New Marketing Research Journal
Special Issue, 2013
PP: 51-58

Toward the Design of Rural Intelligent Public Transportation System Rural Public Transportation of Iran

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Abstract
In order to improve the level of intelligence, availability, being on demand, convenience, information and humanization of rural public transportation systems, they are more willing to use modern information and communicative technologies. In addition to management services, intelligent transportation systems can provide passengers, drivers, travel agencies and other institutions with other services such as trip planning, tracking, routing and so forth. This paper presents a comprehensive design of rural intelligent transportation system based on cloud and grid computing, RFID, GPS, GPRS, NFC, GIS, etc. through electronic commerce and particularly mobile commerce in order to improve the rural transportation management and presentation of user-centric services. The system designed on this paper regardless of the possible challenges could efficiently cover the problems of Iran rural transportation and it can also be connected to urban transportation system and create numerous benefits.

Keywords: Intelligent transportation system; rural transportation; public transportation; cloud computing; grid computing; GPS; RFID (key words)

Introduction
Intelligent transportation systems are aimed to promote the efficiency and security of transportation systems by applying Information and communication technology and management strategies purposefully. These systems include the presentation of existing information to the passengers, facilitation and acceleration

of transportation, precise, comprehensive and efficient management and control, the real- time of traffic and appropriate accountability for the emergency needs [1][2][3].

The studies which are done in the field of ITS are mainly emphasized on urban intelligent transportation systems in order to determine congestion, traffic flow control, routing and so on. and less emphasized on rural transportation. Meanwhile the efficient, accurate and practical service presentation to improve and enhance the public transportation can be considered as one of the most crucial actions of government in major communities. Such a system can present services to different users whether drivers, passengers, travel agencies, and other relevant transportation institutions as well as control and management of rural transportation through applying the integrated wireless communicative technologies such as GPRS, RFID, NFC, WI-FI and also cloud and grid computing technology and GIS, GPS. Which results in less pollution, fuel, cost and time and on the other side increased safety and convenience.

The rest of the paper is organized as follows. The section 2 will briefly review the ITS practices, experiments and applied technologies. Section 3 will present the rural intelligent public transportation system (RIPTS) design and related services; and the final is the conclusion.

Related Works

ITS has been divided into two major categories based on topics and technologies: intelligent infrastructures and intelligent vehicles. Intelligent infrastructure comprises the projects that are able to be performed in urban streets and rural roads by town hall (municipality) or ministry of urban development in roads and rural freeways. Intelligent vehicle segment also comprises the modern technologies inside a car and the automotive industry is basically responsible for the performance. Accordingly the successful national implementation of ITS requires a major coordination between ministry of industry and ministry of municipal at the initial stage. Here we discuss some researches in the first category although ITS systems are practically inefficient and useless without an interaction between intelligent infrastructures and intelligent vehicles.

Table 1 indicates the most significant features of similar and related researches briefly and thoroughly. In addition to these researches some other case studies have been done, for example John Steenbruggen and et al. have presented an article about the importance of incident management and increase of transportation safety and security based on data from telecommunication networks [7]. Zhong-Ren Peng and Ruihong Huang have also designed a web-based transportation information system which uses the GIS technology, web services, GIS processing, network analysis and database management for planning and routing [8]. Hsu-Yung Cheng and et al. have also offered an integrated intelligent system in order to increase the safety of roads and urban traffic efficiency using a video analysis and multimedia network technology [9]. As it can be seen GIS, GPS and RFID are considered the most fundamental technologies applied to collect information from mobile vehicles and people in intelligent transportation system.

TABLE I. THE MOST IMPORTANT AND RELEVANT PERFORMED RESEARCHES ABOUT CURRENT STUDIES [4][5][6]

Paper Title	**Intelligent transportation system based on internet of things**	**The mobile Transportation information Service System**	**A communication network architecture for transportation systems (SWIFT Project)**
Authors	Zhu Yongjun, Zhu Xueli, Zhu Shuxian, Guo shenghui	Yonghua Zhou, Huapu Lu	Yurdaer N. Doganata, Denos C. Gazis, and Asser N. Tantawi
Year	2012	2005	1995
Usage Scope	Urban	Urban	Urban-Rural
functional Objectives and Services	Congestion and overcrowding solution and bus schedule management	Traffic flow control to avoid congestion, route navigation based on predictive control and 9 other functional objectives [5]	Pre-trip information, en-route driver information, route guidance, traveler services information, ride matching and reservation, en-route transit information, personal paging
Technologies	RFID, GIS, GPS, GPRS, RTDB, Wireless comm.	GPS, GIS, Grid computing, Wireless comm.	FM-SCA, GPS, DGPS
Users	Passengers, drivers, transport managers	Passengers, drivers, transport managers	Passengers, drivers, transport managers
Accessible and usable devices	The LCD of the station for passengers, other computer device for drivers and control and management center	PDA, Smart phone, mobile vehicle (car, bus, etc.)	three type of FM receivers: SEIKO MessageWatch, Delco Car Radio, Portable PDA

Rural Intelligent Public Transportation System

In Iran, the rural travel services are done by using the bus transportation through terminals and travel agencies. Therefore the passengers can be divided into official and unofficial groups. The official passengers are those who get the tickets for using transportation services (online, in person or telephone purchase), whereas the unofficial passengers are those who don't buy tickets and search for their desirable bus service outside the terminal in the bus routes or inside the terminal, and no information about these people is saved or archived. On the other hand the traffic and position information of buses are merely available for control and monitor centers and the terminals aren't aware of details. Moreover, the position (situational) information of buses on super highways and roads isn't determined. These described overall positions and conditions may bring up some problems:

- Difficult rural public transportation control and management.

- Inefficient incident management.
- Passengers' security and safety threat.
- Unavailability in routing service, searching the information about buses, positioning and so on for passengers in any place and any time.
- Unavailability in previously mentioned services in terminals.
- Various and non-integrated portals and service desks for passengers.
- Waste of cost, time, and fuel for passengers, drivers and at last terminals and so on.

The overall design of the rural ITS which is stated here is aimed to improve the public transportation, integration of services to all users in any place and any time based upon real-time information along with suitable speed and accuracy to decrease the cost, time and fuel, and increase safety, security, comfort accessibility and availability and the state of being on demand. The functional objectives are services before rural trips (before the departure), during the trip (on the road) and after the trip (arrival at destination). The users of this system are passengers, terminals, drivers, transportation management and control centers and other relevant institutions.

TABLE II. FUNCTIONAL OBJECTIVES OF RIPTS

Pre-trip Functional objectives	**En-route Functional objectives**	**Post-trip Functional objectives**
▪ Pre-trip travel information ▪ Transportation Service information ▪ Routing and trip planning ▪ Transportation Service purchasing and reservation ▪ Transportation Service capacity planning and scheduling	▪ En-route information ▪ En-route transit information ▪ Route guidance ▪ Tracking ▪ Ride matching and reservation ▪ bus/driver behavior monitoring	▪Post-trip travel information ▪Traveler service information ▪Feedback and Support service
Common Functional objectives		
▪ Mobile Positioning of buses and travelers ▪ Alarming and notification ▪ Transportation Service searching ▪ Payment		
Value added services		
▪ Urgent event handling ▪ Incident management ▪ Personal paging		

Functional objectives

The presented RIPTS in this article is indeed similar to an advanced travel information system that can provide some or all the services in table 2 depending on the available equipment for the user, the type of user and its position. Some services such as purchase, ticket reservation could be done by intelligent agents. Each of the mentioned cases in table 2 could be applied as a combination of web services.

System design

RIPTS comprises 7 main parts and each requires its own hardware and equipment which isn't mentioned here.

- **Sensing:** the ability to identify and record the location, features and

status of the vehicle, the passenger and environment. the recorded data provides system with an important input, for instance receiving full information on the status and speed of buses, weather, providing a perfect map of cities and roads using GIS, GPS and GIS-T and also recorded videos by control and monitoring cameras and mobile positioning could be used in some cases. Using RFIDs in entrance and exit gates in terminals to control incoming and outgoing passengers, on the front and rear bus doors to control the passenger flow based on the second generation ID cards or using NFC reader based on the modern smart phone, also installation of RFID electronic tag on the buses to identify the bus identity, the time of passing from the city tollbooth and entering or exiting from terminals. All the information is sent to monitoring and management centers.

- **Communication:** ommunication is at the heart of an ITS system, the ability to send and receive information between two vehicles (two moving points), between the vehicle and infrastructure (a fixed and a moving point), and between the infrastructure and transportation management and functional centers (two fixed pints). Moreover we consider the passengers as moving points which require to have access to ITS services at any time and any place. Communication can be both wireless and wired. For instance the communication between two moving points can be wireless and two fixed points depending on distance can be wired.
- **Computing and data storages:** The existing data is divided into two dynamic and quasi-static categories. Dynamic data can change over time such as bus status, the number of incoming and outgoing passengers in each terminal and so on Storing, processing, retrieving and representing of this huge data and the conclusions require a great amount of storage and high computing power which can be fulfilled by applying grid computing and its main services such as Data grid management, Grid information service, Fault tolerance management, Grid scheduling service [10].
- **Algorithms:** Are the computer methods as backend services which process the collected data by ITS and enhance the transportation operating strategies. Regarding the volume of data, the importance of processing time, and preparation of results, applying parallel algorithms is essential.
- **Services:** For integration, standardization, better development and maintenance management of services, the independence of users' platform, encapsulation, and the ability to combine the services and other benefits, services are offered in the form of web services [11]. Therefore it would be possible to offer some solutions based on XML for mutual operations among heterogeneous systems. As a matter of fact services are the most basic components of functional objectives. Some services can be used directly by passengers and some others can be applied through programs. All the travel agencies can benefit from the same principal services such as bus search, electronic ticket sale, routing, etc.; moreover they can develop their desirable services through combining the favorite services. What we mentioned here, platform as a service is considered as one of three major cloud computing services [12]. Transportation agencies and related organizations can also use these services.
- **Applications and software**: Each application can be composed of one or several services and fulfills a specific operational objective.

Applications regarding to the type of usage and user can be applied via intranet or internet or any device that can be connected to these networks or SMS or MMS. For instance the passengers can benefit via internet through applications that provided by cloud computing as a software service or receive some services through SMS. Some of the applications might be considered in the form of embedded in specific equipment for drivers.

- **Access points:** Access points are defined as fixed points which aid passengers to receive required information and use some services. These access points can be installed on the LCDs in terminals to view the latest information about buses or Bluetooth transmitters.

Conclusion

The offered RIPTS design in this article can stores and processes the relevant information with rural public transportation efficiently via grid computing and provides modern and intelligent transportation management and monitoring. ITS is provided for public use, therefore travelers can use services at any time and any place via cloud computing and internet- connected mobile devices while they can perform the services in the least possible time or can use some basic services through SMS. Monitoring and management centers can control the traffic and have better actions in incident management. Terminals can have better timing based on real-time traffic as well as monitoring the buses entering the cities and terminals and travel demand. As a result safety and security, welfare and comfort of rural public transportation are provided for all involved groups. The most specific advantages of the presented design in this article include:

- The increasing level of service and justice in transportation for public.
- Expansion of rural public transportation.
- Better and more coordination between information sub- systems of each ITS system.
- Prevention of additional costs to improve the computing and storing sources via grid computing.
- Using the latest version of software without updating, easier delivery of integrated services and rapid service developing via cloud computing.
- The increasing benefits of different ITS systems which are linked and integrated simultaneously compared to the time it was performed individually.
- Converting the unofficial passengers to official ones and decreasing the financial abuse, safety and security and better transportation and incident management.
- Better decision- making and planning of managers, drivers and passengers.
- Reducing the fuel consumption and emissions.
- Better transport of goods and passengers.
- Increasing economic efficiency via sustainable transportation system.
- Removing brokers from the rural public transportation supply chain.
- Improving the supply chain management of rural public transportation.
- Supporting the passenger and the driver before departure, during the trip and after arrival at destination.

Alongside the mentioned benefits, there are security, technology and infrastructure challenges dependent on each applied technology in the design and also the interaction between these technologies which require more study.

Of course the stated challenges and issues would be resolved by accepting the defined and existing standards on an acceptable level. The implementation of the mentioned design along with the RIPTS systems can improve the services after arrival at destination such as scheduling and planning of rural transportation for buses and taxies and undoubtedly the collaboration of private and public sector is required for national implementation of this design like town halls, ministry of urban development, universities and research institutions.

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