ANALYSIS AND EVALUATION OF MASS TRANSIT IN PHUENTSHOLING

Paper identification number: YRF13-035

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Abstract

This paper aims to study the existing mass transit system serving Pasakha, and proposes a new bus mass transit in the areas of the city which previously did not have access to mass transit. A general observational study is carried out to understand the structure of current mass transit system followed by customer satisfaction survey and boarding and alighting count to assess the current system. The market research survey was conducted to prominent commuters such as students, office goers and hospital goers to find the willingness to shift from current mode of transport system to mass transit. The scope for mass transit in the city has been analyzed with the help of questionnaires and by studying the travel characteristics of the target group. The results of the studies reveal that the current mass transit is far from adequate, the service coverage is very low and users are dissatisfied with the overall performance of the current system. There is also a great deal of potential for mass transit in the city core and its vicinity. In this context, it can be concluded that installing bus mass transit in the city can be regarded as a step towards a sustainable transport system with less environmental impact compared to private vehicles. Bus schedule and route maps have been developed based on the surveys conducted which also incorporates the current system. As an additional measure, it is recommended to bring forward better policy measures that can reduce private vehicle ownership and attract more people towards mass transit.

Keywords : Mass Transit, Boarding, Alighting, Trip, Schedule.

1. Introduction

Mass transit is closely associated with industrialization, growth of urban areas and the location of work place and residences. It is considered that mass transit is one of the most crucial components for the well-being of a developing and an expanding city. Bhutan has witnessed tremendous growth in transportation sector in the last couple of decades with the number of vehicles soaring every year and the problems associated with it looming large. However, mass transit in Bhutan is relatively new with only the capital city Thimphu availing the services prior to the installation of city buses in Phuentsholing in 2009. Among variety of purposes, mass transit in Phuentsholing carries more weightage in providing mobility to users than it does in any other aspect.

Fig. 1 Bhutan map showing the study area (Phuentsholing)

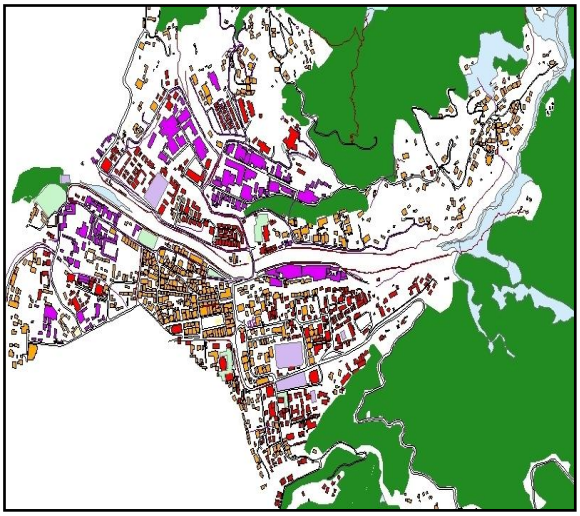

Fig. 2 Phuentsholing City map

2. Literature Review

Mass transit refers to municipal or regional public shared transportation that cannot be reserved and is open to all. Mass transit can be broadly divided into fixed route systems, such as streetcars and subway trains, and non fixed route transit, such as buses and ferries. Mass transit does not include airplanes, taxis and other long distance trains having a formal ticketing procedure. Public transport is nowadays gaining a deservedly higher attention and has been an increasingly popular option adopted for various purposes such as mass mobility, reducing fuel consumption, mitigating problems associated with traffic congestion, air pollution and parking space shortage and creating employment opportunities. An efficient and well planned mass transit results in considerable savings in terms of labor, materials and energy which is not possible in private transits.

3. Methodology

This research is divided into two parts; to study the current status of mass transit in Phuentsholing city and to design a new system which will be providing broader service to meet the transportation needs of the people who previously did not have access to mass transit.

This section intends to describe the methods and techniques used to respond to the objectives of this research.

The fig. 3 outlines the approaches used to collect data and analyze the collected data in a systematic manner. The performance assessment of current mass transit has been done through field visits and observational survey, customer satisfaction survey and boarding and alighting survey. To understand the ground reality of the existing system, several field visits were made and at the same time observational survey was carried out which comprised of digital imaging and vehicle classification survey. Customer satisfaction survey was carried out on-board in the form of questionnaires, whereby a convenient sample based on Slovin's formula was distributed and analyzed. The performance assessment was concluded with yet another survey; namely, boarding and alighting survey to better understand existing ridership trends, collect data on passenger maximum load capacities, on-time performance and also to identify major activity centers based on stop-level boarding and alighting.

The other part of the research, i.e. study for new routes was done through market research

survey, also carried out in the form of questionnaires to comprehensively understand the market of mass transit system so that ridership can be increased through effective planning, marketing and good service design. Subsequently, survey data analysis has been presented to provide a basis for the development of new routes and schedules.

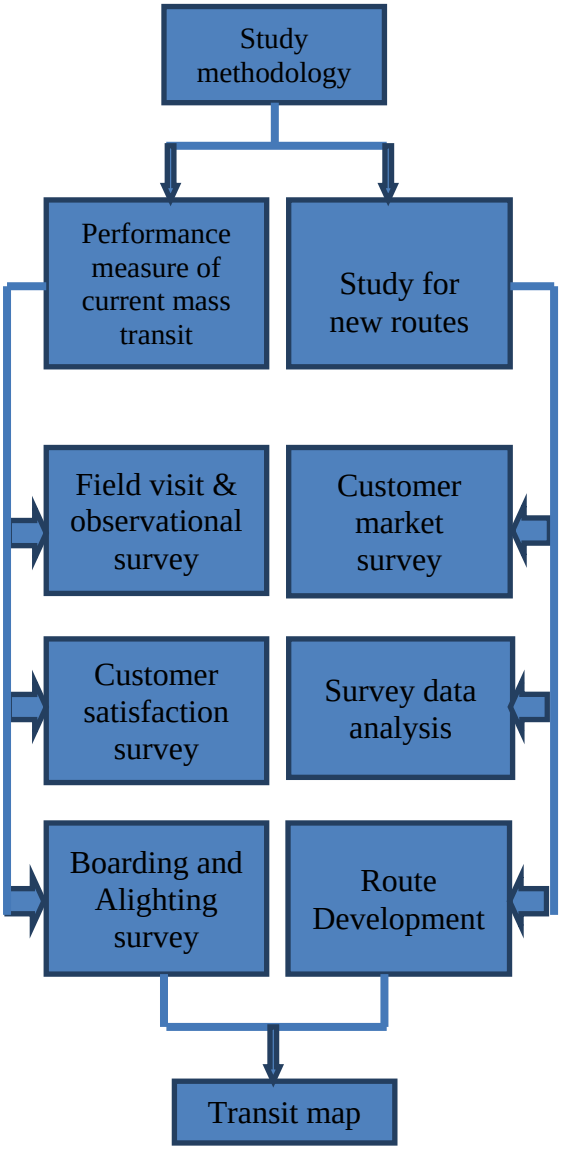

Fig. 3 Research Methodology

2. Existing mass transit system

Mass transit in Phuentsholing was started on 20th March 2010 with two buses having a capacity of 32 seats and 10 standees each. It connects the city with Pasakha, located at a distance of 16 km from the city via a single route. More than three years after the first installation of buses, the number of buses operating is still the same and there has been no revision of any kind in the system. The one way trip to Pasakha takes 45 minutes with a fare of Nu. 20.

Table 1 Existing schedule

Morning	Noon	Evening
7:30 a.m.	11:30 a.m.	3:30 p.m.
8:15 a.m.	1:00 p.m.	5:30 p.m.

3. Observational survey

3.1 Bus type and condition

The two buses in service are identical; a Tata mini bus, and are reasonably comfortable for the trip distance it serves. It has a 2+1 seating arrangement and no major maintenance has been required for either of the buses. The cleanliness can be improved if the system in to attract more users.

3.2 Bus type and condition

There is no proper parking area which is sometimes problematic for the operators. The available parking area is shared with company buses operating between Phuentsholing and Pasakha industrial area. The parking area often remains occupied by company vehicles causing inconvenience to the city bus parking and also in boarding and alighting of the passengers.

Fig. 4 Parking area

3.3 Schedule information

The only available form of schedule information system is the information board. There is only one information board for the entire route which is located at the rear end of the parking area in the city and is often unseen.

Fig. 5 Information board

3.4 Company bus- Pasakha

The other available form of transit is the company buses which serves the transportation requirement of the employees of the industries of Pasakha that runs 24x7 in four different shifts, as well as the students who live in Pasakha and travel to the city for their education. There are 14 companies with 24 buses operating throughout the day which are scheduled in such a way that the employees are reached to the industries and back to the city after every eight working hours. The schedules for 12 out of the 14 companies are same and are shown in Table 2. The schedules for the remaining two companies are shown in Table 4.

Table 2 Working period in shift system

Shift	A	B	C	General
Time	6a.m.-2p.m.	2p.m.-10p.m.	10p.m.-6a.m.	9a.m.-5p.m.

Table 3 Schedule 1

Sl. NO	From P/ling to Pasakha	From Pasakha to P/ling
1	5:15 AM	6:30 AM
2	8:15 AM	2:15 PM
3	1:15 PM	5:30 PM
4	9:15 PM	10:15 PM

Table 4 Schedule 2

Sl. NO	From P/ling to Pasakha	From Pasakha to P/ling
1	7:30 AM	6:30 AM
2	7:00 PM	5:30 PM

4. Customer satisfaction survey

Customer satisfaction survey was carried out in the form of questionnaire survey to evaluate and analyze customers' satisfaction which is considered to be the most important factor whether it is meant for a product or a service. A convenient sample of 275 based on Slovin's formula was distributed out of which 207 forms were collected which corresponds to a response of 75%.

The user gender was dominated by males at 67% as it is understood most of the males don't mind taking a public transport as much as their female counterparts do who are generally influenced by factors such as comfort, cleanliness, privacy, etc. About 79% of the respondents were of the age group 18-49, as people in this age group more often than not have the responsibility of supporting the livelihood of their families and hence travel the most.

A 50% of the users have been found to be in the lower income group, i.e., under Nu. 10,000; which further reinforces the belief that public transport is for the poor. Most of the respondents (95%) have been found to be satisfied with the current fare but are against the fare collection system, i.e., single ride ticket, as they consider it to be tedious.

The buses generally operate on time as reflected by the response of 80% of the users. The respondents were also required to rate some of the aspects of service such as cleanliness, comfort, seats availability and convenience as very good, good, okay and poor. Seats availability and convenience were mostly rated poor and cleanliness and comfort were perceived to be okay by the users.

5. Boarding and Alighting Survey

An equivalent sample of two days each for both weekdays and weekend was collected on-board. The data collected were analyzed by time and location.

Examining the time of the day in which boardings occur provides insight into boarding trends over the course of the day. For weekdays, most of the boardings were found to occur for the morning (38.5%) and evening (36.6%) trips out of the total daily boardings. However, for weekend, peak boardings occurred in the noon (31.3%) and evening (43.45%) trips.

Examining the location along the course of the route in which intensive passenger exchange occurs allows the identification of major activity

locations. The major ridership locations are Phuentsholing town (bus stop), Bhalujhora, Coca Cola factory, BFAL colony and Druk Ferro.

For assessing schedule adherence, on time performance was considered to be zero minutes early to five minutes late. It was found out that the buses started within the standard range and hence were on time.

Table 5 provides guidance in assessing passenger loads as applied to level of service (LOS) aboard transit vehicle. Passenger maximum load, i.e., number of passenger/seats, was calculated for the trips of 3:30 p.m. and 5:30 p.m. Considering LOS 'C' as the desired target, the calculated LOS for weekday falls under LOS 'E' for both the trips which suggests that maximum passenger load has been achieved. Similarly, for weekend, the calculated LOS is LOS 'E' and LOS 'F' for 3:30 pm and 5:30 pm. respectively. LOS 'F' is indicative of the fact that the crush load has been reached and is not acceptable and the only alternative is to either increase the frequency or increase the vehicle size to comfortably accommodate the passengers.

Table 5 Passenger load factor

LOS	p/seat	Comments
A	0.00-1.50	No passenger need to sit next to each other
B	0.51-0.75	Some will need to sit next to each other
C	0.76-1.00	All can seat but limited choice
D	1.01-1.25	Some passengers required to stand
E	1.26-1.50	Maximum load of passenger achieved
F	>1.50	Crush load

Table 6 Calculated passenger load factor for week days

Peak hours	Max. Passenger load on board (p)	Passenger load factor (p/seats)
3:30 p.m.	46	1.44
5:30 p.m.	44	1.38

Table 6 Calculated passenger load factor for weekend

Peak hours	Max. Passenger load on board (p)	Passenger load factor (p/seats)
3:30 p.m.	46	1.44
5:30 p.m.	57	1.78

6. Market Research Survey

In order to understand the market of the transit system so that ridership can be increased through effective planning, marketing and good service design market research survey was conducted. This study was targeted to students and office goers as they are the most prominent commuters in the city. The other target group was hospital goers as the hospital is located slightly away from the city and has no other transportation facility other than taxis and walking.

Table 7 Survey methods and data collection

Sl. No.	Potential users	Method of data collection	Sample size	Responds
1	Students	Forms	51	41 (88%)
2	Office goers	Questionnaires	264	206 (78%)
3	Hospital goers	OPD data and traffic count		

For the purpose of analysis of data, Phuentsholing was divided into eight different zones based on route connectivity and the importance of the region with respect to the city.

Table 8 Zone distribution

Zone ID	Places
Zone 1	Rinchhending, Pasakha and Toribari
Zone 2	Hospital area, Tala Housing, Dhamdara and Pipaldara,
Zone 3	Industrial estate and Kabreytar
Zone 4	NPPF,BPCL Housing, YDF, and AmoChhu
Zone 5	Upper Market, Lower Market and Truck Parking
Zone 6	Telecom, Dungkhag C., Forest C.,

	Bhutan post, BOB and Pemaling
Zone 7	Ramitey and WangdueGatshel
Zone 8	City corp. area, PSA, PWD, Army camp,TMT and Police camp

6.1 Students

The study surveyed 1,111 students in total. The students were required to write down their residential location, mode of transport used to travel to school and back home, and the time taken.

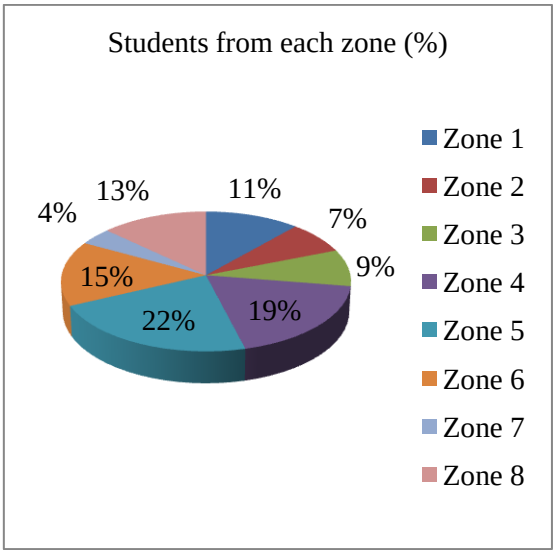

Fig. 6 Students from each zone

Zone 5 has the maximum percentage (22%) of students travelling to schools in the city out of the total number of students with zone 7 having the least (4%).

Considering the distance from each zone to the schools, time taken and the mode of travel used, zone 1 and zone 7 haven't been considered for mass transit as they have been found to either have their own transport in the form of company bus and army vehicles or generates very few number of students. Consequently, zone 2, 3, 4, 5, 6 and 8 have been identified as the zones of interest with maximum weightage for zone 2 and 3 due to longer walking distance.

6.2 Office goers

An appreciation of the demographic, socio-economic and travel characteristics of the people of an area is important to understand the travel needs of the people, preferences for travel modes and the ability to pay for their desires of travel.

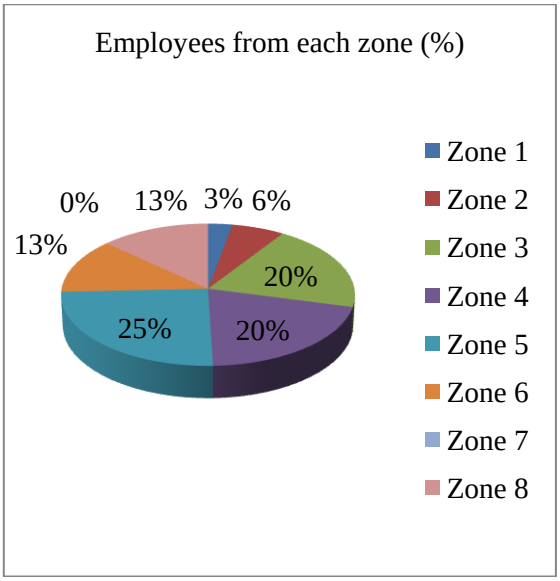

Fig. 7 Employees from each zone

The maximum percentage of office goers is generated by zone 5 and the least is from zone 7 as shown in the figure above. For the same reason as in the case of students, zone 1 and zone 7 haven't been considered for mass transit. For the remaining zones of interest, analysis has been bifurcated into two based on preference for mass transit. The people who would like to use mass transit are mostly males and younger working groups, with lower monthly income and no personal cars. On the other hand, people who do not prefer mass transit are mostly females and older working group, usually with higher income and a minimum of one personal car.

6.2 Hospital goers

As per data from the monthly OPD, there has been an increasing trend in number hospital goers every year as shown in the figure below. On an average 309 patients visit the hospital every day.

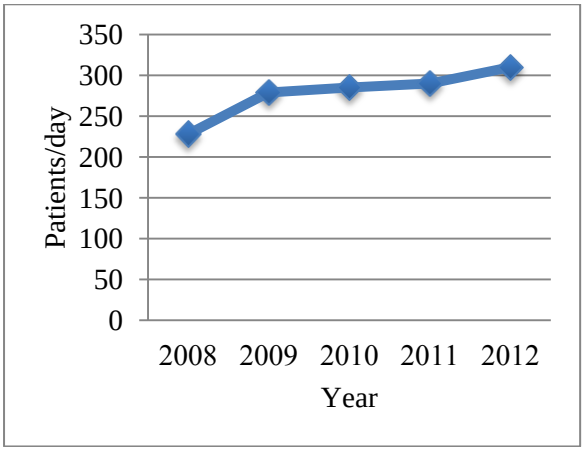

Fig. 8 Yearly patient inflow

A one day mode of transport survey was undertaken which would help in identifying the most common mode of transport and also to identify the peak hours.

Table 9 Survey methods and data collection

Mode	Walk	Taxi	Private car	2-wheeler
Absolute value (N)	89	152	74	16
Relative value (%)	26.89	50	22.36	.75

The most common mode of travel was taxi with 50% of the total followed by walking at 26.89%. The number of people visiting hospital peaked from 11 am to 1 pm.

7. Identification of Improvement

- A proper bus station needs to be constructed with adequate parking space.
- Shelters and benches for the passengers particularly at terminuses at Phuentsholing and Pasakha are required.
- Sufficient information board at various points on the route needs to be installed.
- An additional trip to be installed between 3:30 p.m. and 5:30 p.m. as per the findings of computation of passenger maximum load.
- Provide service to Dhamdara and Kabreytar, and in doing so the remaining areas within the city will be covered due to the availability of only a single route.
- Install one additional regular bus with two double channel doors, 2+1 seating arrangement and sufficient standee capacity.
- Develop a new schedule for weekdays and weekend, incorporating the schedule of the existing system.
- Develop route maps.

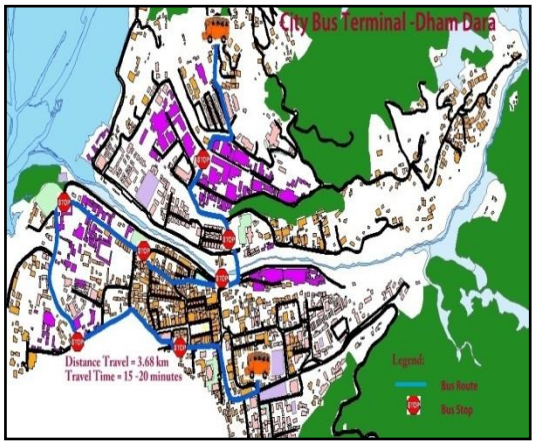

Fig. 9 Bus route map from CBT- Dhamdara

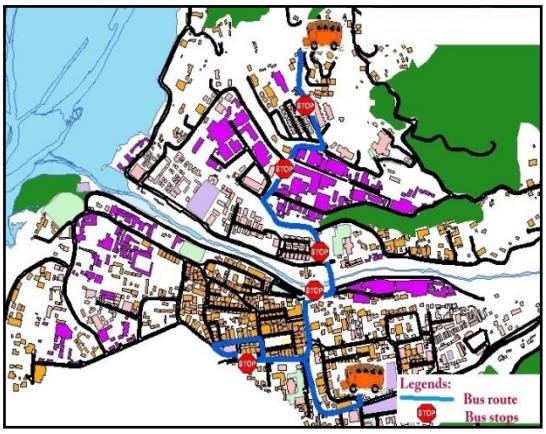

Fig. 10 Dhamdara - CBT

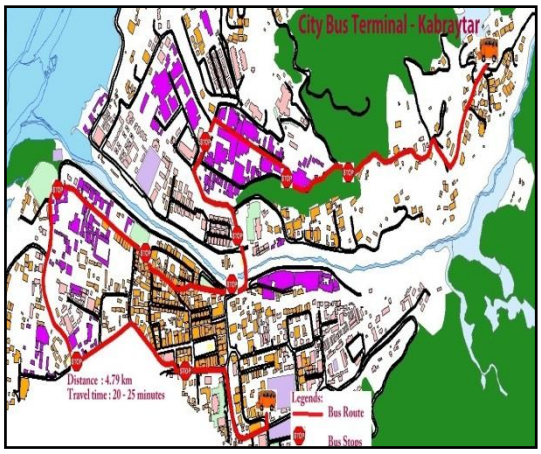

Fig. 11 Bus route map from CBT- Kabreytar

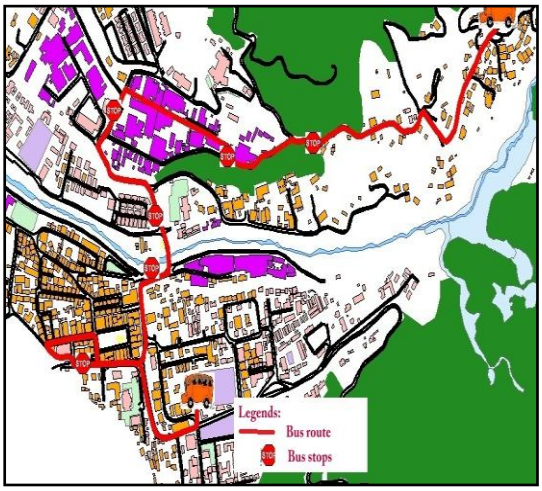

Fig. 12 Kabreytar- CBT

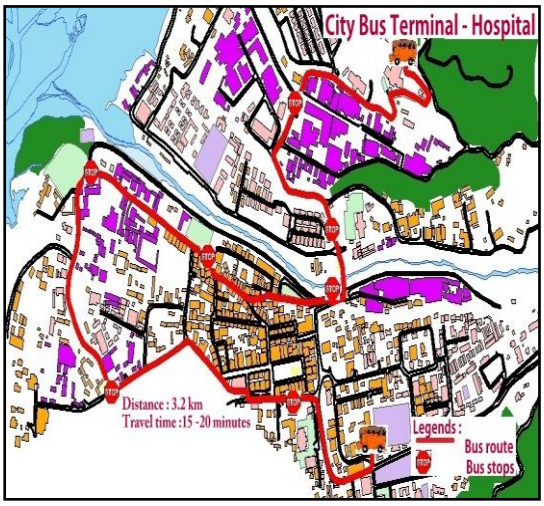

Fig. 13 Bus route map from CBT- Hospital

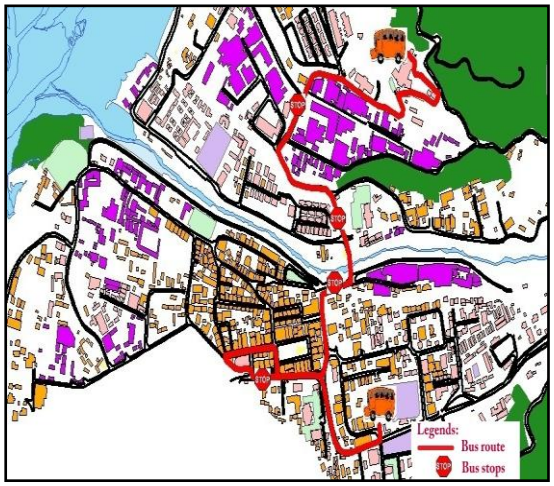

Fig. 14 Hospital - CBT

8. Conclusion

Existing Mass Transit System

- The user gender is dominated by male as most of the workers are male.
- The users are mostly in the working age group with lower income.
- Evening trips are frequently crowded both for weekdays and weekends.
- Bhalujhora, Coca Cola factory and BFAL colony generate maximum ridership.

Market Research (Schools and Offices)

- Zone 1 and Zone 7 have the least potential for mass transit due to minimal potential users and also due to availability of their own transport.
- Zone 2 and Zone 3 have the highest potential for mass transit due to higher walking time and more potential users.
- The remaining zones are accessible through the routes that connect Zone 2 and Zone 3 with the city.

Market Research (Hospital)

- Increasing trend in the number of people visiting hospital every year as per data from OPD.
- On an average 309 people visit hospital every day with taxi as most frequently used mode followed by walking.
- The number of people visiting hospitals peaks from 11 a.m. – 1 p.m.

9. Recommendation to implementing agency

- Formulate policies to enhance public transport usage.
- Undertake awareness campaigns to motivate people to shift towards public transport.
- Keep provision for cycling lane.
- Improvement in fare collection system in the form of passes for regular users.

10. Acknowledgement

We would like to thank ATRANS for organizing such a platform and giving us the opportunity to participate and for reviewing the findings of our study. We would also like to thank College of Science and Technology for all the guidance and assistance rendered throughout. Last but not the least; we would like to extend our heartfelt gratitude to Mr. Sangey Pasang, Assistant

lecturer at College of Science and Technology for the guidance.

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