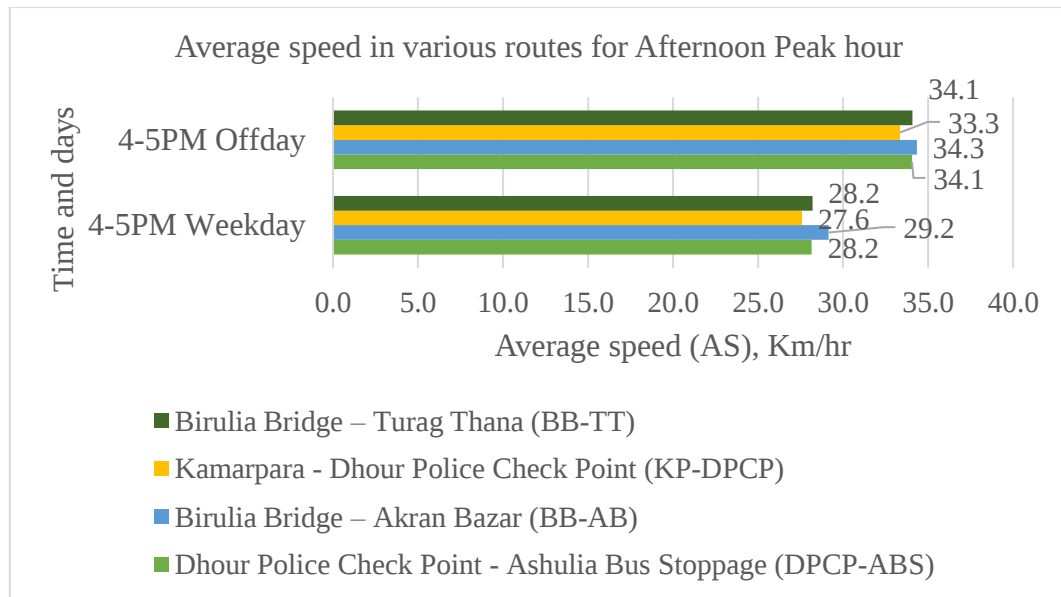


Figure 4-8: Average speed in afternoon peak hour

Observation

1. Off-days among four roads were quite same travel speed.
2. Weekday more congestion area was Kamarpara-Dhour Police Check Point.

4.4 Summary

This part was about data collection. Lots of vehicles were recorded and some of the pictures were attached here. Private cars with many shapes and different colors made it quite easy for us to track cars on the road. Those data and graphs show a clear record of the most congested areas and busy schedules in different timetables.

CHAPTER 5

DATA ANALYSIS

5.1 General

After collection data from different places and different times are recorded for future use. Data analysis is one of the important parameters to use in inspecting, cleansing, transforming, and modeling data for better use in the future.

5.2 Data analysis

From all of the value such as average speed, free flow travel time finally can calculate the congestion index.

Average Congestion Index on Weekdays

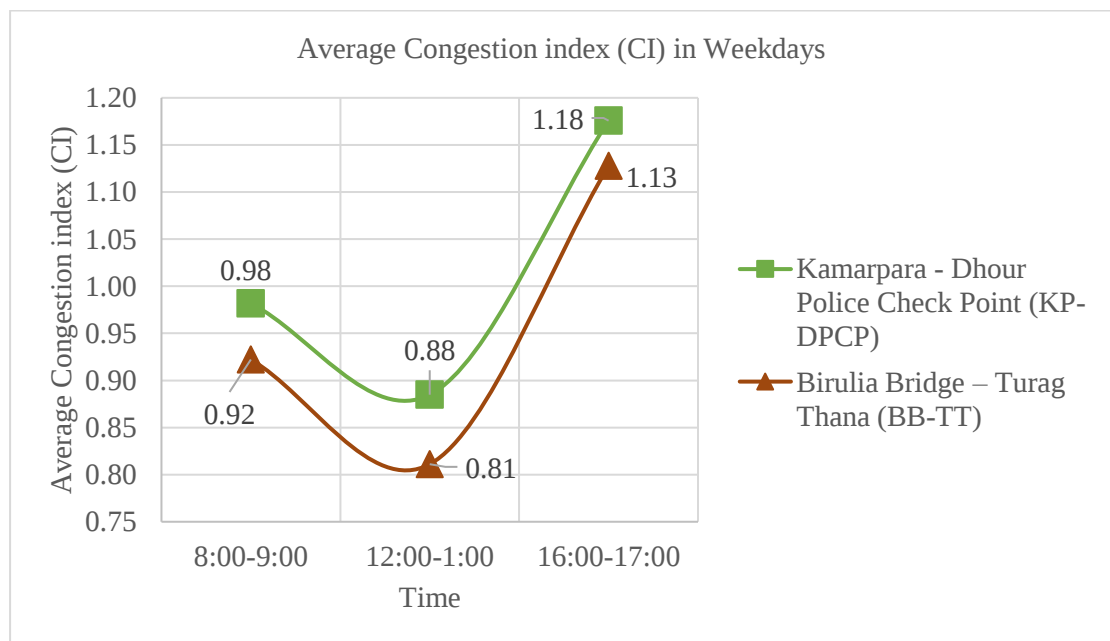


Figure 5-1: Average Congestion Index on Weekdays (KP-DPCP & BB-TT)

Observation

1. Kamarpara – Dhour Police Check Point were most congested area from this graph.
2. Birulia Bridge – Turag Thana less congested which saves time to the passengers.
3. Those two roads was same length after measuring the distance which we had got. But in calculated average congestion index there was many different in both roads. Congested roads suffer the most.

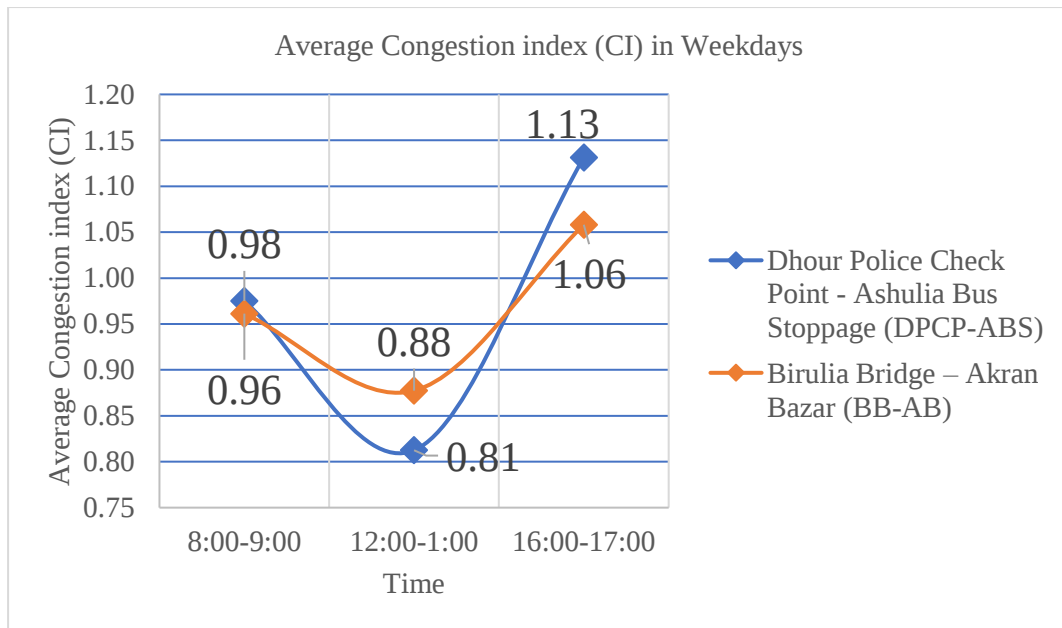


Figure 5-2: Average Congestion Index on Weekdays (DPCP-ABS & BB-AB)

Observation

1. Both locations had similar congestion in the morning.
2. At Noon Birulia Bridge – Akran Bazar get more congested.
3. At afternoon Dhour Police Check Point – Ashulia Bus stoppages had higher congested.

Average Congestion Index on Off days

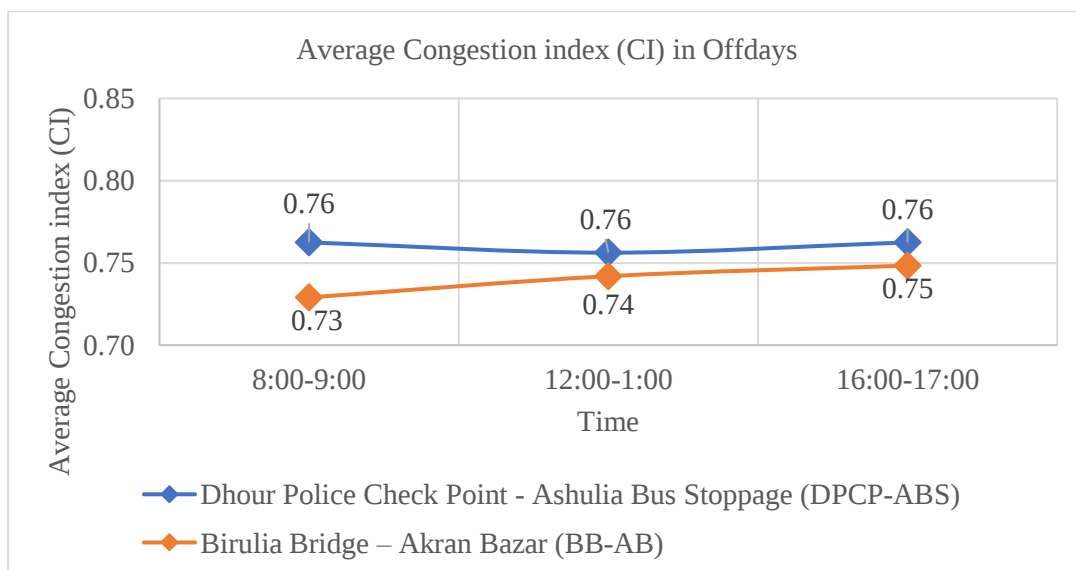


Figure 5-3: Average Congestion Index on Off days (DPCP-ABS & BB-AB)

Observation

1. Birulia Bridge – Akran Bazar had almost similar traffic congested in morning, noon and afternoon.
2. Dhour Police Check Point – Ashulia Bus stoppage had average congested all the period.

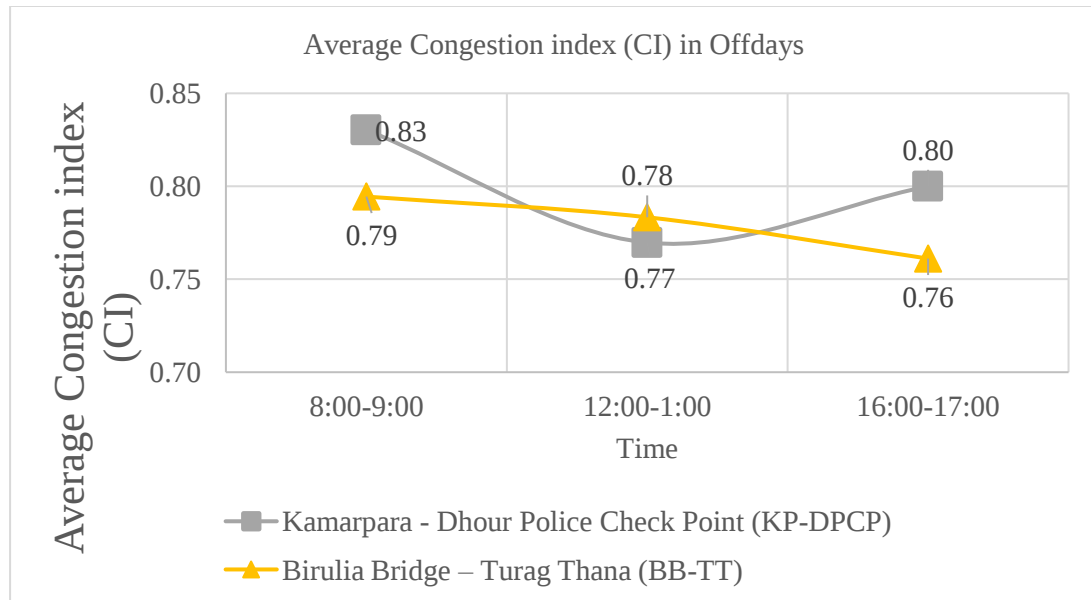


Figure 5-4: Average Congestion Index on Off days (KP-DPCP & BB-TT)

Observation

1. Kamarpara – Dhour Police Check Point in morning and afternoon period more congestion among two roads.
2. Birulia Bridge – Turag Thana had less congestion on afternoon period.

5.3 Summary

Based on the collected data after finding the average travel speed between morning, afternoon, and evening find out the congestion index. It gives information about off days and weekends and most traffic congestion routes. Compare those graphs to get better ideas for every route.

CHAPTER 6

RESULT AND DISCUSSION

6.1 Result

- The congestion index survey provides valuable data for the present situation and future work if needed.
- After analysis 3 period (morning, noon, afternoon) the data and it showed that the peak hour always busy for every roads.
- Most congested period found in the afternoon period on weekdays.
- After the survey of four different roads with different distances it was founded that most congested road was Kamarpara to Dhour police check point and less congested road was Birulia bridge to Akran bazar.
- Traffic congestion impact on four routes -
 - ❖ Increases journey times.
 - ❖ Passenger's energy consumption.
 - ❖ Environmental pollution.
 - ❖ Congestion reduces regional economic health.

6.2 Discussion

- This survey was done on many different routes and at different times.
- Including three times morning (8am-9am), noon(12pm-1pm), and afternoon (4pm-5pm). Morning and afternoon are peak hour because those time office, school, college, garments and so many institutions and work sector get started and end.
- Consider private car for survey. So we record too many cars. There were many types of vehicles with different sizes and speeds.
- Using congestion index formula which was $(C-CO)/CO$ for the data analysis. Congestion index value provided the information of traffic congestion. If the CI value over 1.0 that's include more congested time any area.
- After calculated travel time, average travel time, speed, average speed, free flow travel time than finally calculated the congestion index.
- According CI value afternoon period was over 1.0 for all of the roads. That's mean huge congestion was seen on those roads. And considering morning and noon those value was below 1.0 so there is less congestion compare to the afternoon time.
- Then Kamarpara to Dhour police check point marked as most congested roads and Birulia bridge to Akran bazar marked as the less congested road.
- Traffic congestion impact on those roads was seen to a bad condition. For slow speed, travel time increased. Passengers suffering very uncomfortable.
- Traffic congestion also impacts national income due to late arrival.
- The environment gets more polluted by emitted carbon dioxide from vehicles.

CHAPTER 7

CONCLUSION AND RECOMMENDATION

7.1 Conclusion

- Day by day traffic congestion become a global problem and it is increasing very fast in the cities. Nowadays rural areas roads also become congested.
- To find out congestion index for Ashuila-Savar in Dhaka we selected four roads. Collected data of many cars (travel time), Then calculated the speed, free flow travel time and at last find out CI.
- After analysis data compared with every two roads to clearly understand the different both road's conditions. Compared with CI value (1.0) many roads founded as most and least congested roads.
- Congestion impacts not only roads but also in the economy of a country. Increased travel time and inconvenience to the passengers, environment pollution and so on.

7.2 Limitation

- Operated manual counting without a single-hand counter.
- As manual counting of travel time and travel speed was not up to the point. There were very few differences with actual values which can be neglected.
- Many of the roads were narrow, it was a little bit hard to stand beside the roads to continue the survey.
- On the roadside soil, dust, plastic, and waste materials were also seen which made it very uncomfortable. Those are also very harmful to nature.

7.3 Causes of traffic congestion

- ❖ Roadside block due to works.
- ❖ No fixed bus stoppage.
- ❖ Huge vehicles at the time.
- ❖ Not enough marking on the road for overtaking.
- ❖ Slow-speed vehicles on highways.
- ❖ Water logging in wet seasons and many more.

7.4 Recommendation

Same route both upstream and downstream but some speeds differ due to many causes. Some recommendations for better congestion in the future –

- There is no traffic light or signal on the roadway. All through roads are rural highways but there is no sign for you-turn, no direction for left and right-side moves. We need to install traffic lights as well as traffic signals.

- There is no fixed place for bus stoppage and passengers raise their hands for buses and buses get stopped for passengers. That creates traffic. There should be a bus stoppage in important locations of the locality. Such as surveying all important locations.
- Improve bus service and quality all over roads. Lack of public transportation bad quality and service day by day private vehicles get higher use.
- Charge for workplace parking on all roads.
- Need wider roads for BB- AB.
- Control auto-rickshaw in BB-AB.
- Make a speed limit rule. Because the slow-moving car can traffic congestion at KP-DPCP.
- Make restrictions for low-category speed vehicles on main roads at KP-DPCP.
- For a better future rules should be applied properly.
- If traffic congestion reduces travel time also reduces, passengers not getting board or energy consumption not happen. Also economic health will rise up.

7.5 Summary

Being a smart country needs to change and overcome ruining poor situation. It also creates problems in lifestyle. If there is a problem there is also a solution that just needs to be found out and tried to solve or reduce. Proper rules are one of the best solutions all over the world.

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APPENDIX

Birulia Bridge – Turag Thana

Distance 3.6 km

Weekday

	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
8:00AM-9:00AM	1	29-4189	08:02am	08:08am	6.8	408
	2	17-1825	8:06	8:12	6.9	414
	3	19-4573	8:09	8:15	6.8	408
	4	23-0028	8:11	8:18	7	420
	5	16-1683	8:15	8:22	7.1	426
12:00PM-1:00PM	6	32-5250	12:03	12:09	6.5	390
	7	19-8613	12:05	12:11	6.6	396
	8	17-8043	12:06	12:12	6.2	372
	9	15-4092	12:10	12:16	6.6	396
	10	17-4205	12:13	12:19	6.7	402
4:00AM-5:00PM	11	25-2049	4:01	4:08	7.6	456
	12	21-8290	4:11	4:18	7.7	462
	13	33-4320	4:13	4:20	7.6	456
	14	20-0793	4:16	4:23	7.8	468
	15	26-8032	4:18	4:25	7.6	456

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
415.2	31.8	31.2	216	0.89	0.92
	31.3		216	0.92	
	31.8		216	0.89	
	30.9		216	0.94	
	30.4		216	0.97	
391.2	33.2	33.2	216	0.81	0.81
	32.7		216	0.83	
	34.8		216	0.72	
	32.7		216	0.83	
	32.2		216	0.86	
459.6	28.4	28.2	216	1.11	1.13
	28.1		216	1.14	
	28.4		216	1.11	
	27.7		216	1.17	
	28.4		216	1.11	

Off-day

	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
8:00AM-9:00AM	1	18-7348	08:02am	08:08am	6.5	390
	2	15-3764	8:06	8:12	6.4	384
	3	19-8271	8:09	8:15	6.6	396
	4	35-7653	8:11	8:17	6.3	378
	5	26-5803	8:15	8:21	6.5	390
12:00PM-1:00PM	6	17-3610	12:03	12:09	6.4	384
	7	30-1808	12:05	12:11	6.5	390
	8	35-6547	12:06	12:12	6.6	396
	9	20-2101	12:10	12:16	6.4	384
	10	33-4205	12:13	12:19	6.2	372
4:00PM-5:00PM	11	29-9752	4:01	4:07	6.3	378
	12	21-3457	4:11	4:17	6.3	378
	13	27-2074	4:13	4:19	6.4	384
	14	23-0501	4:16	4:22	6.4	384
	15	27-2619	4:18	4:24	6.3	378

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
387.6	33.2	33.4	216	0.81	0.79
	33.8		216	0.78	
	32.7		216	0.83	
	34.3		216	0.75	
	33.2		216	0.81	
385.2	33.8	33.7	216	0.78	0.78
	33.2		216	0.81	
	32.7		216	0.83	
	33.8		216	0.78	
	34.8		216	0.72	
380.4	34.3	34.1	216	0.75	0.76
	34.3		216	0.75	
	33.8		216	0.78	
	33.8		216	0.78	
	34.3		216	0.75	

Kamarpara - Dhour Police Check Point (KP-DPCP)

Distance 3.3km

Weekday

	Car Serial	Car Number	Start Time	Exist Time	Travel time (TT)	TT (sec)
8:00AM-9:00AM	1	15-5886	08:01am	08:07am	6.4	384
	2	71-1203	8:04	8:10	6.5	390
	3	83-7896	8:07	8:13	6.6	396
	4	51-1669	8:10	8:16	6.7	402
	5	52-1633	8:14	8:20	6.5	390
12:00PM-1:00PM	6	13-4548	12:02	12:08	6.3	378
	7	21-9342	12:06	12:12	6.1	366
	8	53-9512	12:09	12:15	6.2	372
	9	28-8917	12:13	12:19	6.2	372
	10	33-7699	12:15	12:21	6.3	378
4:00PM-5:00PM	11	20-8930	4:02	4:09	7.1	426
	12	15-5806	4:05	4:12	7.2	432
	13	17-7651	4:11	4:18	7.3	438
	14	53-9657	4:14	4:21	7.1	426
	15	15-6980	4:19	4:26	7.2	432

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
392.4	30.9	30.3	198	0.94	0.98
	30.5		198	0.97	
	30.0		198	1.00	
	29.6		198	1.03	
	30.5		198	0.97	
373.2	31.4	31.8	198	0.91	0.88
	32.5		198	0.85	
	31.9		198	0.88	
	31.9		198	0.88	
	31.4		198	0.91	
430.8	27.9	27.6	198	1.15	1.18
	27.5		198	1.18	
	27.1		198	1.21	
	27.9		198	1.15	
	27.5		198	1.18	

Off-day

	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
8:00AM-9:00AM	1	23-2981	08:02am	08:08am	6.2	372
	2	19-3902	8:06	8:11	6	360
	3	30-2701	8:09	8:15	6.1	366
	4	25-2561	8:11	8:16	5.9	354
	5	22-2231	8:15	8:21	6	360
12:00PM-1:00PM	6	29-2568	12:03	12:08	5.9	354
	7	20-7190	12:05	12:10	5.8	348
	8	23-6109	12:06	12:11	6	360
	9	38-1921	12:10	12:15	5.8	348
	10	17-2690	12:13	12:18	5.7	342
4:00PM-5:00PM	11	15-2520	4:01	4:07	6.1	366
	12	26-9219	4:11	4:16	5.9	354
	13	51-2123	4:13	4:19	6	360
	14	22-2197	4:16	4:21	5.8	348
	15	23-2469	4:18	4:23	5.9	354

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
362.4	31.9	32.8	198	0.88	0.83
	33.0		198	0.82	
	32.5		198	0.85	
	33.6		198	0.79	
	33.0		198	0.82	
350.4	33.6	33.9	198	0.79	0.77
	34.1		198	0.76	
	33.0		198	0.82	
	34.1		198	0.76	
	34.7		198	0.73	
356.4	32.5	33.3	198	0.85	0.80
	33.6		198	0.79	
	33.0		198	0.82	
	34.1		198	0.76	
	33.6		198	0.79	

Birulia Bridge – Akran Bazar

Distance 3.1 km

Weekday

	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
08:00AM-09:00AM	1	17-1814	8:01 AM	8:07 AM	6.1	366
	2	21-1871	8:03	8:09	6.2	372
	3	53-4931	8:09	8:15	6	360
	4	71-1823	8:13	8:19	6.1	366
	5	43-7175	8:17	8:23	6	360
12:00PM-01:00PM	6	17-4443	12:02	12:07	5.8	348
	7	23-7827	12:08	12:13	5.7	342
	8	56-6226	12:10	12:15	5.9	354
	9	17-9893	12:14	12:19	5.8	348
	10	20-9018	12:17	12:22	5.9	354
4:00PM-5:00PM	11	21-7488	4:03	4:09	6.4	384
	12	26-1057	4:07	4:13	6.4	384
	13	22-4321	4:11	4:17	6.3	378
	14	19-4673	4:15	4:21	6.4	384
	15	13-8598	4:17	4:23	6.4	384

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
364.8	30.5	30.6	186	0.97	0.96
	30.0		186	1.00	
	31.0		186	0.94	
	30.5		186	0.97	
	31.0		186	0.94	
349.2	32.1	32.0	186	0.87	0.88
	32.6		186	0.84	
	31.5		186	0.90	
	32.1		186	0.87	
	31.5		186	0.90	
382.8	29.1	29.2	186	1.06	1.06
	29.1		186	1.06	
	29.5		186	1.03	
	29.1		186	1.06	
	29.1		186	1.06	

Off-day

	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
08:00AM-09:00AM	1	13-9712	08:02am	08:07am	5.3	318
	2	31-5419	8:06	8:11	5.4	324
	3	28-1940	8:09	8:14	5.4	324
	4	15-8210	8:11	8:16	5.4	324
	5	20-2124	8:15	8:20	5.3	318
12:00PM-01:00PM	6	19-1942	12:03	12:08	5.5	330
	7	53-9401	12:05	12:10	5.4	324
	8	51-1934	12:06	12:11	5.6	336
	9	22-1823	12:10	12:15	5.3	318
	10	20-9018	12:13	12:18	5.2	312
4:00PM-5:00PM	11	24-5402	4:01	4:06	5.3	318
	12	51-2155	4:11	4:16	5.6	336
	13	19-1924	4:13	4:18	5.5	330
	14	17-1690	4:16	4:21	5.3	318
	15	28-3513	4:18	4:23	5.4	324

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
321.6	35.1	34.7	186	0.71	0.73
	34.4		186	0.74	
	34.4		186	0.74	
	34.4		186	0.74	
	35.1		186	0.71	
324	33.8	34.5	186	0.77	0.74
	34.4		186	0.74	
	33.2		186	0.81	
	35.1		186	0.71	
	35.8		186	0.68	
325.2	35.1	34.3	186	0.71	0.75
	33.2		186	0.81	
	33.8		186	0.77	
	35.1		186	0.71	
	34.4		186	0.74	

Dhour Police Check Point - Ashulia Bus Stoppage (DPCP-ABS) Distance 3.2 km

Weekday

Time	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
8:00AM-9:00AM	1	21-8100	8:02 AM	8:08 AM	6.2	372
	2	56-6226	8:06	8:12	6.3	378
	3	20-8453	8:09	8:15	6.5	390
	4	36-8623	8:11	8:17	6.4	384
	5	21-7485	8:15	8:21	6.2	372
12:00PM-1:00PM	6	17-7807	12:03	12:08	5.8	348
	7	71-1203	12:05	12:10	5.7	342
	8	26-1057	12:06	12:11	5.8	348
	9	56-5150	12:10	12:15	5.9	354
	10	20-0589	12:13	12:18	5.8	348
4:00PM-5:00PM	11	28-4919	4:01	4:07	6.8	408
	12	47-1577	4:11	4:17	6.7	402
	13	21-1903	4:13	4:19	6.9	414
	14	20-9018	4:16	4:22	6.8	408
	15	17-7009	4:18	4:24	6.9	414

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
379.2	31.0	30.4	192	0.94	0.98
	30.5		192	0.97	
	29.5		192	1.03	
	30.0		192	1.00	
	31.0		192	0.94	
348	33.1	33.1	192	0.81	0.81
	33.7		192	0.78	
	33.1		192	0.81	
	32.5		192	0.84	
	33.1		192	0.81	
409.2	28.2	28.2	192	1.13	1.13
	28.7		192	1.09	
	27.8		192	1.16	
	28.2		192	1.13	
	27.8		192	1.16	

Off-day

Time	Car Serial	Car Number	Start Time	Exist Time	Travel time	TT (sec)
8:00AM-9:00AM	1	13-7857	8:01 AM	8:06 AM	5.5	330
	2	73-1401	8:04	8:09	5.6	336
	3	15-9578	8:07	8:12	5.5	330
	4	37-8912	8:12	8:17	5.8	348
	5	27-6703	8:16	8:21	5.8	348
12:00PM-1:00PM	6	15-1603	12:01	12:06	5.5	330
	7	71-3407	12:04	12:09	5.7	342
	8	53-9251	12:07	12:12	5.5	330
	9	15-2152	12:12	12:17	5.8	348
	10	21-2543	12:15	12:20	5.6	336
4:00PM-5:00PM	11	20-7218	4:03	4:08	5.6	336
	12	83-2579	4:07	4:12	5.5	330
	13	13-1104	4:12	4:27	5.7	342
	14	19-8320	4:15	4:20	5.6	336
	15	33-7092	4:19	4:24	5.8	348

Average Travel time (Sec)	Speed	Average Speed (km/hr)	FFTT (60kmh)	CI	Average CI
338.4	34.9	34.1	192	0.72	0.76
	34.3		192	0.75	
	34.9		192	0.72	
	33.1		192	0.81	
	33.1		192	0.81	
337.2	34.9	34.2	192	0.72	0.76
	33.7		192	0.78	
	34.9		192	0.72	
	33.1		192	0.81	
	34.3		192	0.75	
338.4	34.3	34.1	192	0.75	0.76
	34.9		192	0.72	
	33.7		192	0.78	
	34.3		192	0.75	
	33.1		192	0.81	

Summary for raw data

Average travel time (ATT), sec							
Locations	Distance (km)	Weekday			Offday		
		8-9AM Week day	12-1PM Week day	4-5PM Week day	8-9AM Offday	12-1PM Offday	4-5PM Offday
Dhour Police Check Point - Ashulia Bus Stoppage (DPCP-ABS)	3.2	379.2	348	409.2	338.4	337.2	338.4
Birulia Bridge – Akran Bazar (BB-AB)	3.1	364.8	349.2	382.8	321.6	324	325.2
Kamarpara - Dhour Police Check Point (KP-DPCP)	3.3	392.4	373.2	430.8	362.4	350.4	356.4
Birulia Bridge – Turag Thana (BB-TT)	3.6	415.2	391.2	459.6	387.6	385.2	380.4

Average speed (AS), Km/hr						
Locations	Weekday			Off day		
	8-9AM Weekday	12-1PM Weekday	4-5PM Weekday	8-9AM Offday	12-1PM Offday	4-5PM Off day
Dhour Police Check Point - Ashulia Bus Stoppage (DPCP-ABS)	30.4	33.1	28.2	34.1	34.2	34.1
Birulia Bridge – Akran Bazar (BB-AB)	30.6	32.0	29.2	34.7	34.5	34.3
Kamarpara - Dhour Police Check Point (KP-DPCP)	30.3	31.8	27.6	32.8	33.9	33.3
Birulia Bridge – Turag Thana (BB-TT)	31.2	33.2	28.2	33.4	33.7	34.1

Average Congestion index (CI)						
Locations	Weekday			Off day		
	8:00-9:00AM	12:00-1:00PM	16:00-17:00PM	8:00-9:00AM	12:00-1:00PM	16:00-17:00PM
Dhour Police Check Point - Ashulia Bus Stoppage (DPCP-ABS)	0.98	0.81	1.13	0.76	0.76	0.76
Birulia Bridge – Akran Bazar (BB-AB)	0.96	0.88	1.06	0.73	0.74	0.75
Kamarpara - Dhour Police Check Point (KP-DPCP)	0.98	0.88	1.18	0.83	0.77	0.80
Birulia Bridge – Turag Thana (BB-TT)	0.92	0.81	1.13	0.79	0.78	0.76

Sample Calculation

Dhour Police Check Point - Ashulia Bus Stoppage (DPCP-ABS)

Time travel in seconds = $6.2 \times 60 = 372$

Average Travel time (Sec)= $(372+378+390+384+372)/5 = 379.2$

Speed= $3.2/(372/3600) = 31.0$

Average Speed (km/hour) = $(31+30.5+29.5+30+31)/5 = 30.4$

Free Flow Travel Time (60kmh) = $3.2 \times 3600/60 = 192$

Congestion Index = $(372-192)/192 = 0.94$

Average CI= $(0.94+0.97+1.03+1+0.94)/5 = 0.98$