THE VVIP SYSTEM:

Encouraging the use of public transport in Edinburgh

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Abstract
This article is concerned with the encouragement and promotion of the use of buses in Edinburgh, especially among visually impaired users and tourists / migrant workers. The report outlines the key issues these groups encounter when using buses, and introduces VVIP, or Visual and Vocal Information Platform as a solution. The report contains detailed research methodology and findings which led to the development of VVIP, and the design and evaluation procedures undertaken by the group. VVIP is a cost effective and easily deployed dynamic location based system which offers passengers a visual and auditory display of where the bus is in relation to its next stop facilitating and improved bus travel experience.

Keywords
Location Based Information System, Social Inclusion, Public Transport, Visually Impaired, Tourists, GPS, Disability Discrimination Act.

ACM Classification Keywords
H1.2 User / Machine systems, H5.1 Multimedia Info Systems, H5.2 User Interfaces

Introduction
"*Edinburgh aspires to be a city with a transport system that is accessible to all and serves all. The transport system should support a sustainable and prosperous*

economy. It should contribute to better health, safety and quality of life of all Edinburgh's citizens and visitors, particularly children, the elderly and disabled people".

- Edinburgh City Council – Local Transport Strategy 2006 Part 1, p.14. [1]

A public transport service that is available to all individuals in society is not only an ethical obligation, but also a legal requirement in the UK since the Disability Discrimination Act of 1995 [2]. Hence, the providers of public transport must not only focus on societal issues such as supplying the basic service that its consumers are paying for and decreasing the congestion of traffic in the inner city, but also reduce the social exclusion of disabled individuals that are, for a number of reasons, unable or unwilling to use public transport. This report aims to evaluate how a new, innovative service offered may encourage and promote the use of public transport by visually impaired individuals and how this may also benefit tourists / migrant workers.

Project Methodology

The first key decision that needed to be taken when addressing this significant social issue was to consider how the project could be managed. The following process map was designed, presenting a roadmap to completion as well as a list of key tasks and outcomes, in the order that they would be required to complete the project. The process acted as a guidance tool to make sure that the project ran on time. By agreeing upfront on the process, the team was able to manage and deliver each of the aspects in an efficient manner. See Fig. 1.

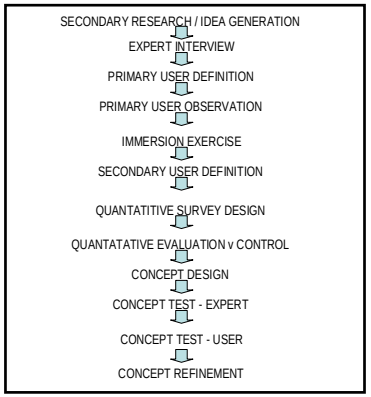


Fig. 1 Methodology

Background Research

For this report, background research has focused on published Academic Papers, Scottish Executive research, Edinburgh City Council strategies and Lothian Buses Ltd development plans, examining what these organizations have done in the past, and are planning to do in the future for disabled users of public transport.

Much of the academic research conducted in the area of visually impaired transport users has focused on pre-journey solutions, either journey planning or information provision at the bus stop [3]. It is therefore our intention to focus on 'in-transit' information provision, an area which so far has not received much focus and will provide real benefits to a wide range of user groups.

The Scottish Executive research on how to improve public transport for disabled individuals was published in the report "Improved Transport for Disabled People – Volume 1 Report" (2006). One of the main points that arise from this research, is that the level of information while using the service is currently not good enough, and needs improvement. Out of the 705 participants involved, 39% felt that improvements to information related issues may encourage the use of public transport. The findings of their specific research with visually impaired individuals also suggest that information in Braille or audio may encourage the use of public transport, and one of the main issues were "*bus drivers forgetting to inform passengers that they have arrived at their destination stop"*. The Scottish Executives recommended changes and priorities would be "Tailored Journey Planning / In-trip information".

The Edinburgh City Council report on Local Transport Strategy (Part 1 and 2)[1],[4], 2006, reinforces the focus of reducing social exclusion as one of the main goals for the next five years. It states their efforts will be on developing the services available, to make them available to all parts of society.

Lothian buses are currently in the process of developing their services to further facilitate the needs of disabled individuals in Edinburgh. According to their Network

Manager, there are currently approx. 2000 trips undertaken each week by visually impaired individuals, although this number may be under-reported and this is *below 1%* of current total concessionary travel, yet 7% of Concession cards are registered blind.

Concept Specification

The research that was conducted, with regards to public transport in Edinburgh, highlights many interesting areas that could be addressed. One subject deemed appropriate for further consideration was the promotion and encouragement of the use of buses, and the need for greater accommodation of 'socially excluded' sectors of society, in particular passengers who are visually impaired.

Using this as our primary focus, we hoped to establish a system that would make this user group feel more comfortable using buses throughout Edinburgh. The requirement for such a task is to introduce a system where it provides the user group information about current location and time to the next stop. To satisfy these criteria, it would be required to inform the passenger where they were and give them sufficient time to disembark from the vehicle. To achieve this, an auditory display would be developed that would give information about what the next stop is and length of time to next stop, therefore, making bus use as easy and comfortable as possible for the visually impaired.

By introducing localized interfaces in the buses it would help more than just the visual impaired. Since most of the Lothian buses have visual display units on board and in view to passengers, it could assist passengers who have hearing disabilities (auditory problems) by supplying the same information as the audio display. Enhancing this real-time system with information on tourist attractions, which are in close proximity of the bus location, could be beneficial to a secondary user group, tourists / migrant workers.

Primary Research

As a group we had decided that for this project we wanted to look at how technology could give access to Public Transport for those that are socially excluded. Two members of the group observed the difficulty that a visually impaired passenger was having using the bus, we decided that this would be the area that we would focus our attention.

Technical / Expert Research We opened dialog with the main public transport provider in Edinburgh to better understand their views and what work they were involved in with respect to Visually Impaired passengers. Lothian Buses were very cooperative and shared their plans to develop the current system by testing auditory display systems at bus stops working along side their Bustracker visual display system.

Ethnographic / Immersion research We observed visually impaired passengers on the bus to try and understand what issues they had. In total 3 passengers were observed without us speaking to them and detailed notes on the observation were made. The key areas that were observed related to location, and time to disembark, particularly if accompanied by a guide dog. All 3 passengers asked the driver to inform them when they reached their stop (in one case a driver changeover created real difficulty for the passenger).

Based on these observations, and to gain a better personal understanding of the bus usage experience, one of our group took a bus journey while wearing eye covers to simulate the experience of a visually impaired user. This was an accompanied journey with another team member observing and taking notes about the feelings and issues that were being experienced. The results of this research component validated the initial observations derived from ethnographic research, and added another dimension and that was the emotional aspects relating to lack of control and disempowerment and sense of anxiety / security (These emotions are likely to have been exaggerated as we were artificially creating the visual impairment, whereas for visually

impaired bus users this was their every day experience – however, this activity allowed a better design of survey).

Survey Based on the first two stages, a survey was designed so that we could get a better understanding of the issues experienced by our primary and secondary user groups and also against a control group of bus users. The survey was designed to be as simple as possible, and take no more than 3 minutes to complete, and scored on 5 point Likert scale.

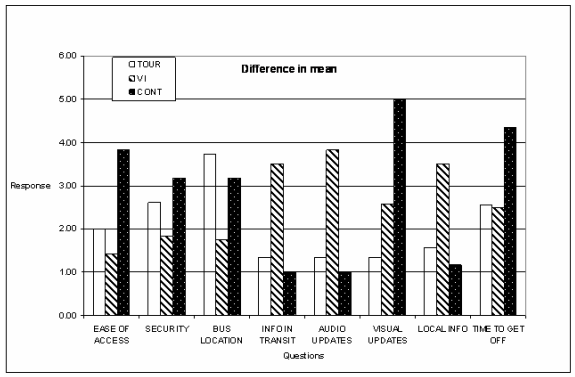
Given the difficulty in using a paper questionnaire with visually impaired respondents, after two surveys had been completed with some difficulty and discomfort by the respondents, we switched methodology and completed the rest by using a combination of telephone interviews and by enlisting the aid of a specialist care worker who works with visually impaired, giving us a further 10 responses. The Questionnaire ended with an opportunity for the respondent to make any further comments.

23 tourists were interviewed using the same survey, and the survey results of 12 frequent bus users who where neither visually impaired or tourists acts as a control group.

Survey Results The results of the survey are displayed in Fig.2. The table represents the difference in mean of survey responses, and using this, the group conducted a number of two tailed t-tests to assure the validity ($p<=0.05$).

- There was a requirement for more information whilst in transit by the visually impaired user group ($p<0.01$)
- The requirement for communication media differed significantly by user group
- Visual impaired users wanted audio information ($p<0.01$)
- Tourists wanted visual information ($p<0.01$)

Fig. 2 Survey Mean Results



- Control group did not want audio display but were comfortable with visual display
- Compared to the control group, there is a significant difference in both tourist and visually impaired groups on the statement *"…whilst in transit, I feel that I know where the bus is located". ($p<0.01$ and $p<0.05$ respectively)*

Conclusions The conclusion drawn from the primary research is that a system providing the target user groups with information while in transit is lacking, and that this may be a cause for visually impaired and tourist users not utilizing the bus system in Edinburgh. This could be developed into both visual and audio output, providing the passengers with in-transit feeds of specific reports on location and time until next stop.

Conceptual Solution Development

Current System All of Lothian buses have on-board CCTV cameras, and all double deck buses have a screen at the front of the bus that toggles among the views of the cameras. This has had a dramatic effect on safety and security on the buses.

In 2005, Bustracker went live on a third of Lothian buses. This was a network control and management system where each bus continuously communicates with a central computer giving its location and whether it is on time or not. This involved significant investment as each bus has a computer unit on board which connects wirelessly to the depot when the bus is parked, packet radio communication system linking the on-board computer with the central computer. Local radio masts across the city relay the data between the bus and central computer, and sign boards at key stops to inform passengers waiting which bus is next and when they can expect their bus to arrive.

Before the bus leaves the depot, its on-board computer (OBC) and the central computer communicate across a wlan. The bus unique reference number and driver number are uploaded and the journey details for that buses route are downloaded. The bus route knows its

start point and its end point and the distance between each bus stop and key traffic items such as traffic lights and pedestrian controls. The central computer also holds this information in a large complex traffic model of the City.

The bus starts at its start point and the onboard computer monitors distance traveled and time gone, it can match that against the route map or journey model, and send a packet of data to the central computer informing of its assumed location. Based upon this information, the central computer sends the data again by packet radio, to the info boards at the bus stops informing passenger's next bus to arrive information etc. At predefined intervals the bus takes a GPS reading of where it is and corrects its position on the onboard computer, and with the central computer. The system is designed to give accurate traffic management information and control to the network manager at Lothian buses – it allows information about road closures to be sent to the buses in real time and inform passengers waiting about delays etc.

VVIP System The system is a simple bolt on to Bustracker and would sit on the onboard computer. A Java based interface with the OBC allows text to be displayed on screens – for example the cctv monitor on the upper deck, showing the next stop and how long until it is reached and a local point of interest. A simple interface converts text to speech allowing auditory display for the primary user group. The visual display would be of benefit to the secondary user group.

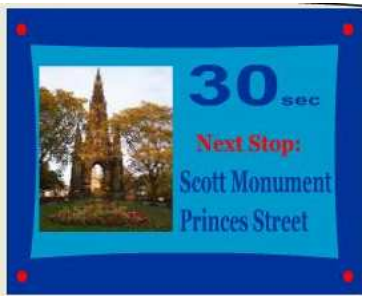


Fig. 3 Visual Display on Bus

The VVIP system takes the data packet based on location and journey time that the bus transmits to the central computer, and converts the data into text. Typically, time to next stop, and next stop name, eg:

"30 seconds Scott Monument, Princes Street"

The text is relayed when the 'distance to' calculation on the onboard computer reaches 30 seconds (initially 25 seconds based upon the survey research, but amended as a result of the user evaluation) and triggers the signal being transferred to the display systems. The auditory display then uses a text to voice system and this is fed through the speakers in the disabled area of the bus (all Lothian buses designate the front area of the lower deck of their buses as for elderly or disabled). The auditory signal would be preceded by a simple 3 tone sound (a suggestion from user evaluation) to alert the attention of the bus user that an announcement follows.

From the survey it became clear that standard bus users would find constant auditory signals an annoyance and strongly rejected the idea of updates, so for this reason we rejected the idea of relaying the auditory display throughout the entire bus. Simultaneously the text signal would be displayed visually on the bus monitor at the front of the top deck. The VVIP software also contains an image database, and shows a simple image of what points of interest are serviced by the next stop, so in the case of the example shown above the visual display would look like Fig3.

Evaluation of VVIP

Primary User Group The primary group is visually impaired people, so for the evaluation of VVIP - telephone descriptions were used, two visually impaired bus users were selected. The presentation to the users was totally based in audio. The Auditory display was explained in detail and a mocked up example was then used to demonstrate how it would work. After listening to the announcements, they suggested that maybe it would be better to add some sound before to alert them. This was incorporated in the final design. It was also suggested that the volume might be too low because sometimes if the bus is full of people it is very noisy (especially if full of children) and he was worried about if it would be able to listen correctly. It was explained that the sound would only be in the disabled area of the bus and volume testing would be conducted at the implementation stage.

It was thought that 25 seconds was not sufficient time and 40 would have been better. First, they need more time than other passengers to find the exit door and if they are traveling with the guide-dog is more complicated to move around the bus. It was also concerns that when the bus is crowded and the corridor is full it becomes more complicated to exit. Given the proximity of bus stops in Edinburgh – The Expert User suggested that 30 seconds would be optimum, and that is what the final design implements.

Secondary User Group The secondary user group is Tourists and Migrant Workers, so this time for the evaluation of VVIP a focus group was conducted at the English School, *Randalph Academy*, with 5 tourists/ migrant workers from different countries (Spain, Italy, Poland and France) and presentation of the design was audio and visual demonstrated on a laptop. The main issue was that the audio might not be clear enough to understand for people for whom English is not their first language, although it was suggested that a popular and recognizable voice should be used, such as Sean Connery. The Secondary User Group particularly liked the visual display the idea of seeing an image of the place and not just the name of the bus stop. It was raised as a concern, however, that it may be difficult to see the display if they are sitting at the back, so if the sound announcements are only downstairs and the display it is so far away VVIP wouldn't help them very much.

Reflections and Conclusions

VVIP addresses the problems which the user groups deal with in using public transport. Visually Impaired passengers, through implementing the localised auditory system at the front section of the bus, would allow them to feel more confident traveling on buses. The system would provide relevant information and in sufficient time for them to disembark. These are key issues that arose when interviewing this target group. Although visually impaired bus users were the primary user group, other parties were taken into consideration. By providing information regarding landmarks and tourist hotspots through the Visual display units located on the buses, this benefits the visitors to the city as it gave them an understanding of where these were, without having to use other services. The research suggested that continuous auditory updates would annoy the 'average' bus user, so the localised system was useful for confronting this problem.

From an implementation and cost perspective, the VVIP is a simple bolt on to the current technology in place and would require minimum financial investment to introduce across of Lothian Buses.

Since all the objectives are satisfied, there is no significant modification needed to the design. It is apparent from the research that there may be a slight hindrance as audible levels need to be established as part of implementation to ensure that the volume of the auditory system is loud enough to overcome background noise on the bus, a self adjusting audio system could easily be incorporated to vary the audio level.

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