People, Plans and Place: understanding and supporting responses to rural public transport disruption.

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Abstract
Public transport information provision in rural areas is often fragmented and of poor quality at best and non-existent at worst. This can have a significant impact on the everyday life of the inhabitants of rural areas, particularly in terms of limiting their travel choices and thereby their opportunities to access goods, service and social networks. Inadequate information provision also poses significant challenges during times of transport disruption. In this paper we examine the responses from a series of interviews (69) and focus groups (9) in which we explored the rural passengers' experience during disruption, their coping strategies, and their behavioural responses to disruption. We identify that each passenger experiences disruption uniquely, and that the behavioral adaptation of the passenger relates to the severity and impact of the disruption. Furthermore, we identify that the most prevalent ways of mitigating the impacts of disruption is through time buffering and the use of kinship networks. Based on these findings and six co-design sessions with rural passengers we were able co-design and develop a prototype passenger information system to support the passenger during disruption. The results of this work aim to advance understandings of the interplay of technology, information provision, and passenger experience under disruption.

1 Introduction

Rural communities face a range of challenges associated with accessibility and connectivity [5]. Limitations in transport infrastructure, information and services can reduce travel possibilities in rural areas and hinder access to opportunities relating to employment, education and business. [6].

Technology has long been heralded as offering the potential to mitigate some of these barriers, by providing alternative means of access and connectivity [7]. For example; transport telematics (a term which encompasses a range of advanced computer-based information and communication technologies, navigation/positioning systems, and digital technologies) has been shown to improve the efficiency and service quality of transport systems [15, 25, 9]. Though such transport technologies have been widely deployed in urban and suburban areas in the developed world, their application in rural and remote rural areas has been very limited [20]. Velaga [26] has identified two main reasons for this:

a. Fewer passengers; so therefore there is little incentive to operators to provide current transport information.
b. Rural areas are sparsely populated making it difficult to collect travel/traffic information from the system.

The lack of real-time passenger information (RTPI) systems in rural areas has resulted in the provision of fragmented and inaccurate passenger information. This has been documented as a contributing factor to the low public usage of public transport [24].

The potential exists for these technologies to contribute to the alleviation of accessibility and problems for rural passengers, as evidence exists that they can influence travel behaviour, cultivate positive attitudes towards the service provider and create positive perceptions of efficiency and security [5,30, 28, 29].

In this study we consider disruption as a chance for reflection and re-evaluation of travel, and aim through interviews and focus groups to explore the interplay between disruption, travel behaviour, and passenger decision-making. Furthermore, based on the research findings, we design a set of technologies that aim to improve the passenger experience during disruption.

2 Related Research

Related previous work falls into two main areas: Real-Time Passenger Information (RTPI) and disruption, and transit information systems.

Previous work in transport research

High quality information is a key enabler of successful transport service provision [1]. RTPI provision during transport disruptions is a major concern particularly for public transport riders in rural areas [18].

Velaga et al [26] identifies RTPI as especially important for public transport users in rural areas, because the impact that disruption has upon rural passengers compared to urban passengers is likely to be greater. This is because passengers in rural areas usually have more limited transport connectivity, and have fewer alternative routes for a given origin/destination.

Papangelis et al [22] suggest that RTPI information during disruption should be focused upon passenger needs, –which can be described as being for Timely, Accurate and Personalized (TAP) information. The same study categorises the passenger recovery process during disruption in phases, demonstrating that the TAP RTPI requirements depend upon the phase of the passenger recovery process being experienced during a disruption. They identify that the most important phase for minimising trip abandonment and affecting the travel behaviour during disruption is the response phase – in which the individuals take preventive measures to mitigate the potential effects or lessen the effects of disruption for the current and subsequent journeys.

Papangelis et al [22] identify that individuals mainly make choices during disruption based on:

a. The information the individuals have available before and during disruption,
b. The perceived quality of information at hand,
c. The passenger's trust in information,
d. The passenger's ability to use the information.

This paper also discusses how the aforementioned affect behaviour during disruption, relating them to information provision scenarios based on current RTPI systems. The findings from this study suggest that even though an increasing number of real-time passenger information (RTPI) systems are being developed (E.g. 11) to provide transport information, the role of real-time information in supporting travellers during service disruption is poorly understood, particularly in rural areas.

Related work in transit information systems

In recent years, mobile devices have started to play a significant role in the provision of passenger information. The most prominent mobile applications are Roadify (www.roadify.com), Seeclickfix (www.speedclickfix.com) and Waze (www.waze.com). Roadify crowdsources information about parking and the state of the public transport systems in New York, USA. Currently, roadify covers parking spaces, bus locations, subway arrival times and status (e.g. line disruptions). Seeclickfix enables residents to identify 'non emergency' public transport problems, and also provides administrative tools for organizations in order to effectively use the crowd sourced data. Waze is a mobile phone based in-car GPS system that crowdsources information about traffic congestion and incidents from its users and provides the data back through various channels (e.g. SMS, mobile application, e-mail).

Besides the commercial mobile applications, there have several academic social computing transit/computing projects. The most prominent examples are the OneBusAway RTPI system, and Tiramisu [11, 12]. OneBusAway, provides real-time bus information from bus operators for the Seattle area, USA. Having built a larger user community they noted some change in the travel behaviour of the users, such as, improved perception of personal safety. Tiramissu advances this work by not only providing real-time information about the bus service, but by allowing passengers to share their GPS traces, generate their arrival time and submit problem reports.

It should be noted that all of these systems focus exclusively on densely populated urban areas. Rural areas arguably have more pressing need for such real-time information as a majority of the journey planning scenarios cannot be adequately completed due to the operator data not reflecting real world situations or being incomplete, missing or inaccurate [26, 27].

In this paper, we aim to investigate rural passenger experiences during disruption, their coping strategies, their behavioural responses to disruption, and their disruption recovery phase behaviour. This forms the basis of a research-based study that aims to understand, design and develop a rural RTPI system to improve the passenger experience.

3 Methodology

As part of the study a series of interviews, focus groups and co-design sessions were undertaken with rural inhabitants, utilising a variety of transport modes in various locations in both Scotland and England. The geographic location of the areas where the interviews and focus groups were conducted is shown in Figure 1.

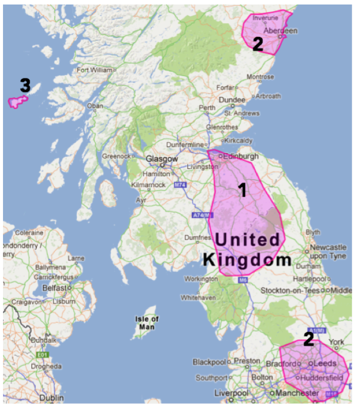

Fig. 1 – The study Area

The interviews were conducted in the Scottish borders area (labeled as one in Figure 1) along the A7 (highway) corridor, which is mainly served by the 95/X95 bus services. These services operate between Edinburgh and Carlisle via the town of Hawick, and cover a distance of approximately 100 miles, passing through areas ranging from urban to extreme-rural. The 95/X95 mainly serves two types of passenger, (a) travellers that use the route from Carlisle to Edinburgh as a cheap alternative to the train service, and (b) locals that don't usually have access to a car and use the service for short trips for a variety of purposes (commuting, shopping, entertainment etc.). The interviews explored the common experiences, the shared culture and the individual stories of a representative sample of these two groups with regard to bus disruptions in order to elicit information regarding the effects of disruption in the everyday life of participants. The interviews took place during bus journeys when the passenger was in transit, and involved 69 participants (35 male, 34 female) with a mean age of 37.2 years. Each interview lasted approximately 18 minutes. It must be noted that the participants were recruited based on a pre-screening interview regarding their frequency of bus usage, rather than randomly selected.

In addition, four focus groups were conducted in the Universities of Aberdeen and Leeds in the UK (marked as two in Figure 1). The participants were a mix of urban, rural bus, car users, and cyclists from the Aberdeen and West Yorkshire respectively. Each focus group was comprised of 8 to 11 participants with a mean age of 34 years, and lasted approximately 90 minutes. The participants were recruited through the use of email and flyers. The main discussion concentrated on the effects of disruption in everyday life, and the individuals' adaptation and decision-making processes during and after different types of transport-based disruptions.

Furthermore, five focus groups and three co-design sessions were conducted on the Isle of Tiree (marked as three in Figure 1), which is based in the Inner Hebrides of Scotland. It has a population of eight hundred and the most common modes of transport within the island are demand responsive transportation, cars, and a twice a day air service to Glasgow, and a bi-weekly ferry to Oban. Due to its geographical location it is very prone to disruptions and there are often food, fuel and medicine shortages. The focus groups involved 5 to 7 participants with a mean age of 38.7 years, and lasted approximately two hours. The discussion mainly revolved around two key issues: (a) the dependency of the islanders on the ferry and air services, and (b) the in-island travel. The co-design sessions aimed to explore the design space and create design exemplars.

Finally, three further co-design sessions were conducted in the Scottish Borders. The co-design sessions involved 5 participants each with a mean age of 34.2. These aimed to further explore the design space and consolidate the design. The participants of both the focus groups and co-design sessions were recruited through e-mails, flyers and announcements on the local noticeboards.

4 PASSENGER EXPERIENCE AND DISRUPTION

In each of the geographical areas that we studied, disruption was both a frequent and expected occurrence. This is well illustrated by the following quotations "Whenever I'm going further than my daily commute, I think it's 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". This expectation that a disruption might occur results in high levels of frustration. However, our data illustrates that this is not always the case as 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 may be ascertained by the following quote: "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".

The aforementioned quote also supports our findings in regard to the experience of disruption as something that is experienced on a personal level. One person's perception of disruption may be perceived by another as an opportunity or inconvenience. The following two quotes illustrate this, "Some things, are just interruptions but it's 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 it's someone playing loud music then it's 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 it's 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."

Some individuals living in rural areas don't consider a disruption problematic if they can find ways to work around it. However, this mainly depends on the type of disruption and on the purpose of the journey. For example, individuals have reported that if they have to go to visit the doctor by train, and for some reason or other the service is disrupted, if there is a bus or flexible transport services instead of the train, they do not classify the disrupted service as a disruption, just as long as they arrive on time. This could suggest that some of the users of such services perceive the journey as being successful if they arrive on time. If they were to arrive late they may perceive the break in their journey as a disruption.

The study has also identified that certain groups of individuals are more vulnerable to disruptions than others. These can be summarised as:

- Families with young children
- Individuals without family or friends
- Those living in the outskirts of rural hubs or in hamlets
- Individuals dependent on public transport
- Individuals that don't have immediate access to private transport
- Tourists or individuals that don't have knowledge of the locality.

These groups when questioned mention that disruption is becoming easier to cope with and to manage due to new technologies. They also mentioned said that they utilise a variety of formal and informal information channels (e.g. social media, websites, blogs, forums, etc.) in order to stay up to date, and exchange information [21]. Figure 2 illustrates an individual living in a hamlet in the Scottish borders informing her twitter followers that the A7 road works are causing delays longer than expected.

Fig. 2 – Correcting and relaying official source information in twitter

Nonetheless, individuals have stated that disruption can also have positive outcomes. These include: increased fitness from walking instead of taking the bus or driving, working from home, taking days off, and getting a break. The latter is illustrated through the following quotation: "Maybe it's not a positive thing for our climate, but you know if you work in a large office like I was in that incident, when something like that happens, because it's a break from the routine and there's a prospect that they might need to send people home, regardless of the fact they might need to spend five hours getting there, people do look at that as quite a positive experience, it's like that kind of - You get a buzz."

4.1 Coping strategies

The most common coping strategy we have observed is 'time buffering'. Individuals assume that they will be late, or that something will go wrong and therefore in order to accommodate this they "build time on one end or the other" of the journey in case this happens. This is further illustrated in the following two quotes: "By making that assumption I'm always building in time on one end or the other in which I can scramble for whatever I need. As far as my day-to-day commute is concerned I only rely on myself. So the only disruption is when I can't manage to do what I need to do.", and "I travel reasonably frequently down to West Wales and I travel at night because I know that the traffic disruption is going to be considerably less, it's just planning around it."

Access to information was deemed extremely important for shielding against disruption. During our initial interviews when we asked the participants 'how could you minimise disruption in your journey?' most of the interviewees answered that cars, mopeds and motorcycles are the best way to combat this, coupled with technological solutions that could provide real-time information about disruptions, and suggest ways to deal with them (technologies such as in-vehicle satellite-navigation systems). Focus group participants said that technologies and timely, accurate and personalised real-time information was the best way to guard against disruption. In addition, when asked to rank the reliability of public transport and cars in situations without real-time information, they ranked car higher as "it is more flexible". However, when presented with a mock-up of a technological solution that provided real-time information about all modes of public transport they ranked the reliability of the public transport and the car the same, "I will be more confident and when something goes wrong I will find a way around it."

We also identified that kinship networks were utilised as a way to protect against disruptions [21, 22]. Kinship networks are composed of weak and strong ties. The strong ties are individuals within the passenger kinship networks, which consist of family members, close friends, work colleagues, and school peers that are considered to be as close as familial links [10]. 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 received from a friend of a friend about a local man going through her village with his snow-plough. 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.

4.2 Behavioural Responses to Disruption

Individuals living in rural areas have a wide array of behavioural responses to disruption, ranging from minor to major adaptations. Our study indicates that minor adaptations are more prevalent in regard to low impact disruptions, while major adaptations are more common in high impact disruptions as we will illustrate.

In low impact disruptions the journey is usually recovered and a change in travel behavior occurs in order to facilitate that particular journey, with little time being spent in the planning and on the decision making process. The individuals will usually base their actions on local knowledge, previous experience and momentary convenience. Examples of minor short term adaptations include: using local shops, staying overnight with friends, relying on family for lifts, switching mode, working from home, leaving early or late. However, if a low impact disruption becomes frequent it may lead to significant changes in the behaviour of an individual. During such disruptions the individuals spends more time in the planning and decision making process and bases their actions on long-term convenience. Examples include: keeping spare clothes at a friend's house, leaving earlier or later, avoiding social arrangements on the day of travel etc.

High impact disruptions lead to significant changes in the behaviour of the individual. The individual almost always plans a course of action, mainly based on previous experience and knowledge of the locality. A significant number of participants in both our interviews and focus groups mentioned that if a high impact disruption is infrequent they would only try to recover the journey if the purpose was important (e.g. commuting to work, visiting a doctor). The most common examples of behavioural adaptations to high impact infrequent disruptions are mode change, and route change. However, if a high impact disruption occurs often (even as often as once per month) it may result in life changing events, such as buying a car or relocating. The following quotes demonstrate this "I've moved – I use to live on Longtown but due to disruption I moved to Galashiels.", and "I used to commute with my bicycle every day. It's only about 8 miles but it's a really bad journey, and not in itself was a reason to buy a car, but I could not take it anymore!".

5 Co-designing a RTPI system to support rural passengers during disruption

As previously illustrated, during disruption individuals rarely have the knowledge or understanding to resolve the issues that emerge from a transport-based disruption. In order to resolve a disruptive situation the traveller usually requires more knowledge than a single person possesses and the required knowledge is often distributed among various individuals who have different perspectives and background knowledge. This illustrates a need for a system that recognizes the interaction between people and facilitates information exchange between users. Based on this, we have conducted two rounds of three co-design sessions, with the purpose of designing such a system.

The first round of co-design sessions took place on the Isle of Tiree and aimed to identify a suitable design approach, recognise potential challenges and opportunities, and provide us with design exemplars.

In order achieve this we developed four conceptual models. Each model consisted of a description of a disruption scenario (that emerged during the interviews and the focus groups) and a proposed technological solution for that scenario. The scenarios illustrated various types of disruptions. 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) high congestion on an arterial road.

These were presented to the participants at the co-design sessions on the Isle of Tiree. During the sessions, the participants were asked to discuss the scenarios and the proposed solutions, and grade them depending on how strongly they recognised the problem as being a real problem that they faced, and how strongly they agreed that the proposed solution would help. Also, the participants were asked to discuss the conceptual models and provide feedback on what they liked, disliked and would improve about each solution. During all sessions the participants identified that all of the scenarios that were presented to them as ones they could relate to, and mentioned that systems are equally useful.

However, upon being queried on how they would use such a system, they stated that they would use it in combination with a variety of other information channels, such as social media, websites, blogs, forums, etc. One individual mentioned "having an app or being registered to an SMS service that provides you with real time information, delays, cancelations etc. is good but most of the times it simply does not work.. and you end up checking multiple websites such as facebook and twitter to see if the information is recent." When we further started exploring this one individual mentioned "Wouldn't it be great if we could update the information or confirm it, if were there stuck on the bus?"

Upon further exploration of this, we started a discussion regarding an ecosystem of applications including smartphone applications, SMS and e-mail services, websites, and community displays, where the user does not only act as consumer of information but as an information provider as well. Such a design could be based on a Smartphone application and an SMS service with the aim of helping individuals to understand and resolve the issues emerging from disruption by using the collective knowledge of various individuals that are in, or have been in the same situation by creating ad-hoc communities of users with similar needs and wants.

The SMS service the participants designed had two main functions a) provision of bus location information and b) creation of an ad-hoc chat where users in the same route can talk to each other. The SMS service aims to create a platform that will initiate dialogue and cooperation between passengers with the same issues and needs The smartphone application the participants designed focused on the passenger experience during disruption. They did that by (a) enabling the user to validate, and update disruption information, (b) capture passenger experience information about the bus service they are currently on, and (c) and by integrating the

smartphone. Figure 6 illustrates it.

Fig. 6 - Mock-ups of the smartphone application that was designed during the co-design sessions.

The first round of co-design sessions illustrated the need for a technology that not only provides the opportunity and resources for social debate and discussion, but also fosters cultures of participation, and empowers the users to engage in informed participation.

A major component of such an approach is designing an initial technology (or set of technologies) that supports sharing of both an individual's and group's tacit knowledge, enables informed participation from people from all walks of life, and allows the contributors to modify it according to their needs, leading to 'living' information spaces. To make such a system a reality we adopted a modified meta-design approach that took into account the seeding, evolutionary growth, and reseeding (SER) model, and aimed to transition the users to meta-designers [13,14]. This cyclical approach requires a strong initial core user base that actively contributes to the improvement of the solution throughout its lifecycle.

The prototype version of the system that we were planning to develop, aimed to satisfy the needs of the initial user base. We shortlisted a set of functions required during various stages of the journey (that emerged from the literature, our interviews and focus, groups) and through a card sorting exercise we identified that the most required functions are: 1) location-based information, 2) notification of disruptions and 3) metrics on information quality. Based on these, and the findings from the first round of co-design sessions, we co-designed a smartphone app called GetThere[1] as part of a wider project known as the Informed Rural Passenger [8].

GetThere crowdsources user location information, and allowing a user to report disruption. Further, it enables the users to validate, and update the disruption information. Figure 8 illustrates screenshots of the initially developed prototype version of GetThere.

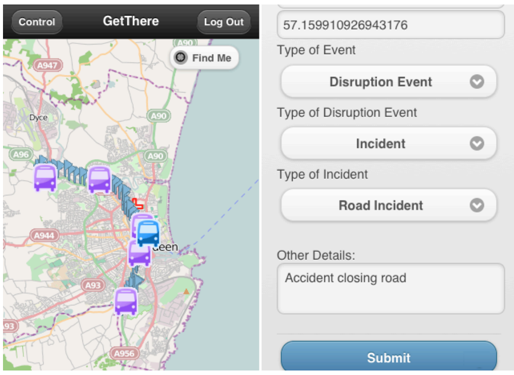

Figure 8 – Screenshots of the GetThere smartphone application

We are also in the process of co-designing and developing an SMS service based on the findings of the first round of co-design sessions, and 3 further co-design sessions. These two technologies will form the initial version of our system.

The overall design of such an approach is characterised by three interrelated dimensions: (a) a social dimension for designing new practices and processes, (b) a cognitive dimension for understanding the interference between providing information and actively contributing to the development of the system, and (c) a technical dimension for creating new technologies that allow the participants to contribute new information without acquiring extensive technical skills. Our work so far has concentrated on the technical dimension. However, we plan on exploring the other dimensions in the immediate future.

Overall, our findings illustrate that multi-channel RTPI systems have the potential to bridge the gap between urban and rural passenger information provision, as

[1] http://www.gettherebus.com/

they are more beneficial than traditional RTPI systems in rural areas. The key reasons for this is that they: (a) facilitate the capture of information at the right time and place; (b) provide non-invasive and cost effective methods for communicating personalised data that compares individual performance with relevant social group performance; (c) and social network sites running on the device facilitate communication of personalised data that relate to the participant's self-defined community.

6 CONCLUSION

In this paper we described our analysis results from 69 interviews and nine focus groups with rural dwellers in order to explore: (a) the passenger experience during disruption, (b) the behavioural responses to disruption, (c) and the coping strategies of the individuals. Furthermore, we conducted a series of co-design sessions, in which we designed a smartphone application and an SMS-based service.

Our results from the interviews and focus groups 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. In addition, we have identified that infrequent disruptions lead more often than not, to micro adaptations in behaviour while frequent disruptions lead to major adaptations. Furthermore, our findings have illustrated that rural dwellers are more prepared to tackle disruption than their urban counterparts. However, this may depend on the individual, as certain groups (families with young children) are more vulnerable than others. Nevertheless, in the recent years information and new technologies are making these groups more resilient to disruption.

Based on these findings we have conducted two rounds of co-design sessions and we have designed a smartphone application and an SMS service that aims to improve the passenger experience during disruption by providing the rural dwellers with real-time information. We are currently in the process of developing and deploying these solutions in the Scottish Borders.

These findings relate to and expand previous studies by providing an initial insight into the rural dweller's behavioural adaptation during disruption, and provide a step towards understanding the interplay between technology, passenger experience/behaviour, and disruption.

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