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Information Technology in public transports of India – A ubiquitous approach

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Abstract: Almost all the developing countries in the world besides the US, UK, Australia and Japan strive to meet the demand of safe, fast and reliable transport services. Lack of operational efficiency, aging transport systems and practices are haunting to bring about a massive change in the transport infrastructure. Information Technology plays an important role in this aspect by sheathing the existing transport services with recent technology in offering a better passenger experience. The transport system of India is a huge area of consideration with its tremendous role as a stakeholder in national economy. India's transport system is one of the most heavily used transport systems in the world with its public transport domain consisting of railways and a handful of road transports, water-transports and airways. If the existing public transport facilities are flanked with the latest Information Technology enabled services, a further smart infrastructure with seamless transport facility could be obtained. Different prospective sectors of public transports where information technology could find its immense use are discussed in this paper, besides relating ubiquitous computing in this aspect. The smart models mostly include next-generation ticketing system, national transport tracking portal, and different other intertwined transport facilities under a common nationalized umbrella. Providing transport facilities in an efficient and simplified manner, that too in a ubiquitous fashion, would definitely contribute to the advancement of India, to a goal of Vision 2020.

Keywords: Information technology, ubiquitous computing, unique identity (UID), GPS, Aadhaar, tracking.

I. INTRODUCTION

The transport system of India is a huge area of consideration with its tremendous role as a stakeholder in national economy. India's transport system is one of the most heavily used transport systems in the world with its public transport domain consisting of railways and a handful of road-transports, water-transports and airways. The demand for the transport infrastructure and services has been rising by around 10% a year with the current infrastructure being unable to meet these growing demands. Public transport is the predominant mode of motorized local travel in cities. But most of these transport facilities are devoid of the linkage with latest advancements in Information Technology. If the existing public transport facilities are flanked with the Information Technology enabled services (ITES), a further smart infrastructure for public transport could be obtained.

Ubiquitous computing is an infant sector of computer science which promotes the availability of service in a wide domain. Basically the incorporation of ubiquitous computing in the existing transport facilities would provide a wide interlinked network of transports, which would be accessible to everyone and everywhere. This paper discusses the different issues in this context and points out the resource-areas for incorporation of Information Technology (IT) flanked with a ubiquitous approach in the existing public transport system in India.

II. DIFFERENT PUBLIC TRANSPORTS IN INDIA

The public transport system in India is multifarious. But most of these public transports are distributed in their own way of variance. The services if linked together in a common portal would be more efficient and available for a greater domain. Hence a ubiquitous inter-linked model is proposed in this perspective. Since the entire transport model adds to a huge cluster, only the major aspects of the system are discussed. With the due course of time, the effectiveness of devising smart transport systems is felt strongly. With the tremendous increase in vehicles in the recent years, methodologies need to be developed in controlling such sectors efficiently. With the induction of Information and Communication Technology (ICT) in this sector, it would be possible in harnessing the efficiency concealed within the vast domain of public transports in India.

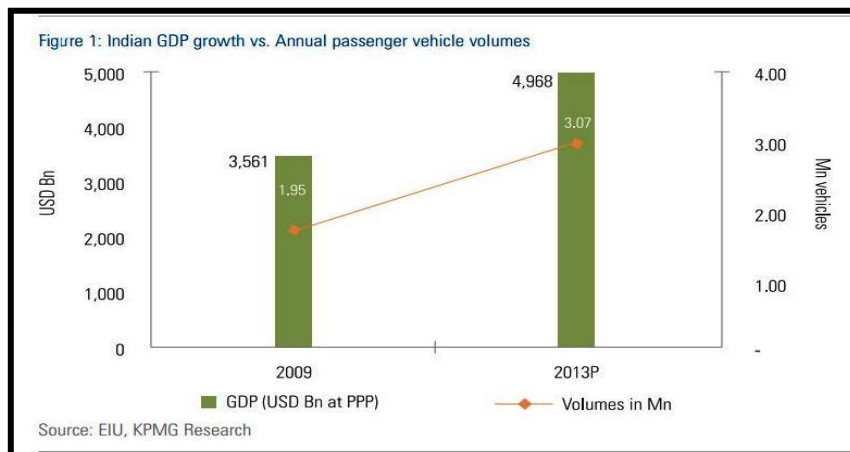


Fig. 1: Indian GDP growth vs. Annual Passenger vehicle volumes

The development of the public transport sector would definitely affect the GDP of India positively. Investing upon the development of IT infrastructure linked to the public transport sector would be extremely viable from business point of view.

III. RAILWAYS PROPOSED INITIATIVES

The railway network in India is one of the largest of its kind in the world. Daily more than 25 million passengers travel with Indian Railways in about 10000 trains running daily. So implementing a slightest technology in this huge system would be a herculean task. But for the sake of better passenger experience the integration of advanced Information Technology is needed very much.

Considering different aspects of development, the first focus lies on the ticketing system. Passenger Tickets are of two types, reserved and unreserved. Also, the present reservation system has two outlets, through the reservation counters and the Online ticketing system. Booking a reserved ticket implies manually entering all the passenger data (E.g. Name, Age, Sex, Address, Phone number etc.). This involves an immense overhead entering the passenger data to the system every time a person books ticket. Also, this overhead multiplies with the number of passengers travelling and booking reserved tickets for multiple trains, even though the passenger data remains the same. An alternative approach is proposed to get off this overhead by using a ubiquitous system. This introduces the linkage of Unique ID (UID) and an inter-database query system between the railways and the Unique Identification Authority of India (UIDAI). As for consideration, Aadhaar Number serves as UID in India. Again, different data associated with and stored in the UIDAI database are "Name", "Address", "Age", "Sex", "Contact Number" etc.

An inter-database query service is proposed, that would accept simply the UID (Aadhaar Number) from the user, send the same to the UIDAI database, and fetch the necessary details of Passenger. These details would be directly fed into the ticketing system and the entire overhead of manual entry could be bypassed.

Besides bypassing the overhead of manual entry, this UID-linked model would be a more secure and comprehensive approach in identity verification for passengers travelling in reserved accommodation in trains. Also tracking a suspected person for security reason using this system would be easier. This UID-based reservation would lead to generation of photo-reservation

charts (bearing photographs of all the passengers travelling) which would be even more efficient in verifying the identity comprehensively, and eradicating the chance of false-personification, which is often experienced these days. This could also be used in preparation of photographic reservation charts (Reservation charts containing photographs of the passengers) which would be an efficient step for identity verification of passengers travelling in reserved accommodation of Indian Railways.

Also introduction of smart automatic ticket vending machines (Smart ATVM) is proposed. ATVMs are already implemented in different stations. But these ATVMs are presently employed to book the unreserved tickets only, that too in urban and suburban trains. To improve the current scenario these ATVMs need to be equipped with the facilities to book reserved tickets also. Passenger data needs to be input to the system but this involves a huge overhead every time. This could also be bypassed by entering just some unique identification numbers like UID or PAN or Voter Card Number. But to implement this, a seamless inter-database query exchange is needed for providing a sole technology in simplifying the existing passenger reservation system. For e-ticketing system, similar system can be implemented using verification by OTP in registered mobile number. Booking of unreserved tickets via SMS would also be another step in simplifying the ticketing system and posing a ubiquitous approach.

An example will illustrate the working of Smart ATVM. In the smart ATVM, a person to buy ticket would just have to enter his/her unique ID number like UID/PAN. Entering the number would generate a One-time Password (OTP) sent to the registered mobile number. Entering OTP in the system would complete authentication and the system would proceed to book the tickets. The authentication could also be done using biometric methods (e.g. Fingerprint, face recognition etc.) introduced in the smart Automatic Ticket Vending Machines. Coming to the E-tickets, authentication could be done in a similar method. A person seeking E-tickets will enter the unique identification number and will undergo similar verification.

Another important inclusion of ICT is proposed in the refund of ticket fare or other fares. A ubiquitous online portal would register the UID of the customer. Again UID is to be linked with the respective Bank Account of the customer. On cancellation of tickets or similar cases, the refund money could be directly transferred to the Bank Account. On one way it would facilitate cashless transactions. On the other hand, in the case of cancellation of trains, the refund fare could be directly credited to the respective Bank Accounts of the passengers linked with their UID (Aadhaar Number).

The smart ticket booking system could be a real pioneer of its kind in India. Though implementing such technology in this huge domain is a massive task, this would reduce the passenger-queue in counters a lot, providing a much more efficient approach stepping a leap ahead for Vision 2020. Besides ticketing system, other IT facilities are to be implemented in railways like introducing GPS facilities in every running train, free Wi-Fi in busy stations and trains (implementation has already started), online tracking service for Goods trains. An overall technology-based railway system would be a real boosting stakeholder in national development.

IV. ROAD TRANSPORTS

The road-transport system in India ranges in different sectors. But the chief public mode of road transport in urban and suburban areas can be broadly classified into buses, auto-rickshaws and taxis. The demand for passenger vehicles especially in the roadways has seen a sharp increase in the recent years. But the aging systems suffer a lack in the inclusion of recent technologies. By 2020, a huge gap would come out between the supply and demand of such transport services. This invokes the implementation of efficient road transports flanked with IT to cater a better passenger experience.

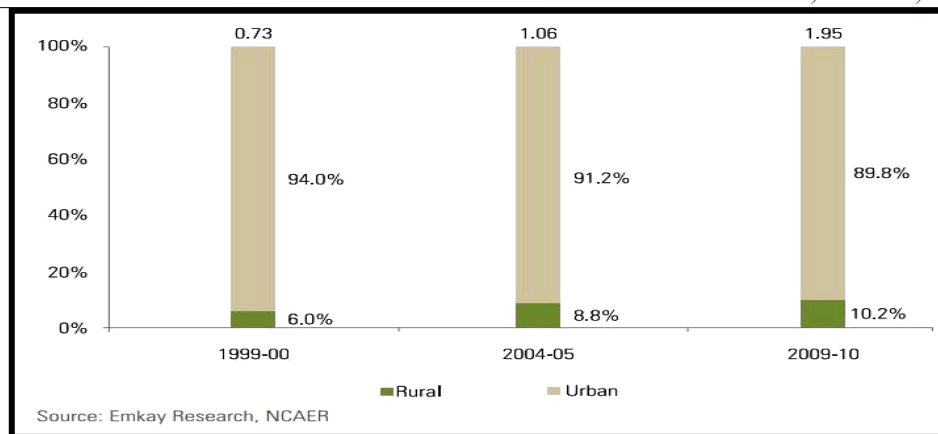


Fig. 2: Growth in rural demand for passenger vehicles

Since the road transports are not operated under a single entity unlike the Railway systems, it is more difficult to implement IT initiatives in this sector. However, the prime modes of road transports are separately discussed with a vision of implementing the proposed IT initiatives.

A. Bus

Buses ply in local urban and suburban routes, as well as in long distance inter-state routes. Primarily, GPS is proposed to be introduced in each and every bus to develop a ubiquitous tracking portal for buses. This nationalized portal for buses (similar to that present for Indian Railways) would provide comprehensive information about all buses, even the local urban short-distance buses. Basically the buses that ply in India are run by public and private initiatives or in partnerships. It is quite difficult to take the whole lot of private buses under the portal scheme at once due to its widely distributed and unorganized domain. For the proposed system to start, initially the Government-run buses are needed to be taken into account followed by the private buses. The second next focus area would be the ticket booking system. A nationalized portal needs to be there to facilitate the existing bus-ticket booking system. Basically booking bus tickets can be classified into long-distance routes and local short-distance routes. For the long-distance routes single portal online booking systems need to be introduced. Different private agencies already have their own online booking system for their own fleet of buses. These agencies may be allowed to run their own online booking system as usual but the system is proposed to be brought under the umbrella of the national bus portal. This would provide a single-window for booking in all the bus services in India.

Next comes the short-route buses running mainly in urban and suburban areas. To include all these buses in the online national portal is practically infeasible from the present point of view. But this too can be implemented in near future with step-by-step approach for inclusion. Initially the state-govt. run buses are needed to be included in this portal; if not possible comprehensively, the precise and approximate data about all the buses (bus schedules, route details, fare info etc.) needs to be included in the portal. Smart cards could be introduced with nation-wide validity; these cards could be punched while travelling. Also automatic ticket vending machines could be introduced in popular locations that would produce tickets for travelling in local/long-route buses. Luxury buses for long-route travel may be equipped with Wi-Fi facilities.

Similar smart ticketing services are proposed to be introduced in the case of short-route bus services in urban and suburban areas. Most of such services use unreserved tickets, purchased by the passengers during travel. Special services like SMS gateways for booking bus tickets could be employed to give the actual ubiquitous cover in the existing system. Just sending a special code through SMS to a nation-wide valid number would book a normal unreserved ticket, deducting the fare from the mobile account balance. The confirmation received for the same over SMS could be treated as a valid ticket. On one way it would save the overhead of purchasing tickets every time during travel. On the other hand, it would provide flexibility in travelling with unreserved tickets and with the choice of using different non-cash payment modes.

B. Taxi/Cab and Auto-rickshaw

Another important mode of public road transport is taxi/cab and auto-rickshaw. Auto-rickshaws mainly run in short urban and sub-urban routes, some with fare-meters and others without them. Every auto-rickshaw needs to be brought under surveillance and tracking system. This could be implemented by setting up GPS systems in every auto-rickshaw which could be monitored from centralized urban traffic control. Regarding taxis, similar GPS tracking needs to be implemented also. Also the metro-cities need to be fully equipped with Smart taxis having in-built Wi-Fi and Phone facilities. Existing prepaid taxi booths in prominent locations needs to be automated; the entry of relevant passenger and taxi-data should be done in computers to facilitate easy-tracking and governance. Online prepaid taxi booking could also be implemented in a large scale (presently this system runs on a specific domain, for selected cab-companies). Smart Kiosks are proposed to set up having the option to call a Taxi at that location by automated system. Throughout the public road-transport, system needs to be incorporated (though feasible mainly in the urban areas) such that the latest traffic information and other updates could be broadcast to all the running vehicles in the city. As for a sudden road accident may cause a huge congestion, but if the information of road-blockage could have been conveyed to all the running vehicles in proximity to that area, some congestion could have been reduced efficiently.

V. AIR TRANSPORTS

The aviation industry has shown an immense advancement in the inclusion of ICT. However some potential areas that call for ICT-based development are proposed. Firstly, in the ticketing and check-in module, introduction of biometric check-in is proposed which would simplify the manual intervention in the system to a large extent. The biometric checking could be primarily implemented in the domestic airways. Since massive biometric registration procedure (Aadhaar) is prevalent throughout the country, it would be easy to link the biometric check-in system to the Aadhaar database to retrieve the necessary data about a particular passenger. On one hand it will add to the seamless and fast check-in, on the other hand it would add a level of security to the existing system, enabling to keep a log entry of every passengers travelling in the domestic airways. Another important sector is the Baggage section which has been the key area of discussion these days. An online ubiquitous portal for tracking of baggage is proposed which would work on some PNR and UID-based authentication. This could operate in a distributed fashion with separate baggage portals for different Airlines but with intertwined service. This would also be helpful for passengers to track their baggage easily using different airlines for a long route with break journeys.

VI. WATER TRANSPORTS

In rural areas, water transport consisting of ferry-services and country-boats is a major mode of travel. But this sector of vital rural public transport has always been void from the blessings of IT. In fact a number of accidents could have been stopped with the trends of different latest technology. Discussing about a few, specific weather forecast is available to most of the sailing boats/ships in the sea. But precise weather alerts and forecasts also need to reach out to the village water-transport also in time. For this, local administration needs to set up proper alert services with the receipt of any weather alerts from the meteorological department. Also tracking system (e.g. GPS) needs to be implemented in the country-boats to reduce the chance of accidents and to provide further quick rescue with the minimum response time. Also this could be quite effective in ensuring security in proximity of national border. Sometimes Indian trawlers/boats enter into foreign water territories mistakenly; implementing comprehensive tracking system can also provide an alert service to them.

VII. OTHER AREAS OF TRANSPORT FOR INCLUSION OF INFORMATION TECHNOLOGY

Besides discussing separately about the major areas of public transports for inclusive development with the help of Information Technology, some other aspects are also discussed which need to be undertaken for a further smart transport system. These add-on features would pave the way to a better transport experience and would help the administration on an efficient monitoring of the entire system in a better way.

A. Smart Fee/Tax Collection

Transport systems are linked greatly with a bunch of taxes and toll-fees. If these fees could be collected using a simple portal, that too available online, the existing facility would simplify to a great extent. Automated toll-plazas would be another field to make the systems smart and efficient. These toll-plazas if intertwined would also facilitate the fund collection in an efficient manner. Online payment facility would also make the existing system faster, avoiding the spot cash/card payments. Specific multi-use nation-wide valid prepaid Toll-cards would also facilitate this cashless transaction and save enough time.

B. Single Portal transport facility

All the available public transports are proposed to be combined into a smart single portal. This implies that one planning to go from a source to destination would be able to view all the modes of travel, their respective fares, break-journeys if possible, and availability. All these travel facilities brought under a single umbrella using this online portal would be a path-breaking technique of its kind in the world, not only because of its concept, but also for its huge domain of implementation. To start with, the model can begin with selected domains, and then work on incremental mode of coverage. This would also contain links to other options like tourism and in this way it would also do its part in intertwining the transport and tourism sectors to some more extent.

C. Smart Parking System

Car parking is a major issue when metro cities are taken into concern. However, if these systems would be automated, the total system would be even smart and efficient. These automated systems include automatic parking fee calculator and collector, where the drivers would be able to pay the requisite fee automatically calculated based on the duration of stay. Also automated human detection in videos would enable to make this parking system more intuitive and efficient for congested metro cities like Kolkata and Mumbai.

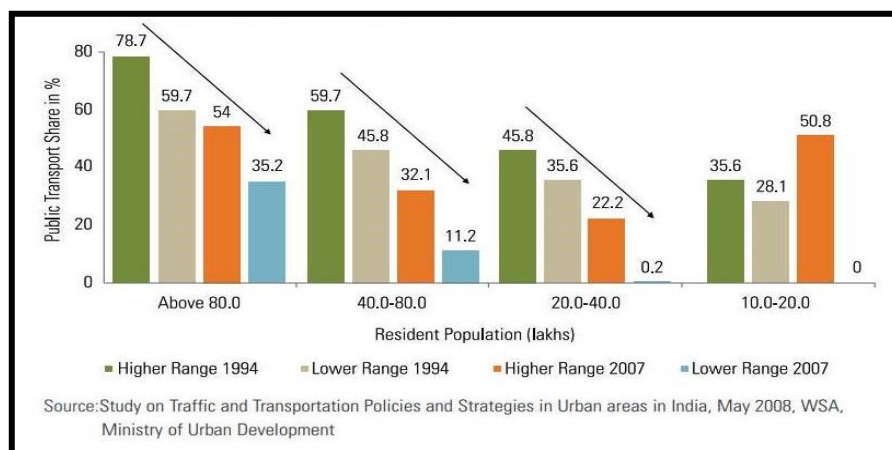


Fig. 3: Public transport share in total transportation

VIII. PROPOSED MODEL OF AN ONLINE PORTAL AND SMART KIOSKS FOR PUBLIC ROAD TRANSPORTS

Ubiquitous Computing is a newer approach in computer science which works over a goal in providing services to everyone and everywhere. Transport sector in India is a prospective domain for the implementation of ubiquitous computing. Ubiquitous system in public road-transport implies the availability of such services to everyone and everywhere. This would effectively use the extensivity of Internet and would help provide the transport related information to everyone. On one hand it would sheath the existing transport information system with a ubiquitous cover, and on the other hand would strive for betterment in user experience in this context. However, portals already exist in Indian Railways which is profusely used by the passengers. But similar portals are lacking in the area of road transports.

To implement such concept primarily in public road-transport, a model for Smart Kiosks is designed by the authors which would serve as the comprehensive IT portal.

TABLE I

| Centralized Ubiquitous Portal for Public Road-Transports, India | | |
|---|---|--|
| Bus | Taxi/Cab | Auto Rickshaw |
| Tracking through GPS on entering Bus Route Number and Source/Destination or other details | Tracking through GPS on entering Vehicle Registration Number | Tracking through GPS on entering Vehicle Registration Number or Route or other details |
| E-Ticketing (unreserved and reserved accommodation) | Prepaid fare payment (using non-cash modes) on fixed routes for Prepaid Cabs | Prepaid fare payment using non-cash modes |
| | Calling for vacant Cabs from Kiosk-point (as Source) to a specific Destination. In this case, a passenger simply need to enter the destination from the kiosk and the nearest vacant cab-driver would get a call. | |
| Lodging Complaint about a particular vehicle at any kiosk to the nearest Police Assistance Centre | | |

This portal would ubiquitously operate on different centres for facilitating the passengers in availing smart and efficient transport services. Primarily the portal is proposed to function in the online platform over the Internet. In that case it would be accessible to a wide domain of audience using Internet enabled devices like PC, smartphone etc. This portal would also be functional in the proposed transport kiosks installed massively at different locations across the country. The kiosks would help the community who do not use the Internet in accessing the smart transport facilities at their fingertips. The query service of the Portal would basically run over a database running at the back end of the entire system. To reduce the volume of the system, the databases of different transport entities are proposed to be distributed. However with the intertwined communication, the query service employed would be able to retrieve the actual real time data based on inter-database communication.

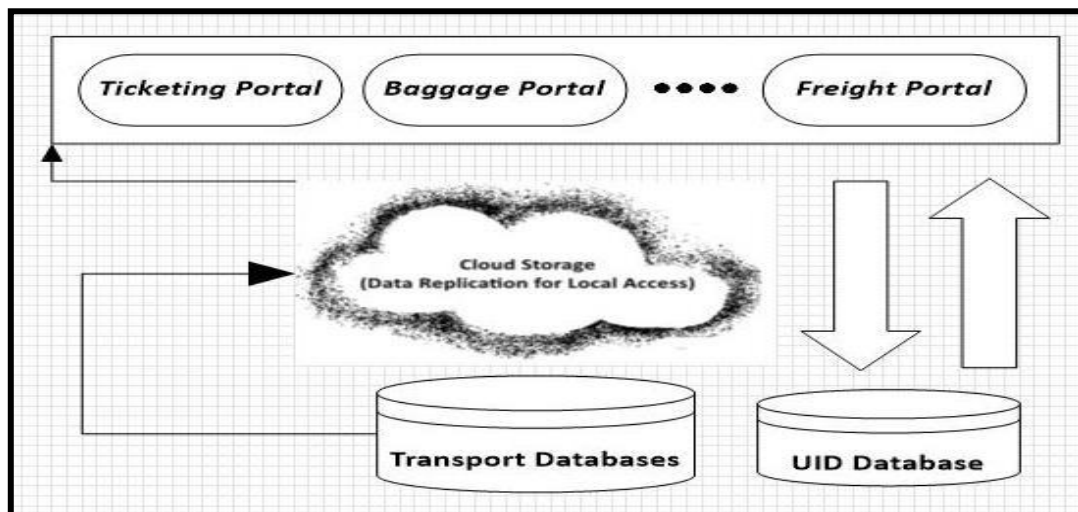


Fig. 4: Proposed model of Cloud storage in Transport Portals

Cloud computing could be efficiently employed in this aspect to store the real time data. Fast database retrieval services could be used to fetch the data when needed. Cloud computing would also enable the efficient and optimum distribution and replication of data to local servers for lesser latency. This would lead to simultaneous UID authentication and query processing from the database. With further work, this cloud storage could be equipped with real time data processing facilities also. This would share the load on real time processors employed in serving the queries.

Mobile Apps are also recommended to be developed. This would make the transport portal accessible at the fingertips, from the mobile devices like Smartphones and Tablets. The authors also recommend fusing the ticketing system with different payment gateways and offering facilities like paying online from Mobile Account balance, Mobile Banking etc. This would attract people more to this online transport portal and this could be game changing in the inclusion of digital technologies in transport system. Also these portals and online entities should to be interconnected and catered in a single window approach and this would enhance the accessibility and user friendliness of the online transport portal.

IX. CONCLUSION

The transport system of India operates on a huge domain. Concentrating all these scattered sectors into one interlinked smart network, flanked with Information Technology and its services is not that easy. Intertwining most of the facilities and bringing them online would actually provide the ubiquitous aspect of the transport facilities. Also it would be more helpful in centralized monitoring of the smart transport system including traffic analysis and security surveillance. Simplifying the modes to avail transport facilities would be more beneficial for further development. The proposed model deals with a ubiquitous smart approach to transport systems using UID. However, Aadhaar registration is presently available for a selective domain in the country. For preliminary setup, the model can be implemented in selective areas only, in parallel to the existing one. In due course, the smart UID-based model would eat up the existing systems with incremental mode of coverage. With the increasing volume and demand of the public transports, the nation would definitely seek the blessings of Information Technology to handle this herculean task in an efficient manner, besides providing state of the art transport services to the public.

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