

A project report on,

Information System for B. E. S. T. Commuters

Submitted by

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Approval Sheet

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Information System for B. E. S. T. Commuters

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Chairman_____

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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1. Abstract

In this project, an information system is designed for commuters of Brihanmumbai Electric Supply and Transport undertaking (BEST) which provides bus service in Mumbai city.

In the process, the current information system of BEST was studied. Also, information system of bus services of different cities was studied to understand new transit technologies. Several regular and non-regular commuters were observed and interviewed and hours of observations were done at different bus stops and in buses to identify their needs and problems. Also, a new pattern of commuting amongst the commuters in the city is identified. On the basis of these background studies, a mobile phone based information system along with indicators at bus stops and inside buses, a telephone helpline service and a website is proposed. Using this solution, users could plan their journey by knowing information of the nearest bus stops or any bus stop; bus routes, fares, arrival time and crowd in the buses arriving at any bus stop. Users could get this dynamic information; anywhere and at anytime during the journey. This information would equip the users to get all the needed information, before beginning the journey, enabling them to arrive at the bus stop just in time to catch the bus.

The design would cater, both regular as well non-regular commuters, by providing the necessary real time data at every stage of the journey.

2. Introduction

In Mumbai there are two major public transport systems, the Mumbai railway which is known as the life line of Mumbai and Brihanmumbai Electric Supply and Transport undertaking (BEST) which provides bus services.

The Mumbai railway is a more linear network along north-south of the city. The city is also linear along north-south. To travel east-west across the city people prefer road ways. Whereas to travel in north-south across the city people prefer local trains to avoid traffic congestions.

But unlike the railways, the bus network is like a spider web on the roads across the entire city. So, the advantage is that one can reach from any point of the city to another using the bus network. There are about 380 different bus routes [1] and 4000 bus stops in Mumbai [2]. This makes the system more complex. Also the traffic congestions in the city make the bus journey more unpredictable and time consuming. In spite of this it is a fairly efficient mode of transport carrying more than 41lakhs commuters per day [3].

In Mumbai, there are 16,31,837 vehicles of which 8,65,466 are two wheelers and 5,07,408 are cars [4]. If the BEST bus service is made predictable, comfortable and special to its passengers i.e. in other words if it satisfies the demands and needs of majority of Mumbaikars (people of Mumbai) then even more Mumbaikars will prefer public transport. This in turn will

reduce the number of private vehicle on roads. Reduction in number of vehicles on roads means less traffic congestion, less parking problems, less fuel consumption and reduction in pollution.

In order to make this come true, the entire B. E. S. T Bus System needs to be improved with the help of technology. As a small contribution to this dream, this project focuses on improving a part of the BEST system, the Information System for the commuters. The Information system plays a vital role because it is the medium of interaction between the bus service providers and its commuters. An improved information system will make the BEST bus service easily accessible to the commuters and help the commuters to easily navigate in the city. It will enhance the travel experience. BEST as well as many bus services of different cities in the world are making an effort to improve their Information system with the help of cutting edge technology.

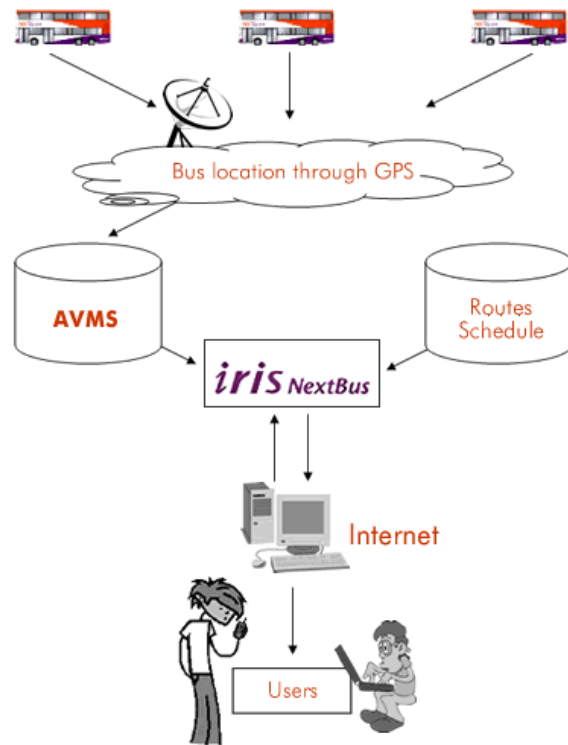


Fig. 1. SBS Transit system

3. Study of bus services of other cities

3.1. Singapore

SBS transit offers bus services in Singapore. It has an Intelligent Route Information System (*iris*) through which it offers two applications: *iris* Nextbus and *iris* Journey Planner

iris Nextbus

It offers bus arrival time estimation on a real time basis. One can know how much time a bus will take to reach the bus stop.

All SBS Transit buses are equipped with Automatic Vehicle Management System (AVMS) tracking device. Their exact location on route is tracked in real time basis and together with relevant route conditions, *iris* NextBus provides the estimated next bus arrival times. When there is loss of GPS signals, bus schedule information is utilized instead to estimate the next bus arrival times.

iris Journey Planner

It helps to plan the best way to get to your destination on their buses based on the cheapest fare, shortest walking distance or shortest travelling time.

iris NextBus and *iris* journey planner are available on website and via GPRS and sms on mobile devices.[5]

3.2. London

The London Transit commission intends to install new "Smart Bus Technology" (Automatic Vehicle Location Communication System) on all buses. The buses would be tracked using (Global Positioning System technology)

Its Enhanced Customer Information System has three sub systems

On board Customer Information

Every stop would be announced and displayed visually in every bus.

Wayside customer information

Automatic on-street information signs would be installed at major locations. The signs will display route number, name and arrival time of next bus. The real time information would be shown only if the bus is not anticipated to reach the stop beyond certain time. Otherwise scheduled time will be displayed.

Webwatch and interactive voice response

The Information available on the website and IVR would be based upon real time information for next buses. The IVR system would utilize voice recognition system and would be capable of recognizing stop name, number, address and significant location [6].

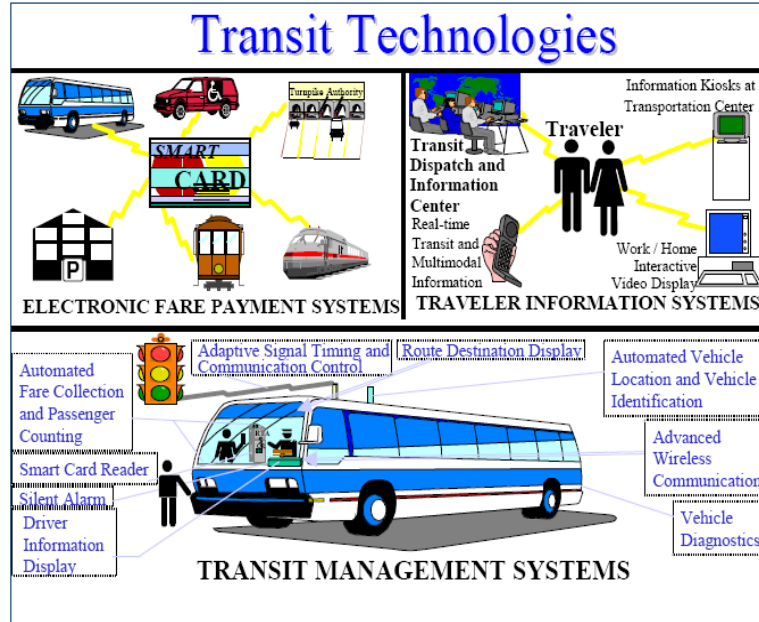


Fig. 2. Various transit technologies

3.3. Technologies used in various transit services of USA

Vehicles are tracked down using GPS which helps the service provider to get the real time location and information about the bus. The real time location of buses is also provided on maps on web services for travelers. Also street view of the route is provided using Google street view. GIS (Geographic Information System) is used to analyze the spatial data such as the bus routes, bus stops, signals, streets and terrain characteristics.

Magnetic strip or smart cards are used for fare payment. It also incorporates passenger identification. This card help the service providers to get the passenger travel data which in turn helps them to manage the bus fleets efficiently. Automatic passenger counting is done using treadle mats, infrared beams and video processing techniques. This helps the service provider to manage the services in real time. [7]

4. Work done at Industrial Design center, IIT Bombay

A product design student project on 'Design of Information System for Bus Commuters of Mumbai' (MDP-286) was done by Mr. Vikram Singh Parmar in the year 2004

In this project, on the bases of field study and background research four design projects were identified. They are as follows

1. Display at main junctions of the bus stops or railway stations, which could give the static information regarding the buses
2. A product at bus stop, which gives information about the bus numbers, bus destinations and timing of the bus.
3. Display device inside buses which would display the last bus stop and next bus stop
4. An interactive product at various sites in Mumbai.

The fourth project was taken up ahead to further details. The product would deliver bus number and its final destination of buses to reach from one place to another and expected time of arrival those buses. It would have touch screen to get the information. An illiterate user could call to a call center for the information. When the product is not in use, it would display local information about that area. The product also has an option to print the information.



Fig. 3. Interactive product for BEST



Fig. 4. Bus stop with shelter



Fig. 5. Bus stop without shelter

5. Study of current Information System for BEST commuters

5.1. At Bus Stops

There are two types of bus stops, with and without shelter. Both of them have printed information showing list of bus route number which would halt at that stop.

Only some bus stops with shelter also gives printed or electronic displayed information about the bus route number, its final destination and names of major stops along that route.



Fig. 6. Bus stop with bus route information



Fig. 7. Bus stop with electronic bus route information

5.2. On Buses

The bus route number and the final destination (last stop) are displayed on the bus in Devanagari on front side and in English on left side. AC buses display this information on a LED panel on the front side and back side.

Bus Conductor and driver are the source of any information regarding various bus routes, names of the stops on that route and time taken to reach the destination. Inside some buses there are digital TV screens known as 'BEST TV'. The contents on these TV screens include chartbuster songs, advertisements, advertiser funded programs, infomercials and film reviews. These clips are called Mumbai Beats.

Also, there is surveillance cameras placed at both doorways. These were placed after the terror attacks in Mumbai. Currently, these TV screens and cameras are installed only in some buses.



Fig. 8. Bus route number and final destination



Fig. 9. Bus route number and final destination



Fig.10. Camera and TV screens inside bus



Fig.11. Bus ticket

5.3. Tickets and Daily Bus Pass

The ticket gives information about fare and the stage number of the stop (on that bus route) at which the passenger gets into the bus. From the fare and the stage number the ticket checker can calculate the distance a passenger could travel i.e. the stop at which the passenger could get down. Except for the fare the other information could only be decoded by bus conductors and ticket checkers. Tickets are issued by the conductors once the commuter gets in the bus i.e. while traveling in the bus. So, the major advantage of this is that one need not wait to buy a ticket before starting the bus journey. It is ticketing on the fly.

The BEST service also issues various bus passes. A one day pass of Rs.20 is similar to a ticket. It contains the fare and the conductor punches the date and gender of the passenger.

5.4. Smart Card as Bus Pass & e-Purse

A monthly pass is a smart card which has information about the route and expiry date of the pass, stored in it. The information could be viewed by a hand held device which is used only by conductors or ticket checkers to check the pass validity. The pass bearers can view this information only by a devices kept at smart card issuing centers.

The smart card could also be used as an e-purse which could be refilled with a particular amount of money and used as a single journey ticket. For this, two devices are used inside the bus to calculate the distance traveled by the passenger. One device is placed at the entry gate and another is placed at exit. The passenger has to place the card in front of the devices while getting in and going out of the bus in order to validate the card and get the exact fare calculated. The smart card as e-purse is currently under testing state on few buses.



Fig. 12. Smart card reader at smart card issuing centers



Fig. 13. Hand held smart card reader with conductor



Fig. 14. Smart card reader at entrance



Fig. 15. Smart card reader at exit

B.E.S.&T.Undertaking AREA | BUS NO. | HOSPITAL | AIRPORT | EXCURSION | EXP. BUS | NIGHT BUS | FRIENDLY BUS

Route Search By Area

Starting Journey Area: AAREY COLONY
 AAREY COLONY
 AAREY COLONY (ADARSH NAGAR)
 AFGHAN CHURCH
 AIROLI
 AIRPORT-DOMESTIC
 AIRPORT-SAHAR
 AKSA
 ANDHERI (AGARKAR CHOWK)
 ANDHERI (AGHADI NAGAR)
 ANDHERI (AMBOLI NAKA)
 ANDHERI (BAHAR CINEMA)
 ANDHERI (DHAKA COLONY)
 ANDHERI (FOUR BUNGALOW)
 ANDHERI (GILBERT HILL)
 ANDHERI (GOKHALE BRIDGE)
 ANDHERI (GUNDAVL)
 ANDHERI (JUMBO DARSHAN)
 ANDHERI (NEW INDIA QRTS)
 ANDHERI (PARSI PANCHAYAT)
 ANDHERI (PUMP HOUSE)
 ANDHERI (RAMESH NAGAR)
 ANDHERI (SARDAR NAGAR)
 ANDHERI (SARVODAYA NAGAR)
 ANDHERI (SEVEN BUNGALOWS)
 ANDHERI (SHIVAJI CHOWK)
 ANDHERI (SPORTS COMPLEX)
 ANDHERI (STATION WEST)
 ANDHERI (TOLANI COLLEGE)
 ANDHERI (VEERA DESAI ROAD)
 ANDHERI (VISHAL HALL)

Destination Journey Area: AAREY COLONY

Search

put your advertisement in this space
BEST

Fig. 16. BEST undertaking website search options

B.E.S.&T.Undertaking AREA | BUS NO. | HOSPITAL | AIRPORT | EXCURSION | EXP. BUS | NIGHT BUS | FRIENDLY BUS

Starting Journey Area: Kandivali (b.h.d.colony) Destination Journey Area: Powai (i.i.t.market)

You can reach Powai (i.i.t.market) by traveling in any one of the following buses.
 Select a Bus for further information.

Bus No.	Start Bus Stop	End Bus Stop	Kms	Fare	Route Map	Zoomed Route Map
398LId	MULUND BUS STATION(W)	BORIVLI STATION(E)	20.6Kms	Rs 14.00	Bus No. 398LId	Bus No. 398LId
461LId	MULUND BUS STATION(W)	GORAI DEPOT	15.4Kms	Rs 10.00	Bus No. 461LId	Bus No. 461LId
489LId	SHIVAJI NAGAR BUS STATION	DAHISAR BRIDGE	16.7Kms	Rs 12.00	Bus No. 489LId	Bus No. 489LId
524LId	BORIVLI STATION(E)	SECTOR NO. 19	15.4Kms	Rs 10.00	Bus No. 524LId	Bus No. 524LId
AS-461	MAGATHANE DEPOT	MULUND BUS STN	15.4Kms	Rs 30.00	Bus No. AS-461	Bus No. AS-461

Search

Fig. 17. BEST undertaking website search results

5.5. Web services

There are many websites on internet which gives information about bus routes from a major bus stop of an area to another area. Some of the websites are the B. E. S. & T. Undertaking and the Mumbai navigator.

5.5.1. B. E. S. & T. Undertaking

This website gives bus route numbers, start stop, end stop, its route map, distance and fare of all direct buses from one major stop to another major stop.

User can select Starting journey area and destination journey area to get the list of all direct bus routes. The areas mentioned in the drop down list are the major bus stops in the area. Then user can further select a bus route to get information about the timing of first and last bus, frequency, fare, distance and route map. If there is no direct bus route then it gives all options of bus routes with one changeover and mentions the shortest route option.

User has an option to view list of all major stops on the route of a particular bus. Then user can select any two stops as starting and destination to get the above mentioned details. [8]

5.5.2. Mumbai Navigator

Mumbai navigator also incorporates Mumbai local Train while generating a travel plan for a user.

The user has to select the origin and destination. It gives all possible options to reach from a place to another and also gives an estimated travel time for each plan. User can view the route of any travel plan on the map. Its database includes bus stops other than major stop but not all the stops.

On the first screen, the user can select any bus and see its route of on the map. The user gets the list of all the routes through the selected stop. [9]

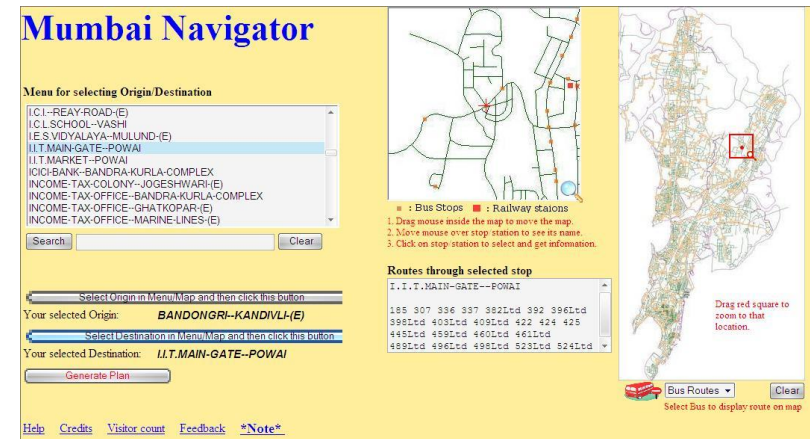


Fig. 18. Mumbai navigator search options

Both the websites does not fulfill the needs of a regular commuter (discussed later) because the information given by the website is already known to them. And for the non-regular commuter, to get the above information, they either need to know the name of the bus stop from where they would catch the bus or where they would get down or bus route number. So, to know the names of the stop they have to ask their friends or relatives who are familiar with the place.

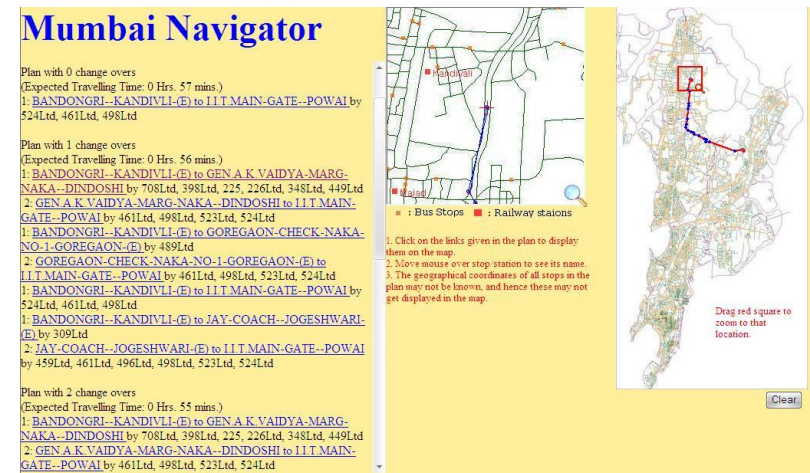


Fig. 19. Mumbai navigator search results

5.6. Future plans of BEST to improve its Passenger Information System

The BEST intends to install GPS (Global Positioning System) in all the buses. With the help of which the commuters at the bus stop would know about the time of the arrival of the bus and inside the bus they would be informed about the next stop and time to reach the stop. Also, if there is traffic on the road then the same would be conveyed to them.

In the buses, two 23" LCD screens, one on each row, would display the name of the next stop, information about shops and malls near the stop and clips of the latest events that would be going on within the vicinity of that bus route. It would be supplemented with announcements in English and Marathi with the help of four speakers at various locations inside the bus. Using GPRS and RFID technology, the announcements would be made 100metres before the stop.

BEST is also going to install Bluetooth devices in all its buses. 'Mobileji', a mobile application could be downloaded from these blue tooth devices when commuters get into the buses. This application will help commuters to get information about bus routes, stops, bus schedules and locations such as- Restaurants, Hospitals, Chemist shops etc through GPRS. In case if he/she does not have the GPRS services on their mobile phones, then that person will have to SMS at a number that would be displayed in the bus, and in return he/she would be availing all the information that he/she wishes to know. A

wireless zone would be created over the city using Bluetooth, Wi-Fi and other wireless technologies. [10] [11] [12] [13]

6. Identifying needs and problems faced by commuters and solving them with initial design ideas

The current Information system for the BEST commuter does not fulfill all the needs and problems of its commuters. In order to identify the needs and the problems of the commuter; observations were done at bus stops at various locations and while travelling in the buses. Also different commuters were interviewed and observed in different context.

The observations at each bus stop were done for about 3 hours on three 3 days at different time of the day. The bus stops were selected on the basis of their role in the journey. The bus stops were-

1. Bandongri bus Stop Kandivli - It is an intermediate on western express highway
2. Kandivli Station west, bus stop - It is an intermediate bus stop as well as a starting and ending stop.
3. Dindoshi Bus depot, Goregaon - It is an intermediate bus stop as well as a starting and ending stop.
4. Sakinaka Bus stop, Andheri - It is an intermediate bus stop.
5. IIT Main gate, bus stop - It is an intermediate bus stop.
6. Mulund Station west bus stop - It is a starting and an ending stop.

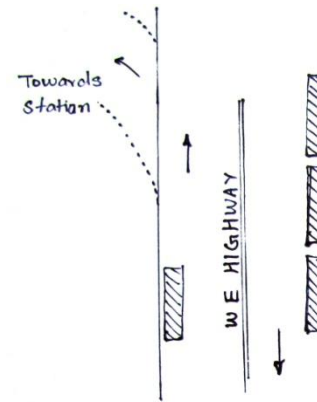


Fig. 20. Bandongri bus stop in Kandivli east

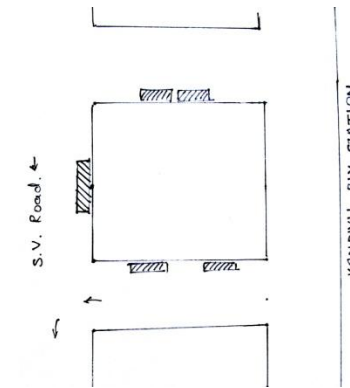


Fig. 21. Kandivli west bus stop

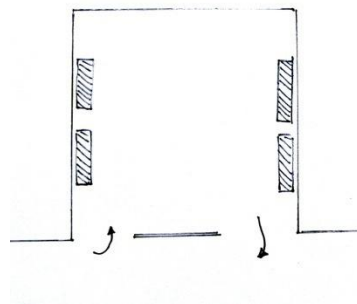


Fig. 22. Dindoshi bus depot

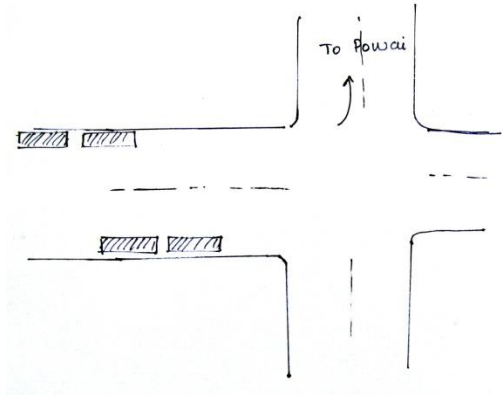


Fig. 23. Sakinaka bus stop

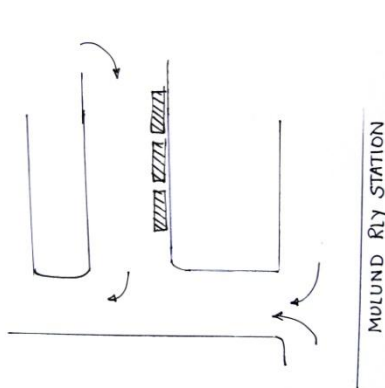


Fig. 24. Mulund station west bus stop

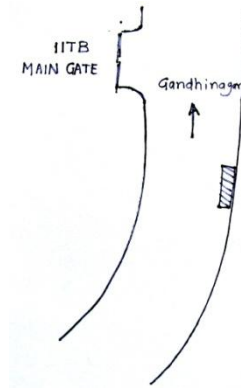


Fig. 25. IIT main gate bus stop

The focus of the interviews and contextual inquiry was to know what problems does users face right from the start till the end of their journey and also to know what information is required at various instances of the journey for the users to make correct decisions related to journey.

Before recruiting users (commuters) for interviews they were classified into two categories

1. Regular commuters

They travel by BEST buses most frequently (at least six times a week) to their regular destination.

2. Non-regular commuters

They travel at most twice a month from a new place or to a new place or both.

Overall 14 users were interviewed (7 Regular and 7 Non-regular commuters) in the context (during their journey) as well as after the journey. These users were followed throughout their journey. Some more commuters were simply observed throughout their journey.

6.1. Regular commuters

They have rough knowledge about all the bus routes to their regular destination. They are mostly bus pass holder. Most of them have a preferred bus route and a particular timing of buses. They have a rough idea about timings of their buses though there is no official time table published by BEST services. (The only published information regarding bus timing is the time of first and the last bus and its frequency.)

Before beginning the journey

-Users do not want to waste time at the bus stop waiting for the bus. So, they leave their work place or house accordingly because they have a rough idea about bus timings.

Design Idea

1. Commuters can get the real time status of time of arrival of the buses approaching the stop on their mobile phones or website.

-Some users have an option of more than two bus routes to reach their destination. At some places, stops for different buses are at different location in that same area. So, user needs the following information to take decision that at which stop he/she should go and which bus to catch.

1. The crowd at the nearby bus stops
2. The arrival time of the buses at each stop
3. The time taken to reach his/her destination for each bus (considering the current traffic conditions)
4. The crowd in the buses approaching the bus stops



Fig. 26. Real time bus status on mobile phone



Fig. 27. Real time bus status on website



Fig. 28. Sensor at gates to count passengers

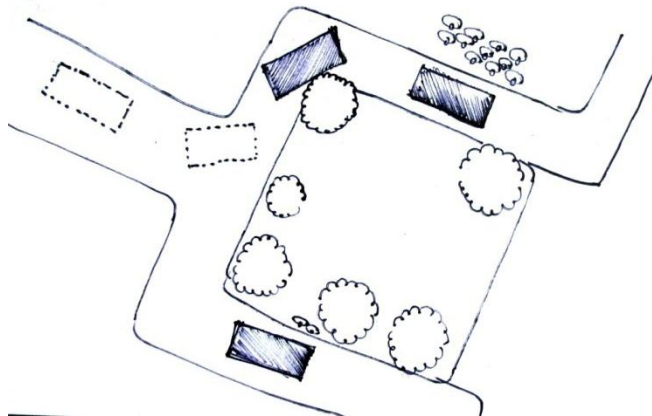


Fig. 29. Bus routing as per number of passenger at stops

Design Idea

1. A website or an application in a mobile could give all the above information.
2. A photograph taken by a camera could show the current status of the crowd at bus stop and in the bus.
3. Number of passengers in the bus could be counted with the help of sensors at entrance and exit. Also, it could be done through various video/image processing techniques

At bus stop

-Sometimes user has to spend most of his valuable time waiting for the bus if he misses his regular bus or if his bus is delayed. Sometimes users miss their bus because the driver doesn't stop the bus at a stop. The reasons for not stopping the bus are that the bus is either too crowded or the bus is behind schedule or there is a less crowded bus just behind it.

Design Idea

1. People who wish to travel can send request for the bus. As per the number of request received, the BEST service can change the number of busses on that route on demand.
2. Also a track could be maintained about number of passenger travelling on a particular route at a particular time of the day. Accordingly, the number of buses and their frequency could be altered. Thus the buses won't be overcrowded and the crowd gets distributed.

-During peak hours user misses the bus because there is too long queue at the stop or there is a huge rush to get inside the bus as queue discipline is not followed at some stops. So, in spite of reaching the bus stop at right time and a less crowded bus arriving at the stop user misses the bus.

Design Idea

1. Tickets could be bought by commuters themselves and reserve seats in the bus on mobile phones.

-It is very difficult to read the bus route number and its final destination written on the bus coming from far and when bus is near then only Devnagri literate commuters can understand the information. An English literate (Devnagri illiterate) commuter has to wait till the bus halts at the stop.

Design Idea

1. Electronic display with bigger font size could be used and the font size could decrease as the bus approaches the stop. Thus the display is always readable
2. An Indicator could be installed at the bus stop which would give updates of the buses approaching the stop

-Some buses have same bus route number but different final destination. Eg. 461-Mulund checknaka and 461-Marol Depot. So, sometimes commuters overlook the final destination and get into the bus.

Design Idea

1. As buses approach the stop the mobile application will tell/alert the user whether to catch this bus or not to reach the destination

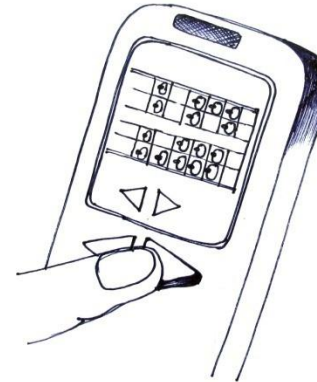


Fig. 30. Reservation of seats in bus on mobile phone

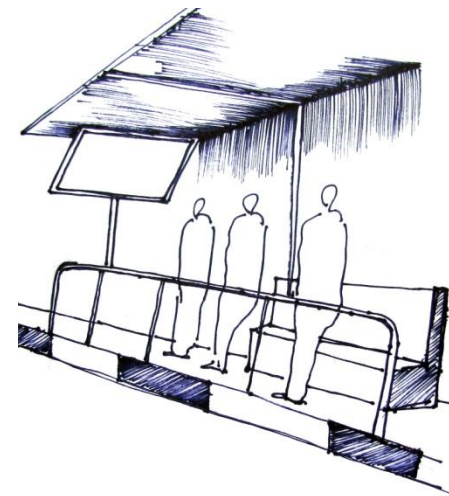


Fig. 31. Indicator at bus stop to give real time status of buses



Fig. 32. Mobile phone alert when destination is about to come



Fig. 33. Passenger requests for driver

In bus

-The users know that at which stop they should get down to reach their destination. But sometimes they miss their stop as they fall asleep

Design Idea

1. The mobile phone could give alert when the destination stop is about to come

-Some passengers stood at exit just before their stop arrives (near bus driver) and ask bus driver to stop the bus at their stop.

Design Idea

1. Conductor could issue tickets using an electronic device. So, the destinations of all the passengers gets automatically logged in and the stops where the driver must stop could be given to the driver.

-Some of them preferred to work or study or read during while they are in the bus.

6.2. Non-regular commuters

They are non-regular on a particular bus route or place. They often travel by other means of transport, mostly by Mumbai local train. Some travel by Taxi or Auto-rickshaw or own a private vehicle. Even a regular commuter could be a non-regular if he/she is at a new place or going to a new place by bus. So, while going to a new place they prefer to travel by transport which is most familiar to them. They travel by BEST bus only if it is the most convenient option or the only option. The non-regular commuters gather information from the regular commuter or people who are familiar with those places (relatives, friends or fellow passengers)

The rigid information they have/know is the address of the place where they need to reach and from the place they would start their journey.

The problems and needs of regular users are also faced by non-regular users but in addition to the above mentioned problems they have some more problems and needs.

Before beginning the journey

-If they are at a new place and going to a familiar place, they need the following information

- location of the nearest bus stop from where they could get a bus to their destination
- the buses which they could catch to reach their destination

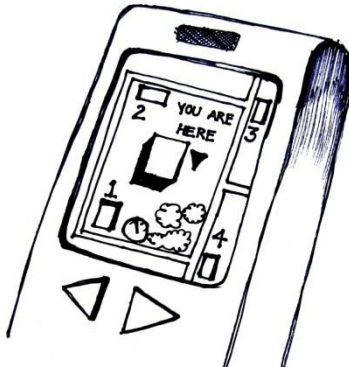


Fig. 34. Location of nearest bus stops on mobile phone

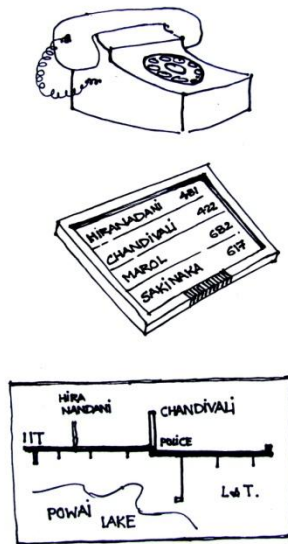


Fig. 35. Modes of getting information

-If they are traveling from a familiar place to a new destination, they need the following information

- the name and location of the bus stop nearest to their destination i.e. the bus stop at which they should get down
- the buses which they could catch to reach their destination

-If they are travelling from one familiar place to another, but they are not aware of all the bus routes to reach the destination. So, they need to know all the possible options and the best of those options.

Design Idea

1. Since they have addresses, the nearby bus stops could be located and the results (bus routes) could be generated accordingly.
2. A kiosk could be installed at the bus stop which could give all the option i.e. bus routes to reach the desired destination
3. An application could be used on mobile phone or website to do the same
4. There could be a telephone helpline/IVRS system for the commuters to get desired information above information.
5. There could be a route map on each bus stop which helps the user to find the bus routes

-Some also need to know the fare so that they could take decision of selecting a particular bus route and whether to buy a one day pass of Rs20.

In Bus

-If they are going to a new place then they do not know when their stop would come and where it is located. So they need an alert just before their destination stop arrives. In the current state they ask the fellow passenger or the bus conductor alerts them, but quite often the conductor is busy issuing tickets and fellow passengers are not aware of names of all the bus stop at which the bus halts.

Design Idea

1. An automatic announcements as well as the route could be displayed on the LCD screen inside the bus. The volume of the announcements could be automatically adjusted as per the surrounding noise levels.



Fig. 36. Display and announcements inside bus

6.3. Observations particular to starting stops/Depot

- Queue discipline was followed
- At some Stops, Conductor issued tickets to the commuters standing in the queue
- Buses arrived at the stop and departed after 10-15mins

6.4. Observations particular to Intermediate stops (Not Depot as intermediate stop)

- Queue discipline was not followed. People rushed towards the bus as it arrived at the stop.
- Sometimes the bus drivers did not stop the bus at the stop as the bus was too crowded to take more passengers.
- Buses arrive at the stop and waits only till the commuters get in the bus.
- Sometimes many buses come to the stop just one behind the other.

6.5. Third Category of Commuters

After the user studies, a new category of commuters emerged on the basis of how they travel in BEST buses. They are regular users of BEST service but they often travel to new places i.e. on new routes. They are mostly marketing/sales person who need to travel to many new places in a day. For them, time is very crucial. Comfort is always low in priority. They travel a lot, so, they have a clear conceptual model of road map of Mumbai. They also have a lot of experience of traveling in BEST buses. So, they know most of the bus stops and bus routes in Mumbai.

Their travelling pattern could be best explained through an analogy. Consider the roads of Mumbai as river beds and the BEST bus network is the water flowing in these river beds. On major roads (highways) the flow of buses is high i.e. many buses ply. These buses either branches out from or merges into the major roads (highways) to main roads i.e. tributaries. Hence, the number of bus on highways is more compared to other roads. So, these commuters, instead of waiting for a direct bus, they catch the first bus arriving at the stop which would take them to the nearest road on which the flow of buses is high. From there they again catch the first bus which would take them nearer to their destination and they continue this pattern. They do not wait for a direct bus to their destination because either it might have a long route or its frequency is low or there no direct bus at all. Once in a bus, they always stand at the entrances or exits to change buses and keep an eye on buses coming from behind or ahead so that they could immediately change the bus.

By travelling in this pattern one saves the waiting time at bus stops. If one sees such commuters from a bird's eye view, it resembles as if they throw themselves into the river of buses and just flow with the stream and change the stream when needed to reach the destination. This type of travelling pattern was also seen among few regular commuters when they are late to their work place.

To travel in this pattern, one needs to have a good idea of road map of Mumbai, bus routes and bus stops. If one doesn't know any of these then they build up a good partnership with the conductors and get all the needed information.

Design Idea

1. This pattern of travelling could be used in algorithms to generate a travel plan for each bus approaching the stop and given to the user to reach the destination. All the travel plans corresponding to each bus could be displayed on the user mobile phone. And when the user is at a bus stop or gets into a particular bus of his/her choice the mobile will detect it and guide the user throughout the journey till he/she reaches the destination. If the user gets down at wrong stop then again a new plan will be generated to reach the destination and the mobile phone will guide the user as if a conductor or fellow passengers in bus or fellow commuters at stop would help.

6.6. Other Findings

Many commuters, regular as well as non-regular, travel by different means of public transport such as bus, train and taxi/auto-rickshaw to reach their destination. They do this because either there is no direct means of any of these to reach the destination or travelling by any one of them is too time consuming or costly or uncomfortable. So, information system of all the modes of public transport could be integrated together.

6.7. Insights

Time, cost and comfort are the three things which matters to a commuter. The priority of time, comfort and cost varies from one individual to another. So, they require various information in order to take various decisions to satisfy their requirements of time, comfort and cost with respect to the present circumstances.

In order to make BEST bus as peoples' first choice of transport it must be more predictable and people must have knowledge about the network. Eg. The regular announcements of the next station in local train, the route maps on every platform and trains and list of stations on fare table always increase the knowledge of the passenger about the names of various stations on the route. This makes the railway network more familiar to the commuters.

7. User Goals and Constraints

After identifying the needs and problem, the following user goals were identified

- User must be able to catch a bus which suits his/her comfort and time requirements.
- If a user misses the preferred bus then he/she must have real time information to make correct decision regarding alternate travel plan
- User must get the desired information whenever required.
 - Bus stop's name and its location,
 - Bus route number, route map,
 - Fare
 - Arrival time of the bus at a bus stop and reaching time of a bus at the desired destination
 - Crowd at a bus stop and in a bus
- User must not wait for a desired bus for long time at the bus stop.
- User must spend less time travelling in the bus.

The above user goals must be satisfied keeping in mind the following constraints

- Mumbai has a multilingual environment.
- The tech savviness of the commuters varies.
- Literacy level of the commuters also varies.
- Commuter may or may not carry a mobile device.

- The mobile devices which the commuters carry while travelling vary from hi-tech to low-tech.
- Cost of implementation of devices at stop/in bus if any must be as low as possible.

8. Design Decisions

The results of user studies clearly indicates that the commuters face problems and have specific needs at every stage of the journey i.e. before beginning the journey (at home or work place), at bus stop and in the bus. So, the situation demands such information system which interacts with the commuters at every stage of journey.

So, there could be a website which gives real time data. The website could also be accessed through kiosks at key locations such as railway stations, shopping malls, Hospitals, bus stops, government buildings, tourist places, banks, ATM etc. The list could be endless. And maintaining the Kiosk at various locations could be challenging. Also, if the security of kiosk is not taken care of then it would result into vandalism.

The information system must be such that user get all the needed information at anytime and from anywhere before beginning the journey. And the user arrives at the bus stop just in time to catch the bus. This could be done by using mobile phones or landline phones (PCOs) as a means to provide the information to the user. As user's mobile phone is with the user throughout the journey, all the information required at every stage could be available. Also, the information could be personalized. But then the set of people without mobile phone will not be able to access the information. So, an indicator at bus stop and in buses and a helpline service on telephone could be provided to get the information. The advancement in

technology and dropping costs of mobile phones will increase the mobile penetration in Mumbai and this will eventually reduce the burden on the helpline service. The indicator and helpline service could be continued as it will provided redundancy in case of failure in mobile system. Along with indicators at bus stop, printed information showing list of bus stops and all possible route number of buses halting at those stop or a route map of entire bus network could be placed on each bus stop.

9. Final Concept

9.1. Mobile based system

Inverted pyramid approach is followed while designing the interface for the mobile application. All important information is displayed on the first screen. The user just needs to view the required information when necessary. In this approach, the user does not have to waste time navigating through several screens to get the desired information.

9.1.1. Scenarios

Regular Commuter

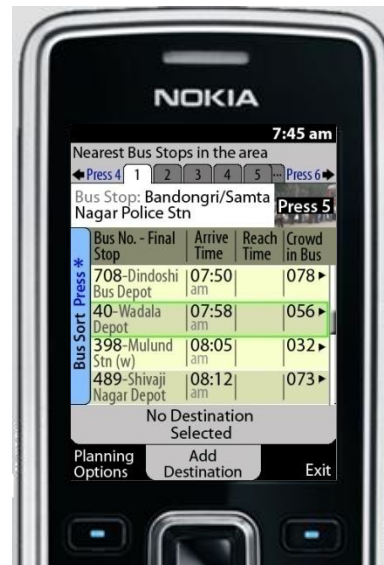


Mr Sarnaik is an employee in a firm near IIT. He has to leave his home by 8am to reach by 9am. He has some important work at home and does not want to waste his time at the bus stop waiting for bus if it is late. He has options of catching buses from a stop at east or at west. So, he simply turns on the application and views the status of the bus stops (crowd) and the desired buses (arrival time & crowd in bus) at the nearest bus stops in his area and leaves his house accordingly. (The nearest bus stops are found by locating the location of his mobile phone.)



He reaches the bus stop at the right time and again checks the status of the buses. At this time when he turns on the application, the mobile phone detects that he is at Bandongri bus stop (by blue tooth or WiFi at bus stop) and shows the status of all buses approaching that stop. He finds that his bus is about to come and gets ready to catch the bus.

Non Regular Commuter



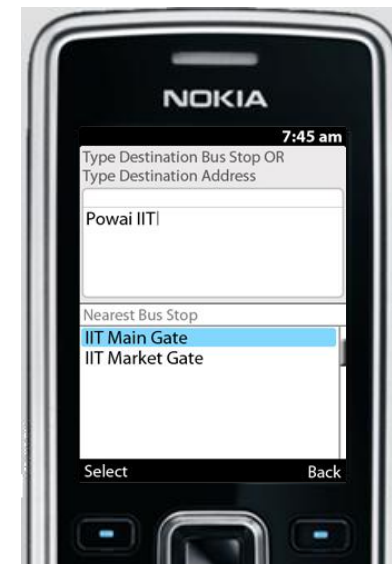
Mr. Srivastava has an interview in a firm in Powai. He has only the address of that firm. He has never been to Powai. He wants to reach that place on time and comfortably. So, he turns on the application and selects the planning option to find an appropriate bus for him.



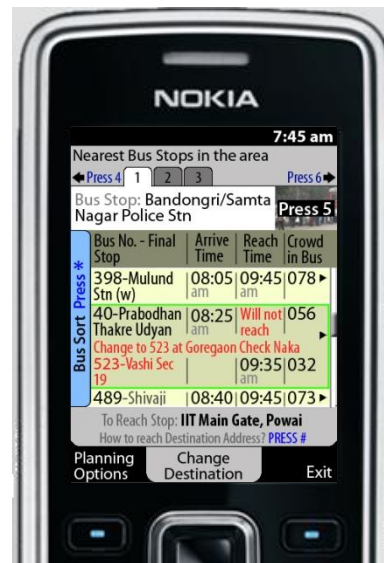
He enters the time at which he wants to reach and then selects to enter the destination address



He finds a list of the bus stops he recently and frequently visited. As he has never been to Powai before, he selects to type the destination address



At first he finds a list of all the bus stop in Mumbai. As he starts typing the address of his destination, the search becomes narrower. On typing the complete address he gets a bus stop which is nearest to that address.



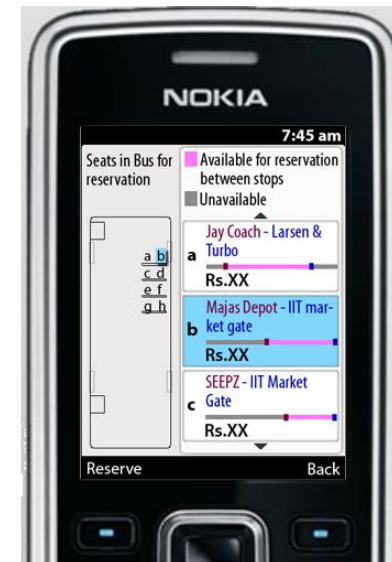
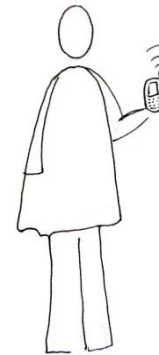
He comes to know the nearest bus stops from where he could get buses to reach his destination. He finds a least crowded bus and selects to make a one break journey. He selects that result to view its details.



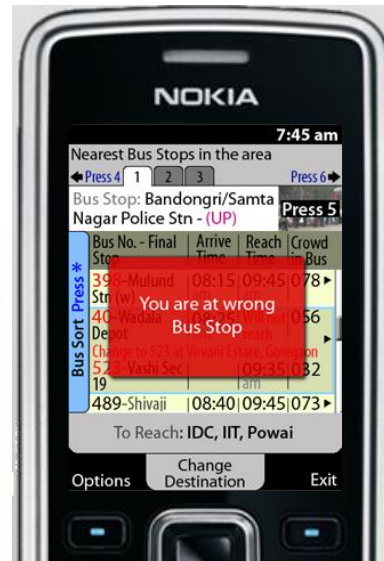
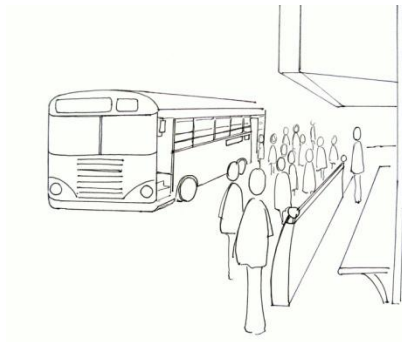
In details, he could see the route of his journey



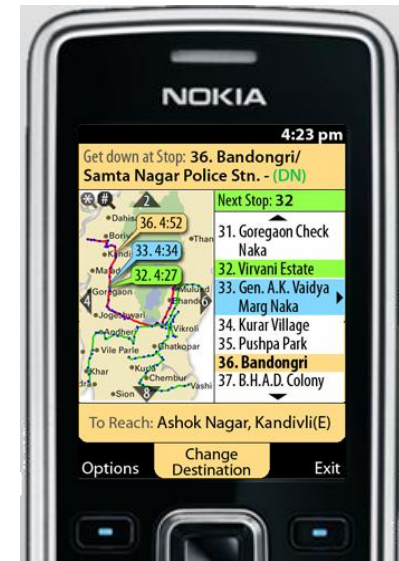
He can see a photograph of crowd in the bus. He selects to reserve a seat in the bus.



He reserves two seats, so that, he could get place to sit throughout the journey.



He reaches the bus stop on time to catch the bus. If he is standing at the wrong bus stop then the application will alert him.



When he gets in the bus, the mobile detects that the user is in a particular bus with the help of bluetooth or WiFi in the bus. He can see the route of the bus and its current location. The mobile phone alerts him in advance when he is supposed to get down at a bus stop.

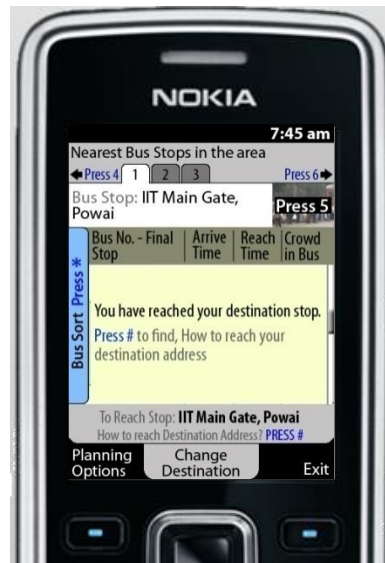


He can also choose to see the information of the buses that would reach the coming next bus stops after his bus reaches that bus stop.

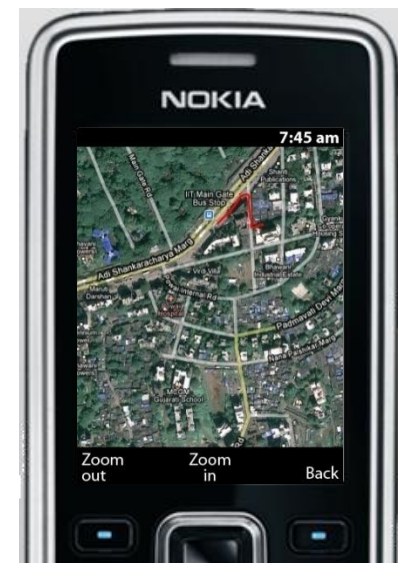


His phone alerts him when he is about to reach his destination bus stop.





He gets down at the bus stop.



He presses # to know the path to reach his destination address and reaches the place on time.

9.2. Indicators at bus stop

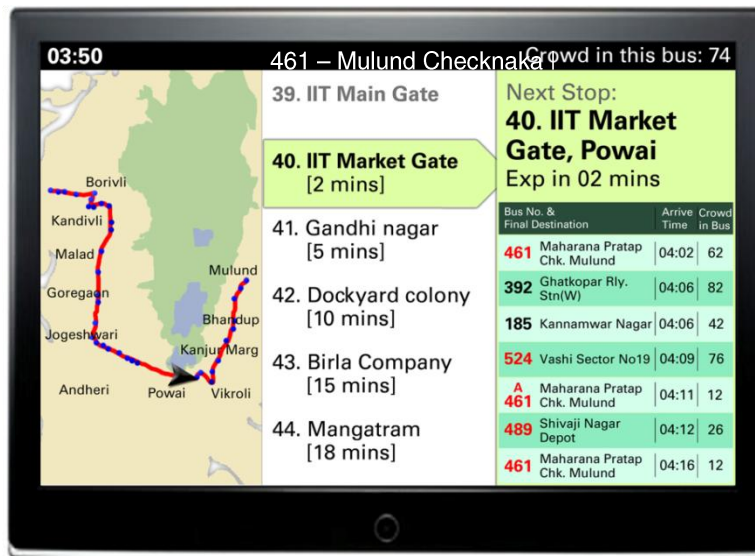
The indicator would display the following about the buses approaching the stop.

1. The bus route number – Final destination
2. Time of arrival
3. Number of people in the bus (Crowd)

The time and crowd shown in grey gives information about the next bus. Eg. The next 524 would arrive at 04:26 i.e. 5mins after this 524 departs and the number of people in the next 524 would be 48.

The bottom most row, rolls continuously and shows the arrival timings of all the bus routes which halt at that stop. This row is sorted w.r.t time. So, it is like a queue waiting to get updated in the above rows.

Bus Route No. & Final Destination बसमार्ग – शेवटचे स्थान		Time वेळ	Crowd गर्दी
524	Borivli Rly. Stn. (E)	04:21	62
	बोरिवली रेल्वे स्थान (पु)	04:26	48
409	Chandivli	04:22	43
	चांदिवली		
522	Marol Depot	04:23	56
	मरोल बस स्थान		
496	SEEPZ	04:24	52
	सिपझ		
445	Agarkar Chk, Andheri Stn (E)	04:24	68
	आगरकर चौक अंधेरी स्थान (पु)	05:05	
460	Gorai Depot	04:25	54
	गोराई बस स्थान	04:27	43
602	Hiranandani	04:25	34
	हिरानंदानी	04:46	28
307	Marol Depot	04:26	46
	मरोल बस स्थान	05:34	
489	Dahisar Bridge	04:26	69
	दहिसर पूल	04:42	56
382	Sahara Cargo Complex	04:26	53
	सहारा कार्गो संकुल	05:20	
524	460	403	AC 461
04:26 48	04:27 43	04:29 54	04:32 32
04:30 46	04:34 52	04:57	05:38



9.3. Indicators inside bus

The indicators inside the bus would display

1. Bus route number, name of final destination and crowd in the bus.
2. The bus route on a map.
3. The name of the next stops and expected time to reach those stops.
4. List of all the bus route number, final destination, arrival timings and crowd in the buses which would be arriving after this bus, at the next stop.

Also announcements would be made about name of the next stop and expected time to reach the next stop.

So, a user without mobile phone application could take help from the helpline to know about bus routes or real time status of buses to reach the destination and reach the stop accordingly. The indicator at bus stop would give a conformation. And the indicator and announcements inside bus would help the user to get down at the desired stop.

10. References

[1] B. E. S. & T. Undertaking, Omnibus time table-cum-fare table, January 2009

[2] <http://www.mid-day.com/news/2009/jun/020609-BEST-buses-passenger-information-system-LCD-screens-Mumbai-news.htm>

[3] <http://www.mesn.org/mumbai%20traffic%20stats.html>

[4] <http://www.mesn.org/mumbai%20traffic%20stats.html>

[5] www.sbstransit.com.sg

[6] www.ltconline.ca

[7] Advanced Public Transportation Systems: The State of the Art Update 2006, Federal Transit Administration, U. S. Department of Transportation

[8] <http://www.bestundertaking.com/transport/index.htm>

[9] <http://www.cse.iitb.ac.in/navigator2/Main>

[10] <http://www.mid-day.com/news/2009/jun/020609-BEST-buses-passenger-information-system-LCD-screens-Mumbai-news.htm>

[11] <http://timesofindia.indiatimes.com/city/mumbai/GPS-in-BEST-buses-to-aid-commuters/articleshow/4396020.cms>

[12] <http://www.business-standard.com/india/news/best-buses-to-have-gps-to-facilitate-commuters/58500/on>

[13] http://www.network2media.com/index.php?option=com_content&view=article&id=555%3Aequifone-solutions-to-install-bluetooth-more-screens-in-best-buses&Itemid=3