Smart Mobility for Reducing School Gate Congestion in Europe

Innovating Smartphone Walking School Buses for Children of Primary Age

Norgate, S.H., Street, N. & Smith, L.
Psychology, University of Salford
Greater Manchester, U.K.
S.H.Norgate@salford.ac.uk
N.Jones@salford.ac.uk
e.smith1@salford.ac.uk

Winstanley, C., Davies, N., & Harding, M
InfoLab21, Lancaster University
Lancaster, U.K.
c.winstanley@lancaster.ac.uk
nigel@comp.lancs.ac.uk
m.harding@lancaster.ac.uk

Cherrett, T.,
University of Southampton
Southampton, U.K.
T.J.Cherrett@soton.ac.uk

Dickenson, J.
Bournemouth University
Bournemouth, U.K.
J.Dickenson@bournemouth.ac.uk

Speed, C.
University of Edinburgh
Scotland
C.Speed@ed.ac.uk

Abstract - **In this paper, we report research on the impact of a Smartphone enabled 'Walking School Bus' Application (WSB App) on parental waiting experience, with a view to influencing a reduction in school gate traffic congestion in European cities. The core concept of the WSB App is to enable parents to track - real-time - the arrival of their child's WSB. This is through use of a moving icon representing the WSB as it sets off from the start and progresses along designated stops towards school, guided by an adult WSB coordinator. Our research aim was to understand how the cognitive appraisal of the waiting experience of the parents differed with and without the intervention of the WSB App. A sample of 46 parents were recruited from 6 primary schools in North West England, and baseline data were collected on their waiting experience either in the experimental (n=24) or control (n=22) group. Preliminary analyses involving a comparison between conditions showed no significant difference on perception of duration of wait or perception of punctuality. In addition, using 'thematic' analyses, three-quarters of respondents reported benefits; in particular, the timing and child use of the WSB were identified as beneficial. The wider implications of application of real-time information systems to modes of active transportation are discussed.**

Keywords-Smart Mobility; Walking School Bus; Application; Mobile Technology; Children

I. INTRODUCTION

In 2013, the most congested European cities were Brussels, London, Antwerp, Rotterdam, Stuttgart, Cologne, Milan, Paris, Ghent and Karlsruhe [1]. In Brussels – the worst affected - drivers can expect to spend as much as 83 hours per year waiting in their cars [1].

Increasingly problematic to most European urban centres in peak travel time is the increase in car use in the morning school run, resulting in congestion around school drop-off zones. Evidence suggests that in the UK around 43% of primary school children travel to school by car compared with 37% a decade ago [2]. This increase in traffic, combined with decreases in 'active transport' (cycling and walking) to school in primary school children has raised associated concerns about impact of air quality, child health-related fitness and independent mobility.

Children of primary school age are on the cusp of becoming independently mobile, and soon to be making decisions about modes for future commutes. Significantly, we know that from a life course perspective that habit uptake in early life, in the area of active transportation is likely to inform children's future mobility behaviors [3], and there is a call for sustainable and convenient transport experience to influence future choice decisions. Today's primary children are the commuters of the future. And with projected birth rate trends in some European countries – for example, the population of UK pupils in state funded schools is projected to rise 18% by 2020 [4] there is a need to provide convenient alternatives to car travel in the future.

Collectively, these trends make it timely to consider alternatives in transport, such as walking school buses

(WSB) to be promoted as a sustainable and convenient choice to shape future travel behavior [5].

The concept of a WSB was innovated in Australia [6] to enable children to get to school walking as a group, supervised by young people or adults. Traditionally, WSBs have involved leaders or coordinators using an informal timetable where there is some indication of a clock-time when a bus is expected to arrive at a particular stop. Whilst the innovative idea has been recognized by those who have adopted it - particularly in New Zealand, USA and Australia [5] - there is still scope to understand the barriers to choosing the WSB over other (less sustainable) modes of transport.

One potential barrier to uptake is the extent of visual access to the WSB's progress and arrival at stops on the way to the destination, particularly the case where the local highways are non-linear or when the WSB route changes orientation. The uncertainty in waiting times or confidence in arrival may influence parents/guardians uptake of a WSB use. It could be argued that if children and parents had a method to visually track the WSB as it leaves the start and travels along scheduled stops until it reaches the school, as with a smartphone enabled WSB, this may help break down these barriers.

In this paper, we report on the innovation of the Smartphone enabled WSB which exploits a real-time information system, to make travel to school a potentially more convenient initiative for parents and children.

A. *Real Time Information System for Promoting Smart Mobility*

In the domain of public transport, real time information systems have long been used with the intention to encourage commuter confidence in the reliability of services. Previous research of the impact of real-time information systems on public transport systems found increased information about accurate arrival time results in a more cognitively satisfying wait [7]. In addition, the more confidence that a user has in the reliability of a service, the more likely a mode of transport is to be perceived as convenient and usable, particularly in adverse weather conditions.

By understanding the influence of waiting experience and confidence in service, we hope to unpick the barriers to choosing sustainable transport in travelling to school and overcome the potential worsening of congestion and non-sustainable travel choices in Europe and further afield.

The WSB application involves using the tracking ability available in Smartphones to give the WSB new temporal visibility to users and potential users (parents, children, and walking bus coordinators) to optimize fluidity across scheduling boundaries between the morning school run and morning work start times, reducing some potential barriers to WSB use such as waiting time information and confidence in WSB arrival and punctuality.

This quest is timely in the context that between 2012 and 2013 the proportion of the global population using smart

phones increased from 16% to 20.2%, with a further projected rise to 24.4% in 2014 [8]. In the UK, the ownership of Smartphones increased from 30% to 45% of the population within 2011 alone [9]. On the basis of this rising ownership, any issue around digital inclusion did not seem a barrier to the access to the innovation.

In the current study, we investigate the extent to which real-time information systems can be utilized to promote perception of a quality waiting experience, thereby facilitating parents to uptake this service. Specifically, this research explores the potential impact that Smartphone enabled WSB intervention as a smart mobility choice, and focuses on the extent to which this real-time information is effective in making a difference to user's waiting experience.

In this paper, we examine the extent to which this innovative smart mobility impacts on the perceived waiting experiences of parents using the WSB App. Specifically, we investigate the extent to which perceived waiting time - as measured by duration - is altered as a result of the use of the App. Second, we look at any differences in perceived punctuality. Finally, we elicit comments from the parents on their experiences of using the WSB App.

B. *Features and Architecture of the Smartphone Enabled Walking School Bus Application*

A 'parent' view of the WSB interface, showing the WSB icon and the pick-up points is show in Figure 1 below. Parents are able to track the movement of the WSB along the route displayed. They are able to add their children to their chosen WSB stop to allow coordinators to expect/know not to expect their child. Once the WSB coordinator has pressed 'start tracking' – see Figure 2 below - real time movement alerts and predicted arrival times are provided for each stop.

The WSB application is compatible for all iOS devices version 5.0+. Lancaster University hosts the centralised web service on a virtual machine cluster. The application downloads the pre-established pickup points and displays it to the user. It then used the Google Maps Directions Service to create a route for the user. The WSB coordinator uses their application to push their location to a central web service every 5 seconds. The web service then queries the Google Maps Directions service to retrieve real-time prediction information for the user. This web service then disseminates this geo-location and prediction information to all other parent devices.

The architecture components in Figure 3 shows the publish-subscribe architecture designed for the system. The native iPhone application is connected to the WSB server back-end through a REST-ful web service. The coordinator device publishes its location in a web request to the centralised service. When it receives a request it interprets the call and stores the pushed information into

the database. The parent side of the application then sends requests to the centralised web service to retrieve the location of the coordinator. The back-end database stores the consistent state of the WSB system.

The devices cache local copies of all the data they receive as objects in a SQLLite database. When the system makes a change to this data a sync flag is checked and periodically objects are sent back to the server. This allows the devices to function and provide useful information to the user without having to hear from the server for substantive periods.

The application can also be used by parents to add their children to the Walking School Bus. The child's information is anonymised, encrypted and sent to the web service. This can then be downloaded by the coordinator to view the children they need to pick-up at each stop.

The WSB application developed is an open and secure platform which has been created based around the smartphone that will enable people to better visualize the activity of other people and things relative to their own immediate and future movements.

Figure 1. Parent view of WSB app user interface

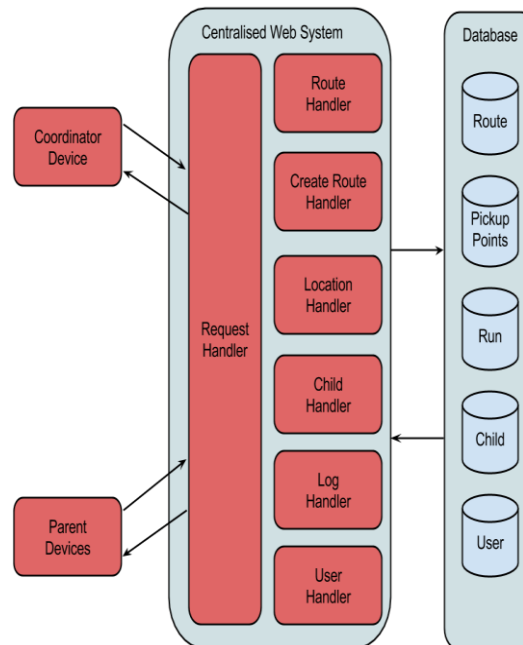Figure 2. WSB coordinator view of WSB app user interface

Figure 3. Architecture components of WSB App

II. STUDY METHOD

A. Design

Between May 2013 and July 2014, an experimental cross-sectional 'between groups' design was adopted to compare the perceived waiting experience of parents either assigned to the intervention of a smartphone WSB Application, or those in a 'control' condition who used the WSB as they would normally. A between groups design was adopted to reduce practice effects. Further, the intervention was a one-day intervention trial, due to the focus on assessing the impact of technology on 'time perception'. Two sets of measures were taken, pre- and post-test of the perceived waiting time duration and perceived confidence of the arrival of the WSB. In addition, participants were asked brief question about their experience of waiting for the WSB.

B. Sample

A total of six established WSB's from primary schools in the North West of England were recruited which involved 46 parents (24=experimental; 22=control group) from a range of low-mid socio-economic demographics. Institutional ethical approval was obtained.

C. Procedure

Following the ethical process of informed consent, parents completed 'baseline' questionnaires about their perceptions of waiting experiences using the 'traditional' WSB. Following this, their waiting experiences were compared before and after using the intervention. The intervention alsted one day. All parents in the intervention group received a demo of the WSB Application.

III.   OUTCOMES

The quality of the parental waiting experience was assessed according to three approaches. The first measure was according to perceived waiting time duration. Our preliminary data analyses of the sample collected until November 2013 shows that on a 'traditional' WSB, the perception of 'typical' waiting time is mean of 4 minutes (s.d. = 2.82, n=32). On the basis of a comparison between conditions, there was no significant difference on this measure.

Second, the same trend occurred for perception of punctuality. In the rating of 'typical' punctuality, the mean score was 4.4 on a Likert scale where '5' is very punctual.

Finally, according to participant perceptions of the waiting experience, three-quarters of respondents reported benefits, in particular around the timing and/or visibility of the WSB. Table I shows representative quotes. Three quarters of participants valued the use of the WSB App,

whereas three participants reported issues with the functionality of the WSB App.

IV.   CONCLUSIONS AND FUTURE WORK

Overall, the findings showed that there was no adverse impact on either the perception of duration of either waiting experience or punctuality based on adoption of a 'quantitative' analysis of perception of waiting times. This is important because it shows that there was no disadvantage of using this real-time information smart technology, which clearly matters in the context of getting children to school punctually.

In contrast, the adoption of a thematic analysis showed - even on one day trials - explicit evidence of positive attitudes by three quarters of parents towards the experience of using the WSB Application. In particular, both 'time' and 'child use' were cited by participants as reasons for the perceived benefits of use. These outcomes are relevant to the planning of the future uptake of the WSB App.

It is also relevant to note that in an earlier phase of the research, user attitudes to privacy around future use of the WSB App were examined through interviews with Headteachers, WSB coordinators and parents/guardians. Only a minority of those interviewed from a range of socio-demographic groups had concerns, and it has not limited longer trials.

One limitation is that these were outcomes from the basis of a one day trial and it remains to be seen whether perceptions remain stable across five week trials.

TABLE I- THEMATIC ANALYSIS FROM EXPERIMENTAL GROUP (N=19)

Theme:	n	Representative Comment:
Positive		
'Time'	6	"Being able to track the WSB meant we were able to leave the house just before it reached us, cutting down the waiting time."
Child use	4	"The children enjoyed following the bus (on App) learning about where the signal came from." "It was an interesting experience for both my child (name removed) and myself."
Visibility of WSB	2	"Felt App useful as I was able to see where WSB was. Also I was able to see when they arrived at school."
Generic	2	"The Application was great."
Negative		
Usability on the day	2	"Bus app did not work so we left early to make sure we did not miss it"
'Time'	1	"The bus arrived later at 8:17hrs when its latest time is 8:17hrs, I was anxious."
Other	2	"I don't really wait when my children are ready as they just knock the door .."
Total	19	

On the basis of preliminary analyses from one day trials, these findings show that although smart mobility devices can consciously be perceived as convenient and enjoyable by users this is not necessarily associated with any reduction in perceived waiting time as assessed by duration. However, this may be because one day trial is not sufficient for altering human cognitive processes. In future research we propose to explore the extent to which perception of waiting time is reduced on the basis of a longer trial. The study of the interrelationships between real time information systems of smart mobility and human cognitive processes – specifically perception of waiting time – will be inform the design of future smart mobility systems, particularly those that are user centered.

V.   REFERENCES

[1]   Transport Network (2013) [online], available:
       http://www.transport-network.co.uk/, accessed June 2014

[2]   DfT, 2010. *National Travel Survey.* [online], available:
       https://www.gov.uk/government/organisations/department-for-transport/series/national-travel-survey-statistics, accessed June 2014

[3]   McDonald, N. (2008) Children's mode choice for the school trip: the role of distance and school location in walking to school. *Transportation*, 35;pp. 23-35

[4]   DfE. 2012. National pupil projections: Future trends in pupil numbers – July 2012, [online], available:
       https://www.gov.uk/government/publications/national-pupil-projections-future-trends-in-pupil-numbers-july-2012

[5]   Smith, L., Norgate, S.H., Cherrett, T., Davies, N., Winstanley, C., Harding, M., (in press) Walking School Buses as a from of Active Transportation for Children – a Review of the Evidence, *Journal of School Health*.

[6]   Engwicht, D. 1993. *Reclaiming our Cities and Towns.* New Society Publishing.

[7]   Edison Watkins, K., Ferris, B., Borning, A., Rutherford, G.S., & Layton, D. (2011) Where is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders. *Transportation Research Part A: Policy and Practice.* 45(8);pp. 839-848

[8]   emarketers Dec 2013 Smartphone Users Worldwide Will Total 1.75 Billion in 2014.[online], availablehttp://www.emarketer.com/Article/Smartphone-Users-Worldwide-Will-Total-175-Billion-2014/1010536 accessed on: 20/03/2014

[9]   Google, Jan 2011. Mobile Internet & Smartphone Adoption. [online], availablehttp://googlemobileads.blogspot.co.uk/2012/01/new-research-global-surge-in-smartphone.html Accessed on: 20/03/2014