Traffic Scenario Analysis: A Case study in Phuentsholing City

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Abstract

Phuentsholing is one of the biggest cities in Bhutan and has played a pivotal role in the economic development of the country. The city was built without proper planning of traffic facilities and no provisions were kept to expand the traffic facilities in the city. The city is presently experiencing traffic related problems like congestions, inadequate parking facilities, and increased accident rates. This study conducted the traffic scenario to guide the planners with traffic information to address traffic congestion. The traffic data was collected by conducting road side interview, and collected users origins and destinations, traffic volume, travel patterns and travel behavior as understanding the users, their travel needs and demand are essential to better plan and improve the facilities. It examined the O-D data to find the critical stretches within the city. It was indicated that some of the routes in the network are critical in terms of more number of traffic while some route are not efficiently used. The study formulates both short term and long term recommendations to improve the traffic performance of the city.

Keywords: Traffic Analysis, O-D matrix, Critical Route, Peak hour, Bhutan

1. Introduction

The transport sector has witnessed remarkable growth in the last forty six years since Bhutan launched its first five-year development plan. With globalization and rapid socio-economic development, the need for an efficient transportation system and facilities has also gained significance. However, the transport facilities in Phuentsholing has not kept pace with the increasing number of vehicle population because of which the city is experiencing acute shortage of traffic facilities like parking spaces and other problems like traffic congestions on a regular basis.

Further, a study on the traffic scenario in Phuentsholing city has never been carried out in the past because of which planners are left with inadequate information about the traffic demand and trends of the city.

The paper in general has been directed towards an in-depth study of the present traffic scenario of Phuentsholing city by using different principles of Traffic Engineering and aims at formulating appropriate recommendations to improve the traffic situation in the city.

2. Literature review

Mobility is a basic human need and travel has been an integral part in everyone's life. We travel for many reasons from transporting of raw materials to a manufacturing unit or finished goods to consumer, we human beings are mobile by nature. For all these needs of humanity, transportation plays a major role and has a strong

correlation with human settlement and the transport facilities. Also, there exists a correlation between the standard of living and the quality of transportation facilities, because of which society places great expectation from such facilities. Transportation engineering is a sub-discipline of civil engineering which deals with the science of movement of people and goods.

The planning aspect of Transportation Engineering involves technical forecasting which is mainly concerned with transport demand analysis and involves the process of estimating the trip generation, trip distribution, mode choice, and route assignment.

2.1 Traffic studies

Traffic engineering is a sub-discipline of civil engineering which uses engineering techniques to achieve safe and efficient movement of people and goods. It focuses mainly on the safety of the public, the efficient use of transportation resources, and the mobility of people and goods.

In order to improve any traffic facility, the traffic engineer must first understand the traffic flow behavior and characteristics by extensive collection of traffic flow data and analysis. Based on this analysis, traffic flow is controlled so that the transport infrastructure is used optimally as well as with good service quality. Such factual traffic flow studies forms the basis for developing methods for improvement of traffic operations and helps in solving problems related to traffic.

Traffic studies or surveys are carried out to analyze the traffic characteristics. The information collected in these surveys constitutes data on types of traffic, volume of traffic, nature of traffic, purpose of traffic, origin and destination, speed of vehicles, conditions of vehicles, and accidents.

2.2 Origin-Destination (O-D) study

The O-D study of vehicular traffic determines their number, their origin and destination in each zone under study. Origin is defined as the place where the trip begins and destination is defined as the place where the trip ends.

The methods of collecting data range from simple observations to intensive home interviews. The observations should be made for representative periods on week days unaffected by weather conditions or other unusual events. The earlier studies have indicated that the period from 6 am to 10 pm is generally found adequate. The complete study area is divided into zones and the counting stations are located within the study area. It is also indicated that it is generally not possible to secure all data on all movements, and the trip information obtained is expanded in proportion to the total volume of traffic recorded at counting stations during the survey.

The specific uses to which O-D survey data can be put are:

1. To determine the amount of by-passable traffic that enters a town, and thus establishes the need for a bypass.
2. To develop trip generation and trip distribution models in transport planning process.
3. To determine the extent to which the present transport system is adequate and to plan for new facilities.
4. To assess the adequacy of parking facilities and to plan for future.
5. To plan the road network and other facilities for vehicular traffic
6. To plan the schedule of different modes of transportation for the trip demand of commuters
7. To locate expressway or major routes along the desire lines.

3. Methodology

The methodology can be divided into two parts; the first part is the method for collection of traffic (O-D) data. This part deals with the methods involved in collecting travel demand data for predicting the traffic scenario of Phuentsholing city by conducting Origin and Destination study in the study area. The second part is the method of Presentation of O-D data after performing required analysis to get the traffic trend in the study area.

The study uses simple analysis tools in analyzing the data from the Origin-Destination survey and at the same time get the required traffic data which will serve as a database for further studies in this field of research. Traffic analysis using sophisticated computer models for forecasting the traffic trend is deemed beyond the scope of the research. However, by using statistical analysis tools, traffic data are analyzed to get the present traffic scenario since the study area is relatively small and the traffic volume is low.

The following are the methods for collecting the O-D data:

1. License plate method
2. Return post card method
3. Home interview method

4. Road side interview method

This study used road side interview method for the collection of data since other methods consume more time and are expensive. It also requires rigorous training for the surveyors, post cards, and some of the methods are not suitable for such study because of the practical difficulties. Further the road side interview method has the following advantages over other methods:

1. The data can be collected within a short duration of time
2. The team can be easily trained
3. Organizing such survey is simple and less tedious.

The main drawback with such method is that the vehicles have to be stopped for interview which causes delay and sometimes leads to traffic congestion near the counting stations.

The data collected from the O-D survey is very large in amount. Therefore its representation becomes very difficult to understand. Thus, in order to represent those data in a simpler and easy way, the following methods of representation are adopted:

1. O-D matrix
2. Pictorial representation
3. Graphical representation (bar graph and pie chart)

4. Case Study for Phuentsholing City

The transportation need associated with Phuentsholing is concentrated within the city's core area which comprises important commercial, residential and office colonies of Phuentsholing city.

As most data required for the study were not available, actual field studies were necessary to gather data. The non-existence of traffic data for Phuentsholing city has prompted to conduct field studies and has been the focus of the research work. The field study conducted for the study area is the Origin-Destination study which was conducted at three stations within Phuentsholing city.

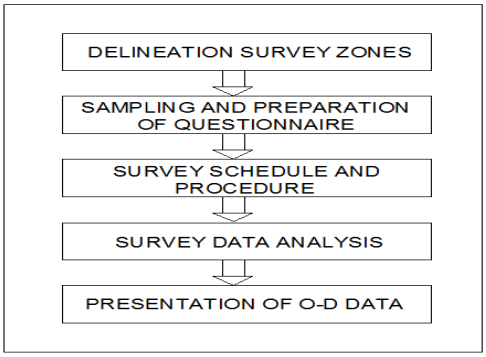

Fig. 1 Methodology for O-D survey

From the OD survey, the magnitudes of travel made externally by the residents are obtained. The travel pattern obtained from the O-D surveys gave the overall travel pattern of the study area. The traffic demand analysis that was performed was based exclusively on the following methodology.

4.1 Delineation of Survey zones

The study area has been divided into different zones in order to simplify the origin-destination survey. The zone system was based on a number of considerations such as compatibility with the traffic zones and operational network currently used in Phuentsholing. Other factors such as geometric location of the area and population distribution within the study area have also been considered. Likewise the study area was divided into eight sub-areas and three counting stations for carrying out traffic demand survey. The sub-areas are either called as Origin zone or Destination zone depending on the cordon station where the survey will be conducted. Fig. 2 shows the survey zones for O-D survey.

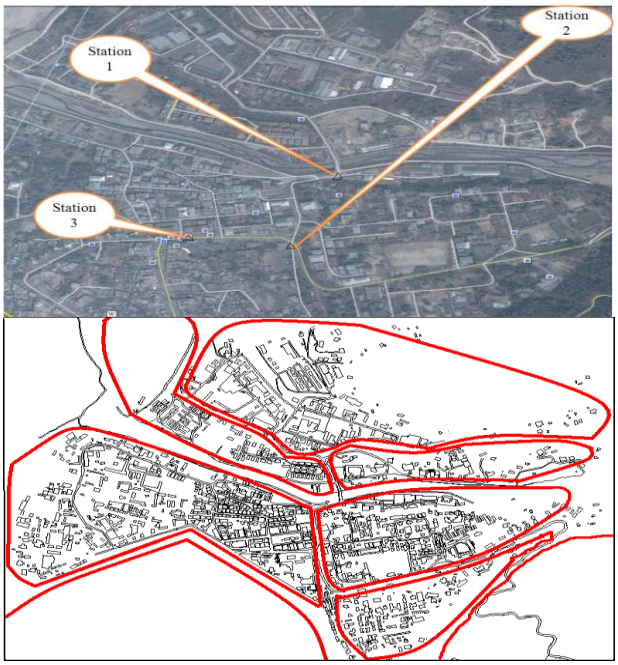

Fig. 2 Delineation of survey zones

4.2 Sampling plan and Preparation of questionnaire

The format of the survey questionnaire was designed for collecting the following traffic information:

1. Form identifiers: date, location, time, and surveyor initials
2. Vehicle type: two wheeler(Motor cycle, Scooter), light vehicle(van, jeeps, cars, taxis), medium vehicle (coaster bus, DCM), heavy vehicle (trucks, bus, trailers, heavy machines)
3. Journey information: trip start and end locations (i.e. origin and destination), trip purpose activity, and travel direction.
4. Type of weather
5. Vehicle occupancy including driver plus passengers
6. Vehicle Registration number

Each survey sheet had a provision of entering the sheet number to ensure that each survey record would be independent and traceable if required. Based on the projected sample size of 8,000, the survey data collection resulted in 6,749 valid surveys. Further an accuracy of 1 in 5 is attempted for this study.

4.3 Survey Schedule and Procedure

The survey was conducted within the study area on 25th September 2010 (Friday) from 7:30 am to 5:30 pm at the three cordon stations with three surveyors and a traffic police at each station.

It was observed that, as time passed on with the survey it became very difficult to carry out the study since traffic congestion increased because of which some of the information like passenger number and registration number could not be collected to minimize the time taken for each interview. Further due to the interruption of the Jaigaon (India) Police at survey station 3 near the Bhutan gate, road side interview was abandoned from 11 am because of the traffic congestion created near the gate (in India) due to heavy traffic from India. Instead, spot survey (traffic count data) was continued where by the number of vehicle, the mode of vehicle along with time without stopping the vehicles for interviews were collected.

4.4 Survey data analysis

Origin–Destination trips matrices were determined for each hour of the day by matching the data interviewed from each station. The resulting trip matrix includes all external to external trips, and all external to internal trips for the study area. Analysis techniques in this study include general manual count of the data and detailed investigation of the data using the analysis methods discussed above.

4.5 Presentation of O-D data

The O-D data presents a summary of 1,601 interviews obtained at station 1 (Doti Chhu Bridge), 1817 interviews at station 2 (City Round about), and 643 interviews and 2,688 spot survey data at station 3 (Bhutan Gate). These amounted to a total of 6749 traffic data from the road side Origin-Destination survey.

4.5.1 Station 1 : Doti Chhu Bridge

1. Mode of vehicle

In order to understand the traffic mode, mode of vehicle study for Origin–Destination data were tabulated for each hour by making manual count from the questionnaire form. It was observed that the volume of traffic through this particular station is 169 vehicles per hour.

Based on the nine and half hours (7:30am to 5:00pm) data of traffic flow by mode of vehicle at station 1 is given in Fig.3

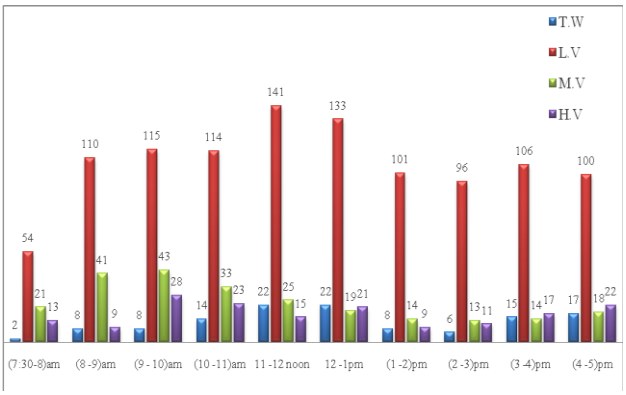

Fig. 3 Traffic flow by mode at station 1

From Fig. 3, it is found that the heaviest traffic flow from 11:00 am to 12 noon through station 1. During this hour a total of 203 vehicles are travelling through this station which comprises of 22 Two wheelers, 141 Light vehicles, 25 Medium vehicles and 15 Heavy vehicles.

The survey indicated that the most common mode of vehicle is Light vehicle (67%), followed by medium vehicle (15%), heavy vehicle (10%), and lastly two wheeler (8%).

2. Trip Distribution

To understand and calculate the trip distribution from different origin and destination, the O-D matrix for nine and half hours of survey

was tabulated by manual counting of traffic from different origin and destination zones. The zones identified for station 1 are given below:

Origin

O_{1-1}: Norgay cinema hall, Bus Station, and Vegetable Market.

O_{1-2}: Phuentsholing Regional Hospital, Food Corporation of Bhutan (FCB), and Phuentsholing Industrial Estate.

O_{1-3}: Royal Insurance Corporation of Bhutan (RICB) Colony, and Phuentsholing Higher Secondary School.

Destination

D_{1-1}: Phuentsholing City Corporation (PCC) Office premise and India House via Pelkihil lam and Gaki lam.

D_{1-2}: Bank of Bhutan (BOB), Bhutan National Bank (BNB), Royal Insurance Corporation of Bhutan (RICB) office, Bhutan Oil Distributors (BOD), Phuentsholing Middle and Lower Secondary Schools, and Phuentsholing-Thimphu Highway via round about (Station 2).

D_{1-3}: Phuntsholing main city via new route (near the Dratshang building).

D_{1-4}: Phuentsholing main city via round about (Station 2).

D_{1-5}: India via Bhutan Gate (Station 3).

The trip distribution across the above station are represented in Fig. 4

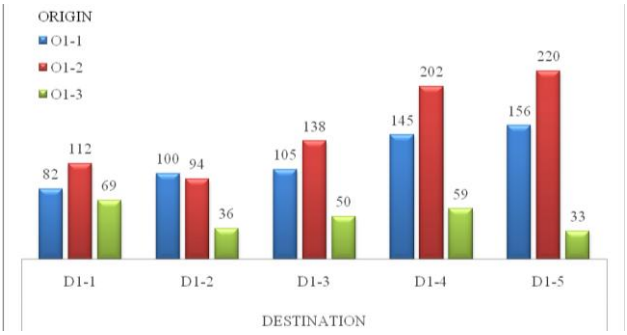

Fig. 4 O-D data of station 1

From Fig. 4, the maximum vehicle movement during the nine and half hours of survey indicated that the critical routes are from **O_{1-2}**to **D_{1-5}**.

3. Trip Purpose

The identification of the trips was based on the purpose of the trip. Based on the surveyed data, business related trips accounted for 46% of the total sample obtained from the peak hour (11:00am to 12noon) O-D data through station 1. One-fifth of the driver's responded work related (20%) reasons for travelling, followed by personal affairs (14%), to home (12%), and school (5%) as shown in Fig. 5

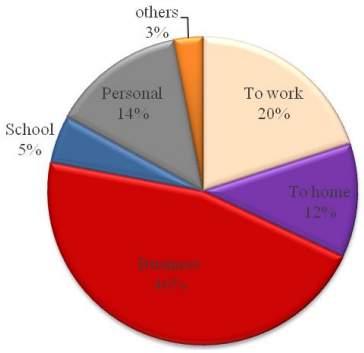

Fig. 5 Trip purpose at station 1

4. Route Assignment

The O-D data are analyzed to get the route or street where the traffic is the maximum in order to get the critical stretch which will determine the relative importance of the roadways within the study area. For this purpose, desire lines are drawn for different origin and destination zones. Desire lines are straight lines connecting the origin points with destinations, summarized into different area groups or zones. The line indicates the number of traffic crossing a station from an origin zone to a destination zone during a particular time period. Fig.6 shows the desire lines between origins and destinations zones for station 1.

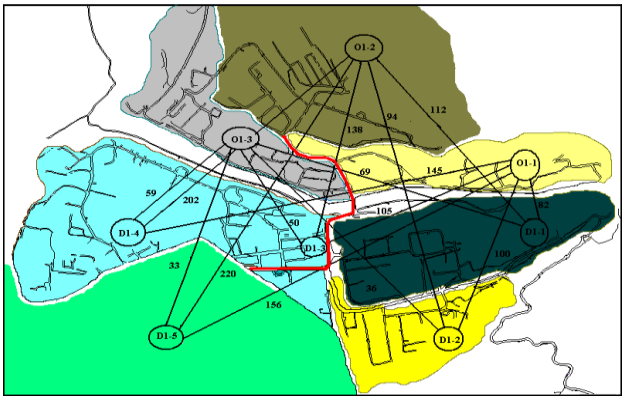

Fig. 6 Desire lines for station 1

From the desire lines from Fig. 6, it is found that the desired direction of travel within the study area is from **O_{1-2}** to **D_{1-5}** with the maximum (220) vehicle movement within these zones. It is found that 51% of the total traffic from cordon station 1 is destined toward the Zhung lam (near Bhutan gate), while 18% use the new route to Phuentsholing main city near the Dratshang

Building, followed by Pelkhil and Gaki lam (17%) and the road towards Kharbandi via roundabout (14%). Therefore, it is observed that the route from the Industrial Estate till the Bhutan gate (Norkhil lam) is critical for traffic from cordon station 1 which is shown by the **red line** on the road network map.

4.5.2 Station2: Phuentsholing City Round about

1. Mode of vehicle

The volume of vehicle through the station is observed to be 182 vehicles per hour. The ten hours (7:30am to 5:30pm) data of traffic flow by mode of vehicle at station 2 is given in Fig. 7

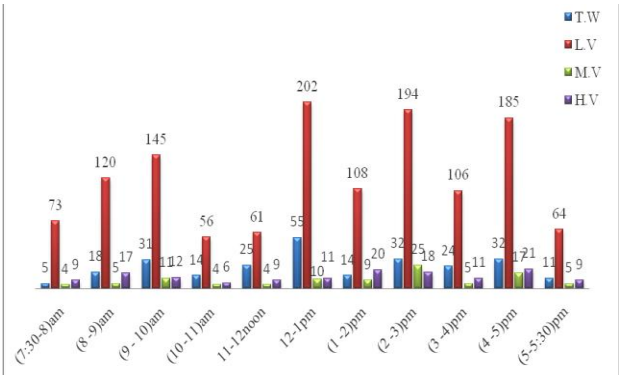

Fig. 7 Traffic flow by mode at station 2

From the Fig. 7, it is found that the peak hour of travel for traffic from station 2 is 12pm to 1pm. The most common mode of vehicle used is found to be light vehicle (72%), followed by two wheeler (14%), heavy vehicle (8%), and medium vehicle (6%).

2. Trip Distribution

The O-D matrix for ten hours of survey was tabulated for different zones for station 2 as given below:

Origin

$\mathbf{O_{2\text{-}1}}$: Royal Bhutan Army (RBA) Camp, and Royal Bhutan Police (RBP) Camp.

$\mathbf{O_{2\text{-}2}}$: Phuentsholing Middle and Lower Secondary Schools, Royal Insurance Corporation of Bhutan, and Bank of Bhutan.

$\mathbf{O_{2\text{-}3}}$: Phuentsholing-Thimphu Highway.

Destination

$\mathbf{D_{2\text{-}1}}$: Jaigaon (India) via Bhutan gate.

$\mathbf{D_{2\text{-}2}}$: Bus station, and Vegetable market.

$\mathbf{D_{2\text{-}3}}$: Phuentsholing Main city (Upper and Lower market).

$\mathbf{D_{2\text{-}4}}$: Phuentsholing Regional Hospital, and Industrial Estate.

$\mathbf{D_{2\text{-}5}}$: Phuentsholing Higher Secondary School, and Royal Insurance Corporation of Bhutan (RICB) Colony.

From the Fig.8, the maximum traffic flow is originating from $\mathbf{O_{2\text{-}2}}$ to $\mathbf{D_{2\text{-}3}}$.

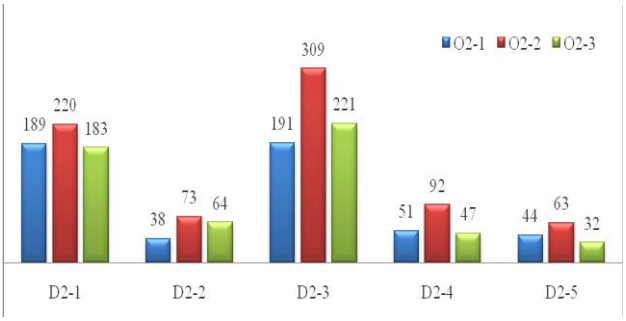

Fig. 8 O-D data at station 2

3. Trip Purpose

Fig. 9 below shows the details of trip purpose made through station 2 from 12noon to 1:00pm.

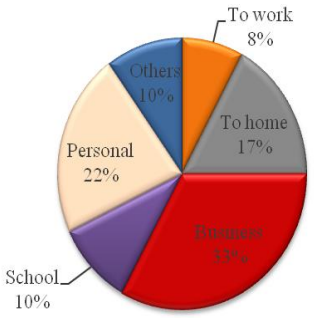

Fig. 9 Trip purpose at station 2 (12noon to 1:00pm)

The analysis of trip purposes of traffic through station 2 showed that business related trips accounted for maximum number (33%) of traffic, followed by Personal trips (22%). Home bound trips accounted for nearly one-fifth of the total trips (17%), followed by trips made to schools (10), and lastly work-related trips accounted for a relatively small percentage (8%) of the total sample.

4. Route Assignment

The O-D data are analyzed to get the desired direction of travel as shown in Fig. 10. From the desire lines, it is observed that the desired direction of travel within the study area is from $\mathbf{O_{2\text{-}2}}$ to $\mathbf{D_{2\text{-}3}}$ with the maximum (309) vehicle movement within these zones. It is also observed that more

than two third (71%) of the total traffic from cordon station 2 is destined toward the Zhung lam (near Bhutan gate), while 21% use the Norkhil lam towards zone $\mathbf{D_{2\text{-}2}}$ and $\mathbf{D_{2\text{-}4}}$, and 8% uses the Pelkhil lam.

Therefore it indicates that the route from the RICB Office till the Bhutan gate is critical for traffic from station 2 which is shown by the **red line** on the road network map in Fig. 10.

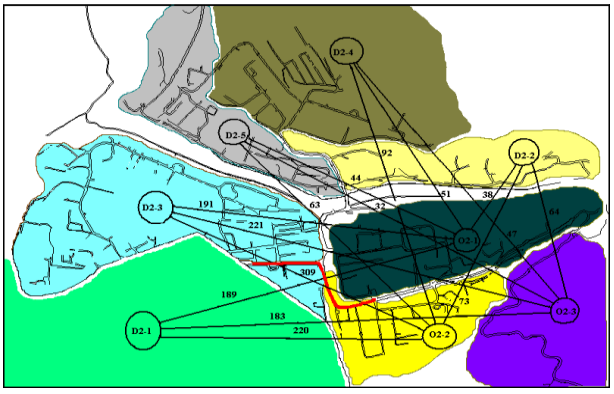

Fig. 10 Desire lines for station 2

4.5.3 Station 3: Bhutan Gate

1. Mode of Vehicle

Fig. 11 shows the traffic flow by mode at cordon station 3 by mode during the ten hours of survey (7:30am to 5:30pm). The volume of traffic through the station is observed to be 333 vehicles per hour.

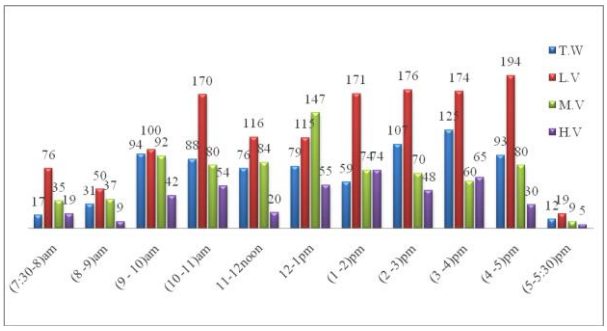

Fig. 11 Traffic flow by mode at station 3

From the graph, the peak hour of travel from station 3 is recorded from 3:00pm to 4:00pm and the highest mode of vehicle is Light vehicle (41%), followed by Two Wheeler and Medium Vehicle (23% each), and Heavy Vehicle (13%).

2. Trip Distribution

The Origin-Destination survey using road side interview method was discontinued at Station 3 from 11:00 am due to the interruption from Jaigaon Police. However, the number of vehicles by mode was collected from the cordon station. The surveyed data yielded the number of traffic by mode and time but did not give any information about the trip distribution of vehicles and the purpose of trips was not collected. Fig. 12 shows the three and half hours data from which the O-D matrix was tabulated.

The survey zones used for station 3 are:

Origin

$O_{3\text{-}1}$: Jaigaon (India).

Destination

$D_{3\text{-}1}$: Phuentsholing Main city (Upper and Lower market).

$D_{3\text{-}2}$: Regional Revenue and Customs Office, Hotel Druk, and Bhutan Oil Distributors.

$D_{3\text{-}3}$: Phuentsholing City Corporation (PCC) Office.

$D_{3\text{-}4}$: Bank of Bhutan, Phuentsholing Lower and Middle Secondary Schools, and Phuentsholing-Thimphu Highway via station 2 (round about).

$D_{3\text{-}5}$: Bus Station, and Phuentsholing Regional Hospital.

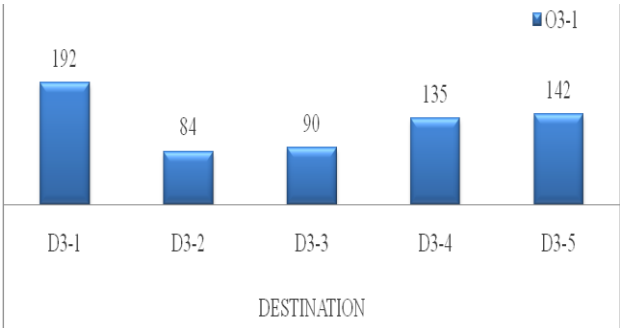

Fig. 12 O-D data for station 3 (7:30am to 11:00am)

From the above graph, the maximum traffic flow is originating from $\mathbf{O_{3\text{-}1}}$ to $\mathbf{D_{3\text{-}1}}$ with a total of 192 vehicles moving through the station in three and half hours.

3. Trip Purpose

Work-related trips accounted for a relatively high percentage (44%) of the total sample obtained. Nearly one-thirds of the drivers responded business related works (32%) when asked about the purpose of their trip as shown in Fig. 13 below.

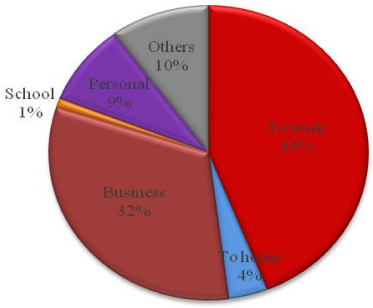

Fig. 13 Trip purpose at station 3 (7:30am to 11:00am)

4. Route Assignment

The three and half hours O-D data are analyzed to get the desired direction of travel as shown in Fig. 14. From the desire lines, it is observed that the desired direction of travel within the study area is from $\mathbf{O_{3\text{-}1}}$ to $\mathbf{D_{3\text{-}1}}$ with the maximum (192) vehicle movement within these zones. It is also observed that more than two third (70%) of the total traffic from cordon station 3 is destined toward the Zhung lam (near Bhutan gate), while 30% are destined to Phuentsholing main city. It is indicated that the route from the Bhutan gate till the roundabout on the Zhung Lam is critical as shown in Fig. 14 for traffic from cordon station 3 since traffic on the Zhung Lam is observed to be the heaviest as shown by the **red line** on the road network map.

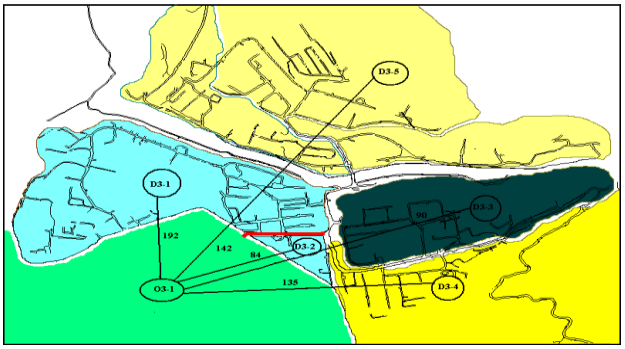

Fig. 14 Desire lines for station 3

5. Conclusion and Recommendations

5.1 Conclusion

The following are the findings and discussions from the study which depicts the overall traffic scenario of Phuentsholing city:

1. The maximum mode of transport from all the three stations is Light vehicle which is a clear indication of the growing number of privately owned vehicles and taxis in Phuentsholing city.
2. The peak hour of travel in the city for traffic from station 1 is recorded as 11:00am to 12noon and 12noon to 1:00pm for station 2 and 3:00pm to 4:00pm for station 3.
3. The travel behavior characteristics of vehicles show that trips are made for mostly business related works (46% from station 1, 33% from station 2, and 32% from station 3).
4. Besides business-oriented trips, through trips through the city is one of the main reasons for the heavy traffic flow in the city. Because of the non availability of a by-pass route which would not necessitate the need to travel through the city stretch which is already heavily loaded with vehicles, the problem still evades a solution.

The table 1 shows the number of through-trips through the cordon stations.

Table 1 Through trips from the O-D stations

Station	Total vehicles	Through Traffic	Percent
Station 1	1601	493	31
Station 2	1817	592	33
Station 3	643	135	21

5. It is found that the number of vehicle using the new route to the main city near the Dratshang complex has been in effective to divert the traffic from the Norkhil lam since only 18% of the traffic use the new route to reach the main city area where as more than half (51%) of the traffic use the route via the roundabout till the Bhutan gate. This has further increased the traffic on the Zhung lam and the roundabout. The Fig. 15 shows the picture of the traffic on the Norkhil lam and the new route.

Fig. 15 Picture of junction of Norkhil lam and the new route

6. The critical stretch for traffic from station1 is the road starting from the junction at the FCB Auction Yard (Norkhil lam) and extends till the road junction in front of the Bhutan gate (Zhung lam). The critical stretch for traffic from station 2 is the road starting from the RICB office building till the road junction in front of the Bhutan gate and lastly the critical stretch for traffic from station 3 is the road starting from Bhutan gate till the roundabout (Zhung lam). If these critical stretches are super imposed to get the overall picture of the traffic scenario in the city, then the most critical stretch from the analysis of O-D data is the stretch starting from Bhutan gate till the roundabout (Zhung lam).
7. The main activities in the city take place in the central part, where the road structure has a very limited capacity. When the study was conducted, although a clear road hierarchy didn't exist, the roundabout at the junction with Zhung lam was constructed to offer enough vehicle capacity and smooth flow conditions. However, it was found that the most critical flow of traffic is located at the roundabout because of which vehicles are stranded at the stretches leading towards the roundabout.

The highest time taken by a vehicle to maneuver through the roundabout was noted as three minutes when a load trailer (maximum dimension of the vehicle is 18 meters) is maneuvering the roundabout from the Zhung lam and then makes a U-turn from the round about as shown in the Fig. 16

Fig. 16 Picture of a trailer truck maneuvering the round about

During the three minutes taken by the trailer to maneuver the roundabout, assuming the average length of vehicles to be 4.12 m and a clear distance of 1.5 m between the vehicles, approximately 50 m of road stretch on the Norkhil lam and at station 2 is stranded when one trailer maneuver the roundabout. The traffic on the Zhung lam from station 3 will be stranded for approximately 94 m for a trailer to maneuver the roundabout.

The above scenario is generated for only one heavy vehicle maneuvering the roundabout. However during the most critical hour (12noon to 1:00pm) a total of 87 heavy vehicles are destined to meet at the roundabout from which 55 heavy vehicles originate from station 3. During such time, the traffic in the city will be congested at critical stretches for almost about 2.5 kms from the roundabout.

If the growth rate of vehicle is assumed to be same as that of the year 2009, it is estimated that the number of vehicles registered with RSTA will increase from 15,345 in 2009 to 40,911 by the end of 2013 (coinciding with the end of tenth five year plan). It is predicted that the increase in the number of vehicles by more than two folds will consequently increase the congestion level in the city with double the travel trips if the travel behavior of the traffic in the city remains same. This will ultimately increase the length of traffic jam to about 5 kms under these conditions ultimately reaching places like Rinchending for traffic at station 2, Damdara for station 1 and the traffic jam at the Bhutan gate will tend to freeze traffic operations at the gate unless the traffic is diverted through a by-pass.

5.2 Short term plan of action

In the Action plan for traffic and transportation, there are two major issues. In the first instance, the short term plan of action is aimed at:

1. Optimizing the use of existing road network and infrastructural facilities.
2. Discouraging all traffic generating uses within the Phuentsholing city and shifting it to the periphery where adequate space is available for better planning of facilities, thus removing extraneous traffic.
3. Improve regulations and controls in order to optimize the use of transport facilities in the city

5.3 Recommendations

The following recommendations are made for the short term plan of action for Phuentsholing city:

1. The mode of travel in the city has resulted in traffic congestion in the city. Other means of travel like walking and city bus services should be encouraged in order to minimize the number of vehicular traffic since light vehicle users ferry less number of passengers as compared to city buses.
2. In order to control the number of traffic during the peak hours, the bus services can be timed at the peak hours and the schedule can be drawn from the O-D matrix having the maximum number of trips.
3. The study indicated business related and work related travel as the main purpose of travel. Therefore it is recommended that the future planning and construction of office complexes, commercial complexes, health facilities, educational institutions, industries, etc. should be located away from the city centre where adequate transport facilities can be provided.
4. At least one-fifth of the total traffic entering the city from the three stations (or entry points) are composed of through trips. These trips further aggravates the traffic situation in the city because of which the concerned authority should look at possibilities of diverting these through trips by a by-pass road or structures within the city in order to reduce the traffic in the city. In order to regulate heavy traffic, no through buses and trucks should be permitted to pass the roundabout for vehicles originating from station 1 (Norkhil lam). Instead the through traffic can be diverted through Pelkhil lam or Gaki lam.
5. The new route to the main city from Norkhil lam has not been effective in diverting a large amount of traffic because of parking of vehicles along the road near the Dratshang building. In order to ease the traffic from the new route, it is recommended that parking along this road to be eliminated to increase the width of the road which will increase the capacity of the roadway.
6. Encroachments on road surface and junctions especially along the critical stretches should not be permitted by concerned authorities in order to increase road capacity due to the limitation in widening of streets and major roads.
7. All heavy vehicles especially the trailers to be restricted from entering the Zhung lam from the Bhutan gate during the critical peak hour (12noon to 1:00pm) since the traffic is heavy at the roundabout during the peak hour as people rush to homes for their lunch.
8. Improvement of road junctions including the geometrics and road alignment to be given top priority especially the roundabout. More traffic police personals to be deployed at the roundabout in order to direct the traffic in a systematic manner.

5.4 Long term perspective plan for traffic and transportation

A comprehensive traffic and transportation plan integrating it with land use plan and population distribution within the city is recommended to be prepared for future development of traffic facilities.

Such a long term perspective plan should consider the traffic and transportation requirements of the urban area for the efficient movement of goods and passengers for the present as well as the foreseeable future.

As part of the plan, major traffic road and corridors in the Phuentsholing city should be widened for segregating traffic flow. The critical stretches which are indicated through this study should be given due importance while planning. In the process, the major limitation is the lack of developable area for improving the transport facilities. The only option to ease the traffic from the city center will be to built a by-pass road or over head roadways which will collect the through traffic from the city and from across the border, thus relieving the pressure on the present road network in the city.

The study indicated that lot more needs to done in our pedagogical approach of planning. As the number of vehicles is expected to increase because of the economic boom, the country is facing in recent times; the traffic related problems are expected to increase.

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