Developing a Real Time Passenger Information System for Rural Areas

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Abstract. Passengers in rural areas are provided with little or no information regarding public transport disruptions. This can result in high levels of travel uncertainty with significant potential to affect travel behaviour. This paper, through 52 interviews, and 7 focus groups in rural areas in Scotland and England, explores the passenger experience, and the technology usage of individuals during disruption. The analysis indicates that a wide range of behavioural responses are evident, extending well beyond the choice of route or mode of transport. Further, we identify that the individual utilises various technologies (e.g. social media), and kinship networks to insulate against the effects of disruption. In addition, we present the co-design process of a set of technologies (a smartphone application and and an SMS service) that aim to improve the passenger exprience during disruption. This work provides an initial step towards understanding the interplay between disruption, passenger experience, and the design space for improving the passenger experience of individuals during disruption.

1 Introduction

The individual in rural areas usually dont have enough information to make informed decisions during disruption. This has strong impact on those with limited access to private motorised transport such as children, elderly, people with disabilities and the mobility impaired (Velaga et al, 2012a). Even though an increasing number of real time passenger information (RTPI) systems are being developed to provide transport information (e.g. Watkins et al, 2011), the role of real time information in supporting travellers during service disruption is poorly understood, particularly in rural areas.

Our previous work has explored disruption by developing a conceptual model of the passenger recovery phases during disruption, and identified the passenger information requirements for each phase. Further, we have investigated that the passenger behavioural responses to disruption are influenced and shaped by several variables, including, the information that individuals have available during disruption, the quality of information, and the passenger's past disruption experiences (Papangelis et al, 2013a; 2013b). Based on these, in this paper, we: (1) discuss the passenger experience during disruption (2) identify how rural

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passengers use current technologies (e.g. social media) during disruption to acquire and disseminate information, (3) and present the development process of a smartphone application and an SMS service co-designed with rural passengers.

This work is part of the Informed Rural Passenger[1] (IRP) project, which is adopting a crowdsourcing approach to acquire transport data, such as bus location, directly from the passengers via their mobile phones. This data is integrated using linked data principles with other transport data, such as operator timetables, geographic information system (GIS) roadmaps, and details of disruptions along with other data such as passenger profiles and social networks, within an information ecosystem (Velaga et a. 2012b).

2 Background

Real time passenger information (RTPI) plays a major role in passenger travel decisions during disruptions (Lu, 2011).

Relatively few rural RTPI systems exist; examples include: Warrington Borough variable message sign (UK), the SEStran-supported bus passenger information system in South East Scotland, and the service to enhance rural transit in Amador County in California, USA. This might be because of: (1) fewer passengers; therefore no encouragement to operators to provide current transport information; (2) rural areas being sparsely populated, making it difficult to collect travel/traffic information from the system; (3) the widespread use of request stops by the passengers; (4) and the higher cost associated with developing, deploying and maintaining these technologies in a rural environment (Velaga et al., 2012a).

Further, the lack of RTPI in rural areas results in fragmented and potentially highly inaccurate passenger information. This can lead to very high levels of uncertainty regarding actual travel conditions in the event of disruption. This is especially true in rural areas where the frequency of services is low and passengers tend to make longer journeys. Also, the lack of information to rural passengers regarding service delays or cancellations has severe impact on passenger convenience, comfort and travel behaviour (e.g., exaggerated perceptions of travel time) (Scottish Executive Social Research, 2006).

In this paper, we utilise evidence gathered from interviews and focus groups with public transport users to explore how rural passengers experience disruption, and how they utilise various technologies to disseminate and acquire information during disruption. Further, based on these findings we co-design with rural dwellers a smartphone application and an SMS service that aim to improve the passenger experience during disruption.

3 Methodology

At the beginning of the development process, 52 semi-structured interviews, and four focus groups were conducted. These through the shared culture and

[1] http://www.dotrural.ac.uk/irp/

the individual stories of the participants elicited the effects of public transport disruption in the everyday life of rural passengers, and explored their technology usage during disruption. The mean age of the participants was 36.7 years. The interviews were conducted in the Scottish Borders, and the focus groups in the University of Aberdeen, the University of Leeds, and in the island of Tiree.

Based on the data from the initial interviews in the Scottish Borders and the focus groups in the University of Aberdeen, and the University of Leeds four conceptual models were developed. Each conceptual model consisted of a description of a disruption scenario (that emerged during the interviews and the focus groups) and a high level proposed solution for that scenario.

These were presented to the participants in three focus groups in the island of Tiree. The focus groups had 6 participants with a mean age of 32.5 years, and lasted approximately 2 hours. During the focus groups, the participants were asked to discuss the scenarios and the proposed solutions, and grade them depending on how strongly they recognise the problem as being a real problem that they face, and how strongly they agree that the proposed solution would help. Further, the participants discussed the conceptual models and provided feedback on what they liked, disliked and would improve about each solution.

Based on the results of the focus groups, two co-design sessions took place. The sessions were conducted at the island of Tiree, lasted approximately two hours, involved 7 participants with a mean age of 38.7 years. They aimed to explore the design space and design a set of technologies that improve the passenger experience during disruption.

The outcomes of the co-design sessions were refined by 4 interviews with domain experts. These included two academic experts from the Centre for Transport Research[2] of the University of Aberdeen, and two human computer interaction experts interested in the effects of disruption in the everyday life of individuals living in rural areas. All interviews lasted approximately 80 minutes, and aimed to critique and evaluate the proposed designs.

4 Experiencing Rural Travel Disruption

In the areas we studied, disruption was frequent, and expected. This is vividly illustrated in the following quotations "*Whenever I'm going further than my daily commute, I think its always a factor for me", and "I just kind of accept that if I'm going anywhere outside the Aberdeen area there's going to be a delay there's going to be a disruption in my travel plans*".

Further, our data illustrate that some disruptions are more acceptable than others. For example, man-made disruptions (e.g. strikes) are less tolerable than disruptions caused by nature (e.g. heavy rain or high winds). This is illustrated by the following assertion "*I would say that public transportation disruption is man-made and the other we can influence. So that's the main problem, for me. I was very upset when I was stuck somewhere on the beach, it was freezing cold and I couldn't get the bus because they were striking and I didn't know they were*".

[2] `http://www.abdn.ac.uk/ctr/`

The latter quote comes in line with our findings that each individual experiences disruption differently, as one individual's disruption can be another individual's opportunity or inconvenience. This may depend on various factors including personality and previous experience (Papangelis, 2013b). This is illustrated by the following two quotes "*Some things, are just interruptions but Its when it affects what you've planned to do you planned to have your breakfast on the train whilst doing your work because you are getting an early train, when you can't have your breakfast and you can't do your work then that's a disruption but if its someone playing loud music then its not really affecting your plans to sit on that train and get to a destination. For me, that would be the thing: whether it affects what my plans were for the journey*", and " *for example weather things, in my home country its not an issue at all, so this I don't feel as a disruption. It makes it difficult but I don't feel it as a disruption.*" Along the same lines, some individuals living in rural areas don't consider a disruption problematic if they can find ways to work around it. This mainly depends on the type of disruption and on the purpose of travel. For example, individuals have been telling us that if they have to go to the doctor, and there is a bus due to cancellation of the train, they do not consider it a disruption as long as they arrive on time.

Our findings also illustrate that individuals living in rural areas are more prepared to tackle disruptions than their urban counterparts. This is especially true for remote rural places. Individuals are more likely to be prepared for disruption in rural areas with higher chance of systemic disruption. For example, individuals living in the island of Tiree, have been telling us that due to high winds during winter the island can be inaccessible for up to two weeks, and so, they stock food and fuel for up to three weeks during the winter. Further, we have identified that certain groups of individuals are more vulnerable to disruptions than others. These can be summarised as:

- Family with young children
- Individuals without family or friends
- Those living in the outskirts of rural hubs or in hamlets
- Individuals depended on public transportation
- Those who don't have immediate access to a car
- Tourists or Individuals that they don't have knowledge of the locality

In spite of that, they mention that disruption is becoming easier to cope with due to new technologies, as they utilise a great variety of information channels (both formal and informal) enabled by the new technologies (social media, websites, blogs, forums, etc.) to stay up to date, and exchange information (Papangelis et al, 2013a). Figure 1 illustrates an individual living in a hamlet in the Scottish borders informing her twitter followers that the A7 roadworks are causing delays longer than expected.

Moreover, we have identified that kinship networks are also utilised as a way to protect against disruptions (Papangelis, 2013a). Kinship networks are composed of weak ties and strong ties. The strong ties channels are individuals within the passenger kinship networks, which consist of family members, close friends, work

Fig. 1. Correcting and relaying official source information in twitter

colleagues, and school peers that are considered to be as close as familial links (Ebaugh and Curry, 2000). The weak ties are usually friends of people from their strong ties network, or other passengers, where they have a strong dependence on the connectivity to the individuals travel patterns. The information the passengers are seeking from these networks is usually to increase their situational awareness and information on how to mitigate the effects of disruptions. For example, during our passenger interviews, a participant mentioned that during the heavy snowfall in the Scottish borders in 2010, she reached home safely not because of information that the operator provided, but from information that the passenger got from a friend of a friend about a local man going through her village with his snowplough. It was explained in our interview that the same individual, picked up other individuals that he did not know personally along the way only because they had shared common networks and ties. Figure 2 captures these information exchanges during times of disruption among strong ties, weak ties and formal information channels.

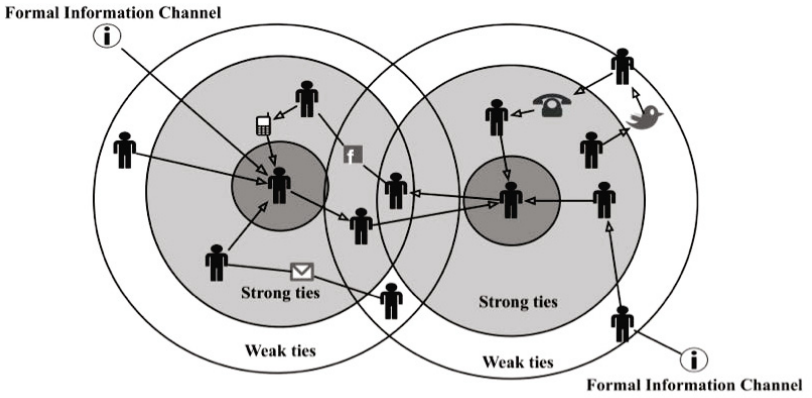

Fig. 2. Information exchange between individuals affected by disruption and their kinship network (Adapted from Papangelis, 2013a)

5 Developing a Rural Real Time Passenger Information System

Real time information has the potential to significantly improve the rural passenger experience during disruption. However, most of the systems are developed for urban areas, and utilise infrastructure not available in rural areas, or use smartphones as the main dissemination channels of information (e.g.Watkins, 2011) . Our work indicates that there is a need for multi-channel dissemination in rural areas as the 3g signal is unreliable, and there is a significant number of individuals with 2nd generation mobile phones. We have identified that the most suitable channels for disseminating RTPI information are: smartphone applications, SMS services, e-mail services, websites, and community displays. The desired functions for each of those technologies as emerged from the interviews and focus groups are as follows:

General functions
Location information
Journey planning
Provision of alternative options in case of disruption
General information about the service
Notification of disruptions
Seat availability
Congestion
Wheelchair/pushcart space
Status of the network
Metrics on quality of information
Route advice to avoid delays
Journey booking capabilities
Ability to create passenger profile, save, store and access information
Functions required on journey
Real time information on own vehicle delays
Information regarding changes, which will affect the passengers journey
Advance warning of changes, which may affect subsequent or later journeys
Information on interchanges
Functions required on boarding point
Waiting time
Information on local amenities
Walking route to connecting modes

As illustrated by the aforementioned functions the technologies should provide both personalised and non-personalised information. According to our studies, the most suitable technologies for disseminating personalised travel information in rural areas are: (a) smartphone applications, (b) SMS services, (c) and e-mail services, while the most suitable technologies for providing non-personalised/public information to rural areas are: (d) community displays, (e) and websites.

During the initial stages of the design of the system, we utilised these functions as emerged from our studies in conjunction with the stories of participants to create four exemplar scenarios illustrating various types of disruption. These were (a) an accident that caused an arterial road to close for a few days, (b) a bus service that constantly runs behind schedule, (c) heavy winds that cut the island of Tiree from the mainland for two weeks, (d) and high congestion of an arterial road. The high level proposed technological solutions were a smartphone application and an SMS service that provided real time bus location information to the users. Both were simple technological solution and were very similar to the ones that already exist in the various smartphone marketplaces.

During the focus groups the participants recognised all scenarios as relatable, and mentioned that both systems are equally useful as long as they provided timely accurate and personalised information. Further, when asked how to improve the technologies, the participant suggested that functions that allow users to validate and update information, and leave comments about a route or a service were required.

Through the focus groups sessions a need for the users to interact with the system, has emerged, "*as during disruption individuals very rarely have right answers and the knowledge to understand and resolve the issues emerged from it*".

Based on that, the concept of 'loose fit' was explored in the four co-design sessions. The participants during these sessions were provided with mock-up tools, and a list with the functions as emerged from the interviews and focus groups and asked to mock-up a prototype of an SMS service and a smartphone application that aim to improve the passenger experience during disruption.

For the SMS system the participants focused in their personal experience to mock-up an SMS service that notifies the user of a disruption, and initiates an SMS based discussion among the users that experience the same disruption. This aims to "*help individuals to understand and resolve the issues emerged from disruption by using the collective knowledge of various individuals that are in the same situation*" by creating ad-hoc *communities of users*" that experience the same disruption. Figure 3 illustrates a scenario where there is a disruption and users organise a car-share through the system.

Further, the participants also designed a smartphone application that aims to improve the passenger experience by: (a) providing information on disruption, (b) allowing the user to validate, and update the disruption information, (c) crowd-source information about the bus service they are in, and (d) allow

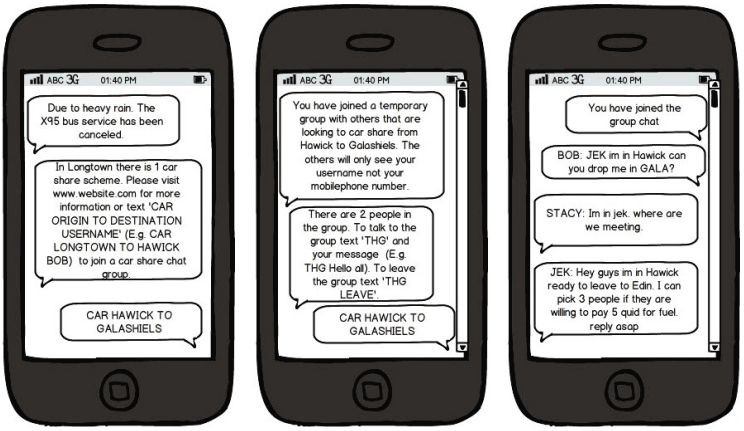

Fig. 3. User notification of disruption and provision of alternatives through group chat

Fig. 4. Mock-ups of the smartphone application that was designed during the co-design sessions

integration of the smartphone application with twitter. Figure 4 illustrates the aforementioned functions.

The various designs as emerged from the four sessions has been further refined through four discussions with domain experts from both the fields of transport studies and human computer interaction. The discussion mainly revolved around the further development of the outcomes, and their integration with the Get-There RTPI that we have developed. The outcomes of these sessions were unified as they all agreed that the outcomes illustrate a need for real time passenger centric information that focuses on the rural passenger needs. Further, they mentioned that the outcomes of the co-design sessions should be further investigated through the exploration of the interactions, and travel behaviour of the

passengers (e.g. through wizard of oz studies), before developed into a prototypes or integrated in the GetThere system[3].

6 Discussion and Conclusion

In this paper we have conducted a series of interviews, and seven focus groups in order to explore the passenger experience and technology usage during disruption. Further, based on these findings, we conducted two co-design sessions to design a smartphone application and an SMS service that aim to improve the rural passenger experience during disruption.

Our result indicate that disruption in rural areas is seen as an inherent characteristic of the transport system. Even though it usually leads to frustration, it is often not seen as a problem if there is a way around it. Further, our findings illustrate that rural dwellers are more prepared to tackle disruption than their urban counterparts. However, this depends on the individual, as certain groups are more vulnerable than others. However, in the recent years information and new technologies is making these groups more resilient to disruption. Further, we have identified that during disruption individuals very rarely have right answers and the knowledge to understand and resolve the issues emerged from disruption, and the knowledge is often distributed among various individuals who have different perspectives and background.

Based on these findings we have co-designed with rural passengers a set of technologies - a smartphone application and an SMS service that enable the collaboration of passengers during disruption, with the aim of improving the rural passenger experience during disruption. The designs were further explored through a series of interviews with domain experts, in which they critiqued the design as emerged from the co-design sessions, and gave us suggestions on how to evolve it and incorporate it in our GetThere RTPI system.

Our future research plans include further exploring the design space, the user interactions, the resulting travel behaviour, and incorporating elements of the co-design process in our RTPI system.

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[3] `http://www.gettherebus.com/`

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