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Managing Wireless Communications in Taxi Services

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Abstract: This paper describes the wireless communications in the context of taxi service operations. Human-system interaction is necessary to taxi vehicle dispatching. However, the process is influenced by various variables in relation to dispatch data conveyed to drivers, display panel, mechanical noise and vibration. The in-vehicle wireless dispatch interface must be ergonomically designed to cope with environmental influences. The findings have practical implications for managing services operations.

Keywords: Technology management, service operations, wireless communications

I. Introduction

The Automatic Vehicle Location and Dispatch System (AVLDS) has been implemented by several taxi companies such as Comfort, CityCab and Trans-Island Bus Services in Singapore. It effectively supports the operations management of taxi fleet and considerably enhances the taxi services. The AVLDS comprises differential Global Positioning System (GPS), wireless data communications, computerized dispatch systems and interactive voice responses. A number of stations have been established for the transmission of data between the control center and individual taxi vehicles equipped with GPS antenna, receiver and transmitter. The system can immediately detect the nearest taxis to a particular customer, and identify each vehicle's route and location. Therefore, it enables the taxi company to immediately respond to a customer request for taxi service. It also enables collaborative operations between call operators and individual taxi drivers. This paper presents the wireless dispatch process and discusses the environmental variables in relation to in-vehicle human-system interactions.

II. Dispatch Operations

The GPS has been extensively used for vehicle navigation and transportation management [1] [2] [3] [9]. In the present case, the GPS-based dispatch system can automatically locate taxi vehicles running within ten kilometers to a customer when a request for service is received from a dedicated terminal or an automated call handling system. It is a significant improvement over the radio-paging system used previously. The computer-assisted dispatch process involves the transmission of a request for service via wireless data communications to a number of taxi vehicles. When a job is circulated, a taxi driver can easily respond to the control center by pressing a button on an in-vehicle dispatch device if he would accept the job. However, if the drivers of those taxis within ten kilometers do not respond to the request for service within a preset period of time, the system will automatically search for the next nearest taxi vehicles and the job will be dispatched again. Upon successful matching, the taxi number and expected time of arrival will be immediately relayed to the customer. As a matter of fact, the expected time of arrival is relatively accurate, because the system has the capability to continuously calculate the time needed for the taxi to arrive at a particular destination. Although the system tends to circulate a job to those taxis within a relatively short distance to a customer, it is able to relay different zones to track other taxi vehicles.

III. Interface

The wireless dispatch device installed in the taxi vehicle enables a driver to read message, send message and review job record. The driver can easily read the dispatch data on the display including name of a customer, pick-up address and time. He can also communicate with the control center using a few keys on the device. For instance, if he presses "Auto" on the device, he will be given a job when his vehicle is identified closest to a customer. In this case, he must accept the job and proceed to the pick-up point, when there is a service request appearing on the panel. On the other hand, if the driver presets "Can Bit" on the device, a request for service together with the pickup address and time of a customer will be received from time to time. If he would like to take up the job, he must bit for it by pressing a "Bit" bottom. Because a number of taxi vehicles may receive the same request for service concurrently, he should respond to the request quickly in order to get the job.

The in-vehicle wireless dispatch device can automatically record and memorize the job completed by a driver. Table 1 shows a record of the sixteen jobs done by a driver on a particular day. In this case, he has completed five jobs (i.e. requests for service) allocated by the control center. In addition, he has served nine different customers hailing taxi service on the street and a customer specially arranged (i.e. special job done). Moreover, there is an "advance register" because the driver has a regular service of sending

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someone to office at 8:30 am every morning. Lastly, he has accepted an advance booking to the airport at 6:30 am next morning.

Several functions associated with the in-vehicle device are summarized in Table 2. If a driver is not sure of the venue and is not able to locate a customer to a particular designation, he can easily ask the control center by pressing "Address not clear." He can also communicate with the control center through wireless mobile phone. The system can provide a taxi driver with road information, route guidance and assistance, since the geographical information system associated with the AVLDS contains a database with electronic maps and road directory.

The driver can inform the control center "Late for pick up," in case he recognizes the difficulty to reach a particular customer on time due to heavy traffic. He can also tell the control center "Far from pick up," if he believes that there is a relatively long distance between his current location and the pick-up point of the customer. Moreover, the driver can report to the control center and request for towing service if his vehicle is breakdown or has any malfunctions. He can also report to the control center if there is a traffic accident. Accordingly, the control center can ask ambulance and traffic police for assistance. Finally, the driver can inform the control center in case of any emergency through a hidden alarm activator, while the control center can immediately identify the location of the taxi and provide prompt aid to the driver.

Table 1 An Example of Job Record

Job specification	Number of job
Call job done	5
Street job done	9
Special job done	1
Advance register	1
Total job done	16
Job rejected	0
Advance job accepted	1

Table 2 Report to Control Center

Function key	Request for assistance
1	Car breakdown
2	Address not clear
3	Far from pick-up
4	Late for pick-up
5	Car accident
6	Towing service
7	Radio me every five minutes

The AVLDS improves the communications between control center and taxi drivers, because it not only enables the transmission of dispatch information in a precise manner, but also cultivates a collaborative operational platform for call operators and taxi drivers. The previous radiophone often caused misunderstanding between a call operator and taxi driver, because both sides had to withstand the drone of sound emitted by phone. Hence, the customer reservation information conveyed by the call operator to drivers might be distorted. In comparison with the previous radio paging system, the working environment of call operators has been greatly improved since the noise level has been considerably reduced.

The system eliminates ineffective communications, because the reservation is digitally transmitted to different in-vehicle devices. In particular, the standardization of data entry and data processing enables an operator to easily handle several calls within a specific time frame. As a result, it permits more reservations to be processed with the similar level of manpower. The efficiency of call operators has been enhanced, because the system effectively enables the call operators to match the call for taxi service from individual customer. With the implementation of the system, the operator is able to quickly retrieve the pick-up location when receiving a call for service.

Many public telephones are equipped with automatic-dial services in Singapore. For example, one can reserve a taxi by pressing the CabLink Hot Button, which is a label indicating one of the taxi companies at a public telephone. Such a request for service will directly go to the dispatch system of that company, in which the reservation is instantly processed because the pick-up location can be automatically identified. Finally, individual customers are encouraged to register the use of the GPS-based dispatch system. Hence, the taxi company can provide them with more customized services. For instance, a regular pick-up at a particular point of time can be arranged for a customer.

IV. Discussion

The implementation of the AVLDS effectively facilitates the management of large number of taxi vehicles and enables the achievement of operational efficiency. The taxi drivers have benefited from the system, because it helps reduce operating costs, obtain on-line route guidance and ensure security and safety. Prior to the use of GPS-based dispatch system, it was not uncommon that an average cruises empty was about 40% of the time. The drivers not only wasted his time, but also used additional fuels. Today, the taxi company is able to accept more reservations, thus creating more jobs for taxi drivers. The drivers have experienced an increase in productivity, because they can serve more customers, while decreasing daily operating costs and empty cruising. Some even prefer to wait until the system matches them with the nearest pick-up point of a customer.

The wireless communications and human-system interactions are influenced by a number of environmental variables [4] [5] [6] [7] [8]. It is therefore necessary to develop an ergonomic in-vehicle interface. The wireless in-vehicle device plays an important role in facilitating communications and dispatch operations. It also enables individual taxi drivers to effectively communicate with the control center and respond to a request for service. The concerns in relation to the human-system interactions include the installation of in-vehicle dispatch device, data presentation on the display, manual operations of the device and the impact of external environment.

The wireless in-vehicle device should be installed close to the driver without interfering automotive instrumentations. When receiving a dispatch message appearing on the display panel, the driver may pay less attention to the road condition, and his attention might shift away from the primary task of driving. In particular, he has to read the message on the display in bright condition such as direct sunlight. Although the brightness of the display can be manually adjusted, the device must be properly installed to avoid extremely bright lighting. It should also enable the driver to read the dispatch data in the dark environment. The dispatch data conveyed to drivers should be short and precise.

The control functions of the wireless dispatch device have an impact on drivers' interactions with the system. Some drivers might not be able to adapt the system within a short period of time. Therefore, manual operations for responding to a request for service should be simple and easy to use, while unnecessary data transmitted to the panel should be eliminated. It might be difficult to customize an in-vehicle display to different drivers. The template of distributing dispatch data should be standardized. Some simple symbols should also help drivers appreciate a dispatch message and react to a request for service.

Finally, the noise mechanically generated by the vehicle considerably influences a driver's response to a request for service. A steady noise from the engine might compete with audio alarms and voice messages. In order to draw the driver's attention towards the dispatch data, the audio output of impulse noises emitted in short burst from the dispatch device should be adjusted appropriately. Finally, the driver has to pay more attention to the road condition when there is a significant vibration. The dispatch data conveyed in such a circumstance might affect the driver's performance and impair his ability to drive safely. The impact of vibration should be taken into account when installing the dispatch device. In sum, there are a number of variables in relation to dispatch data conveyed, display panel, mechanical noise and vibration. Because these variables considerably influence the communications and dispatch operations, they must be ergonomically handled when designing the dispatch devices.

V. Conclusion

The effective wireless communications interface facilitates the improvement of taxi services in terms of time required for processing reservations and dispatching vehicles. With the AVLDS, customers are able to conveniently reserve taxi service at a particular pick-up point such as office and home. They can also easily get a taxi at different locations. In addition to vehicle tracking and dispatching, the system provides useful data for the management of taxi operations and helps the taxi company to optimize the use of limited resources. It also enables the taxi companies to achieve higher productivity and better service quality. However, the interface of wireless communications must be ergonomically designed in order to achieve the expected capacity of the dispatch systems. Environmental variables associated with in-vehicle operations must also be effectively tackled. The present observations not only provide information for improving taxi services, but also have practical implications for managing service vehicles in different environments.

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