ABSTRACT

We present an immersive video system that has been developed for the purpose of evaluating future traveller information system (FTIS). In particular, FTIS scenarios that rely on a pervasive computing infrastructure. Immersive video uses multiple video streams captured from a first-person perspective at key locations in a scenario. By dynamically reconstructing a user’s visual and aural experiences the immersive video system creates a lab-based framework that captures a number of the contextual factors of real-world mobile information system use. Graphical user interfaces, displayed on a personal digital assistant (PDA) and a wearable display, are used in a preliminary evaluation of FTIS. We present both the technical basis of the immersive video system and its application to the study of user perceptions and reactions to pervasive information services.
BACKGROUND

The provision of traveller information, in the form of available travel options, is generally acknowledged as having the potential to change traveller behaviour. Such changes are expected to benefit the whole transport system, if the information provided is timely, reliable, and appropriate to travellers’ needs [6, 11, 16, 17, 18, 22, 23, 24, 25, 26, 32 and 36]. Currently, the provision of traveller information, ranging from paper-based timetables and road atlases, to web-based and in-vehicle dynamic journey planners, is widely accessible. However, integrated multimodal personal navigation systems, which provide bespoke and tailored travel assistance, have not been widely available. An underlying information infrastructure is yet to be established that will allow real-time integration across all transport services and options. Although the provision of timely personalised integrated multimodal information service supporting people on the move remains an aspiration, our goal is to develop a methodology that permits the evaluation of such systems and their impacts on changing traveller behaviour.

A FUTURE VISION AND RESEARCH QUESTIONS

Technological developments in computing and telecommunication are ushering in the era of ubiquitous connectivity whereby everything and everyone will be connected through a pervasive computing infrastructure [29]. Computers will in essence disappear into the fabric of everyday life [12 and 44]. As a result, environments will be sensitive, adaptive and responsive to user capabilities, needs, habits, gestures and even emotions [20, 39 and 40]. Pervasive computing will change transport infrastructure radically, allowing real-time monitoring of networks and services, and the delivery of tailored information and travel assistance to the user and their context. The user will no longer need to search disparate sources of information for the most appropriate travel option, but instead will receive context-aware and personalised travel information and support.

This vision of a fully connected pervasive information service is a component of the future transport system envisaged by the recently published report by the Foresight Directorate of the UK governments’ Office of Science and Technology, ‘Intelligent Infrastructure Systems study [45 and 47] which explored in detail the implications of science and technology over the next 50 years. To understand the potential impact of such systems, a series of scenarios were developed [48] which as a discussion catalyst, helped to identify a number of key issues and unknowns that need to be addressed and researched to better understand the effectiveness of future information delivery, these included: user perception, user acceptance, human machine interaction and the impact on traveller behaviour. Such issues are core elements of an ongoing debate between policy makers, system developers and transport service providers in relation to the benefits of investing in future traveller information services [46].
EVALUATION THROUGH USER PARTICIPATION

Evaluations of information systems can be conducted for a number of purposes: to explore the usability of a system and its interface [19, 50, 51, 52, 53, 54 and 55], or as in this case, to assess the potential impact of a system on user behaviour. Rossi et al [34] describe an effective evaluation as requiring an accurate description of the system performance and user participation as a means of assessing the potential value of the system. Though tests can be conducted with respect to defined specifications of system behaviour, evaluation through user participation permits the use of the system to be observed and user perceptions explored based on their actual experience of and interaction with the system. Here, we use the term user experience to capture the specific notions of knowledge and satisfaction gained through the use of traveller information systems (TIS).

CHOICE OF EVALUATION METHOD

The evaluation of our notion of user experience requires the consideration of a number of factors:

- The current use of TIS
- The current mode choices with respect to journey types
- The perceived usefulness of FTIS and in particular personal travel assistance
- The likely use of FTIS
- The likely impact of FTIS on travel choices

Evaluation can be performed either in the relatively controlled environment of a development laboratory or in the field [9]. In a field study, a minimally functioning prototype of the system is deployed in the target environment (or one very similar) [1, 4, 5, 13, 19, 23, 33 and 38]. The principal advantage of field studies is that they allow the use of the real transport networks and the direct observation of users within genuine travel scenarios. In contrast to lab-based studies, field studies have the advantage of ecological validity1, both in the fact that users are less conscious of their participation in the study (and the impact this has on their behaviour) and in the spatial and temporal constraints to which they are subject. Hence field studies emphasise the importance of a high-fidelity user experience2 [9 and 36] and admit the study of actual information needs, reactions to information provided, and genuine journey choices.

However, a consequence of ecological validity is that rigorous field studies are problematic to conduct. From a methodological perspective, due to the lack of control over certain elements of the study, significant effort is required to distinguish the root causes of

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1 Ecological Validity – indicate the degree of the closeness of the test environment to the actual environment in which the system is used.
2 High-fidelity of user experience – refer to a realistic representation of the proposed user experience.
journey-making choices. In addition to characteristics of the subjects and the journeys themselves, field studies incorporate many additional environmental and contextual factors (e.g. the weather, unexpected variations in transport provision, and incidental occurrences such as receiving a phone call). Furthermore, the physical design of the information provided and a subject’s past experience of travel information (and travel information systems) also influences the decision making process. Whilst these factors have the potential to influence traveller behaviour, resource constraints mean that experimenters must use their experience in judging which need to be considered in detail [9 and 36]. In previous studies of TIS, even detailed studies take little account of environmental and contextual factors in their data collection and analysis [5].

Beside direct observation, field studies usually employ travel diaries in which participants self-report their travel choices and TIS usage. By comparing behaviour before and after the use, the impact of a proposed system can be isolated. However, the use of travel diaries can give rise to factors that interfere with the ecological validity of a field study, in that participants feel somewhat burdened by the reporting requirements which in turn lead to depressed TIS use as participants attempt to reduce the lengths of entries in their diaries [1].

As a summary, studies conducted in the field enable high-fidelity user experience and reliable and valid data to be collected, but tend to be time consuming, complex and costly. An alternative technique, named Wizard of Oz, doesn’t require a full scale deployment of sensor infrastructure in place but a basic deployment. The missing or advanced functionalities can be provided through human intervention between the user and the system [9]. Such system demonstration allows the evaluation to be concentrated on the users’ reactions to the system rather than the performance of the system. However, this technique still confront the challenges remained in a field study. As a result, undertaking the study under controlled laboratory conditions must be considered.

In the lab-based studies, participants are taken out of their normal living environment to take part in controlled tests, often in a laboratory or simply a quiet room [9]. By standardising and controlling the environment and all events, lab-based studies are deliberately designed to ensure that subjects are exposed to exactly the same environment [8]. This makes lab-based studies more easily controlled than field studies. In some situations, a lab-based study can be the only option. For example, if real-world implementations of new generation TIS technologies are impossible or available resources are insufficient, this would limit the evaluation to be conducted in laboratory environments.

The performance of systems is normally demonstrated by either paper-based scenarios or computer-based simulations in lab-based studies. These methods provide low-cost, high-portability to test specific issues of behavioural concerns that are difficult to capture with survey techniques, or that cannot be adequately observed in the real world [2]. However, paper-based scenarios provide little dynamic context within which the system is intended to be used and few opportunities for subjects to interact with the system. Therefore, this method is useful to explore concepts or impacts of pre-trip information on travel choices.
[24], but not suitable for studies in which dynamic context and interactions are highly important for the investigation, such as investigating the impacts of en route timely, personalised and context-based information delivery on travel choices.

In the past decade, computer-based simulations have been developed to provide viable alternatives to create the intended contexts and demonstrate the improved system performance in laboratories [9]. It provides a highly portable and easily reproduced platform to explore user experiences within scenarios [2]. A visit to the physical environment space is no longer necessary for users. However, the main disadvantage of this method is that it requires high-level programming support for the simulation to be efficient and robust.

Comparative to field studies, lab-based studies are generally easier to control, quicker and less expensive to establish. However, they are artificial and are perceived as such by subjects [10]. This may influence the way users behave, compared to their real world interactions.

On balance, there is a need to weight the costs and the difficulty of a field study, with the costs of taking a number of users to a fully equipped and established laboratory. In this study, it is impossible to test the future vision of TIS in the real world due to the lack of underlying information infrastructure. Undertaking a field study with a fully-implemented or even just a partially implemented system would be extremely difficult, costly and time-consuming. The challenge therefore is to find a way in which the reality of the testing environment can be enhanced within the laboratory environment and meanwhile, an accurate demonstration of the performance of the system can be achieved.

**IMMERSIVE VIDEO DEVELOPMENT**

In order to satisfy the evaluation requirements, a new technique, termed *Immersive Video*, is developed by a number of researchers from the Transport Operation Research Group (TORG) and the Informatics Research Institute (IRI) at Newcastle University. This study is the first-ever application to transport research.

The design of this immersive video goes beyond the initial concept developed by researchers from University California which aimed to produce an Environment Model using information collected from multiple, strategically located cameras [30]. This immersive video system is developed to perform more tasks than simply creating an environment model. It contains 4 main components:

1) Reconstruction of the real scene
2) Demonstration of the functionalities of the system
3) Definition of locations
4) Control of locations’ sequence
Reconstruction of the real scenes
Dynamic scene reconstruction is at the heart of Immersive video architecture [30]. Using video streams captured by multiple cameras and replaying the footage on the same number of screens which are closely set next to each other in the same arrangement as the camera setup, a spatio-temporally realistic, three-dimensional environment model of an event can be generated. Immersive video has been proposed on numerous occasions as an alternative form of presentations to traditional paper-based scenarios and computer-based simulations, and provides viewers with a sense that they are truly immersed in an environment [14, 15, 30 and 37].

In the previous design by Moezzi et al. [30], cameras monitored a scene from different perspectives so as to provide viewers of live events with a sense of total immersion by offering them a “virtual camera” (see Figure 1).

![Figure 1: Immersive video uses video streams from multiple, strategically located cameras which monitor a scene from different perspectives (source: 30)](image)

In the real world, the user should not stand still but continuously move from origin towards destination whilst using the FTIS. Therefore, the video streams should tell the user both his/her location and heading direction to allow the subject to understand where he/she is and where he/she is heading. To meet this requirement, a first person perspective is taken to create the sense of being there at the location and also to establish the user’s orientation at the same time. In order to provide a wider field-of-view, three video cameras were lined up on a metal board which was made especially for this task to film the actual environment and capture the ambient sounds from the user’s virtual standing point in the real environment (see Figure 2 and 3).
In practice, a scenario is developed for the purpose of creating the context of using the system (see Figure 3). According to the scenario, traveller information and personal travel assistance are provided at 16 decision-making points (key locations) along the journey:

Mike received a reminder from his personal device – he needs to meet Bob at the Discovery Museum at 10:00am. Upon his confirmation of this plan, the SmartTravel system automatically planned a public transport journey for Mike. Up-to-date information about journey modes, times and costs were shown on the screen of his personal device and links to more detailed information, such as maps, snapshots of relevant places and images of public transport services.

At 9:30am, Mike was alerted to depart. A map was displayed on the screen of his personal device to direct him to the metro station. His current position on the map was updated in real time.

The transport system greeted Mike when he arrived at the metro station and asked him to choose a ticketing option. Mike decided to buy the return ticket for a better value. Meanwhile, he gave the authentication of the system to charge him to his SmartTravel account. Then he was guided to platform 1 and his train was just arriving.

When Mike was sitting on the train heading towards Newcastle Central, Bob sent him a text message and asked to meet at the Baltic, an international centre for contemporary art. SmartTravel recognised Mike was on the train heading towards South Shield and the train had just left West Jesmond metro station. Upon Mike’s confirmation of a new destination, SmartTravel immediately re-planned a journey for Mike from his current location to the new destination with all the details he might need.

The train arrived at Monument metro station. SmartTravel asked Mike to leave the train and guided him to the Royal Theatre bus stop. When the QuayLink bus heading towards Gateshead arrived at the stop, he was told to get on the bus.
When Mike was sitting on the bus, *SmartTravel* presented some information on the exhibitions. Mike was told him to leave the bus when it arrived at Baltic Square bus stop. He saw the Baltic Centre as soon as he got off the bus.

**Figure 3: Scenario for envisaged future traveller information system**

The focal length of the three video cameras must be adjusted manually using a test object placed a few meters away to maintain exactly the same level of zoom. The facing direction of each camera needs to be coordinated so that the frames captured by three cameras can match each other to produce a seamless picture of the actual scene. The white balance (a determinant of scene colour) must be reset at each location to maintain a consistent colour of the picture. Professional editing software, Final Cut Pro, is used to synchronise the three video streams taken at the same location (see Figure 4). The video streams taken at each location are replayed on three screens standing next to each other at the same angles as the camera lenses to form a cave in the laboratory environment to present the reconstructed scene of the actual environment with accompanying ambient sounds (see Figure 5).

**Figure 4: Final Cut Pro**

<table>
<thead>
<tr>
<th>screen 1</th>
<th>screen 2</th>
<th>screen 3</th>
</tr>
</thead>
</table>

**Figure 5: Reconstructed scene from a first person's view**
Demonstration of the functionalities of the system

Graphical user interfaces are designed and applied to the personal devices to demonstrate traveller information services and personal travel support provided by FTIS (see Figure 6). Google Maps are used to display the location of the user and the direction of the planned route. Two personal devices, a wearable display and a Personal Digital Assistant (PDA), are provided for subjects to receive traveller information services and personal travel support (see Figure 7). A wearable display is used to provide peripheral information which is not central to a person’s current task, but provides the person with an opportunity to know more about their travelling environment. It provides information whilst having little impact on the user’s performance on the main task [27]. A subject stands in front of the three screens, and determines where they are. The personal device is consulted to find what information has been provided at this location (see Figure 8). The wearable display exists to supply the user with information and therefore the user is not able to interact with it. However, the PDA is not only an information source but a fully interactive planning device as it allows the user to gain more information by using the onscreen prompts and clickable icons.

Figure 6: Demonstration of the functionalities of the system on a PDA

Figure 7: The wearable display and the PDA
Definition of locations
Positional information is collected using sensors such as GPS and Bluetooth tags. These values are used to define locations. Each location is defined by a unique value or a set of unique values. Bluetooth values are used for indoor locations and GPS values are used for outdoor locations. The sensor values are stored in an XML (eXtensible Markup Language) file, which includes the current location and the reachable locations from this current state (see Figure 9).

XML documents are made up of storage units called entities, which contain either parsed or unparsed data. XML provides a mechanism to impose constraints on the storage layout and logical structure [43].

Figure 8: A subject stands in front of the three screens

Figure 9. An XML file

```xml
<?xml version="1.0" standalone="no" ?>
<video>
  <sensor style="gps" value="" id=""
    longitude="50833333333"
    latitude="1.61345555555556"
    startframe="0" endframe="3000" />
  <state name="station2_4" astartframe="0"
    endframe="3000"
    centersrcfile="AVI/c24z1.avi"
    leftsrcfile="AVI/l24z1.avi"
    rightsrcfile="AVI/r24z1.avi"
    xmlfile="XML/s24.xml"
    iastartframe="" iendframe=""
    state name="station1_1" astartframe="0"
    ...
  ...
</video>
```
Control of locations’ sequence

Video streams are arranged into the correct sequence, which is defined by the state based design (see Figure 10), and are fed into a wizard system via the XML sensor files. The wizard system controls the user’s location by a control panel that can change the location of the user depending on the current location (see Figure 11). As this scenario is not testing the user’s interaction with the environment, and the subject also cannot make their own mode and route choices, the determining of the location and hence which video streams are played is controlled by the researcher.

Figure 10: State Based Design

Figure 11: The Wizard Control Panel
FINDINGS

Description of participants
Twenty people participated in the study, seven males and thirteen females. The age of participants was heavily skewed towards those aged between 45 and 64 years old (all male participants and ten female participants). Only three female participants were aged between 25 and 44 (see Figure 12). Female participants' level of education was fairly high. Among those thirteen female participants, eleven held a university degree (85%). Male participants’ level of education was dispersed among three levels (see Figure 13). Participants came from various economic statuses. Twelve participants were either self-employed or in a full-time/part-time employment. Six had retired. One was a full-time mother and one was a job seeker (see Figure 14).

![Figure 12: Participants’ Age and Gender](image1)

![Figure 13: Participants’ Level of Education](image2)
Participants’ current travel patterns

Among the twenty participants, seventeen were the main driver of their household car, twelve females and five males. Of these seventeen, all travelled by car as a driver or by foot ‘often’ or ‘very often’. Male participants travelled by car as a driver slightly more often than females, but much less often travelled by car as a passenger or other non-car modes (see Table 1). Three participants were not the main drivers of their household car, one female and two male. The female participant travelled by public transport or by car as a passenger. Even being not the main driver of his household car, one of the two male participants still travelled by car as a driver for most of his journeys. The other one did not have a driving license. Hence he travelled by either public transport or foot. This reveals that the car ownership plays a very important role on travel mode choices, which have been reported by many other studies [56, 57, 49 and 59].

Table 1: Mean value of frequency of using various transport modes by household main drivers

<table>
<thead>
<tr>
<th>Gender</th>
<th>DRIV</th>
<th>PSNG</th>
<th>PUTP</th>
<th>BIKE</th>
<th>WKNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>N</td>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>4.60</td>
<td>1.80</td>
<td>2.60</td>
<td>2.20</td>
</tr>
<tr>
<td>female</td>
<td>N</td>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
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<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>4.50</td>
<td>2.92</td>
<td>4.00</td>
<td>2.75</td>
</tr>
</tbody>
</table>

(The frequency was assessed by a 5-point Likert scale:
1-never, 2-occasionally, 3-sometimes, 4-often, 5-very often)

Participants also reported their typical travel mode(s) for each type of journeys. Thirteen of the twenty participants made commuting journey regularly, four males and nine females. Six drove to work. The other seven commuted by public transport, bicycle and foot (see Figure 15 [1]). There were just seven participants, mainly female, who travelled to school/college regularly for escorting children, having evening courses or part-time degree study. For such journeys, only one travelled by car for an evening course, with the rest travelled by non-car modes (see Figure 15 [2]).
The transport modes used for work-related business trips were approximately evenly split into car and public transport. It seemed that female participants were more preferred to travel by car (see Figure 16 [1]). Participants claimed that the convenience was their primary concern rather than the cost as work-related business trips were usually paid by employers. Destinations of the personal business trips were mainly in the town centre which was about 2 miles away from home, reported by participants. Four participants stated that they normally travelled on foot to maintain a healthy lifestyle. Six travelled by public transport to avoid the hassle of finding a parking place or the traffic congestion in the town. Seven travelled by car because they normally chained personal business trips to other regularly journeys, e.g. dropping children off at school or way back from work (see Figure 16 [2]).
As shown in Figure 17, majority of participants travelled by car to visit friends and family (see Figure 17 [1]), go on holiday (see Figure 17 [2]) and go for a day trip (see Figure 17 [3]). Presumably, a family (normally two or more persons) would travel together for these purposes. In such a case, it was claimed by the participants that the car was a cheaper and more convenient option than the public transport:

- the cost of travelling by car was fixed regardless of the number of passengers and very possible to be cheaper than by public transport which requires individual tickets for each member of the family;
- the car provided a private and secured room for the family, especially when travelled with young children;
- the luggage could be stored in the boot; and
- the journey could be door-to-door

![Figure 17: Visiting friends and family, Going on holiday and Going on a day trip](image)

In contrast to the leisure trips mentioned above, mode choices for going to entertainment were clearly leaning towards the public transport as participants claimed the need to be relaxed (see Figure 18 [1]). Participants were also requested what transport mode they would choose if they travelled to public transport terminal/airport. Only two used other modes rather than the public transport – one by car and one by foot (see Figure 18 [2]. They both claimed that public transport was more expensive than driving (comparing the fare to the parking charge with the consideration of parking time). Therefore, they tended not to use public transport but use a car or walk in their daily life.
In summary, it seems that travel patterns were mainly determined by car ownership, travel costs and ease of making the journey. However, managing the level of car ownership and travel costs are beyond the capability of TIS. Therefore, for using TIS to facilitate more use of public transport, it should target on making public transport journey as easy as possible and meanwhile informing car users (or intended car users) the disadvantages of using the car (e.g. congested route, lacking parking space at destination, road use charge, air pollution) whenever these disadvantages exist.

Participant’s perceived usefulness of FTIS services

Table 2 gives a list of services provided by FTIS which intend to offer as much support as the public transport passenger would need. Participants used most of these services whilst making a virtual journey with the immersive video. The last five types of services were not included by the FTIS scenario. Through a face-to-face interview, participants expressed their perceived usefulness of the specific services straight after their use of the system. All participants emphasised that the usefulness of the services mainly depended on the familiarity with the journey. In general, female participants believed that more services were ‘useful’ or ‘very useful’ than male participants. It seems that female participants require more assistance in travelling than male participants.

The ease of using automatic journey replan function was appealing to each participant. Hence, together with the information on ‘delay and alternative departure times’, it was considered ‘useful’ or ‘very useful’ service by all participant regardless their familiarity with the journey. Although the system would have to collect much detailed information about the user in order to provide such services, they claimed they did not have the concern over privacy. They were happy for the system to know them well in order to provide timely and unprompted travel assistance.
Majority of participants stated that ‘delay and alternative mode/route choices’, ‘journey duration’, and ‘travel costs’ were ‘useful’ or ‘very useful’ services. This opens the chance for the system to promote public transport services when they are competitive to travelling by the car concerning travel cost and efficiency.

Participants were surprised by the timely and situation-based ‘travel alerts’. Some thought the service was ‘quite useless’ or ‘very useless’ for travelling in familiar areas. However, over half of them still considered the service ‘useful’ or ‘very useful’ even for travelling in familiar areas, particularly for public transport journeys. They pointed out that, in these days, there were a lot of things distracting people’s attention away from their journeys, for example, listening to the radio or music, playing games or surfing on the internet using personal mobile devices or portable PC. The timely and targeted travel alerts reminding them to depart from home for the next bus or to leave the train at a certain station would take the anxiety of missing the bus/station away from them and allow a better time management. Clearly, participants recognised the advantages of this service as enabling the user to concentrate on his/her mainly interested tasks and meanwhile adding the value to the time spent on travelling. The service, together with ‘personal navigation’, was regarded as ‘useful’ or ‘very useful’ by all participants for travelling in unfamiliar areas.

<table>
<thead>
<tr>
<th></th>
<th>Table 2: FTIS Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>journey duration</td>
</tr>
<tr>
<td>B</td>
<td>walking time</td>
</tr>
<tr>
<td>C</td>
<td>in-vehicle time(car, bus, train, etc)</td>
</tr>
<tr>
<td>D</td>
<td>travel costs</td>
</tr>
<tr>
<td>E</td>
<td>travel alerts: alert to depart from home or get out of the bus/train based on the real-time transport information and your location</td>
</tr>
<tr>
<td>F</td>
<td>personal navigation based on your current location</td>
</tr>
<tr>
<td>G</td>
<td>images of the route/vehicle</td>
</tr>
<tr>
<td>H</td>
<td>information on comfort (e.g. seat spacing, waiting areas)</td>
</tr>
<tr>
<td>I</td>
<td>information on convenience (e.g. ticketing)</td>
</tr>
<tr>
<td>J</td>
<td>information on events, point of interest</td>
</tr>
<tr>
<td>K</td>
<td>automatically replan the journey when change occurs</td>
</tr>
<tr>
<td>L</td>
<td>real-time traffic conditions</td>
</tr>
<tr>
<td>M</td>
<td>precise weather condition</td>
</tr>
<tr>
<td>N</td>
<td>delays and alternative mode choices</td>
</tr>
<tr>
<td>O</td>
<td>delay and alternative departure times</td>
</tr>
<tr>
<td>P</td>
<td>delay and alternative route choices</td>
</tr>
</tbody>
</table>

Over half participants stated that they were not too much bothered by ‘information on comfort’, ‘images of the route/vehicle’ and ‘precise weather condition’ when deciding how
to travel. They were more concerned about ‘information on convenience’, ‘in-vehicle time’ and ‘real-time traffic information’. Once again, this demonstrates that the ease and efficiency of making the journey play more important role on travel choices than other issues such as the comfort, the weather, and the actual route and type of vehicle.

**The likely use of the services**

Reported by the participants, the use of FTIS, in general, would depend on two factors: the familiarity of the journey and the constraints of the journey. They believed that they would more likely to use the services for undertaking a non-regular journey in a familiar area, a familiar journey with time-constraint or travelling in an unfamiliar area. However, it was claimed that many services provided by FTIS would be unnecessary for a familiar journey without time-constraint (see Table 3).

In detail (see Table 4), reported by participants, three of fourteen would use the system for commuting to work, one of seven for going to school/college, seven of eighteen for personal business trips, seven of twenty for visiting friends and family and eight of twenty for going to entertainment due to being familiar with the journey. Of those who were in employment, all stated that they would use the system for work-related business trips. One female participant believed that she would use the system for every journey and the use of such a system whilst travelling could become a habit. However, one male participant thought that he would not use the system for any national based journey because he believed that he had known everything and everywhere about this country. Another male participant claimed that he would only use the system for work-related business trip for the same reason.

Majority of participants believed that they would use the system for going on holiday and going on a day trip because very likely they would not be familiar with the area. Most participants also believed that they would use the system for travelling to public transport terminals due to the time-constraints or a better time management.

**The likely impact on travel choices**

About half of participants believed that the services provided by FTIS could encourage them to make more use of public transport. Most of the other half of participants stated that they had used public transport a lot. However, majority of participants considered that the FITS would certainly encourage them to make more use of public transport when travelling in unfamiliar areas (see Table 5).

Participants also stated that the FTIS could enhance their confidence in using public transport, make public transport journey easier and less stressful, and always allow them to be aware of the relevant availability of public transport options.

At the meantime, participants pointed out that if they had started their journey with the car,
they would prefer to finish the journey with the car, particularly for a chained journey. They could switch to public transport choices only when information on delays or congestions could be received before they got into the traffic jam and the alternative options were extremely convenient. Only proactive and sophisticated FTIS services could meet such types of user requests.

**CONCLUSION**

Our experience has shown many useful insights which can be gained both from user feedback and the actual process of creating the immersive experience (planning and filming the video scenarios). Although we encountered considerable difficulties in filming, editing and in feeding the video streams into the wizard system, we have developed a process where by a complete travel scenario can be created within the immersive video system both efficiently and effectively.

To date, twenty participants were taken through the immersive video experience of a public transport journey using a hypothetical FTIS scenario. Significant advantages were apparent in the manner that the immersive video contextualised the tasks (these were confirmed in reports by the participants) and the design of graphical user interfaces well demonstrated the performance of the FTIS services. The use of the information system to support personal travel has been achieved. Subjects are able to express their opinions, declare their attitude and indicate their likely use of the system in the future based on their own experience with the system.

Results indicate that the functionalities of FTIS were appealing to majority of participants. The services provided by FTIS were perceived useful and have the potential to enhance the confidence in using public transport, eliminate the uncertainties of travelling by public transport, make it easier and less stressful to use public transport and enable people to be aware of the relevant and viable public transport options all the time.

Our results also indicate that immersive video has the potential to become a very promising evaluation tool for FTIS. When contrasted with fully implemented or even partially implemented systems, it is apparent that immersive video provides a low cost and easily developed alternative. In addition, immersive video has the potential to create high fidelity scenarios capturing many of the environmental factors that play an important role in the evaluation of the user experience.