WILL PRIVACY CONCERNS LIMIT THE ABILITY OF SMART PHONE TECHNOLOGIES TO HELP FOSTER COLLABORATIVE SCHOOL TRAVEL?

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ABSTRACT

The GPS functionality in modern Smartphones has the capability of pinpointing an individual's position at any given time. As a result, a wide variety of apps are now available, providing the user with location-specific services, tailored to their location in space and time. In a transportation sense, such functionality has potential for providing users with visibility of current and future potential transport options. Understanding where an individual is, where they have been and might be in the immediate future, and knowledge of their typical schedules and historic trace patterns means that opportunistic, collaborative travel opportunities might be possible.

A key issue with such a concept, however, is the extent to which individuals are prepared to share information on their whereabouts, schedules and travel habits with others. This concept is being explored as part of the 6th Sense Transport project and this paper looks specifically at using smartphone technology to visualise lift-sharing opportunities for the morning school run, and the associated privacy issues.

Findings from a study of parents of primary-age children suggested that such a 'real-time' travel option visualisation system (RTOVS) must consider both who a user's personal information is given to and the type of information given to be successfully adopted by users. This is because the benefits it offers must outweigh the privacy risks perceived by the users. Additionally, the survey results indicated that such a system will be particularly attractive to the educated, employed, high-income household with time-scheduling pressures.

INTRODUCTION

The increase in the number of children travelling to primary (elementary) school via private cars [*1*] has numerous detrimental effects, not only increasing congestion, [*2*] but also increasing the level of child obesity [*3; 4*]. This paper introduces how Smartphone technology could be used to provide parents with visibility of collaborative travel options for the journey to and from school and through a survey, investigates their attitudes and concerns with providing and sharing the personal and location information necessary to enable the concept to function.

The underpinning concept centres around parents at a school joining a 'collaborative travel network'. The members of this community would be able to participate in various sustainable school travel initiatives e.g. official 'walking school buses' where children are walked to school on defined routes, with parents being able to drop their children onto the walking bus at various intersections. Parents would be able to visualise where other members of the community were, and this potentially would be through a 6th Sense Transport smartphone app, providing they had given their consent to share certain information on their scheduling tendencies and location. One can envisage the systems functionality in the following scenario (Figure 1):

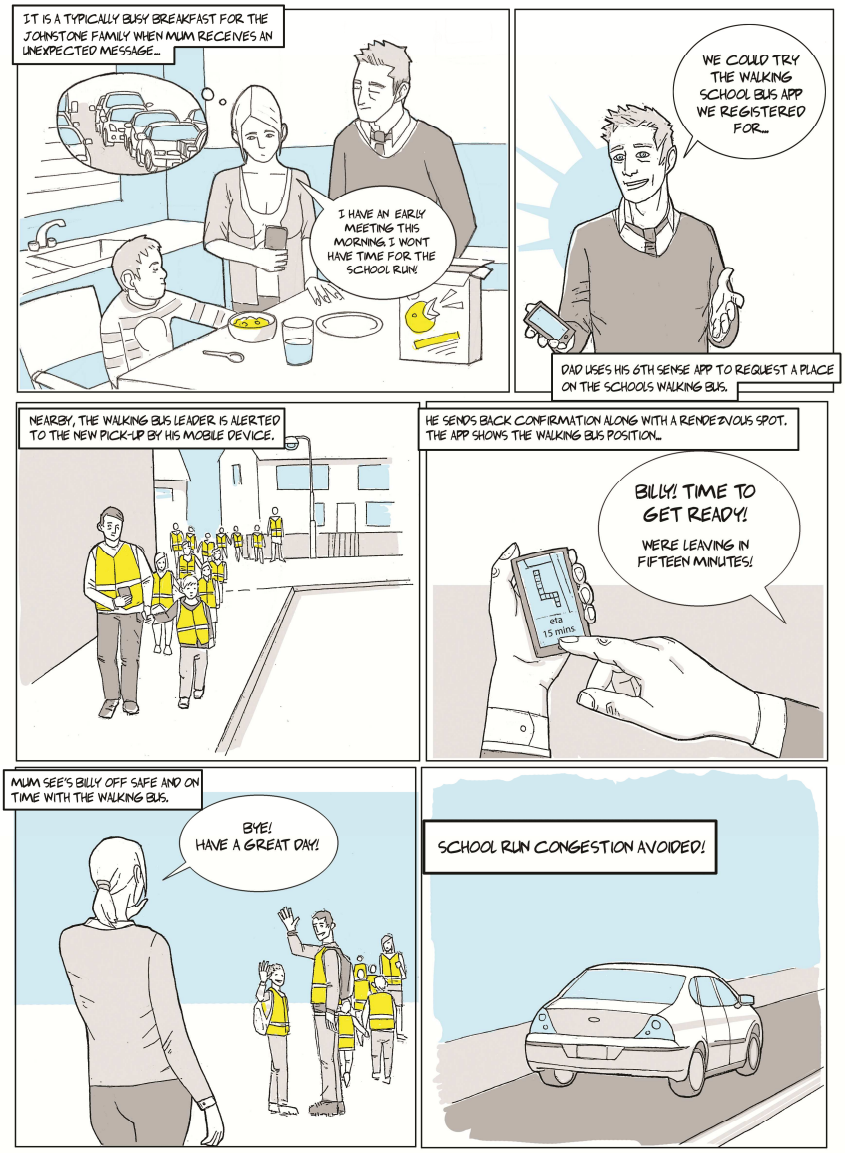

FIGURE 1 6th Sense Transport concept applied to a walking school bus

A key point is that the parent is not simply consulting a timetable that provides a set of fixed arrival and departure times to specific points - rather they are able to see on a smart-phone, real-time multi-modal travel options and to combine them in new, opportunistic ways. This requires parents agreeing to share their location either explicitly in the form of posted location updates, or implicitly through tracking applications operating on the phone or in the network, and details of their typical schedules through on-line calendaring applications [*5*]. This raises important issues about data privacy and how trust can be fostered in a travel system that echoes the openness of social networking systems [*5*].Also, the need to create an appropriate reward structure to motivate and encourage users to participate in the system, both in terms of providing and retrieving data from it. In this regard, it would be important to allow users to see their contribution to the system with clarity, particularly related to where they have helped make connections and aid travel. This paper considers a system that parents will have to opt into and discusses whether the benefits provided by such a system will be realised, allowing for the privacy concerns it creates.

School Travel Trends

There have been well-documented declines in walking to school both in the United States and the United Kingdom in recent decades [*1; 6*]. The 2010 UK National Travel Survey showed that only 47% of primary school children walked to school, while 43% travelled by car. It also highlighted that since 1995, cars taking children to school have increased from 10% of all vehicle trips to 16%, with the morning school run now accounting for 24% of car driver trips by residents of urban areas during term time [*7*]. This trend is further supported by Bradshaw and Atkins [8] who found that car escort trips were increasing even when car ownership was held constant.

Suggested causes for this modal shift away from walking for the school run relate to i) increased safety fears (traffic and 'stranger danger') associated with allowing children to walk, ii) an increase in the distances children have to travel to get to school and iii) a change in the numbers of mothers who are now in employment [*9*]. In 1970, 94% of 10 to 11 year old British children were allowed to walk to school unaccompanied by an adult [*10*]. By 1990 the number had fallen to 54% and to 47% by 1998 [*11*] highlighting parents' concerns with safety which is the most commonly cited reason for modal shift [*10*].

Increasing distance travelled to school has been the second main reason why people drive children [*9; 12*] with the average length of a home-to-primary school trip in the UK increasing from 1.3 miles in 1995 to 1.5 miles in 2010 [7]. Part of the reason for increasing travel distances is continuing urban sprawl and the amalgamation of schools [9].

Another major consideration behind the modal shift to the car during the school run, and the most relevant to the 6th Sense Transport RTOVS concept is the impact of parents' attitude [*13*], in particular how they feel time pressures in the daily schedule restrict their ability to use more sustainable travel options for the trip to school [*14; 15*]. The Victoria Travel and Activity Survey in Australia highlighted that 61% of the chauffeuring trips to and from primary school made by car were linked trips [*16*] and formed one chain on a journey to a separate final destination. The survey also showed that mothers made up 84% of the parents driving children to school highlighting the correlation between the proportion of mothers in employment and the number of children being driven [*9*]. McDonald [*17*] showed that the probability of younger children walking or cycling to school decreases by 8% when their mother commuted to work in the morning. The work and travel behaviour of the father was shown to have a less significant impact on their children's mode of travel to school.

Promoting Collaborative School Travel with Smart Technologies

The concept of collaborative school travel is not new and shared travel by car can be traced back to the 1940s [*18*]. Chan and Shaheen [*19*] found 613 internet-based ride matching programs in the U.S. and in Canada. A recent survey of households in the Greater Toronto and Hamilton Area, Canada, found that only 1.7% used carpooling as their primary school travel mode [*20*] and that carpool users typically worked full-time and had higher household incomes. This suggests that those who are the most constrained by time are the most likely to use some form of collaborative travel to get their children to and from school. Despite the obvious benefits of shared travel,

carpooling schemes have achieved, at best, uptake rates of 20% of the target community [*21*]. This is due to people not feeling safe travelling with strangers, the inflexibility in pick-up/drop-off locations/times and the lack of appropriate tools for publishing and searching for carpool rides. The latter point is now being overcome through ubiquitous wireless networks, GPS-enabled mobile devices and social networking [*22*]. Apps such as Avego (http://www.avego.com) allow car owners to distribute their routes and activities to people who require a ride. Organised on a dynamic basis across the web through a smart phone app, the system allows real-time ride sharing through a subscription service that allows drivers to be paid for offering lifts to people who needed to go somewhere along their route [*23*].

Privacy Concerns

A major barrier to the uptake of a RTVOS as advocated here is the need for significant amounts of personal data [*5*] which can deter potential users due to concerns over data privacy and trust [*24*]. The pilot for the Go520 real-time car-pooling system in the US [*25*] which used the Avego app experienced a significant wave of initial interest from participating commuters but once the true extent of personal information requirements became apparent (social security number, driving license details etc), participants withdrew.

A parent choosing to share data in the RTVOS has to make a trade-off between whether the reward on offer for participating outweighs the potential risks of disclosing information about themselves and their child [*25*]. This trade-off can be seen as a form of cost-benefit analysis [*26*] where individuals may accept small rewards for giving away information, because they expect future costs associated with releasing their personal information to be smaller [*27*].

According to the traditional arguments of the individual being seen as a rational, economically minded information-processer [*25*], the parent will be expected to act according to expectancy theory, which states that individuals will behave in ways that maximise positive outcomes and minimise negative ones [*28; 29*]. This is supported by Culnan and Bies [*30*] who argue that individuals will disclose personal information if they perceive that the overall benefits of disclosure are at least balanced by, if not greater than, the assessed risk of disclosure.

Other research has also shown that an individual's willingness to disclose personal information is likely to decrease with an increase in age, be lower in females and increase with the user's level of experience of using a technology [*31*]. In addition to this, the 2007 Community Attitudes Towards Privacy Study [*32*] found that the level of trust a user had in the person their information was going to varied significantly, from 91% for the health sector to 17% for the ecommerce industry. The same survey also showed that different types of information had very different sensitivity levels.

For a RTVOS to be deemed acceptable in privacy terms, a reasonable assumption to make is that parents using the technology will need to feel that the benefit offered by the system (reduced travel time, improvements in their child's health, reduced environmental impact etc.) outweighs their perception of the risks associated with giving away information about themselves and their child. Their perception of the risks involved will rely heavily on how sensitive the parent feels the type of

information required is and the level of trust the parent has in the people operating the system, related to how their data will be accessed and used.

RESEARCH METHODOLOGY

To investigate these issues of data privacy in the context of the 6th Sense Transport RTVOS concept, an online questionnaire was created and distributed to 12 diverse (in terms of the socio-economic demographics of each schools catchment area) primary schools around Hampshire in the UK. A letter directing the parents to an online survey (www.isurvey.soton.ac.uk/4152) was distributed by each school via their pupils (n≈2400) and a response rate of 6.3% (n=153) of which 110 fully completed questionnaires were analysed.

The sample size of the survey was relatively small and the demographics of the participants could have been more diverse, Table 1. Eighty seven percent were female, highlighting the role of women in coordinating the school run [*16*]. The sample was bias as 45% were between 46-50 years old and 45% held a postgraduate degree. Due to this bias it is fair to say that the results of this study are only representative of this skewed sample and that further research is required to see whether the conclusions made in this paper also hold true for the wider population.

TABLE 1 – Sample Breakdown (N=110)

Age		Gender	
<30 Years	2.2%	Male	9.0%
31-35 Years	14.6%	Female	86.5%
36-40 Years	15.7%	Undisclosed	4.5%
41-45 Years	21.3%	Household Income	
46-50 Years	44.9%	<£20.000	9.0%
Undisclosed	1.1%	£20-40.000	20.2%
Employment Status		£40-60.000	27.0%
Employed	76.4%	£60-80.000	13.5%
Self-Employed	9.0%	>£80.000	18.0%
Unemployed	5.6%	Undisclosed	12.4%
Other	9.0%	Education	
Ethnicity		None	2.2%
Majority	92.1%	Compulsory	14.6%
Minority	5.6%	Non Compulsory	15.7%
Undisclosed	2.2%	Undergraduate	21.3%
		Postgraduate	44.9%
		Undisclosed	1.1%

The questionnaire itself covered a maximum of 90 questions over 6 sections, gathering detailed information on current school commute behaviour, the motivations behind this and the reasons for variability, the mean time taken to complete the questionnaire was 15 minutes. Relevant to this paper were the questions covering willingness to collaborate and share personal information with others related to the journey to school using a combination of binary and customised Likert scales.

To examine the participant's willingness to disclose personal information the survey asked the participants whether they found a range of different privacy scenarios acceptable, following on from a similar methodology used by Cruickshanks and Waterson [31] and Ackerman, Cranor and Reagle [*33*]. Each scenario involved either a different reward; a different type of information required from the participant or a different person the information was going to.

An example of a scenario is: '*Would you give your daily travel schedule to a friend of a friend if it meant you reduce your travel time?*' In this example the reward on offer is a reduction in travel time, the type of personal information is the participants travel schedule and the person the data was going to was a friend of a friend.

RESULTS AND DISCUSSION

Figure 2 shows morning and afternoon modal splits for the sample's travel to and from their child's primary school. During the morning school run, 50% of the children walked, while 35.4% were driven in a private vehicle whilst on the return journey, the figures were 48.5% and 39.2% respectively. These findings correspond with those of the of the 2010 UK National Travel Survey [*7*] which found that 43% of the sample travelled to/from school in a private vehicle.

An interesting point was that 9.4% and 9.3% of the sample travelled by an 'other' mode during the morning and afternoon school runs respectively. When examining these trips in more detail, virtually all of the children in this category either walked with or were driven to school by a child-minder.

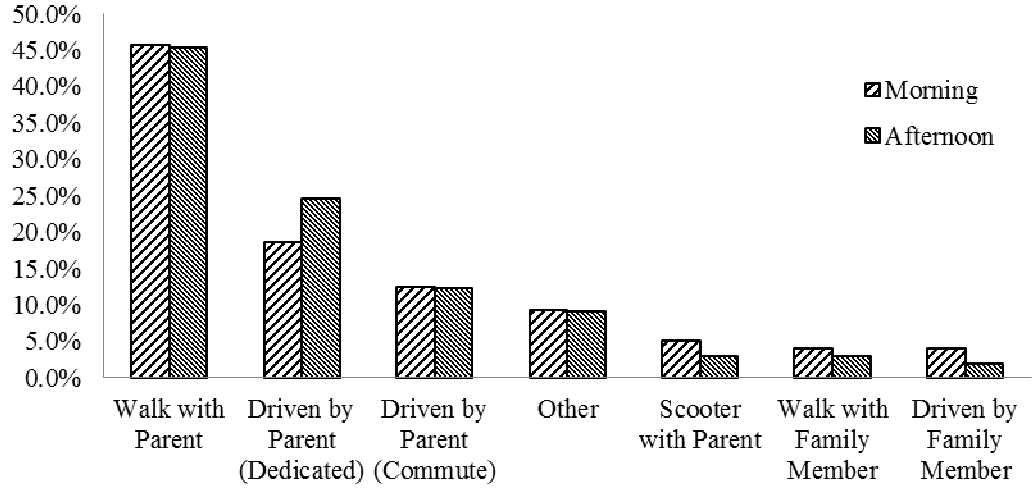

FIGURE 2 Modal breakdown of the survey sample's current school travel

Amongst the survey sample, 28.2% stated that they already had experience of sharing the responsibility of the school run with others while 29.1% stated that they would be willing to collaborate with others on transportation during the school run. Thirty three percent would not be willing to consider sharing the responsibility of the school run with others.

Forty one percent of those participants that currently shared the responsibility of the school run did so on most days, with a further, 55% doing so at least once a week. Sixty one percent shared responsibility for both the morning and afternoon journeys, while 14% and 25% shared responsibility for just the morning and afternoon runs respectively. The majority of the arrangements were based on an agreed fixed schedule (62%) and were made between existing friends and family (59%). The modal split for the shared journeys was 59% walking / 41% private vehicle in the morning and 55% walking / 45% private vehicle in the afternoon.

The participants were also asked the reasoning behind why they would not consider sharing the responsibility of the school run. The main reasons given related to personal enjoyment in talking to children during the school run, a lack of time, and close proximity to the school, the latter two being highlighted as key factors in the literature [*9; 12; 14; 15*]. The issue of gaining enjoyment from the school run was unexpected:

Participant 60*: 'This is a time when we can chat about what is happening in the day ahead/what has happened at school that day. We love having this time to ourselves without any other distractions.'*

Participant 22: *'I enjoy walking my children to school as it gives me an opportunity to discuss things with them. We also go over times tables and spellings… I find it quite frustrating the amount of time people devote to palming their children off onto breakfast clubs, after school clubs, nursery etc. I think people should spend more time with their children not less.'*

Participant 72*: 'I gave up work to spend more time with my kids which includes taking them to and from school.'*

A simple cluster analysis was used to investigate the underlying factors behind the participant's reported behaviour. The sample was split into three distinct clusters dependent on whether the respondents: i) already collaborated with others on the school run, ii) did not currently collaborate but were willing to do so and iii) would not be willing to collaborate on the school run. By comparing these three clusters it was possible to draw conclusions about the factors impacting on individual's attitudes towards collaborative school travel [*34*].

Table 2 shows the demographic breakdown of the three chosen clusters. Similar to the findings of the Greater Toronto and Hamilton Area survey [*26*], the results suggested that educated, employed people with a high household income were more likely to collaborate in the school run activity. It is also interesting to note that the cluster containing the parents who already collaborate contained fewer married people compared to the other clusters. These facts add weight to the theory that people with less spare time are more likely to collaborate on the school run [*19*].

TABLE 2 Demographic breakdown according to willingness to collaborate in school travel (percentage of disclosed values) (N=111)

Cluster	Employment Status (Employed)	Income (£60000+)	Education (Level 4+)	Age (36+)	Marital Status (Married)
Already Collaborate	88.0%	50.0%	79.2%	83.3%	83.3%
Willing to Collaborate	77.8%	37.5%	61.1%	82.4%	94.1%
Not Willing to Collaborate	69.6%	27.5%	63.0%	73.3%	88.6%

Thinking about the potential data required by the RTVOS, the survey measured to what extent parents would be willing to disclose personal information relating to their school run to a variety of different people for a range of different rewards. The results suggested that even the most unconcerned cluster (the parents who already collaborate) still only found 37% of the privacy scenarios acceptable on average. Figure 3 shows how the acceptability of a privacy scenario that rewards a parent with reduced travel time varies with both different information types and different data recievers. There are two clear tiers of data recievers, those who are trusted and those who are not with a parents family, friends and their childs head and teacher all percieved as being trustworthy.

Figure 3 also shows that there are two clear tiers in the sensitivity of the different information types. Parents are far less concerned about giving away their rough address (zip/post code), email address, travel schedule, mobile number and full address for a reduction in their journey time than giving away information about who they are friends with and their historic and current locations. The evidence suggests that sharing travel schedules amongst 'friends' would be acceptable in the 6th Sense Transport RTVOS concept, but the definition of 'friend', particulalry in a social network warrants further investigation in this regard. Location history and exact current location may cause privacy issues with a lot of parents, to the extent that even 'trusted friends' might not be granted access. The role of the school in setting up and legitimising a walking school bus RTVOS should not be underestimated.

Figure 4 considers the acceptability of various privacy scenarios that require a parent to disclose a detailed travel schedule to a range of data users, for a variety of different school run related benefits. The results suggested that the acceptability of a scenario increased with the parent's perception of the value of the reward on offer. With an improvement in their child's safety, helping another member of the community and reducing the time taken on the school run being the most valuable benefits. While reducing financial costs and improving their social image were the least valuable rewards. It would be interesting for future research to explore whether the demographic groups not covered so heavily in this sample have a different outlook on the perceived value of the rewards on offer. Unlike that found for the data type and data user, there were no clear tiers in the acceptability associated with different rewards. Instead, each reward holds a different value to the parent.

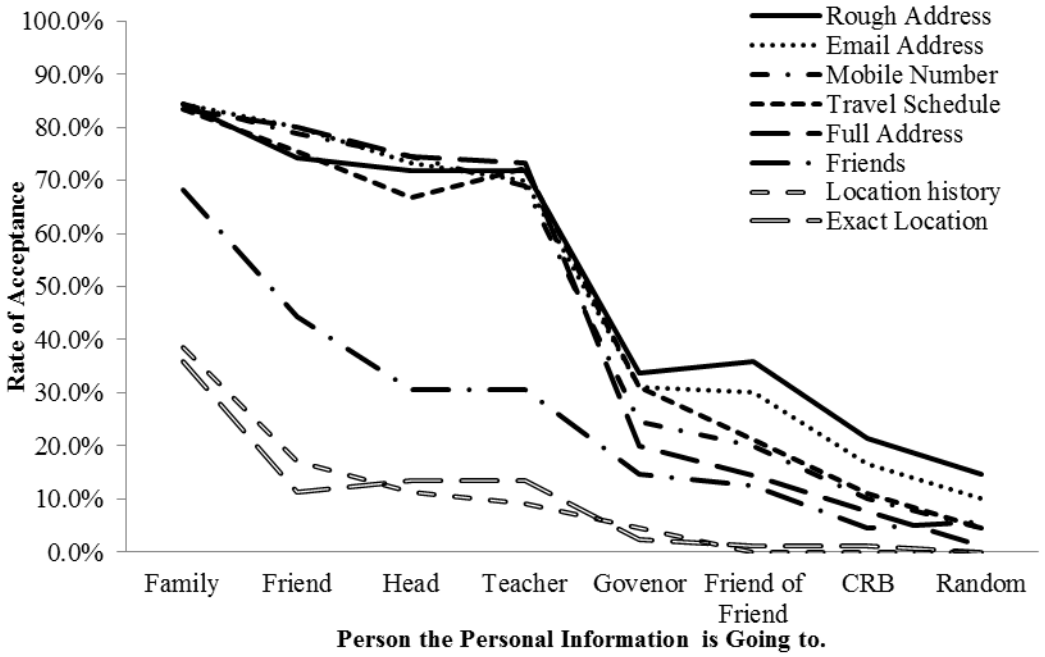

FIGURE 3 Rate of acceptance of scenarios that would result in the parent saving time during the school run

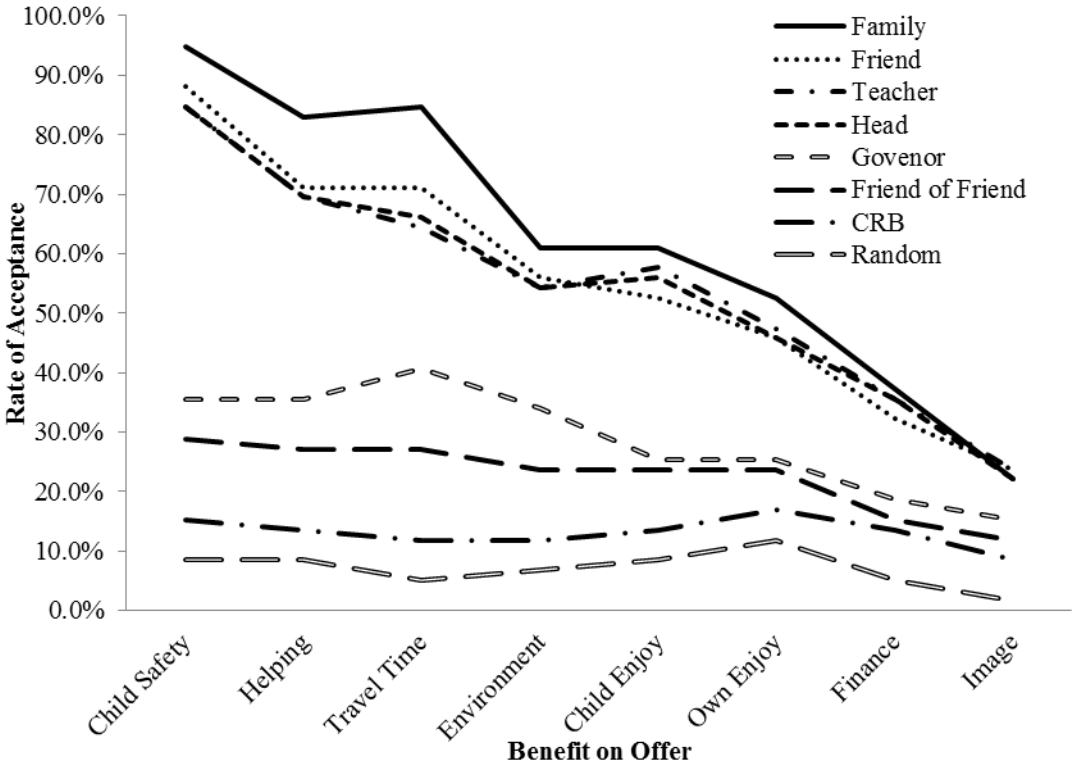

FIGURE 4 Rate of acceptance for scenarios that involve the parent giving away information about their daily travel schedule (e.g. typical departure times and routes taken by mode)

Table 3 again splits the sample into three distinct cluster according to the participants attitude towards collaborative travel. The table compares the acceptability rates for each cluster when asked if they would be willing to share either their daily travel schedule or their exact location with a range of different people in turn for a reduction in their journey time. The results suggested that those people who stated that they were not willing to collaborate with others found all of the scenarios the least acceptable.

More noteably, over 70% of the 'Already Collaborate' and 'Willing to Collaborate' clusters (the clusters that contain a higher percentage of highly educated, employed people with a high household income) would be willing to share their daily travel schedule with either a family member, friend or their child's teacher in return for a reduction in their travel time. One interesting finding was that 42% of the 'Willing to Collaborate' cluster would share their personal information with random criminal record bereau(CRB) checked parents, with a higher acceptabilty rate than for the other two clusters. In contrast however, all three clusters had acceptability rates of less than 10% for the scenarios that involved giving away their exact location to a friend, a friend of a friend, a random parent or even a CRB checked random parent.

TABLE 3 Acceptability Rate of Participants Giving Their Travel Schedule/*(Exact Location)* to Different People for a Reduction in Travel Time Split by Cluster (N=111)

	Family member	Head Teacher	Childs Teacher	A friend	A friend of a friend	Random Parent	CRB Checked Random Parent
Already Collaborate	87.0% *(47.8%)*	65.2% *(26.1%)*	73.9% *(26.1%)*	78.3% *(8.7%)*	26.1% *(4.3%)*	4.3% *(0%)*	13.0% *(4.3%)*
Willing to Collaborate	91.7% *(41.7%)*	75.0% *(16.7%)*	83.3% *(16.7%)*	83.3% *(8.3%)*	33.3% *(0%)*	16.7% *(0%)*	41.7% *(0%)*
Not Willing to Collaborate	64.5% *(22.6%)*	58.1% *(6.5%)*	58.1% *(6.5%)*	58.1% *(6.5%)*	9.7% *(0%)*	3.2% *(0%)*	3.2% *(0%)*

Implications for RTVOS design

The outcomes of the survey and literature suggest that the reward a RTVOS potentially offers in terms of allowing parents to better deal with the scheduling uncertainties revolving around the school run directly targets one of the major causes of car based trip generation. In terms of the target audience, the survey results suggested that the system would be most applicable to the educated, employed, high income household but further research is necessary looking at potential take-up amongst other demographic groups not represented in the study.

In terms of system design, the results raise some interesting issues regarding how individuals' locations should be recorded and portrayed to others. At its simplest, a RTVOS based on the school walking bus concept would produce traces of common travel patterns derived from participating parents and walking school bus co-ordinators, enabling users to see, in a suitably aggregated and anonymous form, where they were, and were likely to be at any given time. Adding features such as location-

based notes, sharing of travel experiences and additional travel feeds could provide richer experiences and foster user engagement [*35; 36*]. The real potential of such systems however comes from providing an ability to see travel patterns (both historical and predicted) which provides obvious means for parents to better coordinate their activities. The findings from the surveys suggest that users would be likely to give away typical school run behaviour patterns to trusted friends and members of the school teaching community which would allow historical trip traces to be derived. Personal location updates however may be more problematic unless they are presented in a suitable way to not compromise the privacy concerns of the parent.

Rather than the parents physical location being indicated on Google maps via the smartphone, an arrival countdown to a specific rendezvous point might be more appropriate, indicating the time remaining before a specific parent was due to appear. Of key importance is ensuring which system users are allowed to see which data from others in the network. The findings suggested that official walking school bus co-ordinators sanctioned by the school would be able to broadcast their positions to parents and that parents would be happier sharing their location with these individuals (in an appropriate form) for the reward of overall journey time savings.

CONCLUSIONS

Considerable reductions in congestion and improvements in well-being could be achieved if a more collaborative approach to school travel could be adopted. This paper has introduced the concept of a 6th Sense Transport 'real-time' travel option visualisation system (RTOVS) which would use Smartphone technology coupled to social networking principals to relay potential travel options in space and time through an understanding of where users are and are likely to be in the near future. This is achieved through combining knowledge of an individual's typical schedule with updates on their current location and predictions of likely position in the near future and broadcasting to others in the network. A survey ofof parents looking at attitudes to this concept framed in the context of a walking school bus suggested that time scarce, educated parents with disposable income would be the likely takers and that the school headmasters and teachers would need to play a crucial role as perceived 'trusted sources' in system set up and administration. A key issue to consider in system design relates to how individuals' locations are visualised by the rest of the network, at what time and by whom? The evidence suggests that rather than giving traditional GPS location on a smartphone map, a 'time-to-arrival' countdown to a specific point would be deemed more acceptable to users.

Such a concept relies on engaging a critical mass of users and this will not be achievable unless privacy issues are affectively addressed. Mobile users have become relatively accustomed to sharing their location through applications such as Google Latitude but most are resistant to any form of tracking (the distinction again being related to time - instantaneous access to a user's location versus continuous tracking of a location over an extended period of time).

Other challenges to developing such a system relate to developing the right social conditions and models of trust that will enable a RTVOS to function. The system relies on users to share transport resources based on new opportunities highlighted by

the system. Sharing transport has long been seen as a partial solution to transport problems, typically in the form of lift sharing schemes, yet there is often reluctance by users to engage in transport sharing. The important questions to address are how trust can be fostered in a travel system that echoes the openness of social networking system and what rewards are appropriate for people engaging in the sense of sharing their data for the benefit of others.

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