

e-BusGuide: An IT-based Approach to Improve the Profitability of Bus Transportation Systems in India¹

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Abstract

One of the problems faced by Bus Transport Systems in India is low occupancy rate. Efforts are being made by Bus Transport Corporations to improve bus occupancy by requesting the public to use buses over other modes of transport. One of the reasons for low occupancy is that a passenger normally does not know the bus scheduling information, and bus-arrival timing information to bus-stops. Trends in wireless technology have resulted in most of the passengers owning mobile phones. We believe that by providing reliable bus-route and real-time bus arrival information to passengers' mobile phones, it is possible to improve the bus occupancy. In this paper we propose an architecture of IT-based Bus Information System (called "eBusGuide") which aims to improve the bus-occupancy by providing bus-route and arrival information to passengers in a timely manner. The proposed system can be built using available Internet/Web technology and messaging service provided by mobile phones. The profitability computation by considering the case of local bus transport system in Hyderabad (India) shows that it is possible to double the profitability, even eBusGuide attracts one percent more passengers. In addition, with eBusGuide, it is possible to improve the quality of bus-service, work culture, passenger satisfaction, environment and profitability of tourism department.

During last decade one can observe that progress in information technology (IT) is affecting all spheres of our life. Due to progress in hardware technologies, we are able to procure high-speed reliable computers with huge storage capacities at affordable cost. Also, database and data warehousing technologies can be used to store and retrieve large amount of information, that can be coupled with Internet/Mobile technology to deliver information instantaneously to the needy. Recent IT developments enable the maintenance of huge information (text, image, sound and video) repositories with negligible down-time. The stored information can be quickly extracted by millions of users simultaneously. Currently Internet speed is doubling every nine months [1]. Within a decade, it is possible to provide instantaneous connectivity (both ways) to millions of people (Indian population) enabling mass customization and personalized services. Also, data mining technology can be used to extract useful knowledge from huge databases and simulation technology can be used to predict into future [2]. Such IT based developments provide new opportunities to improve the utilization and performance of livelihood technologies such as agriculture, education, library, health and medical services, transportation, and artesian technologies. The research challenge is to identify the areas where progress in IT could be effectively used to improve the performance of these services and technologies, and build cost effective IT-based systems that improve the living standards and convenience of people. In this paper we made an effort to improve the utilization and performance of Bus Transportation Systems by exploiting recent progress in IT.

Bus is a convenient and economical mode of transport for long as well as short distances. In India thousands of buses are being plied daily to help public in reaching destinations quickly, economically and

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conveniently. However, bus transport is facing several problems to improve efficiency. One of the problems is *low occupancy rate*. Bus Transport Corporations are making efforts to improve bus occupancy by requesting commuters to use buses over other options for travel.

One of the reasons for low occupancy is that a passenger normally does not know the exact arrival information of a bus to the bus-stop in advance. Also, several passengers do not know about scheduling information. Normally, a passenger reaches bus-stop and waits for some time; if bus does not come, he/she opts for other alternatives which will enable to reach the destination quickly by opting other modes of transport. It is possible to motivate a passenger to opt for bus by providing the exact time of arrival to the bus-stop along with scheduling information. One way to know the arrival time is through time-table booklet. However, very few passengers own time-table booklets. In addition, due to traffic jams and other reasons it is very difficult to ply the bus according to the schedule. It can be noted that if the passenger knows with high confidence that the bus is going to come, he/she will definitely wait rather than opting for other modes of transport. So, we believe that more passengers opt for bus transport, if we provide the arrival timing information of bus (to the bus-stops) and route information in a real-time manner.

Trends in wireless technology have resulted in most of the passengers owning mobile phones. We believe that by providing bus-route and arrival information to passengers' cell phones in a timely manner, it is possible to improve the bus occupancy. In this paper we propose an architecture of IT-based Bus Information System (called "eBusGuide") which aims to improve the bus-occupancy by providing bus-route and arrival information to passengers in a timely manner. The proposed system can be build using Internet/Web technology and messaging service provided by mobile phones.

With the proposed eBusGuide, it is possible to provide the timing information about bus-arrival to bus-stops in a timely manner. Also, the system provides optimal routing information with respect to cost and time based on the source and destination bus-stops. Passengers can access the information through Internet and Internet enabled mobile phones.

The main motivation is to attract more passengers to opt for bus-transport by providing them reliable timing and scheduling information. Also, according to the current trends in mobile communication technology, majority of the passengers are going to have mobile phones as the cost of the mobile phone and corresponding services is decreasing year by year. Also, increasing number of people are going to have computers with Internet access at home as the cost of the computers and Internet service is falling. By designing a web-portal that contains the details of bus timing and scheduling information, it is possible to attract more passengers to bus-travel.

The objectives of eBusGuide is to provide people, especially the traveling community access to information, which would allow them to choose the optimal route and at the same time effectively manage time. The problem involves being able to provide the users with information regarding the availability and schedules of the various buses plied by Bus Transport Corporations. The user should be able to plan his travel according to the information provided to him by an on-line portal. He/She should be able to decide which of the routes available is the best possible based on the information provided by the on-line portal. The user should also be provided with information about the fare on the path chosen by him, so that he could make a conscious decision based on either the distance or timing or the fare. The list of objectives of eBusGuide is as follows.

- Real-time information regarding bus-arrival to the bus-stops
- Timing/Frequency of the various buses.
- Buses connecting various places of interest to the passengers.
- Optimum path by considering time-duration, distance and fare.

We believe that the proposed system improves the bus occupancy especially during non-working hours and holidays by helping the passengers in making the appropriate travel plans in advance. Also, by disseminating reliable arrival timing information of bus to bus-stops, to passengers, through mobile phones and internet, it motivates the passengers to opt bus for travel over other alternatives modes of transport. With eBusGuide, the profitability of Bus Transport Corporations could be increased significantly. In

addition, it is possible to improve quality of service, work culture, user satisfaction, environment and profitability of tourism industry.

eBusGuide Architecture

The proposed information system should provide the passengers the timing information regarding bus arrival and routing information in an online manner. Figure 1 shows the architecture of the proposed system. The proposed system can be divided into three parts: Input/Output, Information System, Users.

i) Input/Output:

- **Input:** The input to the system comes from several sources: Passengers, Bus drivers, and Administration.
 - i. Passengers' input includes the names of source and destination bus-stops with time and date information to know the alternative schedules. Passengers may give the name of the bus-stop and destination to get the timing of the next bus arrival. Also, they can browse the required information.
 - ii. Bus drivers: We provide a communication instrument (mobile phone) to bus-drivers. They send a message to the Web portal through Internet by informing the position and identity of the bus.
 - iii. Administration: The input consists of routing information in the form of new routes, modifying existing routes, withdrawal of existing routes and changes in fares and so on.
- **Output:** The output from the system consist of arrival timing information, routing information with travel cost, scheduling information, other interesting information for convenient travel.

ii) Information System:

The information system consists of database, middle-ware and user-interface (web browser). It contains the routing information, distance information, pricing information, scheduling information and so on. Based on the input supplied by the user, the system returns appropriate answer to the user. The system can be accessed through a web-browser.

iii) Users:

Main users include passengers, administrators, and bus drivers.

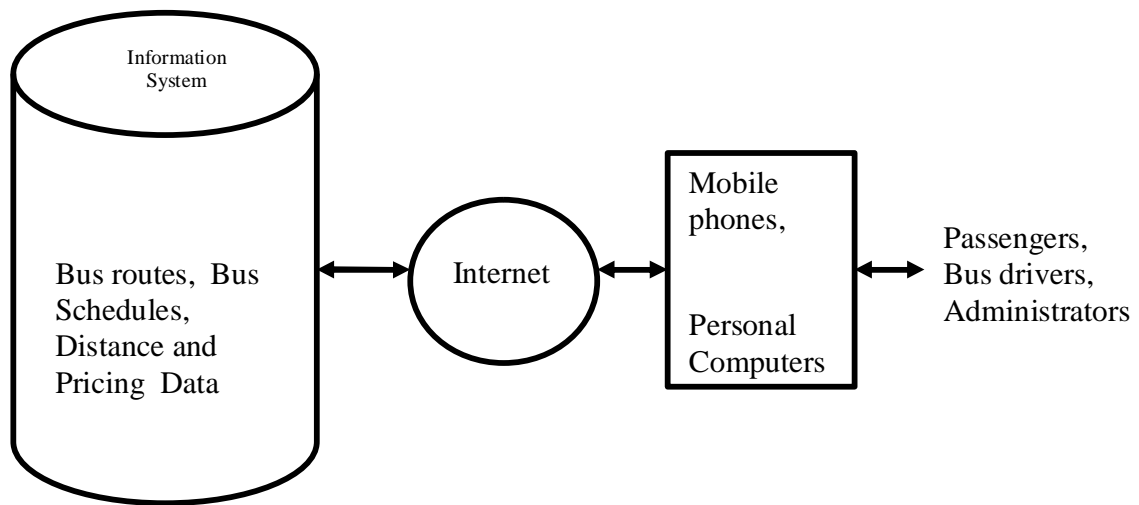


Figure 1: eBusGuide Architecture

Operation of eBusGuide:

At first, all the bus route, schedule, distance and pricing data is entered into the system. Appropriate algorithms will be developed to retrieve optimal paths based on the source and destination information supplied by passengers. The passengers can access the web-portal and get the scheduling information by supplying appropriate input data.

Once a bus starts, the system provides real-time information regarding bus-arrival to the bus-stops in the following manner. The driver of the concerned bus sends an SMS message to the web portal at appropriate intervals (for example, once in every 30 minutes). Based on this information, the system computes approximate arrival time of the bus to the bus-stops. The passengers can access the web site through Internet enabled mobile phones or computers to access the bus-arrival information.

Discussion of cost-benefit analysis

To analyze cost-effectiveness, we have considered the Local Bus Transport System in Hyderabad operated by Andhra Pradesh State Road Transport Corporation (APSRTC), Hyderabad. The details regarding bus transport system in Hyderabad (India) are as follows (as of March 2005).

- On an average, on each bus schedule the APSRTC, Hyderabad spends Rs.4536/- per day having 2544 schedules daily. The total expenditure comes to Rs.1,15,39,584/- (about Rs. 1.15 crore).
- In Hyderabad, daily, about Rs. 31 lakhs passengers travel by bus.
- On an average, the utilization of a vehicle is 252 KM/day. The operational cost is Rs. 17.60/- per kilo-meter. The average income per KM including government subsidy is Rs.18.05/- per day. Daily, about 7,00,000 KMs are being covered by all busses.

The daily profit equals to = $7,00,000 * (18.05 - 17.60) = \text{Rs. } 3,15,000/-$

Calculation of extra benefit with eBusGuide:

Assume that each passenger spends about Rs 10/- per day (on average). Consider that the proposed eBusGuide attracts additional one percent passengers. The one percent passengers equal to 31000 (equal to 31 lakhs *0.01) .

The extra income that could be earned by APSRTC for Hyderabad region by attracting one percent passengers comes to 3.1 lakhs (equal to 31,000 * Rs 10/-) .

Note that the additional income is approximately equal to the daily profit which is being earned by APSRTC for Hyderabad region. So, we can conclude that if the proposed system motivates even one percent additional passengers for bus, the current APSRTC's income could be doubled.

Discussion on system cost: Note that the main components of the system cost are human resources, hardware system (computers and mobile phones) and software system. Note that the cost of hardware and software comes under non-recurring which can be used for longer time (over five to 10 years). The human resources and maintenance costs come under recurring costs. By putting appropriate figures, one can observe that as compared to the extra benefit, the expenditure is very less.

Advantages and Beneficiaries

We now list the advantages and beneficiaries of the proposed system.

Advantages

- The profitability of Bus Transport Corporations will be increased as more passengers will travel through bus. This approach helps the transport application to increase the quality of service and user satisfaction.
- The conductors and bus drivers will get more job satisfaction. The work environment will be changed. The notions of timely and reliable service will be cached by the employees in the department.
- The passengers enjoy more consistent and lower journey times together with accurate well presented real-time information.
- The better quality of service encourages modal shift and reduces the environmental effects of traffic due to a lower number of trips by cars and other motor vehicles.
- This will help population to make tourism trips, picnics on weekends and holidays. This will be highly useful for non-regular passengers and regular passengers during holidays and odd hours.

Beneficiaries

- Bus Transport Corporations: The main beneficiaries would be Bus Transport Corporations/Companies. The profits and quality of service will increase. Work environment will improve.
- People/Society: Passengers travel safely and economically. The number of deaths due to accidents would be reduced.
- Environment: There would be less environmental pollution as relatively people reduce adoption of four- and two- wheelers.
- Tourism: The people can plan tourism trips for Sundays and holidays by sitting at home. As a result, the earnings for tourism department would be increased.

- Government: As increased number of people is opting for bus travel over four wheeler travel, there is less fuel consumption. So environment will be improved.

Related work

In this section we briefly describe some research efforts that are being made to provide real-time bus information to the passengers.

In [13], an agent-based architecture has been developed to provide accurate information about bus location and arrival times to Dublin Bus users. In this each bus is equipped with GPS receiver. The mobile phones are also GPS enabled. The system capture the users position and bus position through GPS, and provides appropriate routing and travel information to the passengers. In [14] a mobile user based application prototype system has been discussed. That system guides the user by calculating the best route by using mobile user position and geographic database of one local area. Through simulation it has been shown that public transport application can improve the quality of service and the user satisfaction. In [15] a real-time transit vehicle information system is reported that delivers content to Internet-enabled mobile devices. Based on scheduling information, the proposed system MyBus predicts the arrival information of the bus to the bus stops. In [12] a small prototype system has been reported which gives optimal paths given source and destination information. Experiments were conducted on the data set of 300 routes to extract paths preferred by commuters by employing a combination of shortest path algorithms, dynamic programming and heuristic based approaches. The results show that the system provides the bus-route information to the user with high accuracy.

The proposed system in this paper differs due to the fact that it is a cost-effective system and can be developed by using messaging and Internet services. No additional infrastructure is required to build the proposed system. It can be developed and tested incrementally.

Conclusions

In this paper we have proposed an architecture of IT-based information dissemination system to improve bus occupancy by disseminating bus-scheduling, and bus-arrival information to bus-stops. The proposed system can be built with available technology such as database, Internet and mobile phone. By considering the statistics of local bus transportation system in Hyderabad, an approximate profitability computation shows that it is possible to double the profitability even one percent more passengers opt for bus transport due to the proposed system.

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