
Pathways to passenger resilience during rural transport disruption: A conceptual model development

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Abstract

This paper defines the concept of disruption in travel and transportation, specifically in the rural context. Resilience is introduced as a theoretical tool to model individual and community development in times of change and disruption. Various resilience characteristics that influence passengers during disruptions are identified. A conceptual model - which links passenger behaviour characteristics, identified from expert studies with community resilience characteristics - to identify possible pathways to enhancing passenger resilience is developed. The resilience characteristics presented in the model are formulated and evaluated from existing resilience literature, 60 interviews with passengers and rural dwellers in Scottish borders and rural Lancashire, and consultation and brainstorming discussion within a research group. The developed model can provide a better understanding of resilience in the context of transportation disruption and uncertainty. It can also identify new technology options to lessen disruption impacts; decrease recovery times; and provide transport service planning during disruption.

Introduction

There are few separate studies concentrating on resilience (Magis, 2010; Norris et al., 2008; Adger, 2000) and travel and transport disruptions in rural areas (Lu et al., 2011; Zhu and Levinson, 2010; Cairns et al. 2002). Application of resilience concepts in travel disruptions has not yet been considered in literature. Passenger resilience during a disruption varies with type, impact and duration; it is also influenced by secondary factors including geographic area and passenger alternative transport options. In existing research and practice, travel and transport disruptions in a rural context are not well defined (Papangelis et al., 2012). The use of resilience as a method for understanding passenger behaviour during transport disruption is a new method for the academic transport community, and is increasingly relevant given the policy atmosphere is utilising resilience as a core concept for emergency and disaster management planning. Further, it is interesting to identify passenger resilience with a specific type of disruption; this demonstrates the variation in passenger resilience within different levels of disruption impact. By identifying pathways to passenger resilience through a conceptual model, we aim to link current behaviour patterns with their potential for increasing resilience in times of future disruption with the view to inform policy matters. This paper will begin with a brief literature review of travel and transport disruptions as well as the resilience literature. It will outline the methodology taken to understand travel behaviour variables and its links with resilience theory. It will then discuss the development of a conceptual model to link these various factors of transport behaviour and how they can identify pathways to passenger resilience. Finally, this paper concludes with a brief

discussion of the importance of identifying such pathways, including the impact on policy matters, technological development, and the place for future research.

Travel and Transport Disruptions

The transport literature conceptualises disruption as: I) disruption to infrastructure - which typically results from major natural or man-made events, such as: high winds, floods, earthquakes, poor maintenance and relocation of road-spaces; II) disruption to the operation of the transport system - which usually results from strikes, accidents, weather events and road works (Van Exel and Rietveld, 2001).

Disruption to infrastructure: Disruption to infrastructure is considered in the literature as departure from the norm. The relevant studies are limited and mainly explore behavioural responses and the time taken for a new norm to be reached.

Disruption to the operation of the transport system: There are very few studies exploring the impact of disruption to the operation of the transport system. These focus around strikes and special events, such as the fuel crisis in 2000 or the volcanic ash cloud in 2010 (Guiver and Jain, 2011; Lyons and Chatterjee, 2002).

Overall, the evidence regarding the passenger's behavioural responses, as well as passenger resilience during disruption is quite limited. However, the limited evidence on the behaviour of passengers suggests that there is a very wide range of behavioural responses, and there is an inherent structured resilience approach in them. Understanding resilience during disruptions may be an initial stepping point or a key nexus in: (a) designing Real-Time Passenger Information (RTPI) system that support a recovery process of disruption without presupposing what that would be, and (b) improving the understanding of the passenger decision making process during disruption.

There is very limited research on the role of travel and transport disruption on policy and decision making for transport service planning during disruption. Chen and Zhang (2009) developed optimal vehicle dispatching policy during transportation disruptions by modeling transport disruption scenarios as a stochastic optimal control problem. Wilson (2007) developed a simulator to identify the effect of a transport disruption on network level transport performance. However, it is required to understand the functional relationship between passenger resilience and type and duration of disruptions; this is particularly helpful for partitions, operators, government agencies and authorities to develop RTPI provision, technology support, policies and decision making process.

Resilience Theory

There is a vast array of literature discussing and debating resilience, mainly concentrating on community response to environmental and socio-economic change (Wilson, 2012; McManus et al. 2012). Ecologically, resilience refers to the development of ecosystems and their ability to absorb changes and maintain structure in times of disturbance (Holling, 1973). Within governance structures across Europe and the United Kingdom, the concept of resilience is often found in strategies and policies as part of emergency or disaster planning (see Scottish Government, 2012; Department for International Development, 2011). This notion of resilience is concerned with adapting to stresses to maintain acceptable levels of function and identity. Social resilience builds on these themes to represent the ability to withstand shocks due to external factors. Norris et al. (2008) define it as both a reactionary and proactive process: "A process linking a set of adaptive capacities to a positive trajectory of function and adaption after a disturbance" (p. 131). Magis (2010) further contextualises this, defining broader community resilience as "...the existence, development, and engagement of community resources by community members in order to thrive in an environment characterised by change, uncertainty, unpredictability, and surprise. Members of resilient communities intentionally develop personal and collective capacity that they engage to respond to and influence change, to sustain and renew the community, and to develop new trajectories for the communities' future" (p. 401). This definition of resilience has distinct ties with disruption in rural transport. The characteristics of resilience, located in Figure 1, have

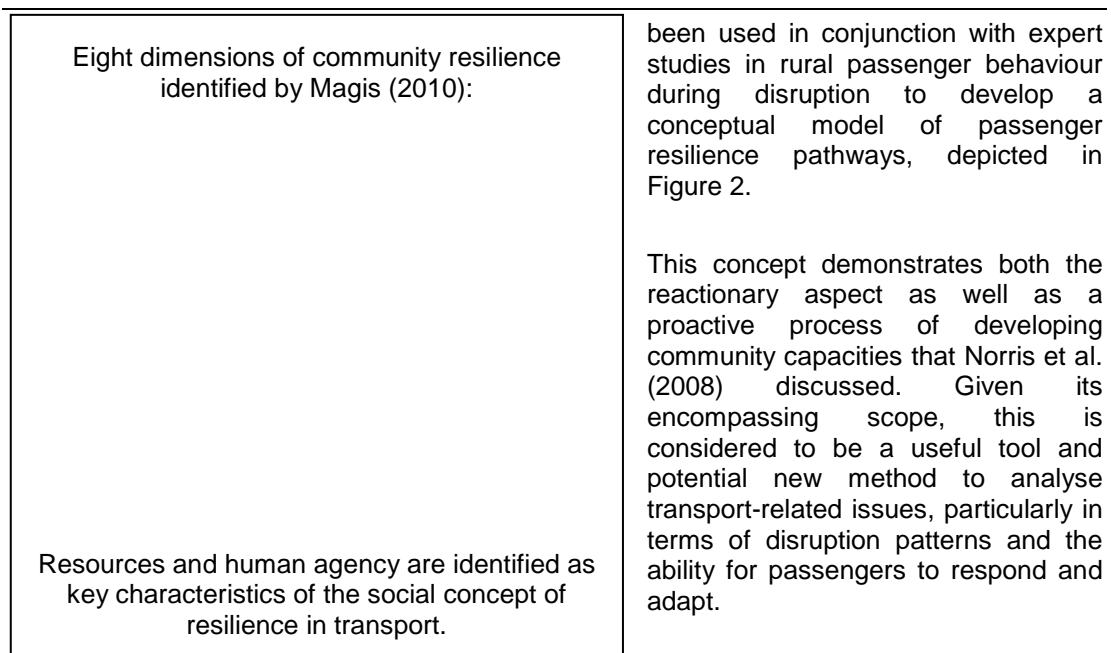


Figure 1 Characteristics of Resilience

Methodology

To facilitate the present study, a series of interviews and focus groups were undertaken with rural public transport passengers, and transport operators. These were conducted as part of a separate study (see Papangelis et al. 2012), but links with information collected in rural Lancashire identified the possibility of developing an alternative analysis to understand passenger behaviour; through this framework of resilience.

The operator interviews and focus groups included different members in the hierarchy of a public transport (bus) operator company. The interviews included the head information manager and the manager of a bus depot, in a rural area in Galashiels, UK. Furthermore, two focus groups were conducted with bus drivers in Scottish borders, UK, with extensive experience and knowledge of the area. Table 1 outlines the various events.

Table 1 Data Collection Events

No	Event type	Date	Number	Area / Organisation	Aim/Objective
1	Interviews with rural passengers	February 2012	52 interviews	Scottish borders, UK	<ul style="list-style-type: none"> • Discuss the effects of the public transport disruptions in the everyday life. • Understand information requirements during disruption
2	Interviews with rural dwellers	Aug 2012	Eight interviews	Rural Lancashire, UK	<ul style="list-style-type: none"> • To analyse the importance of high-speed broadband and other public services • Understand the lived experience of rural dwellers with limited accessibility (digital and physical)
3	Interviews and focus	May/June	Two focus	Scottish	<ul style="list-style-type: none"> • Understand the effects of the public transport

	groups with public transport operators, and bus drivers.	2012	groups with public transport operators, and two focus groups with bus drivers.	borders, UK	<p>disruptions in the everyday life.</p> <ul style="list-style-type: none"> • Explore decision making process during disruption • Consider behavioural adaptation during disruption
4	Interviews and roundtable discussions with domain experts	May 2012	Two sets of interviews and roundtable discussions with domain experts	University of Aberdeen, UK	<ul style="list-style-type: none"> • Further exploration of the effects of the public transport disruption. • Further explore the information requirements during disruption. • Further exploration of the decision making process during disruption.

Each focus group lasted approximately for one hour. The discussion mainly focused on the effects of disruption on passengers.

The Scottish Borders interviews with the rural passengers and the bus drivers, and the focus groups with the public transport operators were transcribed verbatim and the data analysis used a grounded theory approach involving data reduction and inductive content analysis. These techniques, in combination with interpretational analysis drew elements, categories, patterns and relationships from the data. The results of this process were refined based on interviews with public transport operators and through inputs from domain experts from the Centre for Transport Research at University of Aberdeen, UK. This work, as part of a related project, was identified as having links to resilience theory, conceptual model development and evaluation.

Interviews being held in rural Lancashire as part of a related project used a semi-structured technique and sought to determine the importance of high-speed broadband and related public services for rural residents and their relationship with resilience. Individuals were selected through community organisation partners and in-depth interviews were conducted at various locations over a 10-day period in August 2012. Interviews were transcribed verbatim, similar to the Scottish Borders study methods, and a grounded approach was deployed to identify key themes in the data. Transport options, particularly public transport options were identified as one aspect of public services in select interviews, and were discussed by multiple individuals as particularly important for those with mobility issues, including for the elderly and the youth that were not yet of age to drive. These were highlighted as characteristics of transport behaviour in that rural region, and specifically aligned with drivers of transport behaviour adaptation identified through the more extensive data collected in the Scottish Borders reflected transport behaviour. Through this, the model of resilience was identified as a possible alternative method of analysing travel behaviour, leading to the development of the conceptual model.

Conceptual model development and evaluation

The model presented in Figure 2 depicts the link between eleven resilience characteristics (which are under four different groups) and two extreme types of travel and transport disruptions: (1) Short term and low impact disruption and (2) long term high impact disruption. The resilience characteristics presented in the model are formulated from existing resilience literature, and consultation and brainstorming discussion within a research group. Further various transport disruptions are categorised based on type and impact of a disruption. As mentioned before in this research we have considered only the two extremes of disruptions to obtain an understanding of the extent of possible behaviour patterns (i.e., short term low impact and long term high impact); an example of such short term low impact is 'a road closure due to a minor accident' and an example of a long term high impact disruption is 'travel disruption due to heavy continuous floods'. A series of studies conducted

in Scottish borders UK generated the passenger behaviour data and information requirements used in this model.

The characteristics of resilience are listed first, with the concepts of strategic action and resources being broken down into more detailed dimensions. Rather than keeping strategic action as an independent characteristic, the model incorporates it into either individual or collective action, demonstrating the place for proactive human agency within the development of transport behaviour. Resources, a critical component of resilience, are broken down into resource identification (the need and ability for individuals and groups to identify currently available resources), resource development, and resource engagement. The drivers that affect transport decision-making during disruptions are identified from expert studies, as specific characteristics are believed to impact transport behaviour differently and as such play into the opportunity to enhance resilience of passengers. Finally, we include impact, to demonstrate how specific types of disruption may impact the development of resilient characteristics. From this we identify behavioural traits in line with these characteristics based on the two extreme disruption occurrences, a) short-term, low impact disruption, and b) long-term, high impact disruption.

Proactive individual and collective human agency is a key characteristic of resilience. Based on the preliminary data, individual action and collective action occur differently during short term and long-term disruption: in the short term, actions are marked with individualism, whereas in the long term, actions steadily become more collective and pro-social. This is particularly interesting, as it appears that the ability to develop collective resources and collective resilience does not occur unless the disruption is long-term, whereas individual resources are developed in the short term. This signifies that there is a temporal component to developing and enhancing different levels of resilience.

In resilience theory, communities are not resourceful, but rather have resources that can be developed, expanded or exhausted over time. The *capacity* to act is not enough to develop resilience; it is the action taken that is critical (Magis, 2010). The identification of resources by the passenger results in them accessing those resources to create new travel arrangements. This process is identified as more relevant in the long-term disruption data. In the short-term, individual information provision is more relevant. Studying the drivers for transport adaptation has provided some preliminary results, demonstrating that whilst in all cases previous experience and knowledge are utilised, alternative options (also a resource available to rural passengers), become more intensively analysed and utilised the longer the disruption. Demographic and socio-economic characteristics, trust in information, and social norms also impact behaviour, but play out differently depending on the type of disruption. This also demonstrates a need to understand the temporal distinctions in behaviour. Understanding these characteristics in communities prior to disruption can allow planners to have a better understanding of behaviour patterns and how to lessen the impact if disruption occurs.

Finally, the impact of such disruption is analysed in the context of the potential to develop resilience characteristics. In the short-term, changes made are non-drastring, rarely permanent and do not tend to result in adapted behaviour once the recovery period is over. In the event of a long-term disruption however, adaptations are more extreme, occasionally resulting in permanent changes to behaviour in an effort to lessen the impact of future disruption, demonstrating the ability for disruption to contribute to the creation and enhancement of passenger resilience. The model was validated through reflection on the interviews and focus groups content.

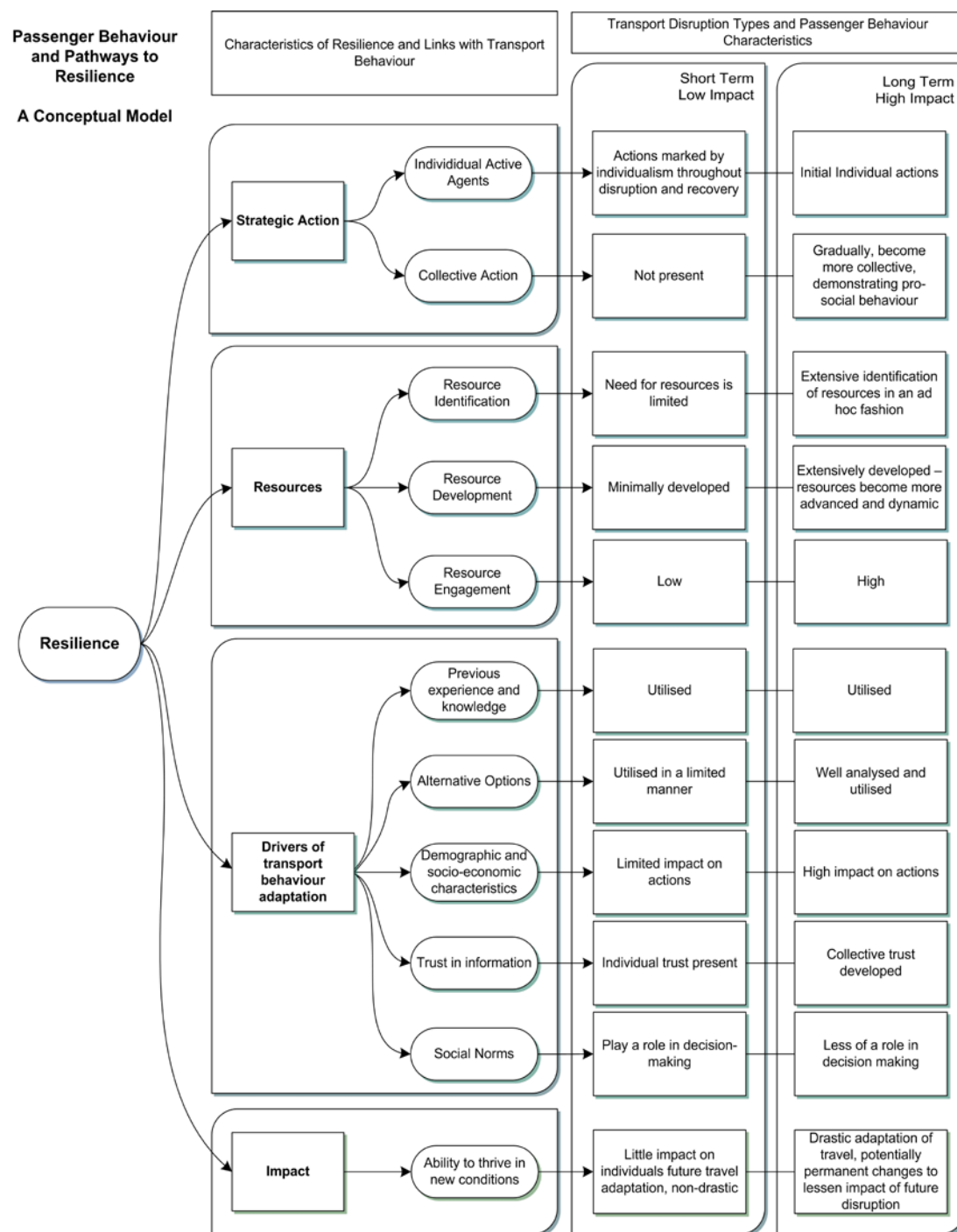


Figure 2 Conceptual Model

Research Impact

There are multiple reasons to study such pathways. In the context of academic research, this type of relationship between resilience theory and transport has not yet been discussed or validated; it can provide a better understanding of resilience in the context of transportation disruption and uncertainty; and it furthers the current understanding of community resilience through practical application. In terms of transportation development, it can identify new technology options to lessen disruption impacts in a manner that increases passenger resilience for future disruption; decreases recovery times; increases consistency in transport planning during disruption. Given the presence of 'resilience' as a concept in government vernacular particularly in the emergency and disaster management sectors, this method is

ideally suited to provide transport service planners with a guide to develop services better suited to passenger behaviour and resilience, as it will also align with wider government discourse and policy.

Conclusions and future research directions:

In this research, an attempt has been made to develop a conceptual model to build passenger resilience during rural transport disruption. The model was developed and validated using a series of interviews and focus groups in rural areas. The model was applied to two extreme types of transport disruptions: (1) Short term and low impact disruption and (2) long term high impact disruption. Such model could help academicians, partitions and operators to better understand passenger resilience in the context of transportation disruption and uncertainty which could lead to appropriate technology options and policies to lessen disruption impacts and provide transport service planning during disruption.

This conceptual model has multiple future research directions. It can be further contextualised through additional case studies, focus groups and associated research, which will serve to add new detail to the understanding of passenger behaviour. In particular, understanding multiple levels of disruption (rather than simply two extremes) will further the ability to use resilience as a framework for planning for transport disruption. New technology, specifically engineered for rural disruption, can be further tailored to enhance the presence of resilience characteristics within passengers and communities, and tested and validated against this conceptual model.

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